PD-AAL-465 931-101114

FINAL REPORT

TO

UNITED STATES AGENCY FOR INTERNATIONAL DEVELOPMENT

ON

CONTRACT NO. AID/DSAN-C-0002

COLLABORATIVE RESEARCH SUPPORT PROGRAM ON INTAKE AND FUNCTION

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COLLABORATIVE RESEARCH SUPPORT PROGRAM ON INTAKE AND FUNCTION

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31 May 1980

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Acknowledgment

About 100 scientists have participated in the conception of research on the functional consequences of marginal nutrition and in the development of the proposed Collaborative Research Support Program, giving generously and freely of their time and, most importantly, of their creative and critical talents. This has been, in every sense, a collaborative effort and we are grateful to all who helped to shape the plans proposed. We wish particularly to thank those who served in more than one capacity, and especially George Beaton, Gaurth Hansen, Hamish Munro, Marion Radke-Yarrow, Leonard Schumann and S.G. Srikantia for their unflagging support and valuable guidance.

Members of the Steering Group were Janina Galler, Lawrence Greene, Alfred Harper, R. Gaurth Hansen, Michael Latham, Marion Radke-Yarrow, Harold Sandstead and Leonard Schumann. Samuel Kahn was our USAID Project Officer. They all played a key role in events as these transpired. We have learned much from having had this opportunity, provided by USAID, to share in the process of scientific-political collaboration.

List of Acronyms and Unfamiliar Terms

AID	Agency for International Development
AIN	American Institute of Nutrition
BIFAD	Board for International Food and Agricultural Development
CRSP	Collaborative Research Support Program
JRC	Joint Research Committee, of BIFAD
LDC	Less Developed Country
PI	Principal Investigator
Précis	Guidelines for Research on Intake and Function
Roster Schools	Land-grant universities, sea-grant colleges, and other United States colleges or universities which have demonstrated capacity in teaching, research, and extension activities, in the agricultural sciences.
UCB	University of California, Berkeley
USAID	United States Agency for International Development

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ABSTRACT: COLLABORATIVE RESEARCH SUPPORT PROGRAM ON INTAKE AND FUNCTION

This research aims to advance understanding of the complex relationships between food intake and human functioning in ways that are likely to provide a sound basis for policy formulation. A combination of nutritional, biomedical and social science approaches are utilized in conceptualization, data collection, and analyses. This research will investigate in a systematic and quantitative manner the relationships between a range of energy intakes (from moderately deficient to adequate) and specified functions: disease, reproduction, physical activity, cognition and social development. The program's concern extends also to societal functions, viewing food deprivation both as an independent and dependent variable.

The research plan for each project involves an initial survey from which a population of at least 200 households will be selected for an intensive naturalistic study. Several methods of determining energy intake and food patterns are proposed. Within the household, the mother-infant dyad is selected for particular study.

The initial CRSP is to include projects located in Mexico (University of Connecticut), Kenya (University of California, Berkeley/Los Angeles) and Egypt (Purdue/University of Arizona/University of Kansas). Other projects are to be phased in over 2-4 years. Each project will require 3 to 5 years for completion. A managing institution is to be selected; that institution will provide for scientific program management and distribute funds to projects.

PART I

COLLABORATIVE RESEARCH PROGRAM ON INTAKE AND FUNCTION: OVERVIEW OF THE PLANNING PHASE AND PROGRAM RECOMMENDATIONS

A. Introduction

B. Précis: Guidelines for Research on Intake and Function

PART I. OVERVIEW OF THE PLANNING PHASE AND PROGRAM RECOMMENDATIONS

A.

1. Background

The National Academy of Sciences was asked by the President in 1974 to address the issue of what the research community could do to alleviate the pervasive problem of world malnutrition. A number of expert groups were impanelled by the NAS with human nutrition research priorities being the focus of Study Team Nine of the World Food and Nutrition Study. Further Academy review of the documentation developed by all of the study teams resulted in the assignment of first priority to investigating the functional significance of nutrition status, i.e.,"...the degree to which a given intake maintains, enhances, or inhibits an individual's functional performance (activity, growth, resistance to disease, and so forth)..."[1,2] The topmost ranking given to the relationship of intake and function (among 22 priority research areas identified) reflects the consensus view that malnutrition affects human capacities and behaviors in ways inimical to societal development.

Study Team 9 recommended that "Determining energy needs and the effects of substandard intakes of energy should receive priority. On a worldwide basis, inadequate intake of energy because of inadequate intake of food appears to rank ahead of all other types of malnutrition." Noting that "...the number of people who suffer from moderate malnutrition...is immensely larger than the number of people visibly affected," the team emphasized a "...need to know the implications of the lesser grades of undernutrition and overnutrition."[2] Thus the scope of the research was established to be a study of the functional consequences of mild-to-moderate deficits (or excesses) of food energy intake.

At the request of the U.S. Agency for International Development (USAID), the Committee on International Nutrition Programs of the Food and Nutrition Board, National Research Council, convened a workshop July 18-21, 1977, to consider research leading to a functional definition of nutritional status. The participants concluded that the research was feasible and identified five major functional areas to be investigated: disease response, reproductive competence, work output, cognitive function and social and behavioral function.[3]

To identify specific research areas and to establish a collaborative research program, the University of California, Berkeley, was awarded a planning grant by USAID in 1978. An explanation of the research areas, the development of the collaborative program, and recommendations for development of the CRSP follow at length in Parts II, III, and IV. Part V describes the scientific and fiscal management necessary to ensure successful progress and completion of this CRSP. A summary of Parts II through V is included below and a chronology of planning activities appears as Appendix I-1.

2. Planning the Research Strategy (Part II)

In order to determine the state of knowledge concerning the way that graded levels of marginal food/energy intake affect an individual's ability to function in society, multi-disciplinary workshops were organized to include scientific investigators from developing and developed countries. To facilitate discussion, each workshop dealt with one of five functional areas: disease; reproduction; activity/work; cognitive and sensorimotor competency; social and societal competency. Two background papers were solicited for each area, one from a biological and one from a social science perspective.These were to discuss the state of the art and suggest research approaches to serve as the basis of discussion in the workshops. About 80 scientists participated in these workshops that provided scientific underpinning of the CRSP.

The workshop and background papers on disease response discussed the established relationship between malnutrition and disease and the immune response capacity. Objectives of future research should be: 1) to develop a functional classification of nutritional status vs. expression of disease; 2) to determine the relationship of nutritional status and vulnerability to or expression of disease; 3) to identify the specific contribution of total food intake to nutritional status in the presence of prevailing disease patterns; 4) to establish the validity of linkages in the total system of food intake and disease.

The workshop and papers on reproduction discussed the lack of proved linkages between nutrition and reproduction. Intermediate behavioral variables are significant determinants of fertility. The most critical research should be to define: 1) the relationship between maternal nutrition and lactation; 2) the relationship of weight gain patterns during pregnancy to pregnancy outcome; 3) the timing and characteristics of human milk

supplements (weaning foods) with respect to lactation and child health; 4) the significance of birth weight; 5) the relationship between pregnancy/lactation and maternal nutrition/reproductive status; 6) the effect of family planning on lactation and maternal and infant health.

The workshop and papers on activity and work performance discussed the lack of knowledge concerning the relation of intake and activity. The intervening variable of body energy stores confounds the linkage so that long-term effects of moderate malnutrition may have more serious societal consequences than short-term effects. Research objectives should include: 1) relating individual food/energy intake to utilization of time, choice of activities, capacity for physical work, quality of performance, and work output; 2) determining the levels of energy intake required for individuals to perform particular activities; 3) investigating the extent to which childhood malnutrition affects adult work capacity and fitness; 4) relating performance capacity level to physical activity and work output; 5) differentiating activity patterns at various energy intake levels and determining the consequences of these patterns for the individual, the family, and the community.

The workshops and papers on cognitive development and social competence discussed evidence for a synergistic effect between social-environmental factors and moderate malnutrition which may alter cognitive function. The effects of any of the three are difficult to separate since any one effect does not operate independently. Priority research objectives include: 1) investigating the ways that biological and social-environmental factors interact synergistically to alter cognitive functioning; 2) defining the aspects of and mechanisms by which intelle tual competency is affected by undernutrition; 3) determining how the adverse consequences of (1) can be prevented or ameliorated; 4) investigating the social interactions, behavioral adaptation and assumed responsibilities of children and adults in the face of undernutrition or uncertain stores of food; 5) relating food intake to women's social competence both as individuals and as a group.

A sixth workshop was held to evaluate the recommendations of the five previous workshops with respect to feasibility of studies in a less developed country (LDC). Seven experienced foreign investigators attended this workshop, as did staff members from the World Health Organization and the

Food and Agricultural Organization of the United Nations. The report of this meeting, a document entitled "Précis: Collaborative Research Support Program on Intake and Function," appears in full as section B, below. The Précis, which emphasized the LDC viewpoint, became the guideline for proposals to be considered for this CRSP. It made the following points: 1) the unit of study is the household; 2) the mother-child dyad is the focal point; 3) food intake is represented by energy (calorie) intake encompassing a range of habitual mildly-to-moderately restricted energy intakes; 4) data produced should be generalizable to nutrition problems in LDC's, not country-specific; 5) certain core research determinants are common to all projects; 6) food intake is the independent variable; 7) nutritional status measurement is an explicative intermediary variable; 8) selected communities should be stable with low migration rate; 9) specific research topics should have potential policy and program application; 10) US standards for human research should be maintained, including informed consent; 11) beneficial services provided during the projects should be maintained upon conclusion of the projects.

3. Proposed Projects, Sites, and Evaluation (Part III)

In May, 1978, a "Notice of Research Opportunity under USAID, Title XII: Intake and Function" was mailed by the University of California, Berkeley, to all roster schools and to non-roster schools where recognized nutrition research exists. In January 1979, a meeting of representatives from all interested institutions was held to discuss guidelines for research grant applications.

During this time, a list was prepared of LDC's in which nutrition or related research had been conducted or proposed by US institutions interested in submitting proposals. Site visits were carried out to include those LDC's most frequently mentioned and others thought to be strong possible locations for projects. The purposes of the site visits were: to inform the local USAID mission and assess mission receptivity; to discuss the nature of the research program with local investigators and evaluate interest and institutional capabilities; to discuss the program with local government officials. The site visit was made by a team of two persons representing the planning phase of this CRSP.

By the deadline of April 1979, thirteen proposals were received by the Planning Contractor as well as three expressions of interest which did not result in proposals. Each grant application received was sent to four reviewers; an epidemiologist/statistician, a nutritionist with a medical sciences orientation, a nutritionist with a biological sciences orientation, and a social scientist/psychologist. Proposals containing sections of an economic/systems nature were also referred to appropriate experts. A copy of the Précis was sent to all reviewers to assist in the review.

All reviews were discussed by the Steering Group (a group of experts set up to assist the Planning Contractor) in May 1979. Each proposal was rated according to criteria developed by the Steering Group, including ethics, peer review, research design, data analysis, substudy components, integration of components, investigator experience and competence, budget, LDC linkage, benefits to LDC, appropriate length of proposal, and an overall score. After rating and establishing relative rankings, the Steering Group agreed that funded proposals should represent different USAID regions, have a high degree of scientific merit, and have a strong association with an LDC. They also agreed that an attempt should be made to incorporate into the CRSP components that scored well regardless of a proposal's overall ranking.

The Steering Group recommended a group of projects which would ensure geographic diversity, provide strong scientific merit, and merge significant components of less-well-ranked projects with higher-ranking projects containing weak components. Based on these recommendations, the CRSP profile recommended in July, 1979 to the Joint Research Committee (JRC) of the Board for International Food and Agricultural Development (BIFAD) was:

Primary US Institution	Overseas Location	Study Population	Diet Staple
Connecticut	Mexico	Rural	Corn
Hawaii	Thailand	Rural	Rice
UCB/UCLA	Kenya	Rural	Corn/Sorghum/Cassava
Purdue/Arizona/Kans.	Egypt	Rural	Wheat
Tulane/Lincoln	Colombia	Urban	Corn
To be determined	To be determined	Rural/Island	Mixed cereals, starchy fruits, roots, tubers
To be determined	To be determined	Nomadic/ Pastoralist/Exceptional	To be determined

The first-year budget was anticipated to be of the order of $2.1 million (1979$) for 5 projects or $1.8 million for the top 4. One project in each of four USAID regions could be funded from the budget allocation for this CRSP, provided sufficient forward funding for the second and third years could be guaranteed. (The nature of this research is such that an absolute minimum of three years is required to generate meaningful results. The return on investment in the research will be severely reduced unless funding is secured for five years.)

Unless at least four to six projects are funded during the life of the CRSP, the research will be substantially weakened in terms of interpretive and explanatory power of the findings. For these reasons, it was recommended that six projects be phased in gradually over the first two fiscal years of the program with a guarantee of, at minimum, three years forward funding as each project is initiated. In addition, management costs were expected to be at least 15% of total project costs, with the expectation that management will bear the travel expense of Principal Investigators to attend group planning and review sessions and the costs of special consultants to the CRSP.

The JRC, and later BIFAD, approved continued planning of the CRSP based on one project in each of the four USAID regions.

4. Recommended Content of the CRSP (Part IV)

The CRSP is designed as a series of research projects, each attempting to answer the same critical questions regarding the relationships between levels of food energy intake and functions of physiological, social, and societal importance. Projects must be located in different geographic areas, cover an extended time period of data collection, and include well-nourished members of the population if the effects of factors other than energy intake are to be controlled. If the results of all projects are to be generalizable, the CRSP must be designed in such a way as to permit multivariate analyses across projects so that commonalities can be differentiated from regionally/culturally specific states. This will allow generation of models of intake-function that have wide utility in the development of strategies to alleviate food deprivation and its consequences.

The minimum required information base for all projects was agreed to by all initial CRSP participants at a meeting in December, 1979. This base

included the independent variable (food intake), the key intermediate variable (nutritional status), and the dependent variables (disease, reproduction, activity, cognition, social competence). It was agreed that standardized methods would be used by all projects to obtain information and to store, retrieve, and analyze data.

The following core design was accepted as fundamental and the initial basis for research.

1) community-wide screen: to confirm that appropriate communities are selected; to provide a sample frame for family selection; to provide a baseline description of the community.

2) sampling frame: to ensure inclusion of an appropriate range of the independent variable (and of dependent outcomes); to stratify both by nutritional state and by socioeconomic variables; to include sufficient fertile families.

3) elements of the core research design: to guarantee a sample of 200 families (1000-1200 individuals), considering anticipated attrition, births, deaths, etc.; to schedule observations within a 3-month cycle so that seasonal and physiological changes can be observed; to measure all family members concurrently, making possible later aggregation of family data.

4) core measurements: (a)food intake--24-hour recalls, weighing/measuring at time of consumption, food consumption patterns, food intake by infants, nutrition histories; (b) anthropometric measurements--height, weight, indices of body composition (skinfolds, circumferences); (c)other measures of nutritional status--minimal hematologic and biochemical indicators; (d)behavioral profiles of individuals, households and community; (e)subroutines(special protocols at predetermined marker events)--birth, lactation, death, pregnancy, disease.

5) special studies: to provide additional information on occasion of selected events affecting the community, such as peaks in agricultural labor requirements;

6) approach to data analysis: to document the relationships among the independent variable (food intake) and the dependent functional variables; to determine the direction and significance of the pathways linking the variables; to define the nature and importance of family dynamics as they

affect and are affected by the other variables; to standardize definitions and methods of data collection for all variables included within inter-regional comparisons.

Three projects are ready to be implemented: University of Connecticut/ Instituto Nacional de la Nutricion, Mexico; University of California/University of Nairobi, Kenya; Purdue-University of Arizona-University of Kansas/ Nutrition Institute-Ministry of Health, Egypt. Each of the projects incorporates by agreement all the features of the core research design and project specific additional features described briefly in Part IV, and in full in Appendices IV 2-4.

Development of the fourth project, University of Hawaii/Mahidol University, Thailand, was discontinued when the local USAID mission denied approval, so the CRSP requires another Asian location. An Indo-US group met in March, 1980 to discuss collaborative bilateral research; the delegates approved a CRSP-type project for support with restricted (PL 480) funds. If the Minister of Health approves, the project research can proceed at the National Institute of Nutrition, Hyderabad. This project group would participate in all respects except funding source as other CRSP projects. Several alternatives could be considered if the Indian project is deferred: Tulane and Lincoln Universities might join with Pennsylvania State University in the Philippines; Bangladesh is also a possibility, with the University of Nebraska; Cornell and Harvard Universities might develop an Indonesian project; the University of California, Berkeley, could develop a project with Sri Lanka and leave the University of California, Los Angeles, to complete the Kenya study.

An ad hoc review committee (JRC, USAID and outside experts) recommended that a project should be added to the CRSP based in an area where the diet staple is a low-protein starch such as roots and tubers. An initial CRSP, to consist of five projects (Mexico, Kenya, Egypt, Asia, and "roots and tubers"), was recommended unanimously by JRC and BIFAD in March 1980, for funding by USAID. The FY 1980 budget includes funds ear-marked for this CRSP, but USAID has not committed funding to date (May 31, 1980).

The Planning Contractor recommends additional projects for full development of the CRSP in future years. One project should study an urban or periurban population with the same basic food pattern as one of the first

five projects. A seventh, later, project should study a population with conditions not otherwise present in the CRSP (e.g., a nomadic population) to test the validity of relationships suggested by analysis of CRSP preliminary findings.

A US-based project paralleling the CRSP projects is needed to provide comparable information on a developed country with respect to mild-moderate malnutrition (under- and over-nutrition) and its effects on an individual's functioning within society and on the processes linking variations in nutrition with variations in physiological and behavioral functions. The US-based project should study a population having some characteristic(s) in common with overseas populations and the project team should include foreign scientists involved in the CRSP and their students as well as American personnel. This project could most easily be developed by a US university which is involved in the CRSP but does not have administrative responsibility. Potential sponsors for this research should be contacted by the management entity.

Each project recommended for funding should include a minority institution component. The exact nature of the minority participation would be decided by each set of paired institutions as appropriate but would need to ensure the training and experience of the minority institution in all phases of the research (design, conduct, analysis, reporting) over the 3-5 year life of each project.

A variety of collaborative formats is of prime importance in this CRSP. Collaborative considerations prior to, during, and after fieldwork emphasize continued interaction of personnel and their ideas, hypotheses, analyses, and other research outcomes. Major means of promoting this collaboration are: 1) forums and informal discussion; 2) joint authorship of papers; 3) circulation of manuscript drafts among research participants prior to final preparation.

Utilization of findings from this CRSP needs to go beyond the usual participating scientists and scientific community-at-large. The ultimate goal is that the findings will lead to development of policies and implementation of programs that will lessen deprivation in countries where the research was conducted and elsewhere in the world.

5. Management (Part V)

The AID/JRC concept of the management entity is an organizational framework to carry out the CRSP and administer the program areas. The management entity will assume overall responsibility for managing the program and funding the projects. The managing institution must also provide on-going scientific research management and oversee program development. This CRSP, unlike all its predecessors in the Title XII program, imposes unique scientific management requirements. The basic research design represents the consensus views of some 100 scientists, refined and specified by the principal investigators from the proposed collaborating US and LDC institutions. Once established, individual projects cannot deviate from the core design except with the concurrence of the CRSP members, i.e. decisions cannot be taken independently because of the high risk that comparability across projects would be lost. Matters arising on a day-to-day basis need to be resolved and decisions communicated expeditiously to all CRSP projects. For these reasons, the managing institution must provide an acceptable Program Director with acknowledged scientific expertise and proven administrative capabilities and who is willing to devote sufficient time to the management of the CRSP.

Input from a consultation on management held in August, 1979, and a planning meeting in December, 1979, helped define the following management functions:

1) Management Institution: the legal recipient of the grant or contract from USAID, responsible for financial administration of the contract, proper disposition of funds by the subcontracting institutions, and the design and supervision of all overseas negotiations;

2) Program Director: the liason between the management institution, the scientific management of the CRSP as a whole, and the management of the individual projects, responsible for continued planning and organization of methods to assure scientific validity and continuity of the CRSP;

3) Scientific Coordination Board (SCB): the primary decision-making body of the CRSP, to include one US and one LDC principal scientist per project plus the Program Director, responsible for resolving policy issues appropriate to the CRSP, communicating policies to the individual projects, and bringing input to the CRSP from the projects;

4) Ad Hoc Technical (TG) and Fiscal Groups (FG): established by SCB to standardize procedures, policies, and agreements among projects;

5) Advisory Panel (AP): an external panel appointed by the Program Director from nominations of the SCB, composed of 5 or 6 eminent scientists from disciplines relevant to the CRSP and one experienced administrator, and responsible for evaluation of the scientific progress and management of the CRSP;

6) Institutional Council (IC): composed of one senior administrator from each participating US institution, to resolve any inter-institutional differences.

The management structure is portrayed in Figures I-1 and I-2. Candidate management institutions which have submitted statements of qualification are the University of Connecticut (Kirvin Knox), University of Calitornia, Berkeley, (Doris Calloway), University of Minnesota (Leonard Schuman). The results of a secret written ballot among the Principal Investigators to determine the preference for the management institution ranked Berkeley first, Minnesota second, and Connecticut third.

Interim management in the period between the planning grant termination and the awarding of the program grant to the management institution should be via a consultative group composed of persons with past involvement in the CRSP and/or potential future participation.

6. Projected CRSP Costs

Budget requirements of those institutions recommended for funding and of the management entity are shown in Table I-1. Most of these budgets have not been reviewed by the submitting institutions and will require further negotiating by the management institution.

A minimum of $7 million for three years is required to start the three CRSP projects and to maintain adequate scientific control over the program. A minimum of $20 million for five years would fund the CRSP recommended by the Planning Contractor (see Table I-2), to include the addition of the Asian project, an urban project, a roots/tuber project, and an "exceptional" project.

Figure I-1

Program Administration

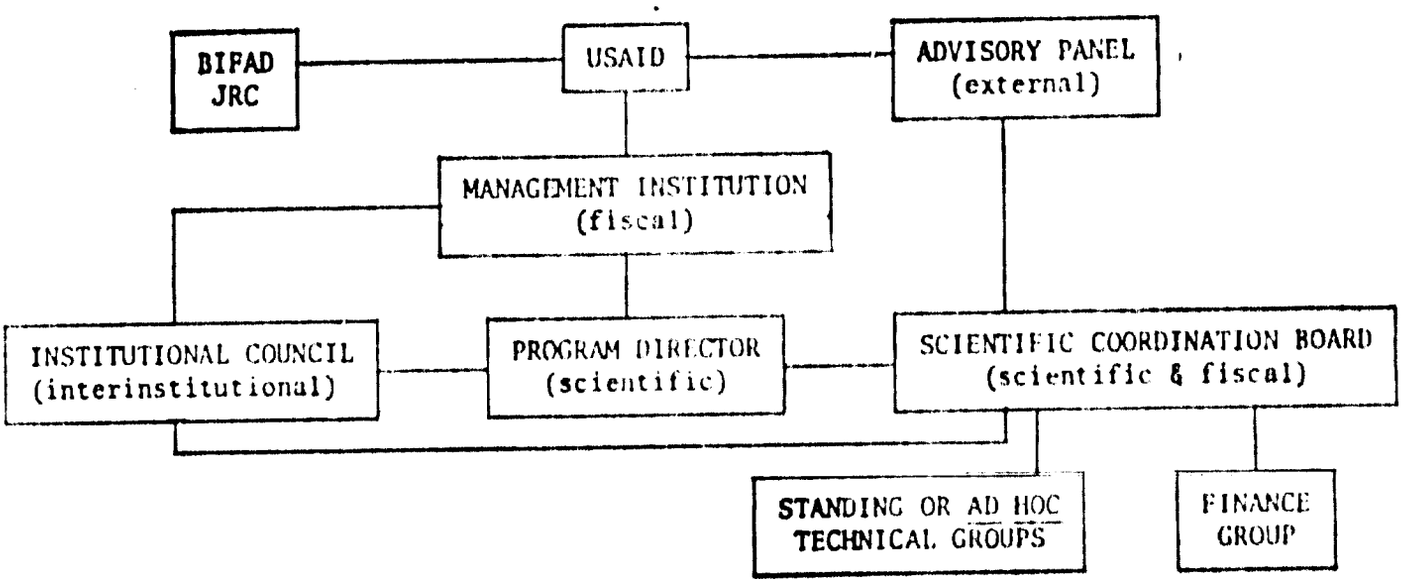

Figure I-2

Project Management

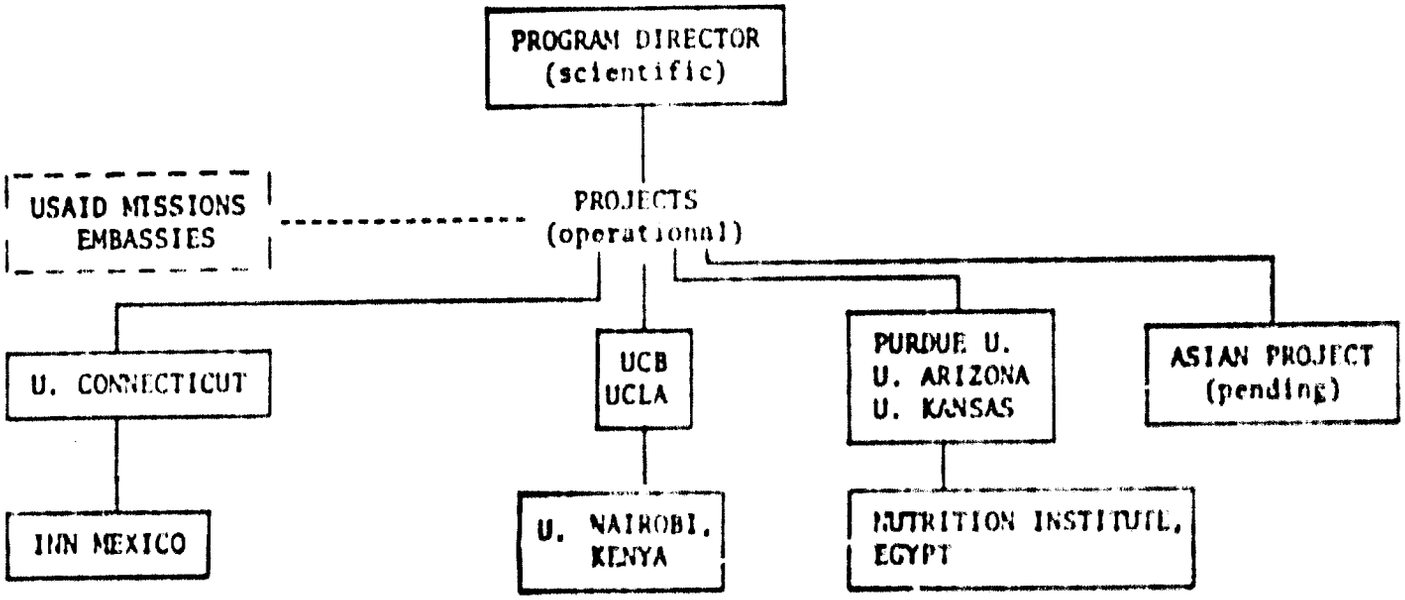

TABLE I-1

Summary of Budget Requirements for First Three Years (Initial Institutions Only)

($1000)

	Year 1	Year 2	Year 3	Total
Univ. of Connecticut	462	630	727	1819
Univ. of California	493	645	683	1821
Purdue/Arizona/Kansas	470	707	831	2008
Total	1425	1982	2241	5648
Management	369	458	538	1365
TOTAL	1794	2440	2779	7013

TABLE I-2

Projected CRSP Budget Through Year 5 as Recommended

($1000)

	Year 1	Year 2	Year 3	Year 4	Year 5	
3 Initial Proposals	1426	1982	2241	2100	1905	
Asian Project	--	550	600	650	700	
Urban Project	--	--	500	600	700	
Roots/Tubers Project	--	--	500	600	700	
"Exceptional" Project	--	--	--	600	600	
Total	1426	2532	3841	4550	4605	
Management	369	458	538	530	612	
TOTAL	1795	2990	4379	5080	5217	19,461

7. Recommendations

1) Funds should be provided to initiate the following projects in FY80 with 3-year forward funding assured:

University of Connecticut	Mexico
University of California	Kenya
Purdue/Arizona/Kansas Univ.	Egypt

2) An interim scientific management consultative group should be appointed and funds provided by USAID to support their activities.

3) The management structure outlined in section E above should be approved in principle.

4) A managing institution should be designated with all appropriate speed and a cooperative agreement with USAID established.

5) Funds should be made available to forge participatory research linkages between the principal US institutions involved in the CRSP and minority colleges and universities.

6) Planning should continue for the development of the proposed Indo-US project. Failing that development the alternatives outlined in section 4 above should be explored in sequence, the project to be funded in the second year.

7) Provision should be made for addition of a new project to the CRSP in year 2, based in an area where the staple crop is a starchy root, tuber or fruit.

8) Consideration should be given to inclusion of an urban-based project in year 3 and of an "exceptional" project (selected for hypothesis-testing) in year 4 or 5.

9) The JRC, BIFAD and USAID should lend their support to development of a US-based project patterned after the CRSP projects.

B. PRÉCIS: GUIDELINES FOR RESEARCH ON INTAKE AND FUNCTION

It is well documented that severe malnutrition, especially when it occurs early in life, leads to functional impairment. There is also reason to believe that mild/moderate malnutrition weakens the capacity of individuals to function in their societies and to adapt to stressful environmental conditions, but quantitative measurements of these relationships are lacking. Because of the large numbers of people affected by less-than-severe malnutrition and because of the potential importance of its sequelae for individuals and for their societies, these relationships must be understood. A study conducted by the National Academy of Sciences (1,2) identified this problem as the highest priority area for research bearing on world food and nutrition issues, and participants in a workshop subsequently convened by the Food and Nutrition Board (3) concluded that such research was feasible and deserved high priority for funding under Title XII of the Foreign Assistance Act. The NAS/FNB workshop identified five broad areas of human function for study of their relation to marginal food intake: disease response, reproductive capacity, work output/physical activity, cognitive and sensory development, and social competence.

A planning grant was awarded to the University of California at Berkeley to develop and recommend to the Joint Research Committee of the Board for International Food and Agricultural Development a collaborative research support program (CRSP) for quantifying the relationship between intake and function. Workshops were held focusing on each of the five program areas listed above. The charge to each workshop was to identify the most critical research questions in each program area that could and should be addressed under the CRSP. A sixth workshop was convened at which representatives from developing countries and international organizations reviewed the recommendations from the previous groups and gave guidance on priorities and research arrangements. Participants in this workshop were:

Hekmat El Sayed Aly (Egypt)
George Beaton (Canada)
Doris Calloway (US)
Edouard De Maeyer (Switzerland)
Jean McNaughton (Italy)
Olyvia M'Gaza (Tanzania)
Jose Obdulio Mora (Colombia)
Giorgio Solimano (Chile)
S.G. Srikantia (India)
Aree Valyasevi (Thailand)
Christina Wood (US)
Marion Radke Yarrow (US)

The Précis attempts to summarize and integrate the results of the workshops. It is intended to guide and assist institutions preparing proposals for this CRSP.

Throughout this document emphasis is on <u>food</u> intake as represented by energy intake rather than on specific nutrients. It is recognized that when food/energy intake is low, specific nutrient intake may also be low and that functional effects attributed to low food intake may not be consequences of inadequate energy intake per se. Also, levels of food intake that satisfy total energy needs may still be deficient in specific nutrients. These possibilities warrant consideration in experimental design and data interpretation. In general, the effects of specific nutrient deficits and their therapies are well-documented; the concern here is with the more widespread and less understood phenonmenon of mild/moderate energy restriction. Any research dealing with food energy deficits will necessarily entail consideration of nutrient content and bioavailability, but the intent is to focus on the more general problem of food energy intake as the primary independent variable.

The concept of "function" had its origin in the recognition that the final concern was the functioning of individuals in their societies and the question of the degree to which marginal food intake might impair that functioning. Perhaps somewhat artificially, and for the purpose of in-depth consideration in the workshops, the functioning of man was divided into the five areas: disease response, reproduction, work, cognition and social competence. In each of the workshops, the participants repeatedly identified the interrelationships among these areas. At the final workshop, the position was taken that to be meaningful, these functional areas should not be studied independently. Thus, the final research model selected was an interdisciplinary, multifaceted examination of households in which would be found the age, sex and physiological groups which had emerged from the workshops as being of primary interest.

OBJECTIVES OF THIS CRSP

There is a need for effective conceptualization at the outset of the interrelationship between variables resulting in impaired function. This would of course include the identification of the relevant variables. Research attempting to quantify the relationship between mild/moderate malnutrition and human function would proceed to establish the validity of hypothesized links by the elucidation of the process and its governing mechanisms. The research should contribute to the understanding of what steps need to be taken for the prevention and amelioration of impaired function consequent to mild/moderate malnutrition, for self-sustaining improvement of human health and wellbeing.

The specific objective of this program is the production of quantitative, generalizable information on the relationship between various substandard levels of food/energy intake and human functional capabilities in the domains of disease, reproduction, activity, cognition and social behavior, in the context of the family unit. The overall CRSP will be designed and managed to provide for corparability of results from different study locations.

The selection of specific research topics must include those perceived as most critical by representatives of the populations of the less developed countries. Research plans must assure the fullest collaboration possible with colleagues in the study locations. The building and the strengthening of the research capability in the less developed countries is an important subsidiary objective of the CRSP

RESEARCH STRATEGY

A central task of this research is to understand the ways and extent to which mild-to-moderate degrees of food deprivation experienced over time interfere with the individual's functioning as a biologically and behaviorally competent member of society. There is little doubt that food intake has an impact on many aspects of human functioning and that these aspects are highly interrelated. Relations between nutrition and function may be direct or indirect, but the nature of the linkages is not well understood. It is of primary importance, therefore, that research be pursued in ways that take complexit and interactive processes into account, and that assess the relationships between functio in rigorous quantitative terms.

In the traditional research approach, nutritional factors have been investigated as independent variables in relation to single isolated outcome variables (e.g. cholesterol intake and myocardial infarction). Associations found in such studies may be difficult to interpret in a broader context, especially as interpretations are complicated by influences of confounding conditions or factors that have not been part of the research. Such influences have an effect on both the nutritional and nonnutritional variables. Continued research in the traditional single variable and single disciplinary model is, therefore, not likely to yield explanations of the mechanisms involved in the associations between nutrition and functioning. This approach is unable to deal with combined or interrelated influences contributing to the associations. Nor can this approach provide reliable guidance for appropriate interventions.

The objectives of this program are to advance research that will lead to better understanding of the processes by which variations in nutrition and variations in physiological and behavioral functions are linked. Priority is given, therefore, to a research strategy in which broad sets of cross-disciplinary variables together are systematically investigated in relation to food intake.

For such an integrated research approach, the family or household unit has been chosen as the most appropriate focus. It is not only a culturally universal unit (with a range of forms), it is a significant setting for the individual throughout the life span, and it is also an important link between the individual and society.

Study of the family or household as a reference unit permits simultaneous measurement of many functions: reproductive and rearing competencies, disease, child development and behavior, and environmental conditions. Very importantly, it permits investigation of the interactions of various functions and conditions. Also the family focus allows examination of time-related processes and of cumulative influences on the individual and group. The mother and child are major focal points of study. The functioning of adult family members in relation to family and society also constitute important areas for investigation.

The feasibility and fruitfulness of an interdisciplinary, multivariate research approach depend on the fulfillment of a number of research requirements. First, choice of variables in each of the disciplines is made carefully and selectively, based on theory or hypothesis. Second, stringent criteria of conceptualization and measurement are applied to all variables. Third, plans for analysis are made which adequately utilize the information obtained from the various sources.

The implementation of interdisciplinary, multivariable research may be more difficult than research focused on single, isolated variables. More effort and care are required in research planning as well as in field operations and analysis. These difficulties can be more than outweighed by two advantages. The first is the economy of research costs and efforts over the long run. Research designed to study questions relating to various functional areas, using the same research population, could decrease the costs of measuring the same variables in separate studies on new populations. The second, scientifically most important asset of this research strategy is the increased explanatory power of the findings. By studying a range of conditions and functions in one study, a more meaningful evaluation of the significance of malnutrition for human functioning will result.

Although the primary focus of research is the household, it is anticipated that the understanding generated in this context will be relevant for the investigators interested in considering more macro-aspects of community functioning, and for national planners concerned with the amelioration of food and nutritional problems. Family units would, nevertheless, still contribute to individual age-and sex-group analyses where necessary and relevant.

RESEARCH DESIGN CONSIDERATIONS

Food Intake. The need for accurate food intake measures arises from the assumption that the range of functional outcomes varies along a continuum of food intake. Each of the workshops drew attention to the problems associated with the measurement of intake, the determination of nutritional status, and the elucidation of the links between the two.

The final workshop had available the documents of the participants in the earlier workshops. Although it shared some of the previous groups' concerns and recognized the limitations of the currently available measures of food intake, it considered that repeated one-day intake data provided reasonable information in the hands of experienced investigators. Although other methods of measuring food intake, particularly innovative methods which showed promise, should not be excluded, projects within the CRSP should give primary attention to obtaining a valid and reliable estimate of food intake by means of repetitive, accurately recorded, one-day dietary intakes. The number and timing of repetitions will be a function of the particular research design, but should take into account intraindividual variation in daily intake, seasonal or other cyclical variations, age-specific changes, and time interval between food intake and function (e.g. anorexia in relation to disease onset, intake in relation to changes in activity, etc.).

The possibility of using selected foods as indicators of total food intake was considered. The utility of such an approximate measure would depend on the specific measures being addressed. The consensus was that seldom would this approach be sufficiently discriminating as a primary measure, although it might be useful for some purposes (e.g. "early warning" of changes in intake patterns). There may be need for innovation in approaches to recording food intake, particularly in situations where food can be consumed by a child outside of the view of the expected observer/recorder, or where family members eat from a communal vessel. If not possible, then the only hope may be analysis by total households adjusted for family size and age and sex distribution.

The description of the food intake of individual members of families within the study population should be as complete as possible. Although the workshops recognized that energy intake is the most useful single quantitative measure of intake, all considered it important to take account of nutrients, including water, and other substances present in food that could influence variables under study. It was pointed out that when energy intake is low, intake of some nutrients may also be low, and that changes in function attributed to the effects of low food energy intake may not be the consequence of inadequate energy per se. In addition to energy, iron, vitamin A, protein, and folacin were indicated as being important nutrients in many situations where mild or moderate malnutrition exists. Where seemingly low intakes of individual nutrients

are reported, the desirability and feasibility of carrying out specific estimations to identify whether or not there are actual nutritional deficiencies should be considered. Information on water intake, which is not usually recorded in food intake studies, may be important where fluid intake may be limited relative to need, especially intakes of lactating women, young infants and children, and perhaps other groups in special circumstances. It may be useful to measure the specific gravity of urine as an indicator of the relative adequacy of fluid intake. The intake of nonnutritive substances, for example caffeine in coffee, can be of importance because of possible influence on tests of function.

It is expected that researchers will carry out research on the proposed intake measures and test their validity on the same or similar target populations before embarking on the operational phase of data collection. In this context, emphasis was placed on the need for rigorous training of interviewers who will collect the information on food intake.

Country-specific data on food composition should be used whenever practicable. The need for additional information on food composition should be reviewed. It seems likely that such information will be needed for specific nutrients, as for example, trace elements. The necessary food analyses could possibly be carried out by institutions in the U.S. as part of the institutional contribution to the CRSP. Arrangements will need to be made for exchange of check samples.

It is suggested that the most practical method of reporting energy intake would be as units per kilogram body weight to allow for comparisons among research projects in different locations.

Nutritional Status. This important intermediate variable needs to be assessed reliably, using measures that will provide linkages to past research where status may have been used as a proxy for intake. Indicators should have high sensitivity and specificity; they should be reliable; and they should be simple and inexpensive to measure.

Different individuals (and different populations) can maintain energy balance, reflected in stable body weight, on dramatically different levels of energy intake. Therefore, nutritional state cannot be estimated from information on energy intake alone. It is energy balance, not intake per se, that is critical for growth of children and maintenance of body weight and appropriate amounts of soft tissue (adipose tissue, muscle, and viscera) in adults and children. Measurements that reflect energy output and other factors, as well as energy intake, are essential for evaluation of nutritional status.

Operationally, various indirect measures of nutritional state are used together with measurement of nutritional intake. While anthropometric measures are simple to make, their interpretation is complex. In spite of this, body morphology and composition have served and will serve as the best presently identified indicators of nutritional state. In adults, height and weight are the best indices of past and present state, respectively. Where needed, the contribution of specific tissues (adipose tissue, musculature) may be determined using approximative methods (skinfolds, arm circumference, or, if critical, by a variety of more complex methods (total body density, extracellular fluid space, etc.).

In children, relative height for age and sex will detect any retardation of skeletal growth that may have occurred in the past. Relative weight for height is a useful indicator of the present state of nutrition and has the advantage that it can be used within certain limits in the absence of information on age. The relevance of various other measurements, such as head and thorax circumferences, remains to be determined.

Undernutrition-overnutrition are continuous variables, a gradient of energy balances producing a gradient of physical states. Relative weight and relative height can be derived from reference values arbitrarily scored as "100" and expressed as percentiles. In the past, somewhat arbitrary cut-off points, separating "normal" from mildly/moderately/severely undernourished and growth-retarded individuals, have been utilized. The issue in this research is the relation of a range of food energy intakes to a range of functional states, using nutritional status as an explicative, quantifiable, intermediary variable.

In investigations of mild-moderate malnutrition, there may be reason to suspect complications due to the composition of food consumed, the occurrence of specific diseases, etc. Specific biochemical tests have been developed for detection of many of these and should be used provided there is sufficient evidence to warrant their inclusion in the protocol.

Other potentially useful indicators of nutritional state might be sought, but there are no proven reliable indicators of past or contemporary energy intakes (and none of the state of body energy balance) other than the morphologic and compositional measures noted above. However, adaptation to chronically low intakes is effected by physiological and behavioral mechanisms and identification of these may offer some prospect for development of other, perhaps more reliable and sensitive indices.

Laboratory studies in man and animals show that basal metabolic rate (BMR) falls with a decrease in food energy intake. The decline occurs early, even in the case of mild energy restriction, and BMR does not return to pre-restriction levels unless intake increases. Present evidence indicates that the decrease with mild restriction results in BMR levels in the lower range of normal values, so BMR may not be a valid index in individuals, but may be for populations. However, when the individual is chronically underfed and has reached the limit of behavioral adjustment, BMR may be depressed to an even greater extent. There is reasonable evidence to indicate that body core temperature (and possibly skin temperature) is also lowered under these conditions. These possibilities might be explored in suitable subsamples as indicators of nutritional state.

The possibility of development of new, more sensitive biochemical methods for detection of less-than-severe malnutrition could be explored, but with successful adaptation to moderate nutritional deficit, biochemical changes (which are known to occur with severe malnutrition) do not occur or rarely reach detectable limits. In the present context, transient variations in the nature of the metabolic pools are seldom of concern. Metabolic studies of malnourished animals and of human subjects who have been moderately depleted of some of the water-soluble vitamins show that the capacity to metabolize a load of nutrient may be impaired, even though no metabolic abnormality can be detected in the absence of a load. The capacity to metabolize loads of certain nutrients or nonnutrient substances might warrant study in selected situations

CONSIDERATIONS IN THE SELECTION OF COMMUNITIES

The research design envisaged in this program gains strength from internal analyses and from comparisons among projects conducted in different ecosystems. The design is not intended to serve as a representation of the population in different regions. This matter was discussed extensively with representatives of developing countries who agreed that the objectives, and hence the design, must emphasize the generation of generalizable knowledge relevant to food and nutrition problems of developing countries rather than the development of country-specific information. This perspective has relevance in considering the selection of appropriate communities. In general, although populations selected should reflect the situation and problems of the country or region in which they exist, they should not be selected as representative of the total population. Rather, to maintain the power of the research design, the population selection for a project should aim for relative homogeneity in variables that are not an essential part of the research design. Selective heterogeneity will be sought across projects. Each of the workshops identified variables that should be measured or recorded both as potential confounding variables and as aid in comparisons across projects.

It is clear that there must be stability in the communities selected. Migration rates should be low. If a segment of the population undergoes seasonal migration (e.g. workers or a school population), the design must consider the impact of these temporary withdrawals, or the feasibility of following those individuals during their short term translocation, in terms of data analysis and interpretation. Although a major risk of disruption in the socio-political milieu of the community or region normally would be grounds for rejection of that locale, a gradual, orderly change in this milieu might add strength to the design provided these changes are recorded and incorporated in the analysis. If multiple communities are included in a single project, the possibility of different rates of change will have to be considered in the design. Since in any longitudinal study, there is a possibility of unexpected disruptions, the potential impact on the research might be reduced if multiple communities were studied (e.g. if an epidemic did not affect all communities). The impact of such perturbations could be used to advantage if their effects were specifically assessed.

Cooperation of the population is essential. Any project proposed will have to deal with the matter of soliciting and maintaining cooperation. In this regard it is wise to recognize that although selection of a previously studied community may be advantageous from the standpoint of having available data and perhaps the existence of a functional research infrastructure, it might be very disadvantageous in terms of attitudes of the people toward further investigations, especially if implementations or interventions were not introduced. Generally, the presence of other research programs in the same community at the same time should be avoided. The burden imposed by the present study is likely to be as great as most communities will bear on a continuing basis.

The community must have an identifiable infrastructure appropriate to the needs of the particular research design. As a minimum, this must be capable of sustaining communication with individuals in the community and obtaining consent and cooperation. Particular research proposals might require other types of infrastructures (school system, health care system, etc.) that will limit community selection for that project.

The requisite size of the community will be a function of the study design. From the household-centered approach it follows that all individuals in selected households will be part of the study. It does not necessarily follow that all households in a selected community must participate. Criteria for the selection of households will be based upon their characteristics in relation to study design (e.g. presence of a "family" group with children of a suitable age range, probability of pregnancy, etc.). To obtain an adequate number of such households, it may be desirable to choose a single large community or multiple smaller communities. Logistical and other aspects of the particular project design may dictate this choice.

Whatever the decision on selection criteria of individual households, the population of households must have certain characteristics, including the following:

--a record system providing vital statistics data, retrospective and current

--a probable range of food intake, and consequent nutritional status that spans the range of normal, mild, and moderate malnutrition (among individuals in each age-sex physiologic stratum)

--an adequate birth rate and lactation pattern to permit examination of reproductive performance

--an appropriate demographic structure for the study design

--an expected low attrition rate (from any cause, including mortality and migration)

--minimal interference from serious parasitic disease such as endemic-epidemic malaria and heavy hookworm infestation.

In terms of the power and efficiency of the research design, the following characteristics would seem desirable:

--a relatively homogeneous genetic and cultural composition (genetic to reduce variability of biological variables; cultural to reduce divergence of food patterns and of family and community structure and dynamics). Intentional diversity will be established across projects. There may be particular specific circumstances in which within-project heterogeneity is warranted, provided, with its inclusion, the project remains manageable and feasible.

--a pattern of morbidity (nature of disease, frequency, duration, severity) that reflects the pattern of the country or region but is neither so high that moderate nutritional deficiencies can have no impact, nor so low that there is not opportunity to express functional change in resistance to, or response to, disease.

--relative freedom from major specific nutritional deficiencies that are unlikely to be a function of total food intake (e.g. serious problems of goitre, severe anemia, etc.), and which would unduly complicate the research design and data interpretation.

It is emphasized that since food intake is the independent variable of major interest in this research program, the principal investigator must provide evidence that individual food intakes (distribution within the household) can be estimated with

reasonable precision. For example, in some cultures food is eaten directly from a communal dish. This would call for innovative approaches. Although it is desirable to study both urban and rural populations (across projects, not necessarily within projects), certain of the suggested selection criteria would seem to favor rural communities rather than urban neighborhoods. This should not be taken to exclude an urban population study where appropriate conditions exist.

It is apparent that there should be considerable knowledge about particular communities before a final selection is made. Some information may be available from national, regional, or local records (e.g. vital statistics and demographic patterns) or from previous investigations. Other information may have to be obtained in a preliminary study. Some of the selection criteria (e.g. distribution of food intakes) may not be assessed directly until the actual study begins (communities might be screened on the basis of apparent nutritional status). It may be appropriate to consider a progressive selection process that allows for dropping inappropriate communities or households in the initial phase of the actual study (i.e. initial oversampling to allow for rejection).

RESEARCH COMPONENTS

There are practical limits to the amount of information that can be gathered in a field study and investigators may wish to give greater emphasis to one topic than another within the framework of the integrated interdisciplinary study. Research questions should be framed so that their answers have the potential for application to government policy and/or practical programs. In choosing among questions to be addressed investigators should attend to problems that are serious and widespread, and consider whether or not efficient use can be made of available knowledge and qualified local manpower.

Each workshop identified major gaps in knowledge in specific areas and noted the ones they viewed as being most important and susceptible to study. An attempt should be made to include these components in all research projects.

Disease. Representatives of developing countries considered the relationship between intake and disease response to have the greatest importance: specifically, how do graded levels of mild/moderate food energy restriction affect the susceptibility, course and outcome of disease. It was recognized that the concept of disease would be defined differently by and have different implications for various segments of populations in developing countries versus U.S. investigators, and biomedical versus behavioral scientists. Any research design should elucidate the various definitions and implications. There should also be coordination throughout the entire CRSP of diagnostic criteria, severity, duration, etc.

The research design should focus on the relationship between intake and disease response in the context of the household/family unit, even though the emphasis may be on the child. For instance, illness may affect the ability of a moderately malnourished mother to lactate, to feed her children, to provide care for them, etc., which would influence the intake and nutritional status of the children and their disease patterns as well. Similarly, illness of a father may result in reduced wages and therefore less food for the family. The nutritional status and disease response of a child may be seen

as outcome variables, and it is therefore necessary to consider how the intake of other family members would affect the intake and disease response of the child. The research design should consider this topic in the context of family behavior patterns and socio-economic and cultural conditions that influence it and are influenced by it.

Disease categories thought to be the most important are gastrointestinal, upper respiratory, parasitic and, in some regions, skin diseases such as scabies. The specific focus in a particular project would depend on family morbidity patterns in locations selected for study. In any case, the research design should incorporate measurement of morbidity patterns and vital statistics of the population, even if the research does not focus primarily on disease response. This will provide for continuity within the CRSP and data on disease as a conditioning variable for any other focus.

In the search for linking or intermediate variables, the effects of chronic or recurrent disease on food intake, nutrient utilization and nutrient requirement might be considered. Questions surrounding family response to disease in one of its members might be examined, particularly as this may impinge on the possibility for catch-up recovery between bouts of illness. Various tests of immunocompetence have been used to predict probable resistance to disease but there is some question if these measures are sufficiently sensitive to be useful in the mild/moderate range of malnutrition. There is room for development of predictive indicators of disease resistance and recovery factors.

Reproduction. Reproductive competence of conjugal pairs may be defined as the capacity to conceive and deliver healthy infants and sustain infant growth through successful lactation. Because of the overriding importance of the period of pregnancy and lactation for survival and subsequent development, special emphasis may well be placed on the period of gestation and infancy. Workshop participants observed that there has been a lack of communication between different disciplines studying nutrition and reproduction so that there has been limited integration of knowledge generated within various biological and social science fields. There have been other limitations to advancement of understanding such as the investigation of specific aspects of reproduction without relating them to previous or subsequent events in the reproductive cycle or life span. Conditioning factors in prior histories of sexual partners have not been adequately considered and pregnancy and lactation have not been treated as integrated processes.

An important area for study is the pattern and amount of weight gain during pregnancy in relation to pregnancy outcome, specifically complications of pregnancy and premature and low birth weight infants. Maternal factors which need elucidation are nutritional states prior to pregnancy, food intake during gestation, and factors which affect food intake, activity patterns, and energy expenditure, health status, antenatal care, and the rate of weight gain in different trimesters, the composition of the weight gain and indices of placental function. With respect to the infant, the lower range of birth weights has been associated with less favorable health conditions. There is however little specific information to link birth weights with subsequent growth and development of children in developing countries. Smallness of size may have quite different significance in different environments. Studies might focus on birthweight in relation to future morbidity, mortality, neurological development, behavior and growth. All these outcome measures may also be profoundly altered by many other postnatal circumstances.

The relation of maternal mild-moderate malnutrition to the quality, quantity, pattern and duration of lactation equally needs study. In exploring this area, studies must control for the fact that variation in lactation performance may be influenced by a number of social, psychological, and physiologic factors. (Among important variables are the timing and characteristics of supplements to human milk, and the effects of hormonal contraception.) The impact of smoking and alcohol use during pregnancy on birth weight, lactation, and post natal development must also be assessed as a confounding variable where such practices occur. Maternal food intake and nutritional status before and during pregnancy, including the dimension of gestational weight gain, may be expected to modify the effects of lactational food intake on lactational adequacy and on maternal health and nutritional status during lactation and in the intergestational interval. Maternal care-giving may be affected in important ways, in addition to the quantity and quality of milk per se that affect the growth and development of the infant and his siblings. (The role of nicotine in breast milk of smoking mothers is not clear.)

In contrast to studies focusing on infants, the physiological effects of reproduction and mild-moderate malnutrition on women is a seriously neglected topic. Required work should examine the issue of maternal deprivation taking into account the woman's past nutritional history, health history, reproductive history, work requirements, and culturally and biologically defined food patterns.

Activity. Questions in this area are concerned with the relationships between energy intake, work output, and the physical and mental performances that comprise the range of human activities. These include activities in the physical, psychomotor, perceptual, cognitive, and sensory domains of human performance. The overall problem is to determine if incremental changes in energy intake have observable effects on activity and performance. Specifically, at different habitual energy intake levels, are there differences in the activities performed (i.e. in the behavioral profiles of the individual, family, and community) and what are the consequences for the individual, family and community.

Are there critical levels of contemporary energy intake that enable individuals to perform different activities? Does nutritional status of an individual in childhood affect that person's performance capacity as an adult? There are significant confounding factors (motivation, incentive, resources, etc.) that affect efficiency and productivity. It would, however, be useful to know to what extent levels of measurable performance capacities limit or how they affect activity patterns, work performance, and productivity.

There are various ways of defining and measuring activities. These include frequency, duration, and intensity of participation in the activity as well as its cultural or local definition and meaning. In so far as possible, reliable standard measures should be utilized but adapted where necessary to the local situation.

In the analysis of these activity data, it is anticipated that the results will be aggregated in terms of time and frequencies. This aggregation describes the behavioral profile of individuals, groups, and populations which can then be used for comparative purposes. In the context of the family as the unit of primary focus, it will be especially important to determine the activity patterns of the primary care-givers and of children.

In operation and by design, the research project will answer not only the association of differences in food intake with differences in activity, but also the effect of differences in activity, manifest as child rearing and other practices, on the nutritional status, morbidity, and function of other family members.

Cognitive Functioning and Social Competence. The "behaving" individual in his various functions as a member of society (a mother managing a household, a child obtaining schooling, a worker, etc.) is a highly relevant criterion against which to assess the impact of inadequate nutrition on function. Food intake is related to cognitive and behavioral functioning of the individual and, aggregately, the community. Psychological and behavioral variables may enter as direct and indirect outcomes of inadequate food intake. They may also be intermediary variables in relationship between food intake and biological functions. Questions to which research attention should especially be given are those that grow out of existing (though inadequate) data bases. Althought there has been considerable research on children's cognitive development, these assessments have tended to be global or composite measures such as the I.Q. Further research of this kind is not likely to provide much new information. Instead, research needs to be directed to specific processes in which the individual utilizes sensory information, namely, attentional ability, memory, information seeking, and abstract thinking. Other related functions underlying intellectual performance that also need study are sensory capacities (visual and auditory acuity) and psychomotor abilities.

The consequences of specific cognitive deficits for other specific behavioral competencies need to be investigated. By way of example, if attentional disorders are associated with malnutrition in children, what are the chains of effects of this disability in the lives of children: in school performance, in learning of skills, in relating and communicating effectively with others?

An important question, particularly but not exclusively for children, is the extent to which cognitive impairments due to mild-moderate malnutrition can be counteracted. Other formulations of this question are (a) How do variables of the socio-economic environment and disease interact with inadequate food intake in relation to intellectual functioning? and (b) How do intergenerational factors (e.g. mother's care of child) interact with inadequate food intake in relation to intellectual functioning? These same questions should be raised as well with other behavioral competencies which have been far less studied than the cognitive. These are the emotional, motivational, and social interactional characteristics of malnourished individuals. Indications from animal research and from clinical-medical experience suggest that the inadequately nourished may show characteristics of apathy, nonpurposive, non-goal-directed behavior, impulsivity and emotionality, unpredictable aggression, failure to respond normally in social interactions. Such behavioral properties comprise a complex of impairments that may enter into a wide range of dysfunctions. How, for example, is the child or adult so impaired able to solve daily problems of living, make decisions, cope with stress? How do impairments in cognition and motivation interact cumulatively in determining functioning in specific critical daily roles (such as caregiver or household manager)? Specific individual behavioral dimensions need to be measured quantitatively, with adaptations in measurement that reflect the particular cultural setting.

The research problem then is one of identifying discr. t aspects of social competency which seem to be related to deficient nutrient intake (nutritional status), to see how the nutritional (biological) status of individuals affects their social

competence, and in turn, how the social competence of particular classes of individuals affects the social competence (and nutritional status) of others, i.e. the social environment, which affects the biological and the social function of others.

ETHICAL ISSUES

Ethical issues may arise from a variety of sources such as the ethical standards of the individuals and populations studied; the history, present policies and administration of a host country and all countries involved; the nature of the research findings and their consequences. It is essential that ethical issues be conscientiously considered by the research teams at every stage of their work, with emphasis on empathy for those studied and those potentially affected by the research findings now and in the future. Research should be pursued in the spirit of concern to increase social awareness of the human condition and societies' effectiveness in response to this condition, especially with respect to the amelioration and reduction of malnutrition.

In their proposals, researchers should identify the anticipated ethical issues (such as those involving policies and guidelines of the countries involved) and describe how they intend to resolve them. The principal investigators must assume personal and invoke institutional responsibility insofar as possible for ethical conduct of the research by all participants in the study teams. In all cases the relationship between the investigators and the subjects of studies should be that of informed consent. When communities or groups of people are to be studied, the investigators must provide details of the manner in which information will be imparted and through which a consensus for consent will be obtained.

If the research imposes any risk or discomfort to the subject, the benefits of the research should accrue to the same individuals, and communities, that experience the risk or discomfort. Health, nutritional, and other humanitarian benefits from any source should not be excluded from participants on the basis of research design, and the research team must not withhold such health and nutrition services as it is capable of providing. Insofar as possible, services provided during the course of the research which prove beneficial should not be withdrawn at the conclusion of the study.

CONSIDERATIONS OF ALTERNATIVE DESIGNS

In the final recommendations offered by the workshops for research design, the experimental model has not been featured. Rather, emphasis has been placed upon a research design that provides information about the nature (pathways) of relationships as well as the presence or absence of these relationships.

The workshops convened to consider single areas of function repeatedly suggested that the "experimental" approach be given serious consideration in deciding upon research design. A major reason for this recommendation would seem to be the apparent benefit in establishing (or supporting hypotheses of) causality of postulated relationships - if the dependent variable responds to change in the independent variable(s) of interest in a situation in which many factors may be operative. Each of the workshops that offered such a recommendation indicated the need for care in the selection of controls and discussed the problems and pitfalls of this approach.

The "naturalistic" (associative) approach is emphasized as the preferable one by virtue of the logical necessity to establish the existence of associations which have not yet been demonstrated before entertaining interventions either for the strengthening of hypotheses of causality or for implementing associations whose evidences via dose-responses and "nature's experimental data" are so strong as to provide an adequate judgment of causality.

As noted in the section on research strategy this emphasis follows from a belief that (a) the output functions of interest in this research are themselves interrelated, and (b) change in food intake of one family member may produce an indirect effect in a different family member. An understanding of the interrelationships was deemed essential to an understanding of the relationship between food intake and function. It may be essential also to the effective design of an experimental approach (clarification of the postulate to be tested) and even to the propriety of undertaking such an approach.

This emphasis in the recommended approach to research does not preclude the use of an experimental design provided that it also gives the type of information about interrelationships that is indicated in the report. To achieve this goal, the data collection requirements for the experimental design would seem to be at least as great as are those for the more naturalistic approach which bases analyses upon already existing ranges of intake without intentional manipulation. In the usual experimental design there would be also a requirement for a control group with the additional data collection requirements for that population.

In some circumstances, and in situations in which the basis of the postulates seems particularly clear, applicants may wish to propose an experimental model. When considering this design, investigators are urged to consider both the feasibility and the ethical issues of such approaches as well as the potential analytical benefits. Since the independent variable of prime interest is food intake, the most logical (but not the only possible) manipulation is alteration of food intake. Experience in other studies has clearly demonstrated that this is not easy to achieve (logistics) and that the effects may be confounded by both sale or redistribution of the food or by displacement of other food (in each case this may have the effect of giving an effective increase in income and this may be what evokes the observed response). There has been considerable discussion of the ethical issues involved in offering food to one segment of a population and not to others and of withdrawing a food supplementation (or other service program) after it has been provided during a research study. These and other issues associated with the experimental approach will have to be considered in any application proposing an experimental intervention.

In some circumstances, applicants may be aware of events that are about to take place that will afford an opportunity to establish a natural experiment (the planned introduction of a program or activity that will assure a change in food intake, etc.). This will continue to demand careful attention to the selection of appropriate control groups which will be expected to exhibit all changes except those directly related to the change in food intake (indeed, in the natural experiment the provision of an adequate control group may be even more difficult) unless this is treated as a "naturalistic" model in which change is occurring over time.

In each case in which an experimental approach is proposed, the proposal will be considered carefully in terms of the power of the research design, the probable feasibility and cost of the proposed manipulation, and the ethics of the proposed manipulation. These considerations will include, of course, consideration of the suitability and adequacy of the control group; criteria for selection must be described in detail in the proposal.

INTEGRATION OF PROJECTS WITHIN THE PROGRAM

Individual projects will be designed to examine the relationship between food intake and function in single ecosystems. The overall CRSP will be designed to test the observed relationships across ecosystems (and social systems). This approach has implications for the review and selection of individual project proposals and for the management of the program.

An attempt will be made to select well planned projects which, in combination, encompass some of the major differences in traditional diets (and proportional sources of energy). At the same time, situations in which major micronutrient deficiencies or major disease problems would be likely to confound design and interpretation will be avoided. Applicants will be expected to describe in general terms, the nature of the diet consumed by members of the proposed study population. If there are potential alternative study populations with different dietary practices, these should also be described.

To permit interstudy comparisons, some special requirements for data collection will be developed. These may affect the manner in which some data are collected (e.g. the instruments used in soliciting subjective data), the definitions of illness and disease syndromes, the manner in which data are tabulated (in relation to reference standards), etc. Successful applicants should anticipate that there will be a process of harmonization of data collection and recording systems, and of research protocols before implementation; however, such procedures should be incorporated into the proposals. Applicants should be as specific as possible in describing proposed approaches. It will be advantageous if individual proposals identify those measurements and design features that are deemed by the applicants to require interproject discussion and standardization.

It is anticipated that all materials and data gathered and analyzed will be made generally available to the scientific community after reasonable provision of time for the investigators to complete the analysis.

SUMMARY OF THE RESEARCH MODEL

An understanding of the interrelationships among the individual functional domains is essential to an understanding and quantification of the relationship between food intake and expressed function. There is need to focus study of these relationships in a manageable and relevant system. A research model based upon household or family units is proposed as the most appropriate.

In this model, the individual members of the family are the primary foci of measurements and the interaction among these members of the single household is taken as the unit system. The approach is multidisciplinary and multifaceted. The statistical analyses are forms of multivariate and pathway analyses. The issues of design relate to identification of parameters to be measured, of frequency and timing of measurements,

and of variables to be included or controlled in the context of a very carefully planned research project.

Research should be formulated (and ultimately executed and communicated) with concern for and involvement of academic and administrative colleagues in all countries that participate in the CRSP. Effort should be made to design and conduct research so as to strengthen local resources and capabilities.

INSTRUCTIONS FOR SUBMISSION OF PROPOSALS

Proposals should be formulated in accordance with the usual format of NSF proposals.* Under personnel, in addition to the usual biographical information, please specify language competency relevant to proposed study location. In the budget section indicate how you propose to meet the 25% matching funds requirement, and provide justification for requests for major equipment and for travel. We also request that the body of the proposal not exceed 30 pages, exclusive of budget, biographical materials and supporting documents.

Background literature need only be cited to support the selection of particular communities (the characteristic ecosystem of that community or region) and the particular choice of methods and of analytical approaches. The proposed design of the study must be described in sufficient detail to permit an assessment of feasibility of implementation and of achievement of goals. Particular attention should be given to thorough explanation of procedures to be followed to obtain informed consent of participants and for protection of their privacy.

Appropriate documentation must be provided to support proposed collaborative arrangements with other U.S. institutions and with institutions or groups in the developing country.

The review process will include independent consideration by at least three reviewers. Proposals that are judged meritorious by these experienced peer reviewers (i.e. meet accepted scientific and ethical standards and fall within the scope of the guidelines provided) will be evaluated by a Steering Group that will recommend projects for integration into a balanced CRSP.

Four copies of each application must be received by: Dr. D.H. Calloway, Department of Nutritional Sciences, 119 Morgan Hall, University of California, Berkeley, California 94720, before April 18, 1979.

It should be emphasized again that final project proposals will be coordinated to ensure continuity and generalizability within the CRSP of hypotheses under the overall mandate; selection of variables to be measured; data collection techniques; and data analysis. Principal Investigators of proposals that the reviewers and the Steering Group recommend for the program (in late May) should anticipate a need to convene and subsequently modify their proposed projects appropriately.

January 30, 1979

*National Science Foundation Grants for Scientific Research, NSF 78-41, Washington, D.C.

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2. Commission on Internat. Relations, NRC. Supporting Papers: World Food and Nutrition Study. Vol. IV. Study Team 9, Nutrition. Natl. Acad. Sci., Washington D.C., 1977.

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PART II

PLANNING THE RESEARCH STRATEGY OF PROGRAM AREAS

A. Rationale and Significance

B. State of the Art

C. Research Activities Recommended by Workshops

D. LDC Investigators' Evaluation of Workshop Recommendations

PART II. PLANNING THE RESEARCH STRATEGY OF PROGRAM AREAS

Many aspects of the study of human nutrition constitute an applied science to which many different sciences must contribute in order to find answers to the questions that arise when attempts are made to improve the nutritional state and living standards of people. Answers may be found using new theoretical perspectives or new methods or may require considerable observational data systematically obtained. The proposed program reconstitutes this trilogy of theory, methods, and data to provide a clearer context for public discussion of nutritional concerns and public nutrition policy formation. Merely providing better data is insufficient rationale for research in human nutrition. Conceptual-theoretical and methodological concerns are a necessary and productive complement to nutritional investigations, including this project. The concerns of this project are designed to be cumulative in the sense of increasing the depth, quality, and scope of understandings achieved.

Not enough is known about the basic functional relationships between energy intakes and,for example, resistance to and recovery from disease. Associations between intake levels and infection, cognitive and behavioral functions, reproduction,lactation, and general behavioral adaptations are also not understood. Such relationships have not been quantified sufficiently nor examined systematically within a context which includes not only the biophysical issues, but also the broader long-term and short-term sociocultural,economic,and administrative aspects. Some of these functions about which knowledge is needed have never been studied in terms of socially relevant values. Part of this research will need to be methodologic but all will contribute to an understanding of the ways in which nutrition and therefore food affects the lives of people. Definitive conclusions about nutritional needs cannot be drawn on the basis of observed food intake alone. Rather there is a complex of relationships between levels of food intake and individual and societal functional capacities and capabilities. This program must offer simultaneous approaches to an investigation of such relationships.

This research will examine in some detail the nature of the processes by which food experiences--especially the experience of episodic or chronic deficiencies of intake--affect the lives of individuals, social groups, and communities. The research will have a worthy outcome if it improves understanding of the roles food plays in people's lives and helps improve the basis for design of social responses to conditions judged undesirable. The investigation's suggested aim is to elucidate and/or quantify relationships between intake and functions in ways that will be significant either to the appraisal of "nutritional problems" or to the design of social actions to address them.

A. Rationale and Significance

Five program areas were suggested by a workshop convened by the National Academy of Sciences to consider the feasibility of research in this area.* It is clear that the five program areas were chosen to encompass the major events and concerns of the household unit in relation to food intake.

As a first step, five multi-disciplinary workshops were held, the participants being scientific investigators from both developed and developing countries. The purpose of the workshops was to establish the most critical research questions and approaches for each program area under the overall mandate to study how graded levels of marginal food/energy intake affect the individual's ability to function in society. "Function" in this sense includes, but is not limited to, the five program areas: response to disease, reproductive competence, physical

*Workshop on the Need for Research on Nutrition and Function, July 18-21, 1977, Comm. on Internat. Nutr. Programs, Food & Nutr. Board. Report dated March, 1978.

activity/work, cognitive and sensory development, and social competence.

Human nutrition field research typically involves the measurement of nutritional status and its correlation with specific functional/physiological events with some attempt to account for confounding variables. This research program differs in several respects: 1) the independent variable is taken to be food/energy intake rather than nutritional status, 2) it is recognized that the functional consequences of marginal malnutrition in turn contribute to the perpetuation of deficient intake and this must be incorporated into the research design, and 3) the behavioral as well as environmental aspects and interrelationships comprising the operation of a household unit will be integral parts of the study as dependent variables rather than confounding variables.

In preparation for the workshop in each program area, two background papers were solicited, one to be written from the biological perspective and the other from the social science viewpoint. It was requested that each should cover the state of the art and should suggest research approaches to serve as the basis for discussion in the workshop.

Most of the workshop reports covered the following topics: research objectives, research needs and priorities, design and methodology considerations, and ethical issues. The state of the art and major recommendations of each workshop are summarized below. The complete workshop reports and accompanying background papers are included in Appendices II-1 through II-5.

B. State of the Art

The two background papers requested for each of the program areas were to include a section on "the state of the art" for the relationship between mild-moderate malnutrition and function. In general, research to date has focused on severe malnutrition; relatively little is known about the effects of mild-moderate malnutrition. Better methodological techniques are needed for precise quantification of intake and many of the functional variables; in addition, some measurements are straightforward but their interpretation remains ambiguous.

The following summary provides an indication of the state of the art. More thorough presentations are given in the appended background papers and some of their references.

DISEASE RESPONSE.

An association between malnutrition and infection has been established. While nutritional deficiency appears to affect the susceptibility and severity of certain diseases, so infection in turn influences the desire and ability to consume food and therefore may alter nutritional status. Epidemiological surveys carried out in Asia and America support the correlation between nutritional deficiency, growth retardation and infectious disease. Structural changes in organs such as the gastrointestinal tract, pancreas, and liver, which occur as a result of malnutrition, contribute to the frequency and severity of diarrheal episodes. A study of Mexican children found that moderate malnutrition was significantly associated with the duration and severity of infectious illness. Undernourished communities carry a heavier load of parasitic infestations (Ascaris, Necator americanus, etc.) than well-nourished communities and they express higher rates of enteropathic infections (Shigella).

Studies have addressed the relation between malnutrition and immune response capacity. The evidence reveals impaired cell-mediated immune responses (cutaneous delayed hypersensitivity, number of circulating thymus-dependent lymphocytes, mitogenic response, factor production, etc.). The

interpretation of some of these results is controversial, however, due to methodological characteristics. Humoral responses are generally normal or increased with malnutrition. Amounts of secretory IgA and mucosal antibodies have been found to be depressed. In one study, secretory IgA responses to measles and polio vaccines were significantly reduced in malnourished subjects. Most studies concerning immunity and nutrition have involved severely malnourished subjects. Immunocompetence methodologies used should be sensitive enough to show significant changes even in mild-moderate malnutrition. (From background paper "Nutrient Intake and Disease Response" by R.K. Chandra.)

REPRODUCTION.

There is some agreement that nutritional state affects fertility, however, the intermediate behavioral variables appear to be more significant than the biological variables in determining population fertility levels. Nutrition is considered to be a major determinant of age at menarche, though genetic and other factors are also important. Studies in Guatemala and Bangladesh have reported a weak correlation between intake or status and duration of post-partum amenorrhea interval. Such studies lack measurements of nursing patterns which may affect such a correlation. (From "Nutrition and Human Reproduction: A Demographic Perspective" by J. Bongaarts).

Infant mortality rates are good indicators of the magnitude of malnutrition among both mothers and infants. Low birth weight has been found to be the main determinant of infant mortality when age, race and socioeconomic conditions are taken into account. Pregnant women who have suffered early malnutrition and enter pregnancy in a depleted state run a high risk of miscarriage, stillbirth, low birth weight of infants and prematurity. The demands of pregnancy impose a serious drain on the mother's already deteriorated physical condition, particularly as it is usually impossible for poor women to reduce their work loads in compensation. If the lactating woman's intake is inadequate, lactation will be maintained to some extent at the cost of her tissues but the period of lactation is shorter than normal and her infant grows slowly. These hardships ultimately take their toll on the woman's body and in unmeasured ways on her family.

ACTIVITY.

Very little is known about the relation between intake and the ability to perform work. The short-run linkage is ambiguous since the body stores energy. It is the long-term link that holds consequences for social function and productivity. Anthropometric measures of status cannot yet be precisely related to the ability to perform work. Some evidence from Guatemalan studies suggests that increased caloric intake affects work output. (From "Nutrition, Physical Activity and Work Output" by C.J. Bliss.)

There is no doubt that severe nutritional restriction limits ability to perform work and requires treatment--individuals with mild-moderate intake restriction, however, presumably carry on at some "adapted" level of activity. The following facts are established:

(a) Work capacity is related to body size, lean body mass, muscle mass, and cell residue. Nutritional deprivation in utero and in infancy results in restricted growth and smaller adult size.

(b) Total circulating hemoglobin affects work capacity.

(c) It is suggested that present energy deficit does not decrease physical fitness in short-term activities but can adversely affect endurance.

(d) Physical activity and energy expenditure are related to energy intake in both children and adults. Recent studies show that relative inactivity of children reduces growth rate during rapid growth periods. There is no documented evidence that actual productivity is decreased in populations with marginal or inadequate energy consumption.

(e) Percent of maximal aerobic capacity sustained at normal work and work output per unit time are reduced in cane cutters with suboptimal energy intake.

There is a high probability that chronic energy intake restriction reduces productivity. (From "Physical Activity and Work Output: Biological Perspectives" by F.E. Viteri.)

It may be the case that mild-moderate malnutrition does not affect work performance but does affect the type of activities engaged in outside of work. Behavioral adaptation to caloric restriction may occur in an increase in resting or quiet activities.

COGNITIVE DEVELOPMENT AND SOCIAL FUNCTIONING.

Evidence suggests that mild-moderate malnutrition acts synergistically with social-environmental factors to affect cognitive function. It is experimentally difficult to separate out their specific contributions. Most of the reports relating malnutrition with cognitive deficits come from animal studies (particularly rat studies) and neurobiological evidence. Mildly malnourished primates do not demonstrate primary learning deficits, but they do show passivity, apathy, shortened attention span, and failure to habituate to repetitive stimuli. Lower species show similar apathy, but also increased nonpurposive behavior, increased excitability and emotionality, and aggression. Disturbances have been noted in mother-child interactions. Animal studies of intergenerational mild-moderate malnutrition show irreversible behavioral deviations including impaired cognition. Neurobiological studies report mild-moderate malnutrition severely affects the developing brain, but not the structure of a developed brain. Prenatal malnutrition is likely to reduce the number of neurons formed while postnatal malnutrition reduces their size. Myelination and formation of pre- and post-synaptic membrane components are impaired by undernutrition. (From Report of Workshop on Nutritional Status and Cognitive Functioning.)

Guatemalan studies suggest that provision of nutritional supplements to mildly-moderately malnourished children has little effect on enhancement of intellectual development. The effects of supplements given in severe malnutrition are greater in an unfavorable environment than in a supportive environment. Rather than addressing the question of how much variation in cognitive competence can be attributed to nutrition alone, research may profit more by investigating the interaction between nutritional and social-environmental conditions. A current popular hypothesis is that malnutrition affects behavior through dysfunctional changes in attention, responsiveness, motivation, and emotionality rather than direct impairment of learning ability. A recent U.S. study found reduced attention to moderate stimuli

and hyper-reactivity to more intense stimuli in premature or low birthweight infants. Decreased curiosity and exploratory behavior have been found in malnourished infants. There are suggestions from studies on pre-school and school-age children that malnutrition may be associated with deficient performance of tasks utilizing short-term memory and attention. Such factors as mentioned above may provide the most sensitive measures of disturbed cognitive ability with regard to malnutrition. (From "Malnutrition and the Development of Intellectual Competencies: Research Issues and Priorities", by H. Ricciuti.)

In conclusion, the effects of malnutrition on the body's structural integrity is more firmly established than the effects on adaptive behavior, capacity for learning and dealing with social and environmental demands. Since behavioral impairments are probably multi-causal, research must take into account the diversity of and interrelations among the causal dimensions.

C. Research Activities Recommended by Workshops

DISEASE RESPONSE.

The workshop on intake and disease response was the first workshop held. The nature of the topic was such that it related directly to all of the other program areas. For these reasons the content and conclusions of this workshop were broader than that of the other meetings. The specific objectives addressed were the following:

(1) to develop a functional classification of nutritional status as it relates to expression of disease;
(2) to determine the relationship of nutritional status to vulnerability to disease and/or its expression;
(3) to identify the specific contribution of total food energy intake to nutritional status in the presence of prevailing disease patterns; and
(4) to establish the validity of linkages in the total system which relates food intake to disease.

Research design patterns to fulfill the above objectives were extensively discussed with emphasis on the systems approach, the epidemiologic cohort approach, and the experimental epidemiologic/intervention method. Guidelines for selection of communities were presented.

Other methodological considerations were noted. For example, definitions, concepts, and consequences of illness must be culturally defined. The use of immunologic parameters as indicators of resistance to disease expression must be selected carefully considering the ambiguous nature of their interpretation and that statistically significant differences may be difficult to observe between healthy and only marginally malnourished groups.

Subsequent to the workshop, participants were asked to indicate high priority diseases for study, critical target populations, and optimal measures of response to disease. Responses suggested that parasitic and diarrheal diseases deserved attention and target groups should include all family members.

REPRODUCTIVE COMPETENCE.

This workshop presented a detailed list of research needs in the area of quality of reproductive ability from birth to first conception, and during

pregnancy, lactation, and inter- and post-reproductive periods. Lactation and maternal nutrition during pregnancy were given highest research priority with the following specific topics considered to be the most critical research questions:

(1) The relation of maternal nutrition to the quality, quantity, pattern, and duration of lactation, including the meaning of reported "lactation failure" and the effect of timing, amount, and content of nutritional supplementation of the mother on lactation performance.

(2) The relationship of patterns of weight gain during pregnancy to pregnancy outcome, specifically, complications of pregnancy and low birthweight infants.

(3) The timing and characteristics of supplements to human milk with regard to lactation and the health of the child.

(4) The significance of weight at birth.

(5) The effects of pregnancy and lactation on maternal nutritional and reproductive status.

(6) The effect of family planning on lactation and maternal and infant health.

The merits of initial cross-sectional studies to define the population base in each country and to estimate the magnitude of nutrition and reproductive problems were discussed. Subsequent prospective, longitudinal studies would provide more detailed measurements of variables and better estimates of relationships.

ACTIVITY AND WORK.

This program area includes considerations of intake with regard to utilization of time, choice of activity, capacity for physical activity, quality of performance, and work output. The most critical research question is what levels of energy intake are needed to enable individuals to perform different activities. Second, does nutritional status in childhood affect work capacity and fitness in adulthood. Third, to what extent do levels of performance capacities relate to physical activity and work output. Fourth, are there differences in the activities performed at different habitual energy intake levels and what consequences ensue for the individual, family, and community from different levels.

COGNITIVE FUNCTIONING.

Cognitive functioning for this purpose includes memory, learning, problem solving, language acquisition and use, and abstract thinking. Priority research objectives include the ways in which biological and social-environmental factors act synergistically to alter cognitive functioning; aspects of intellectual competency that are affected by undernutrition and the mechanisms involved; and how adverse consequences of combined conditions of undernutrition and social-environmental disadvantage can be prevented ameliorated.

Participants felt that the information processing paradigm provides a useful organization of cognitive functions from acquisition to utilization of information. It is an approach suitable for studying basic cognitive processes across cultures and over life span.

SOCIAL FUNCTIONING.

The idea of "social competence" has been variously defined and might include a range of phenomena from interactions and adaptations of children to family participation in social institutions. The objective of this program area is to characterize the biological and social-environmental factors which influence one's ability to meet culturally appropriate responsibilities. It has been suggested that a particular research priority would be to ask how the intake of women affects their social competence as individuals and as a group. The concept of "social competence" is the logical result of the consequences of the interactive and interdependent nature of disease response, reproductive quality, activity, and cognitive development in relation to intake.

D. LDC Investigators' Evaluation of Workshop Recommendations

In January, 1979, a meeting was held to evaluate the recommendations of the five program workshops in terms of feasibility of this research in Less Developed Countries (LDC's). Most of the participants were established investigators from representative LDC's. As a result of this meeting, a document was drafted with emphasis on LDC viewpoints which would serve as a guide for institutions preparing proposals for this CRSP (see "Précis: Collaborative Research Support Program on Intake and Function" in Part I,B.

It was decided that since the various components of function are interrelated and interdependent, they should be studied as such. Similarly, since the functioning of individuals is related to and depends on the functioning of other family members, the unit of study should be the household with specific substudies done on appropriate individual members of the household. The mother and child would be major focal points of study. Food intake will be represented by energy (calorie) intake encompassing a range of habitual mildly-to-moderately restricted energy intakes.

The research approach in each study location will include broad sets of cross-disciplinary variables which together are systematically investigated in relation to food/energy intake. Data produced should be generalizable to nutrition problems in LDC's rather than specific to the country studied. As several LDC locations are planned, the program as a whole must consist of core determinants which would be common to each project within the program. The Précis attempted to describe the core determinants necessary for each project and to indicate related research questions given high priority for study by the program workshops.

With food intake as the independent variable, success of the program depends on the acquisition of reliable quantitative measurements of food/energy intake of individuals within the household. It was agreed that repeated one-day intake measurements should be taken in each project and that other methods such as weighing and measuring, index foods, etc. would be optional. Particular attention should be given to measurement of water intake which is frequently overlooked in intake studies and may be a critical factor to the fun tion of lactating women, infants subject to certain disease episodes, etc.

Nutritional status measurement will be used as an explicative intermediary variable. Body morphology and composition are the best presently identifiable indicators of nutritional state. Height and weight in adults reflect past and present state; indirect estimates of composition by skinfolds or arm circumference may be necessary. In children, relative height for age and sex detects past growth retardation while relative weight for height indicates present nutritional state. Circumferences and skinfold measures may be necessary. Specific biochemical tests should be used only when sufficient evidence of specific deficiencies or diseases warrants their inclusion.

Communities selected for participation in the projects should be relatively stable with low migration rates. The necessary infrastructure for communication and record-keeping must be present. The range of intake levels should span adequate through moderate restriction. The community must have an appropriate demographic structure, birth rate, lactation pattern, and morbidity pattern. The research design would be strengthened by the choice of communities with relatively homogeneous genetic and cultural composition, with freedom from major specific nutritional deficiencies, and with moderate morbidity levels and minimal parasitic infestation.

Specific research topics should have potential application for government policy and programs and they should address problems which are serious and widespread. In the area of disease response, questions should address nutritional effects on susceptibility, course, and outcome of disease. Culture-specific definitions of disease should be elucidated and comprehended; however, diagnostic criteria and characterizations of diseases and their patterns will be standardized throughout the CRSP. Measurement of morbidity patterns and vital statistics must form part of the core determinations.

With regard to the quality of reproduction, pregnancy and lactation should be considered as integrated processes. The physiological effects of reproduction and mild-moderate malnutrition on women is an important and neglected topic. Therefore, CRSP projects should include examination of maternal deprivation; taking into account the woman's nutritional and health history, reproductive history, work requirements, and culturally- and biologically-defined food patterns. The quality, quantity, pattern, and duration of lactation should be investigated with regard to maternal malnutrition. Studies of the infant might focus on birthweight in relation to future morbidity, mortality, growth, neurological development, and behavior.

For activity/performance, the basic question is the following: are there differences in activities performed (behavioral profiles) at different habitual energy intake levels, and what are the consequences for individual, family, and community? It would also be useful to know to what extent levels of measurable performance capacities limit or affect activity patterns, work performance, and productivity. Projects must include determinations of activity patterns of primary care-givers and children.

With respect to cognitive and social functioning, research should be addressed to specific processes in which the individual uses sensory information (attention, memory, information seeking, abstract thinking) and related sensory and motor capacities. The social consequences of such disorders as school performance, learning of skills, and communication should be evaluated. Interactions among social-economic environment, disease,

caregiving, and malnutrition with regard to intellectual development as well as emotional and motivational behavior should be studied.

All workshops addressed the issue of ethics in research design, with each successive workshop elaborating further on such considerations. U.S. standards for research on human subjects must be maintained and subjects must give informed consent. As far as possible, services provided during the research project which prove beneficial should be maintained after conclusion of the project.

Finally, after many workshop discussions of possible research designs, it was decided that a naturalistic epidemiologic approach would be preferable, particularly in the beginning of the project. Certain caveats were issued in the event an experimental/intervention approach were to be used.

A summary of core program recommendations implied in the Précis follows in Table II-1, below.

TABLE II-1

Summary of Core Recommendations from the Précis

Ethnographic Study	
Community Selection Procedures	
Household Selection Procedures	
Ethical Considerations	
Nutrient Intake:	one-day repeated intake measures on individuals
Nutritional Status:	adult--height,weight,(skinfolds) children--height/age,weight/height
Disease Response:	morbidity, vital statistics of population
Reproduction:	maternal deprivation related to nutritional and health history, work requirements, culturally-defined food patterns
Activity:	activity patterns of caregivers and children (effects of measured capacities on activity patterns, work performance, productivity)
Cognitive & Social Functioning:	sensory information--attention, memory, information seeking, abstract thinking and related sensory and motor capacities, discrete aspects of social competence.

PART III

Proposed Projects, Sites and Evaluations

A. Solicitation of Proposals

B. Site Visits

C. Proposals Received

D. Evaluation Process

E. Initial Recommendations Made to the JRC for CRSP Content

PART III. PROPOSED PROJECTS, SITES AND EVALUATIONS

A. Solicitation of Proposals

In May, 1978, a "Notice of Research Opportunity under USAID, Title XII: Intake and Function" was mailed by the University of California, Berkeley, to all roster schools and to non-roster schools where recognized nutrition research exists. The notice was also published in AIN "Notes" and The American Journal of Clinical Nutrition.

Expressions of interest were received from 42 institutions in response to the first announcement. Analysis of these responses indicated to the Steering Group and the Planning Contractor that a better indication of the probable nature and scope of the research envisioned should be given to the respondents so that the need for multidisciplinary components and sophisticated design and analysis would be clear. The hope was that sufficient guidance and lead time would be provided thereby to enable investigators to establish necessary linkages, or to avoid wasting time in grant preparation if linkages were not feasible. Response to this second solicitation was mixed (60 institutions contacted; 36 responded); some potentially qualified investigators did not respond to the request and others failed to provide information in the form desired. The Steering Group evaluated the material received but because of the deficiencies cited recommended that the wider group of potential collaborating institutions be included in future planning activities. All interested institutions were invited to send representatives to a meeting in Washington, D.C. on January 31, 1979 at which the guidelines for research grant applications were discussed and USAID/BIFAD officials answered questions regarding overseas linkages, funding and the like. (See Appendix III-1.)

B. Site Visits

A list was prepared of LDC's in which nutrition or related research had been carried out by US institutions interested in submitting proposals. Site visits were then planned to include the most frequently mentioned countries and others thought to be strong possible CRSP locations. The purpose of the site visits included the following:

(1) to inform the local AID missions about the CRSP and assess their receptivity;

(2) to discuss the nature of the research program with local investigators and to evaluate their interest and institutional capabilities for conducting a long-term, multidisciplinary research project; and

(3) where possible, to discuss the program with local government officials.

Generally, each site visit was made by a team of two persons representing the planning phase of this CRSP. The following lists the site visitors:

Barbados - Dr. Doris Calloway, UCB; April, 1979.

Brazil - Dr. Gaurth Hansen, Utah State University, (Steering Group), and Dr. Janina Galler, Boston University, (Steering Group); March, 1979.

Colombia - Hansen and Galler; March, 1979.

Egypt - Dr. Samir Basta, World Bank, (participant Workshop on Work), and Dr. Christina Wood, UCB; February, 1979.

Haiti - Wood; August, 1978.
Indonesia - Calloway; July, 1978.
Kenya - Dr. Michael Latham, Cornell University, (Steering Group), and Wood; February, 1979.
Mexico - Calloway; April, 1979, and September, 1979.
Peru - Hansen and Galler; March 1979.
Philippines - Calloway; July, 1978.
Senegal - Basta and Wood; February, 1979.
Sri Lanka - Dr. Leonard Schuman, University of Minnesota,(Steering Group), and Wood; April, 1979.
Tanzania - Wood; February, 1979.
Thailand - Schuman and Wood; April, 1979.
Tunisia - Dr. Anna Ferro-Luzzi, (National Institute of Nutrition, Rome, participant Workshop on Work Performance), and Wood; February, 1979.
Zaire - Wood; March, 1979.

The Table III-1 summarizes the responses encountered in the countries visited. The full set of site visit reports is included in Appendix III-2.

Site visits were made to all countries presented in the thirteen proposals received, except for Bangladesh and Honduras. Recent visits to Bangladesh have been made by competent investigators who contributed their impressions to a report for Bangladesh. A scheduled visit to Honduras was cancelled due to lack of Honduran investigators.

C. Proposals Received

Thirteen proposals were received on or shortly after the deadline of April 18, 1979 from the following sets of institutions for the LDC locations indicated:

Univ. of Arizona/University of Kansas (Barbados & Grenada)
Univ. of California-Berkeley/Washington Univ. (Tanzania or Sri Lanka),
Univ. of California-Los Angeles (Kenya),
Columbia University (Brazil),
Univ. of Connecticut/Univ. of Massachusetts/Yale Univ. (Mexico),
Harvard Univ./Cornell Univ. (Colombia & Haiti),
Univ. of Hawaii (Thailand),
Iowa State Univ./INCAP (Honduras),
Univ. of Nebraska (Bangladesh),
North Carolina State Univ. (Peru or Senegal),
Purdue Univ. (Egypt),
Tufts Univ. (Thailand), and
Tulane Univ./Lincoln Univ./Medical College of Wisconsin (Colombia).

There were three other expressions of interest that did not result in applications:

(1) Dr. Helen Guthrie of Pennsylvania State University decided not to apply on learning that USAID would not be likely to approve a project in the Philippines, where she has a strong established linkage from prior related research activities.

(2) Dr. Carl Taylor of Johns Hopkins University was out of the country during this time but indicated that he would be prepared to apply in the

TABLE III-1

Site Visits

Country	Major Investigators and Institution	Government Officials	USAID
Barbados	Frank Ramsey, Barbados Nutrition Center	none visited	not avail.
Brazil	Eduardo Marcondes, Instituto de Criana Yaro Gandra, Universidad de Sao Paolo Anibal Fourdez, University of Campinas		not visited; went to Sao Paolo, USAID mission located in Brasilia
Colombia	Eduardo Aldana and Jaime Varela, Javeniana University, Bogota Dr. Fajardo and Mario Barac, University of Del Valle, Cali		local info.
Egypt	Hekmat El Sayed Aly, Director Nutrition Institute, Cairo	M. Gabr, Minister of Health	brief discussion-supportive.
Haiti	William Fongére, Director Bureau of Nutrition, Port-au-Prince	no one seen	patient, helpful, minimally interested
Indonesia	Darwin Karyadi, Indonesian Nutrition Research and Development Center	no one seen	No discussion of this project
Kenya	James Kagia, Chairman Dept. Community Med., University of Nairobi Omlnde, Dept. Population, University of Nairobi	Kinoti, junior official, Ministry of Health	thorough discussion. Supportive if mission would have no role
Mexico	Adolfo Chavez, Director Instituto Nacional de la Nutricion, Mexico City	no one seen	no USAID mission. R. Wilcox, US embassy was visited
Peru	Victor Perez, National Institute of Nutrition		provided local info expected new Nutr. Officer
Philippines	Florentino Solon, National Nutrition Council N. Deonapo and J. Eusebio, University of the Philippines, Los Baños		interested
Senegal	A.M. N'Diaye, Director, Organisme de Rescherches sur L'Alimentation et la Nutrition Africanes (ORANA) M.T. Basse, Director, Institut de Technologie Alimentaire (ITA)		extremely helpful and supportive in absence of Mark Vincent

TABLE III-1 (cont'd)

Country	Major Investigators and Institution	Government Officials	USAID
Sri Lanka	M. Fernando, Dept. Community Medicine, Peradeniya Campus Davy Perera, Medical Research Institute, Colombo	W.A.L.Wijayapala, Ministry of Plan Implementation	friendly,communicative,supportive. Ambassador encouraging,but with reservations.
Tanzania	Maletnlema, Director,Tanzanian Food and Nutrition Center, Dar es Salaam	no one seen	helpful, patient, not unsupportive
Thailand	Aree Valyasevi, Director, Institute of Nutrition, Mahidol Univ., Bangkok Ousa Thanangkue, Director, Anemia and Malnutrition Research Center, Chiang Mai	Samboon Vachiotai, Ministry of Health	long discussions. A clear lack of appreciation for research on malnutrition.
Tunisia	Z. Kallal, Director, Institut National de Nutrition et de Technologie Alimentaire, Tunis	H. Reaheb, Ministry of Health	helpful,professional, polite
Zaire	Kabamba Nkamary, Director, Institute of Nutrition	none seen	polite, uncommunicative. Not unsupportive.

future, having established linkages in Baroda, India and Recife, Brazil. Dr. Cecile de Sweemer sent a letter of intent and supporting documents concerning Baroda, India.

(3) Dr. Michael Latham of Cornell University was out of the country during this time but indicated that he would be prepared to apply in the future, having an established linkage in Kenya.

Each proposal included a project summary prepared by the investigators. Instructions were that the summary should not exceed 20 typewritten lines. These summaries are given below.

UNIVERSITY OF ARIZONA.

This project will investigate the interrelationships between mild to moderate deficiencies of total food intake and human function in several related areas (disease response; reproductive competence; cognitive function; physical activity and work performance; and social competence) in two populations in the southeastern Caribbean (Barbados and Grenada). The project will employ a variety of instruments and methods applicable to the environmental and living conditions in Barbados and Grenada to obtain quantitative data on the relationships between dietary (energy) intake and aspects of physiological, psychological and social functioning in individuals from 540 households spanning the range from adequately nourished to moderately undernourished. Although households will represent the units of analysis, emphasis will be placed on the individual within the household context.

The two islands are similar in many respects, but the level of physical work done by adults differs due to different cash crops on the two islands. Thus the two populations offer a unique opportunity to study the interactive processes by which people adapt to marginal food supplies under conditions of varying physical activity. The project will investigate the interactions and strategies which maximize functional competence under conditions of marginal food supply, and will quantify the effects of increments in energy intake on these functions.

UNIVERSITY OF CALIFORNIA, BERKELEY.

This research aims to advance understanding of the complex relationships between food intake and human functioning in ways that are likely to provide a sound basis for policy formulation. A combination of nutritional/biomedical and social science approaches are utilized in conceptualization, data collection, and analyses. This research will investigate in a systematic and quantitative manner the relationships between a range of energy intakes (from moderately deficient to adequate) and specified functions: disease, reproduction, physical activity, cognition and social development. The project's concern extends also to societal functions, including sociocultural, economic, and administrative aspects, viewing food deprivation both as an independent and dependent variable. The research plan involves a survey of about 800-1,000 households from which a population of 300 households will be selected for an intensive naturalistic 2-year study. Several methods of determining energy intake and food patterns are proposed. An anticipated confounding variable, iron-deficiency anemia, will be eliminated by use of

iron-fortified salt in the study community(ies). Within the household, the mother-infant dyad is selected for particular study. Research in future years will be: a) longitudinal in cognitive and reproductive domains, and b) experimental, testing hypotheses developed in years 1-3.

UNIVERSITY OF CALIFORNIA, LOS ANGELES.

The broad goals of this research project are as follows:

(1) The primary goal is to determine the degree to which marginal nutrient intake and consequent mild/moderate malnutrition result in impaired human function in these five areas.

a. Disease response
b. Reproductive competence
c. Physical activity and work output
d. Cognitive and sensory capacity
e. Social competence

(2) The second goal is to examine human functional competence not only as it is associated with determinants of food intake, with food intake and with nutritional status, but the interaction (and possible synergy) of all variables will be studied.

(3) If analysis of the primary goal above indicates that mild/moderate malnutrition does impair human function, then the third goal is to identify intervention points for prevention or ameliorating impaired function attributable to marginal nutrient intake and mild/moderate malnutrition.

(4) The final goal is to cooperate in the comparative analyses of results of similar (linked?) systematic studies in other countries to identify common variables and to construct a model of mild/moderate malnutrition that is applicable worldwide.

COLUMBIA UNIVERSITY.

The proposed studies will address the interrelationships between marginal intake and reproductive capacity, disease response, and cognitive/social competence in an urban setting in Sao Paulo, Brazil. A prospective observational study is planned, utilizing known differences in the economic and nutritional status of the population living in a single area to provide a quasi-experimental study of reproductive outcomes, disease response and cognitive and behavioral competence.

From data available in the literature and previous studies done by the various investigators several hypotheses have been generated and areas of interest defined. These research questions will be explored in the same family units, thus allowing an integrated analysis of the collected data.

In the area of reproductive competence the following hypotheses will be tested:

(1) the age of menarche is influenced by dietary intake and the interval between menarche and first conception is associated with the quantity of pre-pregnancy nutrient stores and reproductive outcome.

(2) women suffering the effects of chronic mild/moderate restriction in food intake have a higher probability of reproductive loss.

(3) mild/moderate restriction in food intake during pregnancy affect fetal growth only in mothers without an excess quantity of pre-pregnancy body stores of nutrients (lipid and protein).

(4) the size of maternal body mass at the end of lactation influences the length of time required for the resumption of normal ovulatory cycles.

In addition to testing these hypotheses, information will be collected to elucidate the following aspects of reproductive competence:

(1) the maternal "costs" of pregnancy during mild/moderate restrictions in food intake during pregnancy.

(2) the effect of postpartum nutritional status and food intake on lactation performance.

(3) the effects on the fetus of mild/moderate restriction in food intake when other factors such as maternal height, cigarette smoking, alcohol consumption and infections are controlled. Aspects to be investigated include fetal growth and length of gestation.

In the area of disease response information will be collected to answer the following questions.

(1) what is the prevalence and biological, social and economic consequence of common infectious diseases in individuals suffering mild/moderate degrees of malnutrition?

(2) what are the short term nutritional consequences of certain vaccines known to cause secondary reactions in infants affected by mild/moderate degrees of malnutrition?

(3) what are the nutritional consequences of the treatment of a parasitic disease of the gastro-intestinal tract in children affected by mild/moderate degrees of malnutrition?

In the area of cognitive and behavioral competence the following hypotheses will be tested:

(1) children with mild/moderate restrictions in food intake are less responsive to their environments than children with adequate levels of intake.

(2) children with mild/moderate restrictions in food intake are more likely to demonstrate problems in perception and cognition.

(3) children with mild/moderate restrictions in food intake have less adaptive capacity than those with marginal intakes.

(4) families with mild/moderate restriction in food intake are more likely to reflect altered family dynamics as a response to a new pregnancy.

(5) mothers suffering from mild/moderate restrictions in food intake are more likely to have difficulty responding to personal and family needs even prior to the birth of a child.

(6) maternal behavior during pregnancy is likely to be predictive of postpartum behavior and interaction with the newborn, particularly under conditions of marginal food intake.

UNIVERSITY OF CONNECTICUT.

Our proposed research is designed to assess the degree of association between nutrient intake and a series of outcome variables of functioning and behavior. These outcome variables include health status, reproductive performance, activity patterns, and social and cognitive performance. In addition, we will verify the role of postulated intervening mechanisms within this network of associations, such as immunocompetence, maternal energy stores and work capacity.

The project will be performed in cooperation with Dr. A. Chavez, Instituto de Nutricion, Mexico City. The proposed research site is a Mexican rural community (4000 persons, 400 households), in which poor subsistence agriculture is the main activity. Corn and beans are the main staple crops.

In a brief, initial survey of the community, data will be obtained which will enable us to select 160 households, representing a range of nutritional adequacy, for further study. The second phase of the project includes household interviews by a nurse practicioner and community aide. Data to be collected (every 2 or 4 months for 4 years) include: household composition, socio-economic status, weighed food record, 24-hour recall, observed food intake, food purchases, observed activities, anthropometric measures, morbidity, and biochemical analyses of blood, urine and fecal samples.

In the third phase, we will conduct three sub-studies in order to collect more in-depth data on disease, activity and cognition. Each sub-study will contain 50 of the households evaluated in phase II, selected to contain the full range of energy intake. This phase will be used to examine hypotheses concerning the intervening mechanisms between inadequate dietary intake and suboptimal performance. All women (estimated 40) who become pregnant in the second project year will be members of a reproductive subsample and followed for the duration of the study. Careful examination will be made of the factors that affect maternal body composition, such as dietary intake, activity, and metabolic rate. The inter-relationships between maternal nutritional status and body composition, pregnancy outcome, mother-infant interaction, and the quality, quantity, pattern, and duration of lactation, are of prime importance. All women who become pregnant in year three will be provided with a daily food supplement (300 kcal/day during pregnancy and lactation) consisting of an enriched, milk-based formula. This nutritional intervention will assist us in measuring the role of nutrition per se in explaining behavioral differences. Otherwise, factors whose effects cannot be statistically controlled for may be responsible for some differences in behavior.

HARVARD UNIVERSITY.

A collaborative research project is proposed to investigate the interactive effects of dietary intake, health, family, socioeconomic status, and micro-environment of the outcome of pregnancy, mortality, morbidity, activity, physical growth, and behavioral competence during the first two years of life. The proposed project has three components:

(1) Analysis of the extensive data-base collected by the ICBF-Harvard collaborative project in Bogota, Colombia to obtain information relevant to the objectives listed below and needed to further refine the design and methodology to be used in the proposed field studies.

(2) A new prospective randomized trial utilizing food supplementation initiated during pregnancy to be conducted in Bogota on a smaller but intensively studied sample, in which dietary intake measurements will receive major emphasis. Instruments refined on the basis of previous findings will be utilized to study the family as an economic unit and the characteristics of the home environment. Major emphasis will be placed on family decision-making processes and the setting of priorities in the household. These factors are likely to be important determinants of the family's ability to cope with food scarcity and to utilize food supplementation programs. Physical activity and morbidity will also be measured.

(3) A larger scale study to be conducted in rural Haiti to assess the

effects of maternal nutritional status and dietary intake during pregnancy on pregnancy outcome, perinatal mortality, duration of amenorrhea and lactation as well as on child health and development during the first 18 months of life. The effect of energy intake on work output by members of rural households will also be examined.

Collaboration between the Department of Nutrition at the Harvard School of Public Health, the Division of Nutritional Sciences at Cornell University, the Haitian Bureau of Nutrition, and the Universidad Javeriana in Bogota, Colombia, makes possible the organization of a multidisciplinary task force with the expertise and international experience necessary to execute the proposed project. The group includes well-qualified professionals in nutrition, epidemiology, physical anthropology, developmental psychology, economics, physiology, medicine, immunology, biostatistics, and information management. The senior staff have participated in major research projects dealing with the effects of malnutrition on survival and development. The field sites proposed were chosen because of long-standing linkages with the HSPH and previous collaborative research.

UNIVERSITY OF HAWAII.

Project summary. This research to be conducted in Thailand, will be a participatory project of the Collaborative Research Support Program on Intake and Function. The studies suggested are based on the hypothesis that mild or moderate malnutrition influences human functioning through a number of processes which are interrelated and interdependent. The objectives of the studies are, first, to obtain, through a multitude of closely coordinated observations, quantitative and generalizable information on the specific interrelationships and interdependencies, and second, to assist in the strengthening of the nutrition/function research capabilities in Thailand.

Detailed information will be obtained on food/nutrient intake of all family members in households selected for study as well as on their nutritional status which will reflect their long-term food intake and/or utilization. Simultaneously, data will be collected on disease response, reproductive competence, work output/performance, cognitive functioning, and social competence. All participating investigators, being fully cognizant of the cross-disciplinary variables involved, will integrate their efforts to maximize assessment of the relationships between/among food intake and functions in strictly quantitative terms.

It is anticipated that the successful attainment of the first objective will provide information which is useful in the development of national nutrition planning in all LDC's while attainment in the second objective will strengthen the scientific expertise of Thai and American participants.

IOWA STATE UNIVERSITY.

(1) Reproductive performance. The aim is to determine the capacity of women of reproductive age to undergo pregnancy and lactation with minimal risk to their health and nutrition and with the highest probability that the infant be born and breast-fed under optimal conditions. The project aims, also, to determine the importance of reproductive competence on the health, physical and mental development of the child and of the health and well-being of the family.

(2) Cognitive and neurologic development and social competence. The aim of the project is to correlate food intake, nutritional and health status of the child with neurometric and cognitive developmental patterns measured by psychological tests that explore specifically the functions which previous studies have identified as related to nutritional status.

In terms of social competence, the project aims to determine the capacity of the individual and of the family to function within the sociocultural patterns of the community. Indicators will be developed that will provide a better knowledge of the present social competence of the individual and the family and of the effects which health and nutritional status have within a rural-poor population receiving a series of stimuli aimed at the acceleration of the community's socio-cultural development.

(3) Capacity to perform physical work; productive activities; and leisure time activities. In the rural Central American environment the productive activities of adults and of adolescents (i.e., employment, subsistence, etc.) frequently require a high capacity to perform physical work. Previous studies indicate that nutritional deficiencies of energy and/or iron not only can limit work capacity, but also the productivity of agricultural workers. They may also influence the pattern of non-work activities, activities with economic, recreational, social and educational repercussions for the individual and the family that might foster interactions with other families in their society. The nutrition of the productive segment of the rural families can become even more limiting within a developmental plan that demands additional expenditure of energy. This project aims at further defining the role of nutrition and health on the productivity and social competence of the workers in the family within the developmental process.

(4) Disease response with emphasis on infectious diseases. The majority of the episodes of illness affecting rural Central American populations are of an infectious nature, especially diarrhea and respiratory diseases. There are certain indications that chronic undernutrition limits the individual's capacity to resist these diseases. The project will permit a better evaluation of the importance of food intake and nutrition on the capacity of the individual to respond to infectious processes, as well as of the repercussions of infections on the health and nutrition of the family and the population. It will also provide a better definition of the characteristics of families with different morbidity patterns within communities and thus it will document and establish the basis of actions aimed at improving the health of various segments of rural communities.

It is evident that these four areas are intimately related; it is for this reason that the project is directed towards the simultaneous evaluation of the four functional areas in population groups, taking the family as the study unit.

UNIVERSITY OF NEBRASKA.

Nutritional Impact of Poultry Foods in Bangladesh--Project Summary. The main thrust of this proposal is to determine the effect of improved poultry and poultry food production through eradication of Newcastle disease and through other modern and scientific techniques upon the nutritional status of the citizens of Bangladesh. This proposed Nebraska project contemplates not only to supplement and complement but also to build on the two other nutritional projects that are now in operation in Bangladesh--one sponsored by the Bangladesh Government and the other by UNICEF. Poultry management and utilization would also be emphasized as well as related agricultural, food preparation and distributive practices. Poultry production as women's work would enhance the involvement of women in the economic system. In

cooperation with the Bangladesh Government and UNICEF, Nebraska researchers will focus their intervention program on typical 60 families in each of four selected villages. Evaluation of program will be done at the beginning, in between at periodic intervals and at the end, and will include impact of nutrients/food intake, especially poultry and egg consumption, on the physical, cognitive and social well being of the target population. Appropriate instruments will be developed to assess 1) disease response, 2) reproductive competence, 3) work output and physical activity, 4) cognitive development and 5) social competence. Assessment measures, governmental records and survey results on the selected families will also be obtained for analysis. It is hoped that the project will be completed in three years.

NORTH CAROLINA STATE UNIVERSITY.

The purpose of the study is to identify and quantify relationships between human food consumption patterns and functional capabilities in the following areas: disease response; reproductive activity; physical work activity; cognitive and sensory capabilities; and social competency. The study will consist of applying statistical methods to measurements and observations of behavioral, biological and economic characteristics of a random sample of Peruvian households. The sample of households will be followed for approximately three years. Major attention will be focused on the effects of marginal intake of food energy on specific issues of human functional capabilities.

Statistical analysis will be undertaken to examine the relationship and interrelationships between food consumption and particular aspects of household behavior. The analyses will consist of structural multiple regression methods as well as other multivariate and path analytic techniques.

This research is expected to be of scientific relevance to inquiries on human development and nutrition and be of direct policy relevance to economic and social development institutions in Peru.

The study will involve collaborative efforts of a team of United States researchers and personnel from a consortium of institutes and agencies in Peru.

PURDUE UNIVERSITY.

Children, pregnant women and the elderly in families will be studied in a rural Egyptian setting. The effects of marginal and moderate caloric deficiency will be assessed. Changes in host defense and incidence of common diseases will be measured and correlated with differences in the work capacity, psychomotor function, and cognitive development. The effects of marginal nutritional stress will be determined in the elderly, emphasizing an area of nutritional research extremely poorly studied in less-developed countries. In the aged, disease incidence will be studied in detail as well as humoral, secretory and cellular immune responses, and work capacity. The immune responses will also be developed for the first time in the aged as a technique for better biochemical assessment of their nutritional state. A major portion of our study will be the measurement of early infant undernutrition and the relationship between nutrition and the outcome of pregnancy and quality of lactation. Infants will be followed after birth for nutritional status, and disease incidence and duration. Particular emphasis will be attached to diarrheal infections. The interactions of family members with the development of infants and children will be studied in a long-term,

prospective manner. The development of the child born to an undernourished mother, or one who becomes undernourished as it matures is a principal objective of the research. It is expected that the project will cause a significant increase in the professional development of the Egyptian nutritionists and clinicians participating. Efforts will be made to encourage their rapid development, intensive involvement and assistance in disseminating the information generated to appropriate governmental agencies and health care professionals in Egypt and elsewhere in the Middle East.

TUFTS UNIVERSITY.

The principal investigator proposes to extend studies which he and his associates did from 1969-1975 in villages in northern Thailand in which children are markedly retarded in growth and development although adequate amounts of commonly eaten foods are available. The study will measure the nutritional and health status of village children. It will then initiate a number of nutrition and health interventions using day care centers for pre-school children as a primary delivery system. The study will be designed so that the effects of the interventions can be evaluated separately and together. It will be the main purpose of this study to develop an effective low cost practicable nutrition, health program which will prevent the growth and developmental retardation seen in the Thai village children. The effects of the program on the physical capacity, immunocompetence and behavior of the Thai village children will also be examined.

TULANE.

We plan to do a longitudinal study to determine the relationships between maternal energy (food) intake and fetal growth/breast feeding competence. We will do this first by comparing maternal energy status (=combined availability of energy from the body stores and from the dietary intake), taken at selected weeks of pregnancy, with anthropometric measurements of newborn at delivery. Other maternal variables which can modify baby size - demographic and socioeconomic - will be included in the study. The data obtained from middle and low socioeconomic families of PRIMOPS in Cali, Colombia, will provide a wide enough range of food intakes to allow for appropriate statistical analysis to relate them to the intended measurements. A second approach will be an experimental intervention by which the mother will receive increased food intake and similar measurements will be made. A third approach will be to relate maternal energy status to her capacity to breast feeding by using groups of mothers with and without food supplementation. Maternal milk quality, quantity, lactation patterns and duration as well as weaning practices and effects will be investigated in the mother-child pairs for whom a systematic follow up will be developed. Finally we plan to study the quantity and quality of protective substances present in the milk of mothers and the specific mechanisms by which passively-transformed cell-mediated immunity is accomplished.

A complete list of institutions and personnel named in each grant application is contained in Appendix III-3.

D. Evaluation Process

Grant applications received were each sent to four reviewers: an epidemiologist/statistician, a nutritionist with a medical orientation, a

nutritionist with a basic sciences orientation, and a social scientist/psychologist. Two proposals contained substudy sections of an economic/systems nature and they were also referred to appropriate experts for review of these sections. The peer reviewers, (listed in Appendix III-4), were chosen mainly by recommendation from Steering Group members.

In general, each reviewer received only one proposal, although three reviewers received two proposals and one reviewer received three. Reviewers were asked to disqualify themselves if they felt any conflict of interest concerning the proposal. A copy of the Précis was sent along with the proposal to each reviewer. In addition, a set of criteria reflecting standard National Science Foundation criteria was included at the beginning of each review form(Appendix III-5).The topics and questions on the review form were designed on the basis of the guidelines presented in the Précis. Scoring was done according to National Institutes of Health procedure: a scale of one to five with one being the best and five being the worst score.

Peer reviewers were requested to prepare the review form in duplicate and to send the proposal and one copy of the review to Dr. Leonard Schumann in Minneapolis and the other copy of the review to the University of California at Berkeley. Reviewers assigned to the proposals from the University of California at Berkeley and the University of California at Los Angeles were asked to send the second copy of the review to Dr. Marian Yarrow rather than to the Planning Contractor. The cover page of each review [which identifies the reviewer] was removed to maintain anonymity of authorship.

A copy of each of the proposals plus all site-visit reports were sent to Steering Group members in late April. The members were asked first to consider criteria on which they would base their selection of proposals and to send suggestions to the University of California.

At the May 24-25 Steering Group meeting, criteria for evaluating the thirteen proposals were discussed initially. Each proposal was then discussed by the group; the results of the peer review were presented; and the general reaction of the group was recorded.

Subsequently, each proposal was rated according to twelve criteria on a scale of 1-5 (1 being best) by every steering group member (members were supposed to disqualify themselves where there were conflicts of interest). The twelve criteria were as follows:

(1) Ethics
(2) Peer review
(3) Research design
(4) Data analysis
(5) Individual components
  a) nutrient intake
  b) nutrient status
  c) disease
  d) reproduction
  e) activity/work output
  f) cognitive function
  g) social function
(6) Integration of components
(7) Investigator experience and competence
  a) PI
  b) Co

(8) Budget
(9) Adequate link with appropriate LDC
(10) Extent to which LDC would benefit
(11) Appropriate length of proposal
(12) Overall

After the rating and establishment of relative rank, the steering group approved the following motions:

(1) If two proposals are funded, they should represent two different regions. (Motion by Sandstead; seconded by Galler.)
(2) If three proposals are funded, they should represent three different regions, with the amendment that all projects should have a high degree of scientific merit and a strong association with an LDC. (Motion by Latham; seconded by Sandstead; amended by Greene.)
(3) There should be an attempt to incorporate into the program components that scored well, regardless of proposal's overall score.

Steering Group members were each assigned one or two proposals and requested to write NIH-type summary sheets providing a resume, description, and critique, and evaluation of US investigators, and LDC investigators/institution/suitability. The summary sheet for a given proposal was provided to the principal investigator who submitted the application. Copies of these privileged communications are on file with the Planning Contractor and are available to USAID for official purposes only.

The results of the ratings of each proposal by each steering group member were compiled and analyzed. Considering only the technical research aspects of the proposed projects (research design, data analysis and integration; investigator skills or experience; nutrient intake and nutritional status measures; and studies of the five functional areas), all were found to have merit but three rated far below all other applications and were excluded from further consideration on this basis. Two of the projects rated low because the research proposed was inconsistent with the guidelines and the third because no concrete research plan was advanced to answer the interesting questions posed by the authors. The Steering Group rank order of the ten proposals on technical merit was:

1. Univ. of Connecticut/Univ. of Massachusetts/Yale Univ. Univ. of Miami/Florida International Univ.
2. Tulane Univ./Med. College of Wisconsin/Lincoln Univ.
3. Univ. of California, Berkeley/Washington Univ.
4. Univ. of Arizona/Univ. of Kansas/ARRO/MRI
5. Univ. of California, Los Angeles
6. Univ. of Hawaii
7. Iowa State Univ./INCAP
8. Columbia Univ./Boston Univ./Harvard Univ.
9. Purdue Univ.
10. Harvard Univ./Cornell Univ.

Not one of these proposals rated equally well on all components. Obviously, the top rating projects had fairly consistently good scores but

isolated components of the less well-rated applications in some cases had special merit. Harvard/Cornell rated at or near the top in cognitive development and data analysis components, Purdue in the disease area, and Columbia/Boston/Harvard in reproduction and data analysis.

The quality of food intake measurements is critical to the validity of this research and, therefore, to the ultimate success of the CRSP. Food intake, translated into energy intake, is the independent variable to which all other measures are to be related. Projects that do not take adequate account of food intake could not be entertained. Proposals ranked by the Steering Group in the acceptable range are, in descending order of quality: UC Berkeley; Tulane, Hawaii and UCLA; Arizona; Connecticut; and Iowa. All groups that rated well recognized the requirement to calculate dietary content of protein and micronutrients of importance in the region, as well as energy. In one case (Hawaii) the issue of micronutrient adequacy was given more weight in the design than was energy, an issue that must be resolved with the PI's.

Nutritional status measures are also important, for two principal reasons. Firstly, to take advantage of previous research the same measures must be included in present work as in the past; usually these are relatively easy measures of growth and adult maintenance, i.e. weight and height by age and sex. The second reason for obtaining these measures is to determine what bodily state is achieved by a given diet under prevailing environmental conditions. These measures are needed to begin to address issues such as the efficiency of different foods as sources of nutrients (effects of fiber, tannins, etc.), food wastage due to disease, and the like. Nutritional status is, then, a critical intermediate variable. Steering group rank ordering of the proposals in this area was Tulane; UCLA; Hawaii; Connecticut; and Iowa. The tendency of the Steering Group and also of medical peer reviewers was to rate highly proposals that included more elaborate biochemical measures of micronutrient status as well as simple anthropometric measures. The Planning Contractor believes that investment in expensive biochemical measurements without first determining the probability of deficits based on knowledge of what the diet supplies is unwarranted and should be discouraged. Analysis of foods presents a relatively uncomplicated problem (the number of items is far less, duplicate samples can be obtained easily in case of loss, etc.) and these analyses should be undertaken as a first step. Elimination of measurement of, for example, chromium at project expense should reduce overall CRSP costs. Nearly all proposals made adequate provision for anthropometric measures and thus almost all meet the minimum quality criterion in this area.

Among technical components, the social competency area gave the Steering Group greatest difficulty in scoring. This was at least in part due to a divergence of opinion as to what constitutes social competency, a problem that had also arisen among participants in the workshop held on that topic. (See Appendix II-5.) Some Steering Group members and applicants took a fairly strict behavioristic view, others preferred a broader community/institutional scope. Three applications in particular contained this element and the Planning Contractor requested special peer reviews of the two (Connecticut, Berkeley) that included research plans along these lines. Neither of these special reviews was received in written form by the time of the Steering Group meeting and the Steering Group declined to hear the

orally transmitted review from one of them. Some [illegible] components were not fully evaluated by the Steering Group. Several applications did not address directly the topic of social competency, but included the infant caregiver role set in the context of cognitive development. One application that rated well in this area on the basis of research described offered no demonstrated capability to carry out the research (using previous publication of closely related research as the criterion of capability).

A second functional area in which many applications scored poorly was activity/work performance. This is perhaps a reflection of the more traditional medical mode of much of the overseas and U.S. fieldwork in nutrition which focuses on health and growth criteria and in which performance, if examined at all, is treated in terms of physiological capability. Research has rarely questioned the content, consequences and social and economic significance of the type and amount of activity engaged in and the skill with which it is performed under varying nutrition conditions. Only Tulane, Connecticut, Berkeley and Purdue scored well in this area. The Purdue proposal was unique in linking work performance and information processing parameters.

The functions of disease and reproduction fared better in the applications and the reviews with several scoring about 2 or better. Top ranking proposals in disease were BCM and Purdue with Connecticut and Tulane tied for third place. Hawaii also scored better than average. The focus in most projects would be, appropriately, on study of diarrheal disease. One of the projects, Arizona/Kansas, that scored less well with the Steering Group had some unique components that deserve attention: an emphasis on local definitions of diseases, their cause and cures, and an intent to study dental disease, and bone loss in the aged. The Connecticut group also proposed to sample the elderly population in the disease context, and all ages would be included in the household studies proposed by Connecticut and Berkeley.

Highly ranked proposals for research in the area of reproduction came from Connecticut, Columbia, Tulane and Berkeley. [illegible] and Purdue proposals also rated 3 or better. Among the [illegible] that others ranked highly with the Steering Group, only [illegible] carry very heavily in the reproduction area and a problem there is that no little was proposed. No project indicated an intent to examine reproductive competency of men, except indirectly.

Over half of the applications received scored well in the area of cognition. The highest rating went to Harvard/Cornell, followed by Arizona/Kansas, Purdue, Iowa and Tulane (tied for 4th place), Columbia and Hawaii. Berkeley and Connecticut rated 'good'. The peer reviewers expert in this area did not always agree with the Steering Group judgement. Social sciences peer reviewers gave combined ratings of very good (2) to excellent (1) in the areas of cognitive development and social competency to Berkeley, Harvard, Hawaii, Purdue and Tulane.

Consideration was given to funding small components of exceptional merit in the various applications. One idea was rejected as being counter to the basic concept of the research required to address the issue of food deprivation where it exists. Research design and integration of components are regarded as being of greater importance. Based on these criteria, the Columbia application ranked first with the Steering Group in both areas, Berkeley ranked second, followed by Tulane and Arizona.

Data analysis is the final important section of component of the proposals. Ultimately analytic and data management schemes will need to be agreed on by the CRSP project personnel and, perhaps, management consultations. However, each project needs to have the [illegible] capacity, especially for developing the initial design and data collection/storage/reduction systems peculiar to its [illegible] research approach and facilities available. The Harvard/Cornell group rated far ahead of all others in this area, followed by Tulane, Columbia and UCLA. Connecticut's rating was acceptable and Arizona and Iowa rated about average.

The existence of strengths and weaknesses in the various proposals led the Steering Group to recommend that the Planning Contractor should attempt to attach highly ranked components of lower-ranked proposals to projects that are generally commendable but which could be thereby improved.

Program diversity. The Steering Group strongly recommended geographic diversity within the program. One of the easiest and most logical ways to achieve agricultural, environmental and cultural diversity in the CRSP is initially to place projects in suitable locations in each of the USAID regions. The Steering Group specifically recommended that two projects should not be placed in the same region until program diversity has been achieved. The final rank ordering of proposals by geographic area is given in Table III-2, and Figure III-1 portrays the scores (X100) for the various components of the top-ranked proposals in each region, plus a second well-rated application for Latin America.

E. Initial Recommendations Made to the [illegible] for CRSP Awards

A report entitled "CRSP Planning: Institutional Future and Institutional Competency. Analysis of Research Grant Applications Received and Recommendations for the CRSP" was prepared by the Planning Contractor and presented by her to the IRC meeting held in July, 1978. A summary of the recommendations presented by the Planning Contractor is as follows:

UNIVERSITY OF CONNECTICUT/U. MASS/YALE [illegible]

This application ranked number one with [illegible] technical components and the considerations, [illegible] would [illegible] as a first priority. The proposal was fully developed with Mexican investigators and would be ready to begin as requested (Jan. 1979). The project is sound as presently structured but will be improved by strengthening the cognitive area and data management and analysis. This can be achieved by appointment of external consultants. The budget recommendation includes fees and travel expenses for these consultants. The Planning Contractor suggests investigators drawn from other proposals, and therefore familiar with the research proposed, to serve in this capacity. The project will strengthen significantly both the U.S. and Mexican institutions.

Funding recommended for a minimum CRSP is $761,780 for 24 months from FY80 funds and $507,606 for the 3/4 project year from FY79 funds. Preferred funding is $320,508 in FY80 with four additional years of forward funding is requested in the proposal. Total project cost $2.471 million.

UNIVERSITY OF CALIFORNIA/ASSOCIATES, TEXAS

[illegible] of the University of California's [illegible] research proposals. The Texas proposal rated higher in technical aspects but the UCA linkage in Kenya was already being cited as an [illegible] collaborative research, while the Texas [illegible] and [illegible]

Table III-2

Ranking of Proposals by USAID Region

Of the proposals received, eight locations in the Latin-American/Caribbean region were proposed, two in Africa, three in Asia, and one in the Near East.

Latin America/Caribbean

Connecticut	Mexico
Tulane	Cali, Colombia
Columbia	Sao Paulo, Brazil
Arizona/Kansas	Barbados and Grenada
Harvard/Cornell	Haiti
Iowa/INCAP	Honduras
North Carolina	Peru
Harvard/Cornell	Bogota, Colombia

Africa

California, Berkeley	Tanzania
California, Los Angeles	Kenya
(North Carolina)	(Senegal)

Asia

Hawaii	Thailand
(California, Berkeley)	(Sri Lanka)
Tufts	Thailand
Nebraska	Bangladesh

Near East

Purdue	Egypt

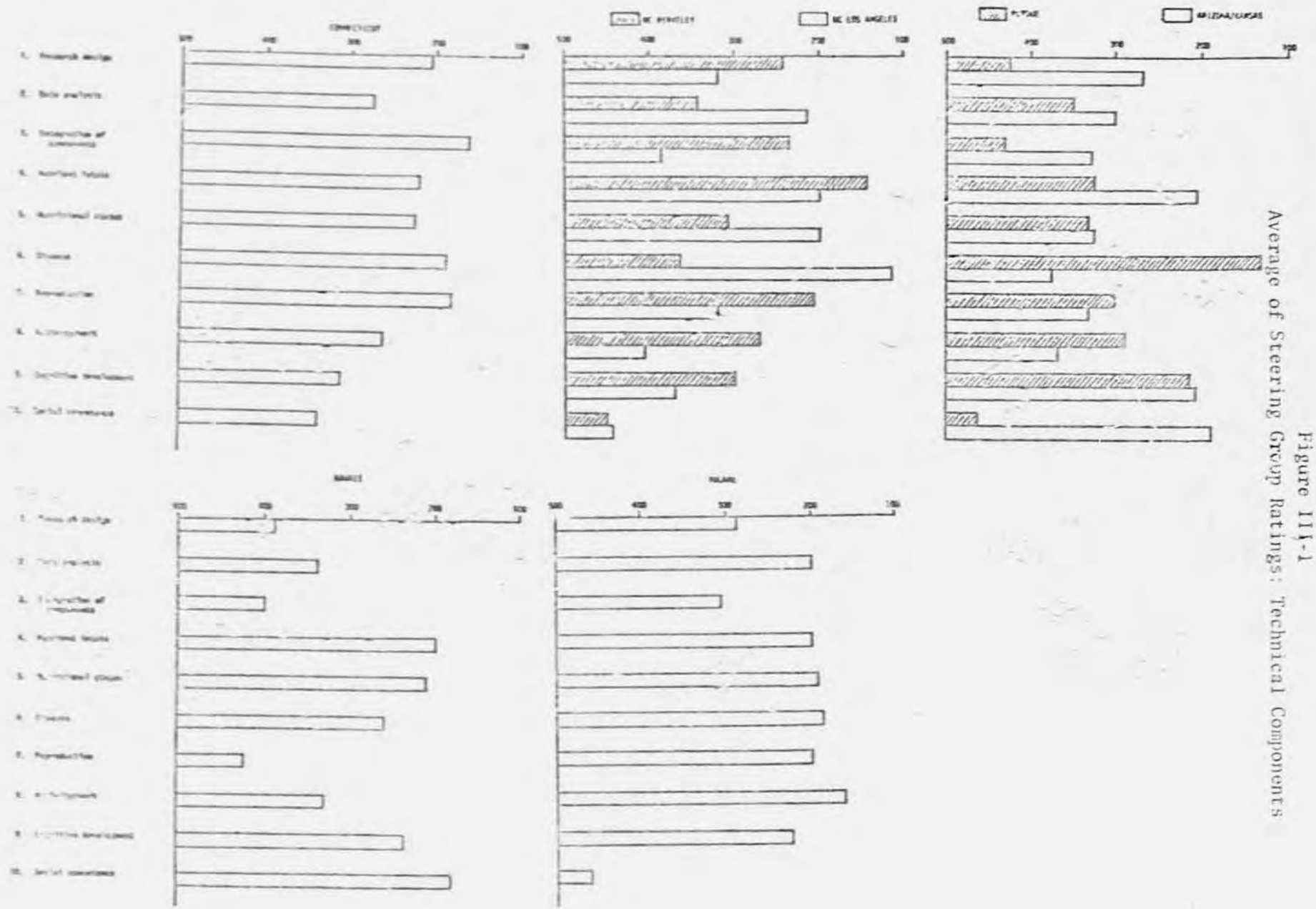

Figure III-1
Average of Steering Group Ratings: Technical Components

ponent ratings indicate that the two campuses have complementary strengths, e.g. UCLA rated number one among all proposals in the disease area and Berkeley scored first in the nutrient intake area. Merging the two research groups yields a project of excellent quality, and this should be done. Because there is only one U.S. institution involved and the investigators are compatible, redrafting of the proposal would require little time. Development of the final protocol with Kenyan collaborators would be relatively easy. (Note that the project could still be based in Tanzania if that were more appropriate to USAID/JRC interests.) Three investigators from Cornell University who have major African experience have indicated a wish to join the UC project and might be included. The integrated UCLA/UCB project should be funded for program geographic diversity. The project would provide major strengthening to the host country including training of professionals as indicated in the UCB proposal. The project will have less impact on the U.S. institutions, as most of the senior investigators will need only to change the direction of their research and the staff projected to spend full-time in the field do not have regular teaching duties.

Funding recommended for a minimum CRSP is $875,002 for 24 months from FY80 funds and $594,000 for the 3rd project year from FY82 funds. Preferred funding is $441,800 in FY80 with four additional years of forward funding. Total project cost: $2.611 million.

UNIVERSITY OF HAWAII/ASSOCIATES: THAILAND

The University of Hawaii's application was the highest rating proposal offering an established linkage in an Asian country. In the interests of CRSP dietary and geographic diversity it should be considered for funding. It was ranked second on overall rating by the Steering Group; however the proposal ranked only 6th on technical components. Substantial strengthening is needed in the areas of research design/data analysis, activity, and reproduction, and the components need to be much better integrated. Some of this may be achieved when the research plan is developed more fully with Thai investigators. However, the proposal already includes one consultant from Cornell University and the Planning Contractor recommends addition of other Cornell personnel for strengthening.

In the area of reproduction possible associates can be recommended from Columbia or UCB. If the Purdue or Tulane proposals are not funded until FY81, one of the groups of investigators in the activity area should be attached to the Hawaii/Thai team for initial strengthening during the first year. Another alternative is for Washington University to participate in the Hawaii project in addition to or in lieu of the University of California project. PC anticipates that revision of the proposal will increase appreciably the lead time required to begin field operations. The project, with collaborators recommended, should strengthen the U.S. institutions involved. The project will significantly enhance Thai capability to attack prevalent nutrition problems, especially if the project succeeds in bringing together the Bangkok-Chiang Mai research groups.

Funding recommended for a minimum CRSP is $404,358 from FY81 funds, for 12 months beginning about October 1980, and $1,008,160 for 24 months

from FY82 funds. Preferred funding is $404,358 in FY80; four additional years of forward funding should be committed as requested if justified by longitudinal components of the revised project plan. Total project cost: $2.439 million.

PURDUE UNIV./UNIV. OF ARIZONA/ASSOCIATES: EGYPT.

The combined Univ. of Arizona/Univ. of Kansas research proposal was ranked 4th by the Steering Group on technical components but only 8th overall because of LDC considerations (Barbados/Grenada). The Purdue application was technically weaker (8th ranking) but had a more highly rated LDC association. The two applications reveal complementary strengths and suggest that the groups could be merged effectively, utilizing the strong disease, (excepting for studies involving nasogastric intubation of children which were disapproved by the Steering Group), activity and cognitive components and LDC linkage from the Purdue group and the nutrient intake, design, integration and social competency features found in Arizona/Kansas. Other components would benefit from consultation, perhaps with Harvard investigators. In the third year, the Kansas group could perhaps be released to initiate a project in the Carribean region. The project would enhance the capacity of the US institutions to conduct interdisciplinary research and would serve as a focus for consolidation of Egyptian nutrition activities.

Funding recommended for a minimum CRSP is $408,119 for 12 months from FY81 funds, to begin about October 1980, and about $1,110,000 for 24 months from FY82 funds. Preferred funding is $408,119 in FY80, with four additional years of forward funding if justified by longitudinal components of the revised project plan. Total project cost about $2.708 million.

TULANE UNIV./MEDICAL COLLEGE OF WISCONSIN/ASSOCIATES: COLOMBIA.

The proposal offered by this consortium was ranked second by the Steering Group in terms of technical adequacy but rated less highly overall because of the LDC site proposed. The Cali group has been the recipient of very substantial U.S. assistance in the past, from the NIH, being designated an International Center for Medical Research and paired with Tulane. The research proposal as it stands could not be transferred to an alternate LDC because much of its strength is dependent upon Colombian colleagues and in-country experience. The Steering Group recommended that two projects could not be located in one region until geographic diversity has been assured in the CRSP. Accordingly, the Tulane project should be the fifth location funded.

This proposal is the only one that includes an 1890 college. Lincoln University has no prior experience of overseas nutrition field work and the proposed association, while commendable in principle, is not integrated into the major work of the project. The separate management function assigned to Lincoln University would not be required when a CRSP management entity is designated, and this entity is unlikely to be Lincoln University because of their lack of experience. The Planning Contractor recommends that Lincoln University scientists be assigned participatory roles in field operations.

This project is unlikely to strengthen either the primary U.S. or Colombian institutions directly because it simply continues a well-developed association. However, the interdisciplinary nature of the project may add

a new dimension and lead to prompt and effective utilization of research findings.

Preferred funding is a 5-year grant of $3.169 million beginning in FY81. The budget assumes that management costs will be borne by a central entity.

OTHER PROJECTS.

To complete the CRSP, at least two additional projects should be included. One of these, a project focusing on a population where main energy source is roots/tubers, could begin in FY82 and require about 4 years for completion, at a total cost of about $2.2 million. The second might be a 3-year study of an exceptional population (e.g., one crop island population, nomadic-pastoralists), to begin in FY83 at a cost of about $1.6 million.

If projects were approved according to these recommendations the CRSP profile would be:

Primary U.S. Institution	Overseas Location	Study Population	Diet Staple
Connecticut	Mexico	Rural	Corn
Hawaii	Thailand	Rural (Urban)	Rice
UCB/UCLA	Kenya(Tanzania)	Rural	Corn/Sorghum/Cassava
Purdue/Arizona/Kansas	Egypt	Rural	Wheat
Tulane	Colombia	Urban	Corn
To be determined	To be determined	Rural/island	Mixed Cereals, starchy fruits, roots, and tubers
To be determined	To be determined	Nomadic/ Pastoralist/ Exceptional	To be determined

This array of projects would provide coverage of the major food crop patterns and includes sufficient cultural and geographic diversity to allow, by comparisons within the CRSP, differentiation of institutional effects from those due to regionally specific confounding factors (diseases, climate, etc.).

FUNDING CONSIDERATIONS.

Few of the budgets were fully developed with respect to the overseas components and institutional indirect costs were computed in a variety of ways. However, all but one of the more complete budgets indicate first-year total costs of the order of $350,000 to $550,000, increasing to about $750,000 to $700,000 in subsequent years when full field operations are in place. Full five-year costs are of the order of $3 million per project.

If the CRSP were to be formulated according to SG recommendations, first year costs for the six top-ranked applications would be approximately $2.7 million (1979$). If the Purdue and Arizona/Kansas projects were fully integrated first-year costs for the five projects would still be $2.1 million. Elimination of Tulane would result in a first-year budget of $1.6 million. Thus one project in each of the USAID regions could be initiated in the first year of the CRSP provided sufficient forward funding for the second and third years of effort is guaranteed. The nature of this research is such that an absolute minimum of three years will be required to generate meaningful results and the return to investment in the research will be severely reduced

unless funding is secured for five years. Unless at least four to six projects are funded, the CRSP will be substantially weakened in terms of interpretive and explanatory power of the findings. For these reasons the Planning Contractor recommended phasing-in projects gradually over the FY80 and FY81, with a guarantee of at minimum, three-year forward funding as each project is initiated.

Management costs can be expected to be at least 15% of total project costs, with the expectation that management will bear the travel expense of Principal Investigators to attend group planning and review sessions and the costs of some special CRSP consultants.

Based on these recommendations estimated total CRSP costs (1979$) were:

Minimum program: four projects, 3 years, $6.26 million or 5 years, $11.32 million. (Table III-3)

Preferred program: seven projects, 3-5 years, $18.71 million. (Table III-4)

The JRC approved the "Recommended CRSP Content" including one project in each USAID region: U. Conn. (Latin America); U. Calif. (Africa); Purdue/Arizona/Kansas (Near East); U. Hawaii (Far East); with Tulane included only if funds permitted. BIFAD authorized, in October 1979, continued program-planning on the basis of the favorable JRC recommendation.

On this basis, the final stages of the official planning phase proceeded by the arrangement of a meeting to convene the US and LDC principal investigators from each of the four projects, plus selected advisors. The purpose of this meeting was to define the core research design encompassing the minimum set of measurements and timing that would be performed by each project within the CRSP. The meeting was to focus on dietary intake and nutrition status measures.

In the meantime, USAID contacted each mission in proposed project locations to determine if the project would be locally acceptable. Only the USAID mission in Thailand indicated nonacceptance. The final scientific planning meeting included representatives from Mexico, Kenya, and Egypt, the U.S. investigators, and external consultants. The senior Thai investigator was included among the consultants to maintain continuity pending additional USAID review.

TABLE III-3

Minimum CRSP Content
as Proposed July, 1979

Primary US Institution	LDC Participant	Dietary Staple	Study Population	Budget, $thousand/fiscal year 80	81	82	83	84	85	Total Budget $Thousand/project
University of Connecticut	Mexico	Corn	Rural	761.8	-0-	507.9	578.7	601.8	-0-	
University of California	Kenya (Tanzania)	Corn-Cassava-sorghum	Rural	875.0	-0-	594.0	609.2	412.0	-0-	
University of Hawaii	Thailand	Rice	Rural	-0-	404.4	1,008.2	-0-	520.8	505.8	
Purdue/ Arizona	Egypt	Wheat	Rural	-0-	408.1	1,110.0	-0-	600.0	600.0	
Management entity				175.0	187.0	230.0	246.0	263.0	120.0	
TOTALS				1,811.8	999.5	3,450.1	1,433.9	2,397.6	1,225.8	

Projected Total CRSP

6,261.4

5057.3

11,318.7

TABLE III-4

Recommended CRSP Content
as Proposed July, 1979

Primary US Institution	LDC Participant	Dietary Staple	Study Population	Budget, $thousand/fiscal year 80	81	82	83	84	85	Total Budget $Thousand/project
University of Connecticut	Mexico	Corn	Rural	320.5 (1/80)	349.5	604.5	578.7	601.8		2,455.
University of California	Kenya (Tanzania)	Corn-Cassava-sorghum	Rural	441.8 (4/80)	554.1	594.0	609.2	412.0		2,611.
Univeristy of Hawaii	Thailand	Rice	Rural	404.4 (7/80)	505.4	502.8	520.8	505.8		2,439.
Purdue/ Arizona	Egypt	Wheat	Rural	408.1 (10/80)	500.0	600.0	600.0	600.0		2,708.
Tulane	Columbia	Corn	Urban		517.2 (11/80)	577.8	635.3	688.3	750.6	3,169.
		Root-tuber	Rural			ca. 500	ca. 600	ca. 600	ca. 500	ca. 2,200
			Nomadic or Island			ca.	ca. 500	ca. 600	ca. 500	ca. 1,600
Management entity				230.0	250.0	270.0	290.0	290.0	200.0	1,530
		Projected Total CRSP		1,804.8	2,676.2	3,649.1	4,334.0	4,297.9	1,950.6	18,712

PART IV

PROPOSED CONTENT OF THE COLLABORATIVE RESEARCH SUPPORT PROGRAM (CRSP)

A. The Nature of the Research Program

B. Core Research Design

C. Projects Comprising the Initial CRSP

D. Future Development of the CRSP

E. Funding Requirements

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PART IV. PROPOSED CONTENT OF THE CRSP

A. The Nature of the Research Program

The initial recommendation of the Planning Contractor was that at least four, and if possible, five, projects be included in the beginning phase of the CRSP, one to be located in each of the four USAID geographic regions. The total CRSP was envisioned as having seven projects, each of at least 3-5 years duration. (See Part III.E.)

The CRSP is designed as a series of research projects, each attempting to answer the same critical questions regarding the relationships between levels of food energy intake and functions of physiological, social and societal importance. However, most of the functions to be assessed are affected by factors in addition to energy intake. Climate and geographic conditions affect what food can be grown, what agricultural work requirements and opportunities exist, when peak agricultural energy requirements occur and under what conditions, and the relative risk of investment in agriculture. It follows that climate and geography affect, seasonally and over time, the food available to a family and the members within it, the spectrum of micronutrient intake, the demand for human work, migration patterns, social stability, and economic welfare. Environmental conditions also affect the kind and periodicity of communicable diseases; and health sector activities are an important potentially confounding variable. Availability and accessibility of potable water and fuel particularly affect the work demanded of women and, to some extent, children, in additional to their normal, expected work requirements for child care, household maintenance and participation in production of family subsistence. Thus environmental conditions, including disease vectors and water and fuel supply, affect activity/productivity patterns, opportunities to participate in educational and community development programs, and social interaction within and between families. Local culture governs the acceptable range of human behavior (who can marry, permissible activities of age/sex groups, family support network, foodways, etc.) and thus determines the response-options available to households and individuals in attempting to cope with stress, including the stress of chronic food shortage.

It is for these reasons that the projects must be located in different geographic areas, cover an extended time period of data collection, and include well-nourished members of the study population. If the results are to be generalizable, the CRSP design must permit multivariate analysis across projects, as well as within projects, so that commonalities can be differentiated from regionally/culturally specific states. In order to do this each project must generate a core of comparable data, i.e., data gathered at the same frequencies and by the same methods. The locally identified functional consequences of malnutrition and its effector networks will be of value in identifying key intervention points for locally appropriate counteraction, of course; but the great worth of the program is in the ability to generate models of intake-function that have wider utility in the development of strategies to alleviate food deprivation and its consequences wherever it exists.

B. Core Research Design

Ultimately agreement must be reached among all the initial CRSP project

participants on what constitutes the minimum required information base: the independent variable (food intake), the key intermediate variables (nutritional status), and the dependent variables (disease, reproduction, activity, cognition, social competence). The principal investigators must decide also what methods will be used and how the data are to be stored, retrieved and analyzed. Principal investigators should not be prohibited from exercising initiative and creativity beyond the core requirements, within the availability of funds and competency of project personnel, provided the additional features do not prejudice completion of the research such as, for example, by limiting participant compliance or taxing local infrastructure.

Of the features requiring CRSP agreement, those that most seriously affect project design and staffing, and thus cost, relate to measurement of the independent and intermediate variables and data management. The last step of the research planning phase was to convene the potential participants to reach agreement on these points. The initial planning effort of the established, funded CRSP will be to reach agreement among projects, regarding assessment of the dependent variables and analytical strategies to permit evaluation of food intake as a dependent variable and disease experience as an independent variable.

A meeting of the U.S. and LDC principal investigators was held December 13-17, 1979. Investigators representing the University of Arizona, University of California (Berkeley and Los Angeles), University of Connecticut, Purdue University, Nutrition Institute (Egypt), Instituto Nacional de la Nutricion (Mexico), and University of Nairobi (Kenya) met with external consultants, Drs. George Beaton (University of Toronto), Leonard Schuman (University of Minnesota), Patrick Francois (FAO), and Aree Valyasevi (Mahidol University, Bangkok). Minutes of this meeting are contained in Appendix IV-1.

The following core design was accepted as a fundamental and initial basis for research by the three participating project groups.

COMMUNITY-WIDE SCREEN. After obtaining informed consent of the community, there will be a systematic collection of information, involving both examination of existing records and collection of de novo information, about communities tentatively selected for study, on the basis of criteria summarized in Table IV-1.

The purposes of this data collection are:

a. to confirm that appropriate communities have been selected;
b. to provide a sample frame for the selection of families to be included in the study; and
c. to provide a baseline description of the community and its situation as it relates to the variables of interest in the research study.

The content of the data collection may be inferred from statements of principles which apply to all projects. The specific content and specific approach to data collection shall be determined in the context of individual projects. However, the initial screen must provide evidence from existing data sources or other rapid assessment that data vital to the purpose of associating intake with outcomes can be gathered. These data ultimately must include features relating to the dependent variables and explanatory

TABLE IV - 1

Criteria for Selection of Communities

Characteristics Sought	Indicators of Characteristic
Stability- to minimize attrition and loss of repeated data collection capabilities and need for follow-up in different settings	Low migration rates, minimal labor translocations. Reasonable assurance of absence of major disruptions of the socio-political milieu of the community.
Homogeneity- Particularly if more than one village needs to be utilized. To reduce variability of biologic variables, divergence of food patterns and family structure and interactions.	Variables not essential to the hypothesis, but likely to confound, are homogeneously distributed across the selected community, (e.g. water supplies and health facilities). Little genetic, ethnic and cultural diversity in the selected community.
Appropriate Size-	Provides either an adequate sampling frame for sample size ultimately determined or, if smaller communities need to be utilized, large enough for a whole population sample (preferably) or: Each of several communities selected must fulfill all criteria and in addition be comparable to each other in vital, ethnographic, demographic and environmental characteristics.
Appropriate Range of Nutrient Intake-	Evidence such as observable status or previous studies provides a reasonable judgement that a suitable range of nutrient intake levels exists in the population.
Adequate Infrastructure-	Sufficient organization to provide continuing communication with the population, to assist in obtaining informed consent, and to assist in maintaining population cooperation to minimize attrition.
Exclusions- Communities which do not satisfy all the criteria above must not be considered for the project.	Other conditions requiring exclusion are a high prevalence of a complicating variable (e.g. diabetes, endemic malaria, voluntary abortion rate), a very low birth rate, atypically high mortality rate among young adults.

factors, such as: birth rates (including demographic distribution of births), abortions, stillbirth rates, perinatal mortality, neonatal and infant mortality rates and causes, fertility rate, birth control practices, lactation patterns; age and sex structure of the population; family and household size and composition; acute disease incidence, parasitism prevalence (infestation by major agents for the community), prevalence (or incidence) of symptom complexes (e.g., diarrheas) where finite disease diagnoses do not exist or cannot be assumed, prevalence of diseases grouped together (such as respiratory) where finite diagnoses cannot be confirmed, causes of mortality by age and sex, health care facilities available; occupational class distribution including seasonality. The initial survey will also define the environmental conditions (climate, geography, water and fuel supply, cultural variables). These data will characterize the community in such a manner that the criteria of selections can be confirmed, including a general assessment of nutritional conditions (e.g., prevalence of specific nutritional inadequacies). This information will facilitate comparisons across projects and may serve as a determinant of specific, recurring, nutritional assessments which must be included within the research design of specific projects for the statistical control of potential confounding variables in data analyses.

It is seen as desirable that over the course of the multiple-year study the general situation of the community be monitored through repeated data collection. The objectives would be to provide an assessment of general changes taking place in the community during the period of the research and to provide a base for public health action programs that might be implemented in that community following completion of the research program.

III SAMPLING FRAME. The prime objectives of the research relate to the examination of the relationships between total food intake and a series of functions, with particular reference to the range of mild and moderate under-nutrition, so it is essential that the study population include an appropriate range of the independent variable (and of the dependent outcomes). It is probable that from the standpoint of efficient research design, certain segments of this range will be overrepresented in the community. Therefore, it would seem desirable to plan for differential sampling ratios across strata of the population. Such stratification would be for the purpose of selection of a study population, it would not be a continuing stratification of study design or data analysis.

A two dimensional stratification is planned.

For primary stratification, measures of nutritional status reflective of energy shall be employed. These may include such measures as height, weight for-height, other anthropometric measures, family food intake, etc. In the well-nourished stratum it would be desirable to include families in which there is reasonable assurance that all existing family members are well nourished. At the opposite extreme it would be desirable to exclude families with very serious nutritional disease (severe malnutrition) as a general pattern, this may imply rejection of families with more than one member with weight-for-height below 60% of reference standards or other analogous criteria. Families not excluded by such criteria (or other criteria as described below) will be ranked or stratified by discriminant analysis approaches, adding variables as required to obtain what is judged to be, for

that community, an appropriate scaling of apparent family nutritional state.

Secondary stratification will then be attempted in each nutritional stratum in order to differentiate by socioeconomic variables (e.g., housing, occupation, income, etc.). This may not be necessary in communities where socioeconomic homogeneity prevails to such an extent that the socioeconomic factor(s) would not confound the independent variable. But its use as a basis of sampling will strengthen the research design by facilitating a separation of effects of food intake from those of socioeconomic variables during data analysis (e.g., multivariate analyses).

The sampling frame might take the following form:

Household Nutritional State

		WELL NOURISHED		...	....		SEVERELY MALNOURISHED*
Family Socioeconomic Status**	HIGH			...	....		
	LOW			...	....		

*Excluded

**Scaled within nutritional state stratum; will not necessarily have a common definition across strata

The sampling ratio will be a function of:

(a) the total sample size needed for data analysis,

(b) the expected attrition rate, and

(c) the number of individual households within each cell.

In the final study population, each cell would contribute an equal number of families/households.

For the purpose of the present design, certain characteristics of a family/household will determine inclusion/exclusion [illegible] sample frame. These include:

(a) only a small proportion of non-fertile families, not actively reproducing, should be included [illegible] increases in sample size requirements [illegible] fertility component);

(b) households containing members with severe nutritional or other diseases, apparent on clinical examination at the time of initial screening, should be excluded;

(c) households representing atypical cultural, [illegible] genetic characteristics for the selected [illegible] should be excluded.

After the community data have been collected, and before the household selections have been made final, the precise criteria proposed in each project shall be reviewed.

The households must be selected in analogous fashion across all country studies. "Volunteer" households should not be accepted as this may introduce the bias of differences in their characteristics from the general pool of households and particularly from those who refuse to participate.

The households must be willing to undergo repeated examinations and surveillance and give informed consent.

For specific [illegible] additional samples may be [illegible] the above or other criteria, [illegible] exploratory research [illegible]

ELEMENTS OF THE CORE RESEARCH DESIGN. Features of research design to be incorporated in all projects are based upon a tentative sample size of 200 families (1000-1200 individuals) living in one or more adjacent communities. This sample size considers the anticipated number of events (births, disease episodes, deaths, etc.) that might occur over a two-year study period, the probable demographic structure and thus age representation of the study sample, and the opportunity for observations over time (e.g. growth rates) as conditioned by the independent variable and by such natural phenomena as seasonal, agricultural and economic cycles. The sample size needs may be modified upward or downward as further information is gained during Phase I and during the initial stages of the research about such matters as the actual variability of both independent and dependent variables, birth rate in the selected families, mortality rates, and frequency of occurrence of infections and other events having analytical significance. The initial sample size must be increased in accord with expected attrition rates; this will be subject to adjustment in the light of experience in the particular project.

If it is subsequently deemed that the selected sample size is too small to detect observed relationship with sufficient certainty, two options remain open. The design selected permits the addition of more families (increased sample size) during the study. The design permits also the extension of observation of the same families since many of the relationships may be expected to be repeated in subsequent yearly cycles (increased duration). A reassessment of the adequacy of sample size will be made within the first year of operation.

This approach is deemed preferable to a prolonged prior study designed to test certain of the assumptions over time, as it is more economic of time, effort and expenditure.

Table IV-2 provides a preliminary estimate of the numbers of pregnancies and cohorts for growth rate or other longitudinal measurements, even assuming the necessity to analyze these over time sequences (e.g. first in certain seasons with disparate nutritional or infectious disease patterns). It is anticipated that common infectious disease episodes (e.g. diarrhea) will occur with a frequency of 5-10 events in the first year of life and somewhat less frequent in older ages. The two-year time frame provides for repetition of phenomena recurring on a yearly cycle. It is also of sufficient length to provide at least minimal observation of a complete reproduction cycle in many of the reproductively active women (average birth intervals for the selected regions appear to be 24-27 months).

Although individual members of family or household may ultimately be singled out for intrahousehold or intervisitation expansions, the basic analytic approaches must continue to consider the family or household as an interactive unit. Thus this unit must be held intact for observational purposes throughout the study.

The scheduling of observations begins well in the core research design to run a 3-month cycle. That is, all core measurements will be made in phase such that analysis by seasonal 3-month groupings can be undertaken. A major determinant of this 3-month cycle has been consideration of the precision of the estimate of the independent variable, food intake. Preliminary data suggest that it may be feasible with the population, representative of weekly intake in food intake, [illegible] to provide a reliable estimate of usual intake. [illegible] a three month [illegible] for the determination of "usual". The [illegible] in the determination of [illegible] with growth,

Table [illegible] - Projected Numbers of Births and Cohorts for a Sample of 200 Families Over 2 Years

Months of Study \ Age	Births	0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23
0-2	12	11.4 (0.6)	-	-	-	-	-	-	-
3-5	12	11.4 (0.6)	11.1 (0.3)	-	-	-	-	-	-
6-8	12	11.4 (0.6)	11.1 (0.3)	10.8 (0.3)	-	-	-	-	-
9-11	12	11.4 (0.6)	11.1 (0.3)	10.8 (0.3)	10.5 (0.3)	-	-	-	-
12-14	12	11.4 (0.6)	11.1 (0.3)	10.8 (0.3)	10.5 (0.3)	10.25 (0.25)	-	-	-
15-17	12	11.4 (0.6)	11.1 (0.3)	10.8 (0.3)	10.5 (0.3)	10.25 (0.25)	0.0 (0.25)	-	-
18-20	12	11.4 (0.6)	11.1 (0.3)	10.8 (0.3)	10.5 (0.3)	10.25 (0.25)	10.0 (0.25)	9.75 (0.25)	-
21-23	12	11.4 (0.6)	11.1 (0.3)	10.8 (0.3)	10.5 (0.3)	10.25 (0.25)	10.0 (0.25)	9.75 (0.25)	9.50 (0.25)
Total with complete history from birth	96 in age	91.2 (4.8)	77.7 (2.1)	64.8 (1.8)	52.5 (1.5)	41 (1.0)	30 (0.75)	19.5 (0.5)	9.5 (0.25)
	19 cohort	(4.5)	(6.3)	(7.2)	(7.5)	(7.0)	(6.0)	(4.5)	(2.5)
3 month cohort [illegible] study	24	22.8 (1.2) (1.2)	19.5 (0.3) (1.6)	16.2 (0.5) (1.8)	13.1 (0.4) (1.9)	-	-	-	-

Footnotes to Table IV-2

[1]Assumptions of model

attrition rate : 0 (on decision, sample size will increase)

birth rate (live births) : 48/100 couples/year in study population (selected as reproductively active)

death rates:

0-3 months	50/1000 live births
4-12 months	25/1000 live births
1-4 year	25/1000 population

[2]Other cohorts, starting with individuals included in the study population at time 0 will be available.

Total deaths 2.5 = 20.8%

pregnancy and similar physiologic conditions) and logistic feasibility (imposition on the family). The actual schedule may be modified in the light of preliminary experience; but the principle of phased, recurring observations will be observed.

The design provides for concurrence of measurements on all family members. This will be necessary if data are to be linked across members (as in the portrayal of profiles and relationships) and over time and with other events.

The design provides for a core of measurements, to be conducted in a scheduled manner in all projects (Figure IV-1). These are the minimal measurements that must be made (a) for longitudinal observations of food intake and functional outcomes, and (b) for inter-project comparisons and data aggregations. The details of a number of these observations will be decided by the collaborating investigators prior to implementation. Preliminary suggestions have been included in the project proposals.

In addition, it is anticipated that special studies of particular functional outcomes, the results of which may be linked at the data interpretation level to the core measurements, will be undertaken on sub-samples of the population or at particular points in time. Some of these will be common to all projects, some will be unique to a particular project. The former reflect the need for more specific information and are scheduled differently to reduce costs, manpower requirements and family intrusions; both the method and schedule for these observations will be determined by inter-collaborator consultation. The latter type of measurements reflect special competencies and interests of individual project participants. While they will contribute knowledge relevant to the goals of the program, it is not necessary that they be repeated in every project. The nature of these special studies is set forth in the individual project proposals (Appendices IV.2-5). Before implementation, final consideration will be given to these to ensure that the special projects as implemented would continue to have scientific merit, would contribute to the goals of the program and would not interfere with the core research design (particularly including any probable effect on continuance of family participation in the core design).

CORE MEASUREMENTS. The focus of measurement is the individual within a household. An extension, for some aspects of the research, is the household within a community and an ecological setting. A definition of household will be developed to encompass the structures of such among the several communities collaborating in this research. The independent variable of primary interest is food intake measured as energy intake. A related interest is the quality of the diet consumed (nutrients), the energy density of the diet consumed, and the source (commodities) of the energy consumed. In the case of lactation, information about the quantity and quality of breast milk is needed both as an independent variable (infant intake) and as a dependent variable (lactating woman's secretion).

The intended data analyses require linkage of data at the level of the individual, the household, and the community.

Food intake. Food intake is the primary independent variable. Reliable estimates of intake are needed at the level of the individual. Two aspects of methodology affect the design -- variability of intake from day-to-day (intraindividual variation) and method of collecting data on a particular day.

Estimates of intraindividual variation in industrialized societies suggests that it is about 25% of the mean for energy. On the basis of this estimate a standard error of about 10% would be obtained in the estimate of

Figure IV-1 Core Research Design:
Minimum Measurement Cycles

12 months

x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
		o						o						o						o				
x						x						x						x						x
o		o		o		o		o		o		o		o		o		o		o		o		o
x						x						x						x						x
o		o		o		o		o		o		o		o		o		o		o		o		o
x			x			x			x			x			x			x			x			x
		o		o		o		o		o		o		o		o		o		o		o		o
x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Food intake* - 2 weeks -

Breast-milk intake
- 3 months -**

Anthropometry (adult)
-3 months-

Anthropometry (to 2 yrs)
-1 month-

Height (2 yrs - 20 yrs)
-3 months-

Anthropometry (pregnancy &
-1 month- lactation)

Behavior/activity profil
-6 weeks-

Mother-child behaviour
-1 month- (to 2 yr)

History of disease
-2 weeks-
(record marker events,
breast feeding)

* In second week. Particular days scheduled to balance days of week in 3-month cycles.
** In fourth week after birth and 3-month intervals thereafter until weaning.
NOTE: Above describes intervals for an individual family. Across study population, families would be phased to distribute load. Cycle to be repeated in the second year.

usual intake with 6 independent observations reasonably representative of the days of the week. In the absence of information on intraindividual variation in the study communities, the above estimate has been used in design planning. In Phase 1, estimates of intraindividual variation will be obtained (by analysis of variance of repeated observations on a limited number of subjects of appropriate age/sex/socioeconomic groupings). The frequency of observation in the experimental design (Figure IV-1) will be adjusted to the findings in each community.

The methodology of food intake measurement in the core design will involve 24-hr. recalls and weighing/measuring at the time of consumption. These different techniques of intake measurement may yield different results not only for individuals, but also across cultures. It is not possible to validate either measure against a reference standard. Therefore it will be important to conduct a pilot study at each site to determine: a) the magnitude of difference between food intake data obtained by recall method compared to the weighing and measuring method, and b) for each method, the number of measurements required to produce a valid estimate of caloric intake.

Validity, for these purposes, will be defined as an acceptable ratio of intra-individual to inter-individual variance, or the magnitude of change in the mean ± standard deviation for each individual when an additional observation is made. For each project, the frequency with which each measurement must be made will be determined by a) the short term food cycle of a household (resulting from cycles in purchasing practices and income, etc.), b) the seasonal food cycle, c) the results of the pilot study, and will comply with minimum periodicity specified by the core design.

If the recall and weighing methods yield substantially similar results, the number of the more time-consuming and costly weighed observations may be reduced. If the day to day variability in individual food intakes is low, then the total number of observations may be reduced.

In a subsample of the study population, special events such as illness may provoke the need to follow food intake of a specific individual for several consecutive days. This will provide valuable information on the effect of illness on food intake. Events such as pregnancy and lactation may also require more frequent observations.

Determination of food patterns, behaviors and beliefs requires study not only of individuals, but the households and communities in which they live. Reasons for food patterns will be sought in sociocultural terms, and information on these patterns will be obtained collaboratively by anthropologists and nutritionists.

1) Food measuring and weighing. For this technique, all eating activities of each household member will be observed during an entire day. All food and liquid consumed by each individual will be measured or weighed. The interviewer will enter the house, unannounced if possible, before the first meal of the day. At the kitchen level all ingredients, including water, will be measured or weighed before they are cooked. This will provide a close estimate of the final composition of a mixed dish. If food is provided to each family member as a serving, the size of each food item in the serving will be measured or weighed. If food is served in a communal pot, the investigator will count the number of spoonfuls, handfuls, etc. the person takes from the container; the amount of food represented by a spoonful or handful will be measured in each case. At the end of each meal measurements will be made of the amount of food left unserved and the amount of each food left on individual plates; the fate of this unconsumed food will be recorded.

Weighing of foods on a gram scale, or precise measurement of liquid vol-

umes, is a relatively time-consuming process. For this reason, weighing and precise measurement will be routinely used only at the kitchen level of food preparation and for plate waste. In order to minimize interference and delay in food consumption, food served on plates will be estimated after weighing the quantities represented by the cups, spoons, and other utensils used to serve the food. With practice, the investigator should become skilled at "measuring by eye" amounts of food and liquid served. These estimates will be checked by weighing or measurement at regular intervals.

Household members who are absent from the house during the day will be questioned about food consumed outside the household. If the amount of food eaten by an individual outside the home is large, or difficult to estimate reasonably, the intake for that day will not be used in data analysis.

It should not be necessary to collect frequent food samples from a household for nutrient analysis, since the proportions of individual ingredients in mixed dishes will be measured prior to cooking. However, collection of samples will be necessary if the meal was not prepared in the presence of the interviewer (e.g. if it was prepared on the previous day, brought to the household as a gift or purchased, etc.). Because water loss is significant during cooking, the pot and contents should be reweighed shortly before serving.

Since the weighing and measuring technique requires an interviewer to be present in a household for an entire day, this time can also be used for appropriate observations or questions on behavior of household members, such as activity, morbidity, social competence, etc.

2) 24-hour recalls. The 24-hour recall is a rapid, and therefore potentially efficient, technique for estimating food intake. Recall data will be obtained by interviewing all members of the household able to report responsibly (age >12 years, alert,etc.) about their food intake during the previous day. This interview will occur during the day of weighing and measurement in order to minimize the number of interviewer visits to the household and to increase the likelihood of contacting each household member. Mothers will be asked to provide the information on food and fluids consumed by infants, children, or other household members unable to report responsibly. Whenever possible, estimates of quantity will be improved by referring individuals to containers or food samples available in the household. All members of the household will be interviewed on the same day so that individual intakes can be aggregated to provide a household average intake figure and distribution pattern.

The person who prepared the meals for the household will be questioned about the types and amounts of foods served. As a check, the amounts reported as served should be similar to the [illegible] of the amounts consumed at home in the recalls of individual family members.

3) Intake by infants. Intake of breast milk by infants can be known by weighing them before and after each feeding. A local worker will carry out and instruct the mother in this procedure during 12 daylight hours. If it is locally acceptable, a worker will remain in the household for the 12 remaining hour to continue the observation, if not, standardized automatic infant scales with prints out will be left in the house overnight for the mother to use and these data will be coded separately. The technician and the mother will record the food or fluid given to the baby during the 24 hours. A milk sample will be obtained by completely emptying one breast with a pump at the end of feeding while the baby suckles at the other breast. A sample of his/her milk will be placed in a sample bottle for later analysis and the remainder will be placed in a clean nursing bottle and fed to the infant.

Supplementation of breast-milk is an important topic of study. Records will be kept of all foods and fluids given by any person in the house to breast-fed infants and weanlings on all occasions when food intake is measured. On days when infants are being test-weighed these supplementary feeds will also be weighed. The frequency and source will be noted and inquiries made of the mother as to the reason for supplementation and selection of specific foods. When infants are weaned from the breast, records of milk-substitute and other food intake will be kept on the same schedule as other family members (i.e. every 2 weeks). Observation will be made of cleanliness in food preparation, and hand- and body-washing practices to determine the likely relationship of aspects of sanitation to the occurrence of diarrheal and other common diseases.

4) Calculation of energy and nutrient intake. All quantified food intake records will be coded for computer analysis of nutrient content. The compositional data to be entered will be derived from local food tables, supplemented by international tables and, as the project progresses, by analysis of food samples. Initially, values will be entered for water, ash, protein, fat, carbohydrate, energy, calcium, phosphorus, iron, vitamin A (retinol equivalents including carotenes), vitamin C, thiamin, riboflavin, niacin, and vitamin B12. As the project develops, an attempt will be made to complete entries for dietary fiber, zinc, copper, folacin, and vitamin B6 for at least the dominant foods used.

If the digestibility of the major energy and protein sources is not known, a series of representative diet composites will be made. These will be fed to rats to determine true protein and energy digestibility and net protein utilization by accepted standardized methodology.

5) Nutrition history. Open-ended questioning will attempt to reconstruct nutritional life experiences such as crop failures, natural disasters, family economic problems and periods of nutritionally disturbing illnesses. Such a history should be obtained for each individual in the study population in the course of the 2-year investigation. Results of interviews to specific queries may produce a more structured set of repeatable questions for subsequent use by the nutritionists and/or other team members who have received initial training from the nutrition supervisors in types of answers to seek.

Anthropometric measurements. Height, body weight and indices of body composition (triceps, biceps, suprailiac and subscapular skinfold thicknesses and arm circumference) will be measured as indicated in Table 3, using the following methods.

1) Height. Length will be measured to the nearest 0.1cm for children up to 36 months, and height will be measured in older children. Portable, rigid height/length boards of 120cm length, locally made, would be suitable. This instrument can be folded in the center and conveniently transported on a bicycle luggage rack.

The adult scale should have a sliding measuring rod for height estimation which suffices for height measurement to the nearest 0.1cm, to be used for persons over five years of age. It is only necessary to measure adult stature twice, the second as a cross check for the first.

2) Weight. (lightly clothed, without shoes). Weight will be measured to the nearest 0.1kg for children up to five years of age. The scale must

Table IV-3

Core Anthropometry Measurements

Group	Measurement	Frequency
newborn	birthweight* length head circumference	once within 24 hours of birth
first year 0 - 12 months	weight length head circumference iliac crest to heel length	monthly
second year 13 - 24 months	weight length head circumference arm circumference skin folds**	monthly
prepubertal 2 - 11 years	weight length-height arm circumference skin folds**	every 3 months
	head circumference	initially then once/year
puberty 11 - 18 years	weight height arm circumference skin folds**	every 3 months
	head circumference	initially
adulthood > 18 years	weight arm circumference skin folds**	every 3 months
	head circumference height	initially
pregnancy	weight arm circumference skin folds**	upon detection of pregnancy and monthly thereafter
lactation	weight arm circumference skin folds**	monthly through weaning***

* Dubowitz exam for all infants < 2800 grams
** Triceps, biceps, suprailiac, subscapular
*** Weaning = breast feeding < 3 times per day

be reliable for fieldwork, sturdy, durable, easily transportable, available at low cost. A basket should be used for very young children and trousers for those age one to five years. Variability in day-to-day weight measurement may be as much as 0.2kg, due to non-nutritional factors (food, feces and fluid).

An adult scale would be suitable for older children and adults. During measurement the knife edge position needs to be checked and the double reading area requires added care. Checking at zero must be done prior to every session and whenever the scale is moved. Scales must be frequently calibrated using reference weights.

3) Skinfold thickness. Subcutaneous fatfold will be measured to the nearest 0.2 or 0.5mm, depending on the instrument used. Precision calipers include the Lange, Harpenden and Holtain-Tanner/Whitehouse. The Lange caliper may be preferable because it is available in the U.S. However, the other two have a larger scale face so that calibrations are of smaller dimensions (0.2mm).

Surveyor performance must satisfy rigid trial criteria before these measures will be considered. In addition, the project must be sensitive to the possibility that frequent fatfold measures in young children may compromise their cooperation for other more important tests. Fatfold measurement reliability is far better within than between observers. Hence the number of surveyors for this study must be kept to a minimum, especially for fatfold.

4) Circumferences. Head and upper arm circumferences will be measured to the nearest 0.1cm using either flexible plastic coated steel tapes or Zerfas insertion tapes. A suitable, wider tape will be devised for arm circumference of neonates and young infants. This is to reduce errors in this age range due to the difficulty in maintaining a reliable tension.

Measures of actual gestation length will be available from the menstrual history solicited on a continuing basis throughout the study, at least for pregnancies conceived after the study begins. The age of puberty will be documented retrospectively on the basis of peak height increase velocity in boys and menarche in girls. For this purpose, inquiry about menarche will be made at 6-month intervals after the age of 10 years.

Other indicators of nutritional status. The very minimal set of hematologic and biochemical indicators agreed upon are listed in Table IV-1. Other measures regarded as highly desirable (but not mandatory if blood sampling limits participation or compliance) include serum transferrin, alkaline phosphatase activity, iron and ferritin. Analysis of blood or urine for parameters of vitamin and mineral status is to be undertaken only if there is presumptive evidence of deficiency from dietary analyses or previous nutrition studies of this or very similar communities, as these assays add appreciably to project complexity and cost.

Local workers are to be trained to identify simple, routine signs of nutritional deficiency and these are to be recorded whenever anthropometric measurements are made.

Protocols are also to quantify major local species of parasites (and ova if indicated) in participants' feces, initially and annually, because of the important relationship of parasitism to nutrient utilization and requirement.

Table IV-4

Other Indicators of Nutritional Status to be Recorded

Indicator	Minimum Frequency
Clinical signs/symptoms of nutritional deficiency	Initially and with anthropometry
Hematocrit, RBC morphology, serum albumin	Initially and two times per year
Urine osmolarity/specific gravity	Adults -- seasonally and, in lactating women, when breast milk output is measured
Urine 24-hour creatinine	Lactating women when breast-milk output is measured
Serum/blood/RBC/urine levels of vitamins, minerals (especially vitamin A, carotene, folacin, vitamin B-6, B-12, riboflavin, thiamin, iron, zinc, copper)	As indicated by clinical signs, probable intake, or previous experience.* If indicated, once per year.

* Individual projects should regularly measure status of those vitamins, minerals, etc. found to be significantly low in 20% or more of the population.

Subroutines. Special protocols will be initiated when predetermined marker events occur. These include at least the following:

1) Birth - weight, length, maternal postpartum weight, health status of mother and child, Dubowitz examination for infants under 2800g. A behavioral/activity pattern study will be initiated.

2) Lactation- breast milk volume and composition studies as per previous description.

3) Deaths - solicit history and record apparent cause of death. A behavioral/activity pattern study will be initiated.

4) Pregnancy- selected measurements and behavioral/activity pattern studies will be initiated and will continue through lactation.

5) Disease - for a selected sample of disease events, distributed across families, a special subroutine to include records of the disease, food intake and behavioral/activity pattern studies will be initiated.

Behavioral profiles. The core measurement of the social scientists will be the pattern of activities and interactions of and among individuals and households. This profile will be developed in conjunction with both the measurement of energy costs of activities and the measurement of social competency.

SPECIAL STUDIES. At appropriate intervals, and on the occasion of selected events affecting the community, detailed and more intensive studies will be undertaken. These will serve to provide more explicit understanding of the phenomena recorded in core measurements (e.g. detailed measures of work capacity and activity analyses, detailed behavioral studies, measures of cognitive development, etc.). They will serve also to provide more complete documentation of the effect of community-wide events. For example, in the agricultural cycle there are often sharp peaks in work requirements which may occur in different phases of the cycle of food supply. It will be appropriate to study in detail the patterns of activity, behavior, maternal-child interactions and related topics at these times.

The decision on minimum measurements of dependent variables to be included in all projects will be decided by collaborative discussion among project leaders when the CRSP is funded.

As noted previously, individual projects intend to add supplementary studies which are unique to that project. The content of such special studies is suggested by the proposals for individual projects (Appendices IV 2-5). Such intensive studies are demanding of time, both for observer and subject. They will be applied to subsamples of the population and will be designed to impose minimum burden upon the participants.

APPROACH TO DATA ANALYSIS. The research design (schedule of measurements) has been developed with certain approaches to data analysis in mind. The objectives of these analyses will be to document:

(a) the relationship between the independent variable, food intake, and the dependent functional variables;

(b) as far as possible, the directions and significance of pathways linking the variables (including linkages between the functional variables) (c) the influence of these variables on food intake (recognizing that there are relationships in which food intake is a dependent variable and one or more of the functions are independent variables)

(c) as far as possible, the nature and importance of family dynamics, particularly as they affect and are affected by the other variables.

Moving cohort analyses, for cohorts of 3 months or multiples thereof, will permit examination of the effects of cyclic events (season, agricultural cycles, etc.) on food intake, growth rate, disease patterns, etc. Since these cohorts can be shifted by one or two months, they will provide also an opportunity to track events and infer causation (time-lapse analyses).

Repeated cross-sectional studies with data aggregated for 3-month periods (the measurement for reliable food intake estimates) will provide family profiles which can be compared across time. Since the same families will be involved, in many instances paired analyses can be undertaken to assess the impact of changes in family structure(such as a birth,a death, or a growing child) or of a seasonal change.

Retrospective case matching can be undertaken to establish differences at the level of the individual (e.g. differences that may have existed between children, matched by birth characteristics, who subsequently differed in regards to nutritional status or one of the functional outcome variables).

Correlation analyses will provide preliminary documentation of probable relationships. These may then be examined by more detailed approaches. The relative contributions of each of a range of variables may be examined by discriminant analysis, factorial analysis, multiple regression, and other multivariate techniques. Regression analyses will provide information about the gradient (slope) of the relationship between the dependent and independent variables. Path analysis may illustrate the probable direction of relationships.

Frequency studies (as for infection), birth interval studies, lactation duration studies can be conducted as general descriptors and as analytic tools when families or individuals are grouped by other characteristics.

The point to be made is that the schedule of measurement in a repeating moveable cycle and the semi-longitudinal nature of data collection permits a range of analytic approaches. This range of analytic approaches in turn implies that a great deal of information can be extracted from the data generated in the study. That is, consistency of results across different types of analyses may be as important, or even more important, for interpretation than for statistical significance in a particular type of analysis.

The existence of multiple projects, in differing ecological settings with coordinated and standardized data collection permits data analysis to address a number of questions that may be difficult to answer within a single project. Some examples are cited below.

Are relationships observed between energy intake and a function consequent to an associated variation in intake of a limiting nutrient? If similar changes are seen in diets of quite different composition, this is very unlikely.

What level of caloric density limits energy intake of young children? The range of energy densities will be greatly increased in an interproject comparison with the very different typical diets.

Is the incidence or severity of diarrhea (or other class of disease) [illegible] due to diet or to infection exposure? This may be subjected to [illegible] intraproject seasonal studies and further examined by interproject [illegible].

What is the relation between diet and breast milk volume and composition? [illegible] relation may be affected by complementary feeding practices [illegible] working mothers to secretion). Complementary feeding [illegible] attitudes. Interproject analyses will permit a more [illegible] of these questions.

A requirement of all projects is standardized definitions and standardized methods of data collection for all variables that are to be included within interregional comparisons. In data analyses, interregional differences in relationships will give indication of potentially important cultural or biological differences between regions. Recognition of these differences, where they exist, will be of great significance in generalization of data interpretation that might form the basis of design of later intervention programs.

DATA REDUCTION, STORAGE AND RETRIEVAL. Efficient methods of collation, reduction, and storage of data must be developed by each project team in coordination with the other project teams so that analysis can proceed in a timely manner. Further, there must be ready access to data files within and across projects. Each project will wish to have its own analytic capability, but there must also be a central capability available to all projects as a reserve, for efficient between and across project analyses and to provide cost-sharing of expensive systems. Decisions must be taken early by the CRSP participants regarding hardware and software requirements so that data may be analyzed concurrently or sequentially by any project team or by management. Each project team, of course, would have priority in the analysis of that team's data.

C. Projects Comprising the Initial CRSP

Following approval in principle by the JRC and BIFAD, the planning contractor proceeded with development of one project in each USAID region. This development included restructuring and realigning so that desirable elements from several proposed projects would be incorporated into the initial four projects to be funded in 79/80. Three of the projects are ready to be implemented: Mexico, Kenya and Egypt. Development of the fourth project, proposed for Thailand, was deferred when the local USAID mission denied approval.

Each of the projects incorporates [illegible] all the features mentioned in the first section of this section, [illegible] and additional features as described in the [illegible] procedure. The measures of dependent variables proposed are [illegible] so that core components [illegible] to be decided by the group [illegible] the [illegible] to include at least the following [illegible]

[illegible] activity pattern during [illegible] and composition); [illegible] growth rate, infant feeding [illegible] over time

[illegible] and upper respiratory [illegible] illnesses, mortality, days [illegible] and food supply, family

[illegible] agricultural and wage [illegible] women, children and [illegible] facilities; energy

Social competency: parent-child interactions; food available to household, intrafamily distribution, and subsistence management strategies.

As each project must hire and train staff and each is to begin with an ethnographic survey/community-wide screen there is ample time to permit development of consistent forms/standards/procedures relating to the dependent variables. If the projects begin field work in staggered sequence at about 2-3 month intervals, this would allow pilot testing of instruments and procedures.

Projects recommended for funding are described in brief below.

PROJECT I: MEXICO. (See Appendix IV-2)

The principal U.S. institution is the University of Connecticut, with co-principal investigators Gretel Pelto and Lindsay Allen. The only Mexican institution involved is the Instituto Nacional de la Nutricion, Mexico City, with principal investigator Adolfo Chavez, M.D. Other U.S. institutions that will participate through senior scientific staff are the University of Massachusetts, Yale University, and Massachusetts Institute of Technology.

The original proposal by the University of Connecticut rated very highly with peer reviewers and the Steering Group. Recommended additional strengthening in the disease and statistical areas has been achieved by recruitment of staff within the institutions originally named. (See the proposal appended.)

In addition to the core measurements, other features of this project include:

(1)identification of relevant local behaviors and conditions as well as local idioms,

(2)description of the social and economic organization of the community,

(3)periodic weighed food inventory and observation of all eating episodes,

(4)observation of all activities in a household,

(5)identification of the effect of ritual events on nutrient intake,

(6)immunocompetence testing,

(7)formulation of a life-span picture of intellectual functioning,

(8)development of a typical community social profile, using key informants from different social groups,

(9)investigation of energy production, consumption, and expenditure (energy flows),

(10)definition of functional competence of the elderly.

PROJECT II: KENYA (See Appendix IV-3)

The principal U.S. institutions are the University of California, Los Angeles, and the University of California, Berkeley, with co-principal investigators Charlotte Neumann and Doris Calloway. (If the prime contracting institution for the CRSP becomes Berkeley, Doris Calloway may no longer be the principal investigator.) The Kenyan institution involved is the University of Nairobi; the liaison investigator is James Kagia, M.D., Department of Community Medicine.

The original University of California, Berkeley, proposal ranked highly in nutritional intake and status, reproduction, and activity measures. The original University of California, Los Angeles, proposal was highly ranked in disease measures. The Steering Group suggested a merger of high quality proposals to create a stronger project.

In addition to the core research design, the University of California group will

(1) periodically record food inventories, observe all eating activity, and compare this consumption with 24-hour recalls and histories,

(2) identify nutritional markers such as age of tooth eruption, age at menarche, age at first pregnancy, age at menopause, etc.,

(3) assess immune status of children,

(4) seek new indicators of state, e.g. body temperature, tonsillar size,

(5) determine which activities are most susceptible to decreased intakes,

(6) define community expectations and definitions of appropriate activities,

(7) follow longitudinal cognitive development in addition to cross-sectional,

(8) assess the social development of children,

(9) explain the need to ensure minimal intakes with respect to the patterns governing household and village economies,

(10) identify the community and national feedback and error-correction institutions dealing with inadequate nutritional intakes, and

(11) model the household decision-making process in the survival-oriented institutional framework of the traditional village economy.

PROJECT 3: EGYPT. (See Appendix IV-4)

The principal U.S. institutions are Purdue University with principal investigator Ronald Watson, working in collaboration with the University of Arizona with principal investigator Gail Harrison and University of Kansas Medical School with principal investigator Norge Jerome. The proposed Egyptian project director is M. Gabr, M.D., Ministry of Health. The principal Egyptian institution involved is the Nutrition Institute of Egypt with Hekmat El Sayed Aly, Ph.D.

In addition to the core design, this group proposes to

(1) study effects of undernutrition on disease response and immunocompetence in the aged and develop immunological methods for nutritional assessment of the aged,

(2) document the effects of disease on growth patterns and on catch-up growth following stress,

(3) investigate the immune system present in the milk and determine whether levels of milk gonadotropin releasing hormone and growth factor are determinants of functional and physical development of offspring,

(4) determine psychomotor performance of adults,

(5)study development of salivary enzymes of infants with respect to maternal malnutrition,

(6)measure the effects of energy intakes on normal mouth flora, and

(7)evaluate the effect of decreased intakes on problem solving and information processing abilities.

D. Future Development of the CRSP

PROJECT 4: ASIAN LOCATION

To complete even a minimum CRSP, an Asian project is essential. As the USAID mission in Thailand disapproved the proposed University of Hawaii-Mahidol University project, another location must be established, where rice is the principal staple food.

A joint Indo-US research planning meeting was held in New Delhi, March 22-25, 1980. Conveners of the meeting were the Indian Council for Medical Research and the U.S. State Department's Division of International Health. At that meeting the planning contractor proposed that a CRSP project be included in the research package, under the aegis of the National Institute of Nutrition (NIN), Hyderabad. Indian delegates concurred in this suggestion and a modified project plan was developed by Drs. S. Srikantia, M. Swaminathan, V. Sukhatme, H. Rice, and D. Calloway. (See Appendix IV-5.) The project plan was approved by the Conference and recommended for funding from PL 480 funds available in India. Some additional dollar funding is needed and this is to be provided from the local USAID budget as the project would serve important development-planning needs in the area of maternal-child health. The project still requires formal Indian government approval.

The proposed Indo-US project follows the core research design and Indian colleagues added the important proviso that in data analysis, disease patterns be treated as both independent and dependent variables (as is food intake in all projects). No different data collection requirements are imposed, but the statistical analytic scheme must take this approach into account. Also, the Indian project would defer measurement of cognitive ability and social competency until the second year of study when variance in the major independent variables shall have been determined and issues of sample size reexamined in light of this variance.

NIN, Hyderabad has a strong research group and can undertake the project with little US participation in the areas of disease and reproduction. The major contribution from the US side would be in project integration of social science components. When the project is approved and funding is assured, formal arrangements will need to be made between NIN's new director (Dr. S. G. Srikantia has resigned effective June, 1980, and his successor has not been named) and an appropriate U.S. institution(s), by the management entity.

If, for any unforeseen reason, the Indo-US project does not materialize, there are some other possibilities that can be pursued easily.

A meritorious research proposal was submitted by Tulane and Lincoln Universities, but there is no indication (from previous publications or CV's of principal scientists) that they have experience or established ties in Asia. Pennsylvania State University expressed an interest in proposing a project in the Philippines, where they have worked previously, but were dissuaded by receiving wrong information to the effect that additional projects would not be accepted in the Philippines. The Tulane-Lincoln group might be interested in developing a project for the Philippines in collaboration with Pennsylvania State University. The University of Nebraska

submitted a proposal for research in Bangladesh with an established linkage, but the proposal had serious technical weaknesses. Bangladesh would, however, constitute an alternate site.

There is excellent nutrition research capability in the Philippines and proximity to the International Rice Research Institute at Los Banos would be advantageous. Nutrition is less developed as a discipline in Bangladesh, so U.S. input would have to be greater and more time would be required to implement a project. The research should be approved in principle by the local USAID mission before discussions are reopened with any of these universities.

Cornell and Harvard Universities submitted a proposal for projects to be located in Haiti and/or Colombia. Cornell has other projects in the field in Indonesia and presumably could develop a project there for this CRSP.

The University of California, Berkeley, received from Sri Lanka an expression of interest in a collaborative research program. The Berkeley group could separate from the Kenya project, leaving principal responsibility with UCLA and arranging a larger role for Cornell University, and undertake a project in Sri Lanka.

Both the Indonesia and Sri Lanka options are viable. Both would involve Cornell University in the CRSP to a greater extent than is now the case and possibly Harvard as well. This is desirable as both groups have extensive relevant experience. There are pro's and con's to both locations as indicated in the site visit reports (Part III) and it would be necessary to consider the local USAID mission views.

PROJECTS 5, 6 and 7: To be developed.

The Ad hoc Review Committee, JRC, and BIFAD recommended that the initial CRSP should include a project located in an area where the diet consists of roots or tubers as the major energy source of a marginally nourished agricultural population. This project is needed for complete coverage of major food patterns. As this pattern is liable to be low in protein-energy it would perhaps allow differentiation of energy and protein effects on function. Ultimately the CRSP should also include at least two other overseas-based projects, such as an urban population and a nomadic population, to complete coverage of sociocultural elements.

None of the proposals received by the planning contractor chose a location in a region dependent on a low protein, starchy crop. The most probable site of such a project (project five) would be New Guinea, where yams are the staple food. Previous surveys in the region have indicated that only 5-7 percent of dietary energy is derived from protein, the lowest average figure recorded for any population. Nutrition has not been a strong area of research by New Guinea-based institutions. Past projects have been led by or had major collaborative input from Dutch, New Zealand, Italian, and English investigators. A number of US-based anthropologists have studied New Guinean food ways and could doubtless be recruited for a CRSP project. Consultations with nutritionists Drs. Anna Ferro-Luzzi (Rome) and Rosemarie Ostwald (Berkeley), who have recently participated in research projects there, suggest that the New Guinea biomedical research community is favorably disposed toward nutrition projects and would welcome further collaboration.

Other possible locations for project five are to be found in West Africa where cassava and matok are mainstays of the diet of poor people. Depending on local food availability and economic conditions, some cassava-producing areas in Central and South America (e.g., Northern Brazil) also would qualify.

A sixth project should study an urban or periurban population having the

same basic food pattern as one of the other projects; this project could be located in the same country as one of the others if this would not overtax local resources. As technologic development proceeds, most countries have experienced population migration from rural to urban areas. Food availability and food management strategies are different in these settings and so is the range of potential individual, household and community responses to changed nutrition/food states. It is important to determine the network through which undernourishment operates to damage biological and social function in this milieu.

A seventh project should study a population that presents conditions not otherwise present in the CRSP (e.g., a nomadic population or one having low energy intake coupled with a high percentage of protein calories). Such a population could be expected, because of their marked divergence from the norm, to provide evidence from which to determine the extent to which other project data are generalizable. Selection of the unique population should follow from hypotheses generated from the data gathered in the original projects.

These new initiatives could be developed by another round of competitive grants but with greater economy by means of negotiated grants or contracts.

A US-BASED PROJECT. There are a number of persuasive reasons for mounting in the United States a research project that parallels the CRSP projects. Comparable information does not exist for any developed country, including our own even though the full range of energy intakes is to be found in all countries. (The percentages of the population subsisting at each level differ between LDC's and DC's, of course.) The United States spends vast sums on nutrition-oriented welfare programs without a full understanding of the nature of the problem and, hence, appropriate preventive efforts. But more importantly in the present context, the existence of an American project would dispel any unfortunate "we-they" implication of the overseas research.

A US-based project should study a population having some characteristic(s) in common with the overseas populations and, ideally, a US population having a special claim to assistance. A black or chicano population located in a low-income area would fit these criteria.

The staff of this project should include foreign scientists involved in the CRSP and their students as well as American personnel. This project could most easily be developed by a US university which is involved in the CRSP but does not have administrative responsibility(e.g.,University of Arizona, University of Massachusetts, University of Kansas, etc.). It would be reasonable for this group to reduce its effort in the second year of an overseas project to assume this responsibility.

Potential sponsors of this research should be contacted by the management entity.

INVOLVEMENT OF MINORITY US INSTITUTIONS. The only research proposal that involved an 1890 land-grant institution was the one from Tulane in which Lincoln University was to serve primarily as project financial manager. There was a small laboratory-based technical contribution from Lincoln, but no indication that Lincoln personnel would participate in the field research.

Several of the 1890 land-grant institutions have nutrition curricula and some have conducted human research, but none has an extensive nutrition field program. The fact that eligible schools failed to submit proposals probably reflects their own negative assessment of their ability to mount a large multidisciplinary field project. All of the US institutions now proposed for CRSP participation have included at least one, and in some

cases several, additional institution(s) to staff the projects, indicating that this difficulty is not unique to the minority institutions, although it may affect them more severely.

It is evident that a communications network, needed to put the original land-grant and 1890's institutions effectively in touch with one another, does not exist. Further, unless the minority institutions acquire training and experience in this type of research, even a communications system would not lead to the formulation of joint projects.

Presumably, strengthening grants could be used to provide needed training, if the institutions so desired, but it would perhaps be more effective simply to include a minority institution component in each of the projects recommended for funding. The exact nature of the minority participation would need to be decided by each set of paired institutions as is appropriate, but would need to assure the garnering of experience in all phases of the research (design, conduct, analysis and reporting) over the 3-5 year life of each project. It is recommended that $30,000 per year be made available to each project for this specific purpose, if an 1890 land-grant institution or the Tuskegee Institute is interested in such collaboration.

COLLABORATIVE FORMATS.

The planning contractor considers a variety of collaborative formats of prime importance to the conduct of this CRSP. Collaborative considerations prior to, during, and after fieldwork emphasize continued interaction of personnel and their ideas, hypotheses, analyses, and other research outcomes. A first concern will be to continue the multidisciplinary interaction developed during the preparation of proposals. Meetings of principal scientists should be convened in the period between funding of the grant (if awarded) and activation of the overseas research in order more fully to acquaint all participants with particular methodologies, literature, and other relevant information. Such continued discussions would also serve refining and integrative purposes. As soon as decisions have been made by the funding agency, arrangements will be made for meetings of the collaborating institutions, and advance training of professionals and exchange scholars can begin.

There are three major means of promoting collaborative interactions. The first is to organize a series of forums to be convened during the active research phase(s) of the projects, in which all researchers will participate at least once. More informal discussion opportunities are expected to be part of each ongoing project. The second is joint authorship of papers, with attention given to appropriate, accessible publication sources. Such sources are expected to include non-academic publications or means of dissemination. The third is the circulation of drafts of manuscripts among research participants for comments and criticism prior to final preparation of various materials. This circulation requirement ensures further interdisciplinary as well as collaborative communication. A mechanism to deal with such controversial issues as data access, publication and authorship privileges, and priorities will be developed by the Principal Investigators collectively. These issues commonly arise in projects involving many people over a number of years. One possible format is election of a review committee composed of senior scholars from both countries.

All collaborating institutions cannot help but be strengthened by this activity. This shall occur in many obvious technical ways but especially by exchange of scholars and by the training of a new generation of professionals in the process and techniques of interdisciplinary research.

UTILIZATION OF FINDINGS.

Each project team must be given sufficient time to evaluate and interpret its own data, and additional time will be required for interproject analyses agreed upon by the principal scientists involved. Experience indicates that information gathered in projects of this type often is useful for purposes beyond those originally conceived; and emergence of new information and new analytical tools may make it advantageous to reevaluate one's own and other's data. After a reasonable period, data from this CRSP will be made available to reliable, qualified investigators from the scientific community-at-large.

Utilization of CRSP findings needs to go beyond these usual scientific applications. The ultimate goal is that the findings will lead to development of policies and implementation of programs that will lessen deprivation in countries where the research is conducted and elsewhere. There is, however, no assured link between research (basic or applied) and policy planning. With regard to this CRSP, the connection between research and policy rests initially on two bases: 1) the carefully thought-out scientific rationale for the project, and 2) the collaborative efforts set forth to accomplish the research. The coordination and attention to research continuity in a field situation of this complexity has already required project attention to provision for subsequent significant uses of data and analyses. Research participants can not anticipate particular policy/planning requirements, but can and will address problems of data accessibility, reliability, and so forth. Usefulness of data and research findings beyond the immediate needs of the CRSP is a legitimate policy concern.

Communication through bilateral collaboration and relatively long research residency in the host country potentially allows for the development of rapport and interaction between project personnel and those charged with policy and planning responsibilities. Informal as well as formal mechanisms of exchange between these two domains are possible and are likely to evolve through mutual commitments to nutritional topics.

Locally generated information may be seen as being more readily applicable locally, but even this does not happen automatically. Those who are subjects of these studies should also be viewed as full project participants, and the outcome of the research should be made known to them. The findings should be related in terms that will contribute to local problem definition and community-originated problem solving activities. If this more modest goal is met, successful local application may serve to demonstrate the practical utility of the findings and be an effective spur to a wider application of the model.

E. Funding Requirements

Budgets have been submitted from each U.S. institution involved in the three initial CRSP-funded projects (see Appendices IV 2-4). A provisional budget has also been developed for the Indo-US PL 480-funded project (Appendix IV-5). These budgets have not been through a review within the submitting institution(s). Thus, the management institution has as the first responsibility further negotiation of these budgets.

These budgets are higher than were indicated when first submitted (April 1979) for a number of reasons. One of these is personnel and supply expenses necessitated by development of the core measures by the CRSP participants. Second is the enormous increases in the price of all airfares and of key scientific supplies such as equipment and film.

It is evident in reviewing the budgets that institutions have not approached the budgeting process in the same way. In particular, institutional matching contributions will need to be specified more clearly. However, these details are best put aside until funding is assured lest further negotiations result in unwarranted expenditure of time and effort on all parts.

Budget requirements for the University of Connecticut and the University of California campuses are presented as submitted by the institutions (sections of Appendices IV-2 and IV-3). Funding for the Purdue/Arizona/Kansas Universities' project had not been fully resolved among those institutions at the time of writing. Therefore, the Planning Contractor devised a joint budget for the Arizona and Kansas Universities' portion of the project (Appendix IV-4) with the recognition that the differences outstanding must be resolved.

The budget projections for the first year appear to be reasonably reliable and equitable in view of such between-project differences as travel between US institution and field site. In these uncertain economic times, it is evident that budget projections into the future are less assured. Again, the five year projections made by most institutions appear reasonable.

It is imperative that projects have guaranteed long-term funding in order properly to complete the proposed work. A funding commitment for the first year or for two years only is not an adequate base upon which to perform research. A minimum of three years forward funding is required to start each CRSP project and maintain adequate scientific control over the program.

Excluding management, considering the Arizona/Kansas addition, and using the budget figures provided by the institutions, a three-year CRSP budget of $5.6 million is required for the three projects now recommended for funding (Table IV-5). The cost for the management entity is discussed in Part V-E. Management costs will bring the budget estimate for a minimum CRSP (3 projects plus India at no cost) to about $7 million for three years.

If CRSP development proceeds as now recommended (i.e., addition of an alternative Asian project, the root-tuber project in the second year, and the urban and the "exceptional" projects in later years) CRSP costs will increase accordingly. Probable budget for projects included in an appropriately expanded CRSP is shown in Table IV-6. The 5-year total figure of $15 million (excluding management and the Asian project) exceeds the estimate made in 1977-78 by 50%. This increase is a realistic reflection of changed economic conditions; it does not indicate significant changes in conceptualization of the problem or conduct of the needed research. Unless inflation is checked, every month of additional delay in CRSP funding will result in increased cost projections.

TABLE IV-5

Summary of Budgets Requested by Institutions Involved Initially in the CRSP
($1000)

	Yr. 1	Yr. 2	Yr. 3	Total
Univ. of Connecticut	462.4	630.4	726.9	1819.7
Univ. of California	492.9	645.4	683.2	1821.5
Purdue/Arizona/Kansas	470.3	706.5	830.6	2007.4
CRSP Project Costs	1425.6	1982.3	2240.7	5648.6

TABLE IV-6

Projected CRSP Budget Through Year 5
($1000)

	Yr. 1	Yr.2	Yr.3	Yr.4	Yr.5	Total
3 original projects	1426	1982	2241	2100	1905	
Roots/tubers	--	550	600	650	700	
Urban project	--	--	500	600	700	
"Exceptional"	--	--	--	600	600	
CRSP Project Costs	1426	2532	3341	3950	3905	15154
[Asian project CRSP funded]*		[3082]*	[3941]*	[4600]*	[4605]*	[17654]*

*If Indo-US PL 480 project is not approved, increase CRSP cost estimate as shown in brackets.

PART V

PROPOSAL FOR MANAGEMENT OF THE CRSP

A. Consultation Regarding Management

B. Recommended Management Function and Structure

C. Recommended Management Institutions

D. Interim Management

E. Management Costs

PART V. MANAGEMENT

The AID/JRC concept of the management entity is an organizational framework to carry out the CRSP and administer the program areas. The management entity will assume overall responsibility for managing the program and funding the projects according to criteria approved by AID.

The Guidelines for the Conduct of Collaborative Research Support Activity under Title XII of the International Development and Food Assistance Act of 1975, Joint Research Committee of the BIFAD (October 11, 1977), state that

> For each CRSP, an administrative 'Management Entity', with appropriate legal status...will be required for administering the resources contributed by AID and for overseeing the individual projects comprising the program. This management entity would receive and administer AID grant funds for the CRSP, sub-allocating them to the participating U.S. and developing country institutions for their respective projects. The management entity should have the capacity to coordinate the effective implementation of the program and be responsible for implementation of the budgetary plans including the contributions to the projects of the participating institutions...AID would hold the management entity responsible, through established AID management procedures, for performance of the CRSP. AID would assure that the management entity would manage the program in accordance with the overall plan and budget agreed to by AID and the management entity. The JRC will, through the Board, assist AID in execution of all these activities by such continuing evaluational and other program development and monitoring mechanisms as may be evolved. Similarly, AID would hold the management entity accountable for the funds and for their appropriate use in all aspects of the CRSP, and this entity would, in turn, hold the participating institutions accountable for the funds and for their use in the project according to budgetary plans. A suitable system of accountability would be developed between the management entity, the contributing universities and AID for holding participating institutions accountable for use of AID funds in their projects... It is hoped that [such a management system] will facilitate participation of a wide range of institutions, make available a diversity of scientific talent, and assure that all necessary disciplinary and institutional components of a CRSP will be integrated into a comprehensive effort.

Thus this management entity must 1) meet legal eligibility requirements, 2) have the ability to integrate the individual projects into one comprehensive scientific program that meets stipulated research objectives and 3) have adequate resources for financial management and accountability. The first criterion is satisfied if the institution selected is a land-grant or BIFAD-roster university, and virtually all of these would meet criterion 3. However, to meet the second criterion, the institution must provide ongoing scientific research management and oversee program development. This CRSP, unlike all its predecessors in the Title XII program, imposes unique scientific management requirements. The basic research design represents the consensus views of some 100 scientists as refined and specified by the principal investigators from the proposed collaborating U.S. and foreign institutions. Once established, individual projects cannot deviate from the core design except with the concurrence of the CRSP members, i.e. decisions cannot be taken independently because of the high risk that comparability across projects would be lost. Matters arising on a day-to-day basis need to be resolved and decisions communicated expeditiously to all CRSP projects. For these reasons, the managing institution must

provide an acceptable Program Director with acknowledged scientific expertise (preferably in the field of nutrition or in management of large-scale epidemiological studies) and proven administrative capabilities and who is willing to devote sufficient time to the management of the CRSP for the duration of the CRSP (or at least the first two years).

The relationship between the collaborating and management institution is fiducial but to the extent feasible, the role and authority of the Program Director vis-à-vis the subcontracting universities (as well as the JRC/BIFAD, USAID and the management institution itself) should be clearly established from the beginning. Trust is probably best reinforced by a codified system of checks and balances, developed by the participating institutions. Thus, the management entity is operationally defined as including the prime contracting institution, the Program Director and various committees to oversee scientific and fiscal coordination of all projects.

A. Consultation Regarding Management

A consultation on the nature of the management entity for CRSP on Intake and Function was held at the University of California, Berkeley, on August 13 and 14, 1979. Those attending included the Principal Investigator and a senior financial officer from each of four projects then on-stream, the planni contractor, and a representative from BIFAD. Scientific management, fiscal management, and management structures were discussed, utilizing background papers prepared by University of California, Berkeley, and Purdue University.

Principal points of agreement were:

(1) The prime contractor is to be one institution encompassing both scientific and financial management.

(2) The management entity is to be a leadership system, not merely a response system.

(3) The management entity will include a Scientific Coordination Committee, the voting members of which are one U.S. and one LDC principal scientist per project, plus the Program Director. Additional Principal Investigators could participate in meetings of this Committee but there would be only two votes per project, one representing the US and the other the LDC participants.

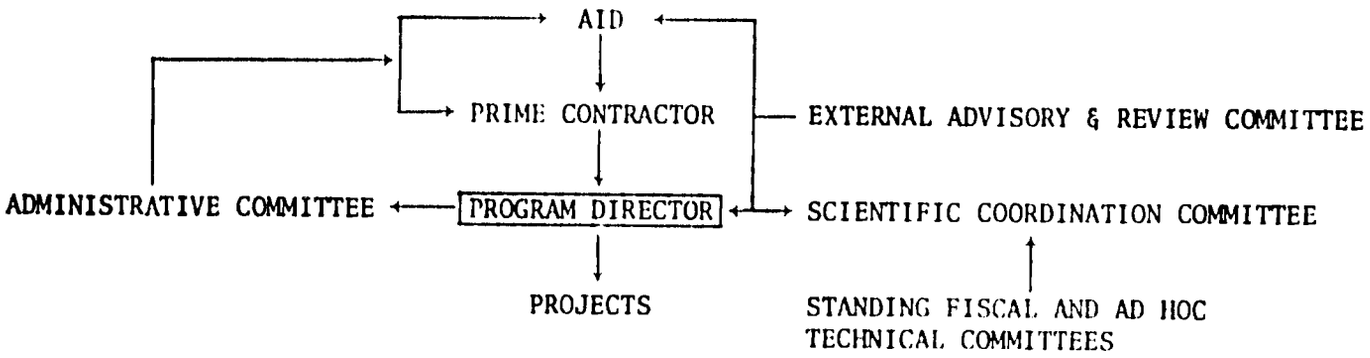
(4) The management entity will include an External Advisory and Review Committee. The panel would be composed of five or six scientists in relevant disciplinary areas and who are not involved with any CRSP project or participating institution, plus one administrator from an outside institution. The members would be nominated by the Scientific Coordination Committee and appointed by JRC/BIFAD.

(5) The management entity will include an inter-institutional Administrative Committee to advise on contract terms and to assist with resolution of inter-institutional differences, problems with USAID, etc.

(6) Subcommittees of the Scientific Coordination Committee will be formed as needed to discuss fiscal or scientific matters in more depth. The standing Fiscal Subcommittee would be composed of one US PI per project plus one administrator/contracts officer per project. The Ad hoc Technical Subcommittees (for a functional area, food-energy intake, etc.) would consist of one person per project and experts as required to assist or advise the projects.

The management structure provisionally agreed upon, from various alternatives proposed was as follows (Fig. V-1.below):

Figure V-1



Extensive comments from participants were received by the Planning Contractor following the consultation (see Appendix V-1). Scientific (but not financial) management was discussed at the December 13-17, 1979, meeting of US and LDC principals. The suggested management structure (Fig. V-2 and below) reflects valuable input from these sources and background material prepared by Purdue University and University of California, Berkeley.

B. Recommended Management Function and Structure

FUNCTIONS OF THE MANAGEMENT ENTITY.

Management institution. The management institution is the legal recipient of the grant or contract from AID. The funds to be granted by USAID will provide the aggregate total budget for each project, plus funds budgeted for management.

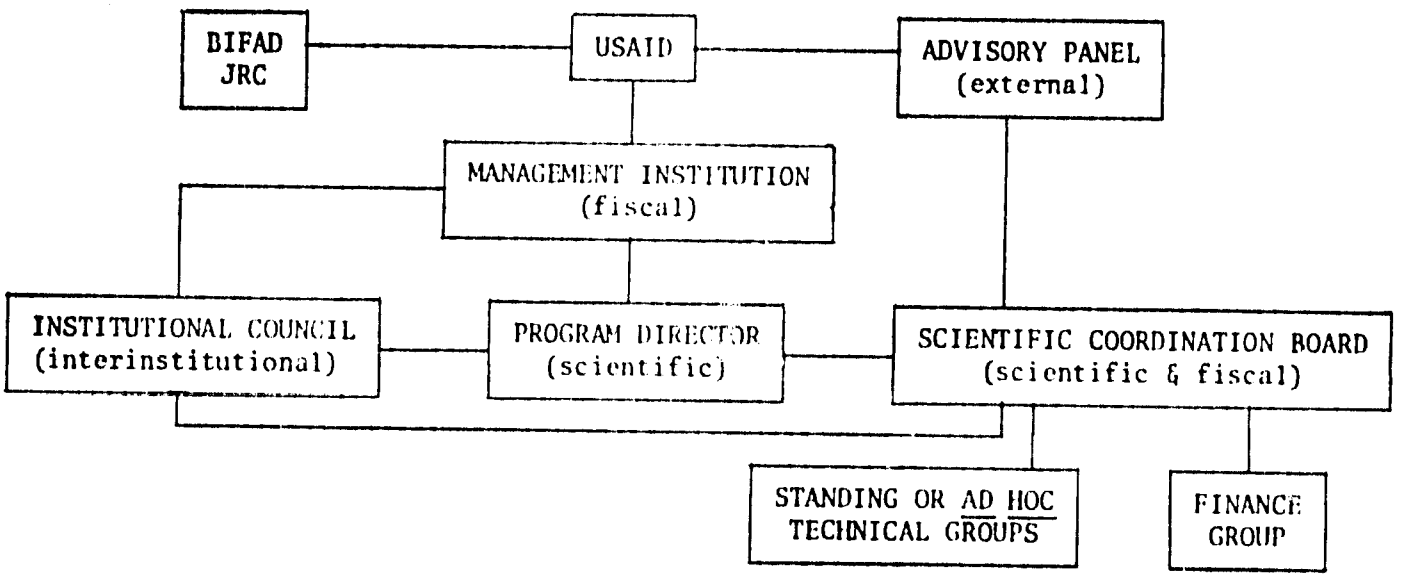
The management institution is responsible for financial administration of the contract: dispersal of funds to the subcontracting U.S. institutions, including funds to be passed through them to all of the participating foreign institutions in accordance with the contract. The budget will be subject to revision in response to changing needs and priorities. In making needed adjustments in the allocations to the budgets of component projects, the managing institution will be advised by the Program Director who will, in turn, have been instructed by the Scientific Coordination Board and its Finance Group (see Figure V-2).

The management institution is responsible for proper disposition of these funds by the subcontracting institutions. This entails at a minimum arranging for yearly audits of the project expenditures at each of the institutions. The prime contractor would also arrange to hold the principal investigators accountable for their institution's project expenditures by requiring that all subcontractors and subgrantees establish suitable accounting and reporting procedures according to federal guidelines. The managing institution will assure that the participating institutions jointly contribute cost sharing at the level required for the CRSP, currently 25%.

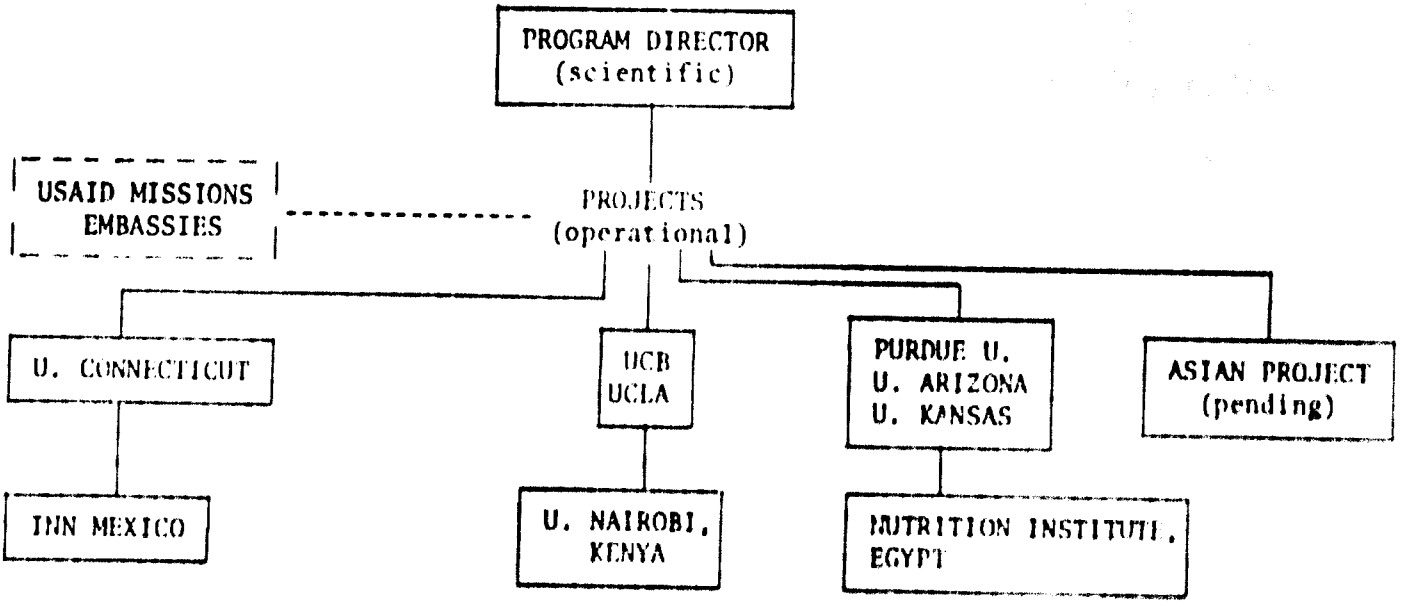
The management institution is responsible for the design and supervision of all overseas negotiations, to insure that all agreements between subcontracting U.S. institutions and overseas institutions are consistent

Figure 1-2

a. Program Administration



b. Project Management



and standard. The management institution will provide a model agreement to be used by all parties and will have the right of approval for all agreements.

Program Director. The Program Director is the liason between the management institution, the scientific management of the CRSP as a whole, and the management of the individual projects.

The jurisdiction of the Program Director with regard to the CRSP and the participating institutions includes scientific and technical administration and the arranging and financing of meetings, consultancies and site visits regarding program substance and performance as described below.

The Program Director is responsible for continued planning and organization to assure scientific validity and continuity of the program. This would include the following tasks:

(1) Management of an implementation phase immediately to follow from the planning phase, which would begin as soon as the contract is awarded. This phase would involve solidifying the financial and scientific linkages with the foreign institutions, establishing and convening of the various bodies comprising the management entity,and planning the specific uses of the first year's funds. Development of the Asian project would be completed. Training and technical services are important components of the program. The Program Director will develop plans for the training and technical services components during the first six months of operation, for review of and implementation following advisement by the Scientific Coordination Board.

(2) As stated in the Précis, "the overall CRSP will be designed to test the observed relationships across ecosystems and social systems," an approach which holds implications for program management. Data collected in each project will be compared to generate conclusions about intake and function. Thus similar data from each project must be collected and described in a consistent form, to facilitate comparison. The Program Director is responsible for assuring and monitoring the consistency of data collection on a continuing basis.

(3) Each project will include appropriate management tools for evaluation, such as a schedule of research operations and targets for accomplishment; the Program Director will assure that projects are evaluated in this manner.

(4) Some proposals include separate studies which address hypotheses based at the institutional level and require ecologic/economic data that would need to be collected in all projects for one project's scientists. The Program Director is responsible for distribution of any additional funds required to conduct such overall studies.

(5) As the CRSP progresses there will be a need to enroll new projects. The Program Director will be responsible for development of these projects as advised by the Scientific Coordination Board and its Finance Group.

(6) Data collected in this program will necessarily be shared among the participants. After investigators have had time for their analyses, the data will be made available to the scientific community at large.The Program Director will arrange for orderly transmission and dissemination of data and conclusions from the CRSP. This task will include arranging computer and statistical services and, if necessary, storing and processing of data.

Scientific Coordination Board. This Board serves as the primary decision-maker of the CRSP. Its voting membership consists of one US and one LDC principal scientist per project plus the Program Director. The Board will resolve policy issues appropriate to the CRSP, communicate policies to the individual projects and bring input to the CRSP from the projects.

The initial Board will consist of seven members; for efficiency of operation its maximum membership should not exceed nine. Provision will be made for staggered terms, to be determined by lot, when it is envisioned that more than four projects shall be included in the CRSP. The Board shall elect a Chairperson annually.

It has been suggested that social science representation on the Board is imperative to carry out the philosophy of this CRSP. In the event that a project(s) has both a biological and a social science Principal Investigator, both should have the option of attending any U.S.-based Board meeting. Participation of a second Principal Investigator would not be funded by the management institution and only one vote could be cast by the joint Principal Investigators.

The Board shall meet annually and on call from (a) the Program Director, (b) representatives of two or more projects, (c) the Advisory Panel or (d) the Institutional Council. Cost of these meetings shall be borne by the managing institution, except as noted above.

The Board shall establish groups as is necessary for the orderly conduct of its affairs. A standing Finance Group will be composed of one principal scientist from each U.S. university directly involved in the CRSP and one administrator per project. Ad hoc or standing technical groups (e.g. statistics, food intake, cognition, etc.) would consist of one person per project plus consultants as required to assist or advise the projects. The Board will establish terms of reference for these groups and determine the need for group meetings and/or other forms of communication within budgetary limitations.

Advisory Panel. An external Panel shall be appointed by the Program Director from a slate of candidates nominated by the Scientific Coordination Board. It shall be composed of five or six eminent scientists from disciplines relevant to the CRSP and one experienced administrator unrelated to any of the participating institutions; and candidates will be selected on a world-wide basis. The Panel will evaluate scientific progress and management and report the state of the CRSP to the Scientific Coordination Board and USAID annually. The Panel will conduct a comprehensive evaluation of each project at least every three years.

The Panel would conform to the regulations for Expert Advisory Panels and Committees adopted by the World Health Organization (1966). Members would be appointed for a term of three years; half of the membership could be reappointed for a second term at the discretion of the Scientific Coordination Board. Members of the Advisory Panel would be paid, from the management budget, travel expenses and standard NIH consultant rates for days actually spent in meeting.

In addition to meeting or corresponding with the Board and/or involved investigators to verify methodologies, data collection techniques, analysis

strategies, etc., and to review progress, the Panel would also promote the overall team effort needed in this type of research. At the end of the data collection and analysis period, the Panel would be instrumental in integrating the results to insure the maximum benefit of conducting multidisciplinary, generalizable, managed research.

Institutional Council. The Council is composed of one senior administrator from each of the U.S. universities participating directly in the research program. The primary function of the Council is to resolve inter-institutional differences, including amendments to be made to the original plan for CRSP organization and management. The Scientific Coordination Board and the Program Director shall report to the Council annually on inter-institutional and structural problems encountered in program implementation. The Council shall review external evaluation reports and maintain liason with the Scientific Coordination Board and its Finance Group. The Council shall meet on the call of representatives of two projects with cost of meeting attendance to be borne by the individual institutions or projects.

STRUCTURE OF THE MANAGEMENT ENTITY.

The structure of the recommended management entity is portrayed with respect to program administration in Figure V-2a and project management in Figure V-2b.

This structure allows the Program Director flexibility to achieve the scientific goals set forth by AID and gives the Program Director sufficient authority to take action on matters of scientific management. A CRSP as complex as this one is dependent upon strong scientific management to achieve the objectives contracted by AID. The management structure reflects this commitment to scientific management by delegating authority directly from AID through the Program Director to the Scientific Coordination Board. This Board of participating scientists (Principal Investigators plus the Program Director) establishes policies relating to scientific management and coordination of the individual projects. Any administrative or fiscal matters that cannot be handled by the Principal Investigators can be referred by them to the Institutional Council. Fair evaluation is assured by appointment of an Advisory Panel external to any of the project participants.

The recommended management entity is consistent with the agreements reached by the U.S. project representatives in August, 1979, and has been elaborated and amended to take account of written and oral comments received from the U.S. institutions that will comprise the initial CRSP.

C. Recommended Management Institutions

CANDIDATE MANAGEMENT INSTITUTIONS.

Since this CRSP is part of Title XII funding, a land-grant institution must be the recipient of the grant or contract. Any land-grant institution could be considered and at the August consultation, it was agreed that any institution likely to participate in the CRSP and desiring to be the management institution would submit a statement of interest and qualifications to the Planning Contractor prior to the December planning meeting. Responses were received from two institutions: University of Connecticut (Kirvin Knox) and the University of California (Doris Calloway). To increase the range of

options, the Planning Contractor sought an applicant land-grant university external to the CRSP. The University of Minnesota (Leonard Schuman) responded. All the participants in the CRSP had a chance to meet with the potential Program Directors at either the August consultation on management or the December Planning Meeting at the University of California, Berkeley campus.

All three institutions have support facilities for both research and management. Each of three potential Program Directors has an international reputation for both scientific excellence and management capability and has agreed to devote 50% time to management of the CRSP.

A summary of the qualifications of the candidate institutions is as follows:

Connecticut. The advantages of management residing at Connecticut are:

(1) the first project scheduled to begin fieldwork is Connecticut, which would facilitate pilot testing, training, etc.; (2) the University of Connecticut Research Foundation uses all collected indirect costs within the Foundation for research purposes; (3) location is convenient to the Washington area, which reduces cost of maintaining liason with the BIFAD and the funding agency;(4)award of the grant would significantly enhance the cause of nutrition in the campus community. The disadvantage is that the proposed Program Director has limited experience with human experimentation. (Please see Appendix V-2 for Connecticut submission).

Minnesota. The advantages of the University of Minnesota are:

(1) Minnesota is not a participating institution within the CRSP and could provide unequivocally unbiased support and guidance for all projects; (2) the Department of Epidemiology has vast expertise in large population research projects with large-scale data collection and analysis; (3) the Department of Biometry and Health Information Services has agreed to assume responsibility for statistical, data management, and processing aspects of the CRSP; (4) the proposed Program Director has been involved in the development of the CRSP. The disadvantage is that the management team proposed is weak in the area of human nutrition.(Please see Appendix V-3 for Minnesota submission.)

University of California.The advantages of the University of California are:

(1) the proposed Program Director generated the research concept that led to initiation of this CRSP and was responsible for its development and funding; (2) the University already handles contracts with USAID and has great experience with large multi-institutional grants; (3) the Nutritional Sciences Department is one of the foremost in the world and provides strong linkages with the scientific community; (4) the Institute for International Studies, where the management would be housed, provides international expertise, established relationships with social scientists, and has support facilities unique to international research. The disadvantage is that Berkeley's dominant role in CRSP development and espousal of a particular research style may unduly restrict individual project initiatives. The proposed Program Director will, if it is deemed necessary, withdraw as Co-Principal Investigator of the University of California CRSP project if Berkeley is selected for management.(Please see Appendix V-4 for University of California submission).

Comments made previously indicated that Purdue University and the University of Hawaii would be willing to undertake management. The question was posed to the University of Arizona in December and the tentative response was favorable.

In July,1979, the Planning Contractor recommended inclusion of Tulane-Lincoln University in the CRSP as the fifth project. On the premise that this is a viable possibility, Lincoln University could be considered for management but the prospect was not explored when the decision was reached by JRC that only four projects could be funded in the first year.

PREFERENCES EXPRESSED BY THE PRINCIPAL INVESTIGATORS.

At the December 1979 meeting the Principal Investigators were asked to express their preference as to management institution by mailed ballot. Each Principal Investigator present was given a written ballot which was to be mailed to University of California, Berkeley, in an interior sealed envelope so that the identity of the voter was masked. Each project was given two votes: one from the U.S. portion and one from the LDC. Where the project included more than one principal institution the vote was divided between them. Thus, the University of Connecticut cast a full vote, Purdue, University of California, Los Angeles, and University of California, Berkeley, ½ vote each, and Arizona and Kansas ¼ vote each. The LDC's were entitled to a full vote. On the basis of the 5 total votes received, Berkeley received the most first rankings with 4 1/2; Minnesota received 1/2 vote. The second-place votes were allocated to Minnesota (2 1/2), Connecticut (2), and Lincoln (1/2). Unacceptable to one or more participants were: Purdue, Minnesota, and Connecticut.

The results indicate that Berkeley is the institution favored by the Principal Investigators to manage the CRSP; and no one found Berkeley unacceptable.

RECOMMENDED MEMBERSHIP OF THE ADVISORY PANEL.

Each CRSP project group (both US and LDC principals) was asked to nominate members of the Advisory Panel. Some names were submitted by two or more Principal Investigators. Recommended members are:

George Beaton, Ph.D., University of Toronto, Canada
Sol Chafkin, Ford Foundation, New York
Lucy Cohen, Ph.D., NIMH and Catholic University, Washington
R. Gaurth Hansen, Ph.D., Utah State University, Logan
Fred T. Sai, M.D., United Nations University, Ghana
Zena Stein, M.A., M.B., Columbia University, New York
Harold Stevenson, Ph.D., University of Michigan, Ann Arbor
J. M. Tanner, D.Sc., Utah State University, Logan.

D. Interim Management

Provision needs to be made for management of CRSP matters arising before a grant is awarded to the management institution. It is recommended that a consultative group be established for this purpose and that the expense of convening and compensating this group, should that be necessary, be borne by USAID.

Members of this consultative group should provide continuity by reason of past involvement with CRSP planning and/or potential future participation. Suggested consultants are:

Professor George Beaton, University of Toronto,
Professor Doris Calloway, University of California, Berkeley,
Provost R. G. Hansen, Utah State University,
Professor Kirvin Knox, University of Connecticut,
Professor Leonard Schuman, University of Minnesota.

Professor Beaton participated in the NAS workshop where the basic conception of this research was formulated. He chaired the workshop on Disease, the workshop of LDC representatives where the final guidelines for research were drafted, and participated in the August, 1979, consultation on management and the December, 1979, consultation on core research design. Professor Beaton is an advisor to WHO. He was nominated by several principal investigators and is recommended for appointment to the CRSP Advisory Panel.

Professor Calloway would provide a bridge between planning and management phases, and will continue to participate in the CRSP either in management or in the Kenya project.

Provost Hansen, a nutritional biochemist, was a member of the Steering Group for the planning phase and made the Latin American site visits. He also served as an external evaluator of the final proposed CRSP, on behalf of the JRC and USAID.

Professor Kirvin Knox is an eminent nutritional biochemist and has been nominated as Program Director of the CRSP should the University of Connecticut be the management institution.

Professor Leonard Schuman was a member of the Steering Group for the planning phase. He conducted the Asia region site visits, participated in two workshops (disease and activity/performance) and the December, 1979, consultation on core research design. He has been nominated as Program Director of the CRSP should the University of Minnesota be the management institution, and he would serve the CRSP as a consultative epidemiologist should the University of Minnesota not be the management institution.

Additional members for this group might be considered once the participating institutions are determined.

A meeting of this group plus a finance/administration representative from each participating US institution should be held soon after the CRSP is approved for funding. Discussion should center on

(1) timetable for CRSP implementation (see Table V-1),

(2) standardization of subcontract agreements between the management institution and the project institutions,

(3) standardization of subcontract agreements between the project institutions and the collaborating overseas institutions,

(4) responsibilities of the management institution, the project institutions, and USAID with respect to auditing requirements,

(5) standardization of budget items for core design measurements,

TABLE V-1 : POTENTIAL TIMETABLE FOR CRSP IMPLEMENTATION

		Management	Meetings	Subcontracts: U. Conn.	U. Calif.	Pur./Az.,Kan.	Asia (India)
FY1	1	implementation of contract		*Minority Linkage Est.	*Minority Linkage Est.	*Minority Linkage Est.	
	2		*SCB+FG+IC				
	3			Sub to U.Conn			
	4	*SV: Mexico	*TG:Disease+ Stat'l Des	Mexico: ethno-graphic and pilot studies			
	5		*TG:Cogn+Socl Competence				
	6		*TG:Reprod'n+ Wk Perf		Sub to UC	Sub to P/A/K	US University Linkage Estab.
	7	*SV: Asia, Egypt,Kenya			Kenya: ethno-graphic and pilot studies	Egypt: ethno-graphic and pilot studies	
	8						
	9						
	10			Mexico: intake/ function studies			
	11		*SCB				
	12	*SV: Mexico, Kenya,Egypt	*AP				
FY2	1				Kenya: intake/ function studies	Egypt: intake/ function studies	
	2	*SV: Asia	*SCB+FG+IC				Asia: ethnographic studies
	3						
	4						
	5		*TG				
	6	*SV: Mexico	*TG				
	7	*SV: Asia	*TG				
	8						Asia: intake/ function studies
	9						
	10						
	11						
	12	*SV: Egypt, Kenya,Asia					

LEGEND:
SCB - Scientific Coordination Board
FG - Fiscal Group
IC - Institutional Council
AP - Advisory Panel
TG - Technical Group
SV - Site Visit

(6) project contribution toward the management institution with respect to cost sharing,

(7) peculiarities of the chosen management institution regarding overhead, contract agreements, etc., and

(8) definition of management versus project responsibilities.

E. Management Costs

Funds will be needed to provide the proper scientific and financial management for this CRSP. In preparing the budget that follows, the assumption is that costs will be similar regardless of the chosen management institution. However, two budget items may vary appreciably depending upon the management institution selected. These are the salary of the designated Program Director and the overhead requirements of the management institution.

Provisions for a yearly external audit are not included in the management budget. USAID has stated that program audit and evaluation is considered a part of their function and that USAID is financially responsible for the audit through funds reserved by USAID.

Representatives of the probable US participants decided (August 1979) that the management institution will subcontract all appropriate project funds to the participating US institutions, which will pass a portion of the money to the overseas institutions. Thus the US institutions are fiscally responsible for the funds granted to the US institutions' overseas collaborating institutions. A USAID requirement now exists for an annual audit of non-US grantees. If this requirement is in force the overseas institutional audit will be performed by and at the expense of the US institutions.

The management institution must reserve the right to audit any of the project institutions within the CRSP. Any internal audit reports on the CRSP grant prepared by participating institutions must be sent to both USAID and the management institution. During fiscal year 3 and at the end of the CRSP, an audit of all granted funds will need to be performed by the management institution unless USAID formally waives this requirement or carries out its own audit.

The budget as shown in Table V-2 includes: personnel for scientific, financial and clerical duties; supplies and expenses for office support; travel and per diem for meetings of scientists, fiscal managers, and administrators; site visit expenses to oversee research progress and to develop new projects; and overhead expenses to offset institutional resource use by the management entity. The first-year budget is estimated to be about $370 thousand. Figures for years 2 and 3 ($460 and $540 thousand) are projected to be higher due to addition of projects to the CRSP and assumed inflation. Justification for expenditures in years 1-3 is shown in the budget table. Costs for the 4th and 5th years will depend on decisions made about continued CRSP development. If the recommendations made by the Planning Contractor are followed and inflation persists, the management budget will be about $530 and $612 thousand to include computer, publication, and travel costs.

TABLE V-2

Tentative Management Budget
(to nearest $100)

	Year One	Year Two	Year Three
I. SALARIES AND BENEFITS			
A) Salaries			
Academic Salaries			
Program Director (Principal Investigator), Professor VI 40% for 11 months per year*	20,800	22,600	24,500
Other Academic Personnel:			
Associate Specialist I 75% for 11 months per year 100% for 11 months per year	16,600	24,000	26,100
Research Assistant 50% for 11 months per year	7,200	7,800	8,400
Total Academic Salaries	44,600	54,400	59,000
Staff Salaries			
Administrative Assistant II, step 3 100% for 12 months per year	15,600	17,000	18,400
Secretary II, step 3 100% for 12 months per year	15,000	16,200	17,600
Principal Typist Clerk, step 3 100% for 12 months per year	14,900	16,200	17,600
Total Staff Salaries	45,500	49,400	53,600
B) Benefits			
Academic Salaries			
@ 26% 1980-81	9,900		
@ 27% 1981-82		12,800	
@ 28% 1982-83			14,400
@ 1.85% (R.A.'s)	100	200	200
Staff Salaries			
@ 25% 1980-81	11,600		
@ 26% 1981-82		12,800	
@ 27% 1982-83			14,500
Total Employee Benefits	21,600	25,800	29,100
TOTAL SALARIES AND BENEFITS	111,700	129,600	141,700

*10% salary cost-shared by institution

Table V-2 (cont.)
Tentative Management
Budget
Page Two

	Year One	Year Two	Year Thre
II. SUPPLIES AND EXPENSE			
Computer Services	2,500	7,500	8,500
Communications (telephone, postage)	4,000	4,400	4,800
Duplicating, Supplies and Miscellaneous	7,100	7,800	8,600
Subtotal	13,600	19,700	21,900
Typewriters, file cabinets	3,000	-0-	-0-
Consultants			
Biostatistician	3,300	3,600	4,000
Epidemiologist	3,300	3,600	4,000
Subtotal	9,600	7,200	8,000
TOTAL SUPPLIES AND EXPENSE	23,200	26,900	29,900
III. TRAVEL			
Management Travel: One trip per year to Washington, D.C., for four members of the Management entity, in order to meet with AID representatives and make reports concerning the project's progress.	4,400	5,300	6,300
Advisory Panel: One meeting per year for approximately ten people, in order to evaluate scientific progress and management and report the state of the CRSP to the Scientific Coordination Board and USAID annually. The location of the meetings will alternate among the LDC's. Cost to include travel and per diem.	10,100	30,000	36,000
Scientific Coordinating Board: One meeting per year to include travel and per diem for approximately 12 people. The location of the meeting will alternate among the US institutions. The Board will resolve policy issues appropriate to the CRSP, communicate policies to the individual projects, and bring input to the CRSP from the projects.	20,400	29,000	40,300

Table V-2 (cont.)
Tentative Management Budget
Page Three

	Year One	Year Two	Year Three
TRAVEL (cont.)			
Scientific Coordination Board, Fiscal Group, and Institutional Council: One meeting per year to include travel and per diem for 20-21 people. The location of the meeting will be at the management institution, in order to advise or assist the projects.	30,800	43,100	58,300
Technical Groups: Three meetings per year to include travel and per diem for 11-12 people, including two paid consultants.	61,500	73,800	88,600
Site Visits: The first year of each new project will require two visits per site. Each continuing project will require one site visit per year.	22,700	22,300	28,700
TOTAL TRAVEL	149,900	203,500	258,200
IV. COSTS ASSOCIATED WITH UNIVERSITY SUBCONTRACTS			
Overhead at 19.7% on first $25,000 of each subcontract:			
First year, 3 (@ $4925 each)	14,800		
Second year, 2 (@ $4925 each)		9,900	
Third year, 1 (@ $4925 each)			4,900
Overhead at 51% (on-campus activities: salaries, benefits, S&E minus consultants)	38,800	46,300	50,700
Overhead at 19.7% (off-campus activities: travel and consultants)	30,800	41,500	52,400
OVERHEAD TOTALS	84,400	97,700	108,000
GRAND TOTALS	369,200	457,700	537,800
THREE-YEAR TOTAL			$1,364,700

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APPENDIX I-1

Chronology of the Planning Contract

APPENDIX I-1

Chronology of CRSP Planning Activities
Under USAID Contract Number: AID/DSAN-C-0002
April, 1978--March, 1980

Chronological Sequence of Events

April, 1978

- Contract signed mid April, effective date April 1.

May

- Major program areas identified as those recommended by NAS Workshop on "Need for Research on Nutrition and Function," July 1977.
- "Notice of Research Opportunity Under USAID, Title XII: Intake and Function" mailed by University of California, Berkeley (UCB) to all roster schools and to non-roster schools where recognized nutrition research exists and published in AID "Notes" and American Journal of Clinical Nutrition
- Calloway met with representatives of USAID May 16 (DS/N: Forman, Hornstein, Kahn; DS/Agr: Raun, Roedel; DS/XII: Barker; BIFAD/S: Cesal; BIFAD/JRC: Roderick). Discussed experiences of DS/Agr., formation of project's steering group, and procedural details.

June

- Steering Group selected, originally six members Galler (M I T), Green (Mass.), Harper (Wisc.), Latham (Cornell), Sandstead (USDA), Schuman (Minn.), plus Calloway (UCB)
- First listing of institutions responding to "Notice of Research Opportunity" reported.
- Experts enlisted to write background papers for workshops.
- First Quarterly Report submitted.

July

- Set criteria for selection of workshop participants.
- Calloway site visit to Indonesia and Philippines, July 10-18.

August

- Dates for five workshops set, locations for first four selected.
- Arrangements made for workshop participants - Chairmen and rapporteurs identified.
- Wood site-visit to Haiti.

September

- Location for Fifth Workshop selected.

- First Workshop, Disease Response, held Hyannis, Mass. September 25-29. Chairman: G. Beaton, Rapp: H. Sandstead.

- Steering Group met in Boston, September 29-30. Attending: Calloway, Galler, Sandstead, Latham, Greene, Schuman, plus Kahn(AID), Wood (UCB), Roderuck (JRC). Representative from BIFAD/S invited but could not attend. All Steering Group members received a copy of the AID/Berkeley contract and JRC guidelines for CRSP. Steering Group developed questionnaire to be sent to all roster and non-roster institutions and devised system for scoring questionnaires. The questionnaire will serve in evaluating institutional competence and resources. Steering Group discussed its functions and responsibilities and country eligibility and selection. Suggestion made that Calloway meet with LDC participants at a sixth workshop in January. Recommendation to expand Steering Group by two. Calloway requested members present submit names.

- Second Quarterly Report submitted.

October

- Second Workshop, Cognitive and Sensory Development, held in Washington, D.C., October 2-6. Chairman: L. Greene, Rapp: A. Harper.

- Questionnaire sent October 19 to all roster and non-roster schools where recognized nutrition research exists, plus any institutions that had submitted an inquiry regarding the Title XII program.

- Third Workshop, Reproductive Competency, held in La Jolla, California, October 23-27. Chairman: A. Chavez, Rapp: K. Clancy.

November

- Fourth Workshop, Work Output and Physical Activity, held in La Jolla, California, October 30 - November 3. Chairman: M. Latham/L. Schuman, Rapp: R. Nesheim.

- Calloway met with JRC on November 8.

- Calloway met with Regional Bureau representatives November 9 (Braunstein (Africa), Rice (Asia), Sandoval (Latin America/Caribbean), Turner (Near East).

- Fifth Workshop, Social Competency, held in Tucson, Arizona, November 27-December 1. Chairman: H. Yarrow, Rapp: J.L. Joy.

December

- Steering Group met in Berkeley, California, December 17-19. Attending: Calloway, Galler, Greene, Hansen, Harper, Latham, Sandstead, Schuman, plus Kahn (AID), Wood (UCB), Roderuck (JRC), Beck (BIFAD/S). Two new members join Steering Group: Hansen (Utah State University) and Radke-Yarrow (NIMH).

- Steering Group defined their criteria for reviewing questionnaires returned by institutions and, based on criteria, identified those schools they believe qualified to submit research proposals for Title XII project. However, following this exercise of review Kahn (AID) informed Calloway and Wood that no institution should be excluded from submitting a proposal based on the review just held, and that a notice must go out inviting all institutions to submit proposals.

- Steering Group discussed: suitability of country sites, research ethics, management entity for follow-on CRSP, overseas and US site-visits. Copies of all five workshop papers were distributed to members for review and general discussion. Allmembers were asked to submit names of scientifically competent individuals who they believed would qualify as reviewers of proposals.

- Sandstead letter to Calloway dated December 20 stated reservations about procedure Steering Group used that could result in exclusion of institutions from opportunity to submit proposals (replied to Jan.22, 1979, see below).

January, 1979

- Letter sent early January to institutions regarding outcome of the Steering Group's review of questionnaires. A second letter was sent re-affirming that all the institutions interested in the program are eligible to submit a proposal, and announcing a meeting to be held at Dulles Airport, Washington, D.C., where discussion of the potential CRSP with interested investigators would take place.

- Third Quarterly Report submitted. Included minutes of First and Second Meeting of Steering Group, letter sent with October questionnaire, copies of first five workshop reports and copies of both January letters.

- Sixth Workshop met in New Orleans January 15-17. Selected LDC experts briefed on Title XII Functional Implications project, given five workshop reports and asked for comments and recommendations. Précis (guidelines for preparation of proposals) written and recommendations of LDC experts given highest priority. India participant indicated interest in potential collaboration in CRSP with UCB; Calloway to contact new director ICMR.

- Calloway letter January 22 to Sandstead - appreciated his concerns and reported three actions taken to rectify deficiencies without violating the decisions taken by Steering Group.

- January 31 - meeting of interested institutions's representatives held at Dulles Airport. Representing AID: Kahn (DS/N) and Johnson (DS/XII) ; BIFAD: Thomas (BIFAD/S) and McGraw (BIFAD/S). Twenty-three institutions represented. Précis distributed.

- Précis mailed to institutions. Proposals to follow NSF 78-41 format. Described review procedures for proposals (peer review plus Steering Group review).

- Wood (UCB) conducted site-visits in Africa and was joined in certain countries by other professional colleagues:

Senegal	- Wood and Basta (World Bank)
Tunisia	- Wood and Ferro-Luzzi (Rome)
Egypt	- Wood and Basta
Kenya	- Wood and Latham (Cornell)
Tanzania	- Wood
Zaire	- Wood

- February 8, letter from Dean Furtick, University of Hawaii, to Fred Hutchinson forwarded to Calloway and Kahn via Woods Thomas. Letter of Van Reen to Calloway dated January 23, 1979. Calloway reply to Van Reen dated February 2, copy to Thomas.

- Calloway reported to JRC, February 13.

- Calloway met February 28 with Thomas (BIFAD/S),Long (DS/XII), McGraw (BIFAD/S), and Kahn (DS/N). Discussed: (1) Roster vs. non-roster eligibility and preference under Title XII; (2) Cost sharing (25%); (3) LDC-US institutions' working relationships; (4) Pass-through funds; (5) April 18 deadline for submission of research proposals. Calloway agreed to present Steering Group's recommendations and discuss program before JRC, July 10. Agreed to extend project with no additional costs from June 30 through September 30.

March

- Calloway reply March 5 to Erik Thorbeck letter to Levin dated November, 1978.

- Galler (MIT) and Hansen (Utah State) conducted site-visits in Latin America--Brazil, Peru, Colombia.

- March 16, Latham letter to Calloway critical of the extent of program request described in Precis and the limited time in which to do it. Requested that period for developing proposal be extended. (Calloway reply - April 20).

- Wood wrote to AID missions (Senegal, Tunisia, Egypt, Kenya, Tanzania, Zaire) thanking them for their assistance with site visits.

- March 30 - Galler letter to Calloway suggested alternative CRSP strategy. (Calloway reply April 20).

- Calloway notified that ICMR not ready to consider CRSP collaboration at this time. India site-visit cancelled.

- Calloway notified that institutional linkage in Honduras with Iowa State and INCAP not identified. Honduras site-visit cancelled.

April

- Contract extension through September, 1979 approved.

- Wood (UCB) and Schuman (Minn.) conducted site-visits in Asia: Thailand and Sri Lanka.

- Calloway conducted site-visit in Mexico and Barbados; consultation with FAO, Rome.

- April 20, Calloway wrote to Hutchinson, CHM/JRC/BIFAD, stating concern of USAID role in Title XII in regard to attitude toward site-visits and developing Title XII research program in certain countries.

- Wood wrote letters to AID Missions in Thailand and Sri Lanka acknowledging their assistance with Wood and Schuman site visits.

- April 23, Forman/Kahn called Calloway to discuss CINP (Committee of the FNB) concerns. Decision made to proceed as planned regarding research proposal review.

- April 24, Wood informed Kahn that following schools have submitted or intend to submit proposals:

Arizona, Kansas, Texas Tech, MRI, ARPQ	- Barbados & Grenada
California-Berkeley, Washington U. (St. Louis), UCSF, Institute of Nutrition (Rome)	- Tanzania or Sri Lanka
California-Los Angeles	- Kenya
Columbia, Boston U., Harvard	- Brazil
Connecticut, Yale, U. of Miami, U. of Mass.	- Mexico
Harvard, Cornell	- Colombia & Haiti
Hawaii, East-West Center	- Thailand

Iowa State, INCAP	- Honduras
Nebraska, Swanson Nutr. Center	- Bangladesh
North Carolina State, Research Triangle, U. of North Carolina	- Peru or Senegal
Purdue, Indiana, U. of Michigan	- Egypt
Tufts	- Thailand
Tulane, Med. College of Wisconsin, Lincoln U.	- Colombia

Expressions of interest in submitting proposals in future received from Cornell (Latham) - Kenya; Johns Hopkins India.

- April 24-27, all proposals sent to reviewers; each proposal reviewed by four peers representing disciplines of epidemiology or statistics, nutrition, social science, and biomedicine.

May

- Wood wrote letters to AID Missions in Colombia, Peru, and Brazil acknowledging their assistance with Galler and Hansen site visits.

- May 16 Calloway acknowledged Hutchinson's answer to April 20 letter; further queried role of AID Missions in relation to U.S. University investigators and LDC counterparts in CRSP.

- Steering Group met May 24-25 in Minneapolis. Attending: Calloway, Galler, Greene, Hansen, Harper, Latham, Sandstead, Schuman, Yarrow, plus Kahn (AID), Roderuck (JRC), Baldwin (JRC), Kiehl (BIFAD), Wood (UCB). All proposals were discussed and rated by each member according to twelve criteria. Motions recommended proposals should be located in different world regions and that attempts should be made to incorporate outstanding parts of other proposals.

June

- Summary review sheets of proposals received from Steering Group members.

- Recommendations for program content prepared for submission to JRC.

July

- Remaining review sheets received from Steering Group members

- Calloway and Wood contacted AID Regional Bureau representatives reporting status of CRSP proposals: Sandoval (Latin America/Caribbean), Rice (Asia), Georges (Africa), Turner (Near East).

- CRSP content recommendations presented to JRC by Calloway, Hansen and Wood, July 10; approval of recommended program voted by JRC. Kahn to inform institutions of results.

- Fifth Quarterly Report submitted.

- Hutchinson presented CRSP recommendations to BIFAD, July 26. Decision deferred for more documentation.

- July 30, memorandum on selection of project sites mailed to AID as per request I. Hornstein.

- July 31, Hutchinson informed Calloway that BIFAD had deferred decision on CRSP until September meeting due to insufficient information presented at July 26 meeting.

August

- August 13 and 14, Consultation on the Nature of the Management Entity held at University of California, Berkeley. The PI and a Contracts Officer from each of the four institutions recommended by the JRC attended: Allen and Van Gelder (Conn); Neumann (UCLA) and Manza (UCB); Watson and Smith (Purdue); Halstead (for Van Reen) and Furtick (Hawaii); as well as Beaton (Toronto), Kiehl (BIFAD); Calloway, Wood, Beall, and Knox (Conn.). Agreement was reached on the importance of scientific as well as fiscal management, the equal participation of all institutions, and the external evaluation of the ongoing projects.

- Cables received from AID missions in Kenya, Egypt, and Thailand and from US embassy in Mexico regarding CRSP. The Thai cable expressed serious reservations regarding the proposed project.

- Prothro reviews all 13 nutrition proposals at USAID Washington.

- August 30, letter sent to White (Purdue) concerning the purpose of the consultation, in response to White's letter to Calloway copied to AID. Copies sent to all Consultation participants plus Hutchinson, Thomas, Kahn.

September

- Calloway conducted site visit in Mexico, Sept. 18, meeting with Wilcox (US Embassy) and Chavez.

- BIFAD at meeting, Sept. 27, deferred decision on CRSP until October meeting to allow responses from overseas AID missions.

- Letter sent to Pelto and Allen (U. Conn.) restating the philosophy of one project-one vote US/one vote LDC regardless of the number of investigators from one project attending a meeting. In addition, the management entity would only pay for one airfare and one per diem per project for each US and each LDC counterpart.

- Letters were sent to the thirteen institutions who had submitted proposals to be considered under Title XII, stating

- (cont'd) that a decision by BIFAD as to which projects to fund is pending approval of sites by USAID overseas missions. This letter was requested by USAID and approved by JRC and BIFAD.

October

- Sixth Quarterly Report Submitted.

- Trip report from Calloway's site visit submitted to AID.

- Calloway notified by AID with clearance by JRC & BIFAD to proceed with December planning meeting without formal approval.

- Invitations for December CRSP Planning Meeting sent to Kagia, Hekmat, Chavez, Aree, Neumann, Watson, Pelto, Van Reen, Schumann, Beaton, François, Wood. Principal investigator participation is contingent upon USAID mission and country approval.

- Letter to Polland (BIFAD) summarizing development, planning, and objectives of CRSP; included JRC report from July.

- Background paper, chronology, and JRC minutes submitted by Kahn to BIFAD for their October meeting.

- Letter to Carter (Tulane) stating status of individual projects and the need for one project per region.

- Watson requests Title XII Strengthening Grant funds to visit Egypt.

- Meeting of Watson (Purdue), Harrison (Arizona), Jerome (Kansas) at Purdue to attempt a merger of the Purdue and Arizona/Kansas proposal.

- Travel for François and Wood to attend Planning Meeting approved by USAID.

November

- Letters received from Harrison and Jerome detailing Purdue's lack of collaborative spirit with regard to the requested joint Purdue/Arizona/Kansas project.

- Letter to Watson reemphasizing the need for collaboration if the Purdue project is to be considered at all.

- Exchange of letters with Chavez regarding necessity of Mexican government confirmation of approval of Mexico/Connecticut project.

- Tickets, agenda, and information regarding December Planning Meeting sent to Kagia, Chavez, Pelto, Harrison, Schumann, Beaton, François, Wood. Agenda and information sent to Neumann, Kahn, Hornstein, Prothro, Kiehl, and Allen.

- Egyptian representative to Planning Meeting chosen by Gabr, Minister of Health.

- AID/Thailand mission refuses to endorse Thai/Hawaii project.

- Ticket, agenda, and information regarding Planning Meeting sent to Aree; attendance on basis of expertise rather than participation in project.

- Van Reen notified that Thai/Hawaii project has not been approved by AID mission; his attendance at Planning Meeting is no longer required.

- Notification and Agenda of Planning Meeting sent to Roderuick, Thomas, Hutchinson.

- Gabr nominates Hekmat as Egyptian representative to Planning Meeting.

- Ticket, agenda, and information regarding Planning Meeting sent to Hekmat via AID/Cairo mission.

December

- Planning meeting to discuss food intake and nutritional status measures and research design held at University of California, Berkeley. Attending: Calloway (UCB), Neumann (UCLA), Kagia (Kenya), Pelto (Conn.), Allen (Conn.), Chavez (Mexico), Watson (Purdue), Harrison (Arizona), Hekmat (Egypt), Aree (Thailand), Beaton (U. Toronto), Schumann (U. Minn.), Francois (FAO), Wood (Karolinska Institute), Prothro (BIFAD), Kiehl (BIFAD), Hornstein (USAID), Beall (UCB).

- Letter received from Dr. Badri N. Saxena, Indian Council of Medical Research, stating that it is impossible to accept proposed nutrition project due to several new projects in India.

- Mexican government notifies Calloway of acceptance of nutrition project.

- Seventh Quarterly Report sent to AID.

January, 1980

- Ballots from PI's regarding choice of management institution received by Planning Contractor and results recorded.

- Revised proposals and budgets received by the Planning Contractor from participating CRSP institutions.

- Draft final report; Part V submitted to USAID.

- letter received from Hutchinson replying to letter from White (Purdue) stating that Program Director should not be a PI within the CRSP and that participating institutions should choose the management institution.

February

- Draft final report; Parts I and IV submitted to USAID
- Copies of draft report Parts IV and V sent to all proposed US/PI's for comment.
- Recommendations for CRSP presented to JRC by Calloway and Beall, February 14.
- Letter received from Buzina (Yugoslavia) indicating an interest in collaborating within the CRSP
- Summary sheet reviewing Harvard proposal sent to Guerrera.
- Letters sent to present CRSP participants regarding results of JRC meeting.
- Letter sent to Hutchinson regarding disappointing JRC meeting. *1
- Letters sent to present LDC participants requesting their vote for the management institution.
- Letter sent to USAID per their request to extend the Planning Grant deadline to May 31, 1980.

March

- Vote on management institution received from Kenya and recorded.
- Reply sent to Buzina (Yugoslavia) thanking him for his interest in the CRSP and indicating possibility for collaboration within the CRSP. Précis also sent.
- Letters sent to Allen, Pelto, Watson, Harrison, Jerome, Neumann asking all to meet with Kahn, Calloway at April FASEB meetings in Anaheim.
- Calloway attended external review of CRSP, March 18. Review approved CRSP as recommended by Planning Contractor. *2
- Calloway to India to discuss possible collaboration within the CRSP. (No cost to Contract).
- BIFAD unanimously approved CRSP on March 27, as recommended by the Planning Contractor.
- Eighth Quarterly Report sent to AID.

* references attached

April

- Letter received from Chavez regarding funding status of CRSP. Response to Chavez that program received strongest possible endorsement from BIFAD but that nothing certain until funds in hand.

- Letter to Howard Schneider of the President's Commission on World Hunger regarding ways to influence USAID re re funding the CRSP.

- Meeting at FASEB, Anaheim, of CRSP participants Calloway, Allen, Pelto, Knox, Watson, Harrison, Jerome, Beall, Kahn to discuss status of CRSP.

- Cable from AID/Thailand stating no interest in CRSP. *3

- Letter from Calloway to Ruttan thanking him for support of CRSP and recommendations to BIFAD.

- Letter to Ramalingaswami (India), to Srikantia (India), and to Drs. Johnsen and La Saar stating that a copy of the India PL 480 proposal will be included in the CRSP Final Report.

May

- Received copy of letter to Forman (USAID) from Dr. Aree (Thailand) stating that AID/Thailand had not consulted the Thai government (Department of Technical and Economic Cooperation (DTEC)) regarding the CRSP. *4

- Letter from Calloway to Donovan expressing dismay that USAID has not decided to fund the CRSP, particularly since India is willing to participate at no cost to the CRSP. *5

- Part IV (Core Research Design) of Final Report of the Planning Phase reviewed by Beaton, L. Greene, G. Hansen, Schumann, Yarrow.

- Cable sent to AID/Kenya from USAID regarding Kenya government approval for CRSP. No response from government, so Kenya mission replies that it cannot concur with CRSP without government approval.

- Letter from Kahn to all Principal Investigators notifying them of delay in funding procedure.

- Letter from Calloway to Bennett (Director, USAID) regarding the delay and the possible refusal of any funding for the CRSP. Political, social, and scientific reasons were discussed. *6

- Letter from Calloway to Clifton Wharton expressing dismay at the disregard of prestigious public advisory bodies by USAID. *7

* references attached

UNIVERSITY OF CALIFORNIA, BERKELEY

Reference #1

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COLLEGE OF NATURAL RESOURCES
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF NUTRITIONAL SCIENCES

BERKELEY, CALIFORNIA 94720

February 21, 1980

Dr. Frederick E. Hutchinson
Chairman, Joint Research Committee
BIFAD
University of Maine
Orono, MA 04473

Dear Dr. Hutchinson:

The February 14th meeting was a great disappointment to me as you well know, and I am concerned about the impact that a further delay would have. I was dismayed that some members of the JRC had not had an opportunity to review the draft report before the meeting, as we had submitted it on time. We shall send copies to BIFAD members directly from Berkeley to prevent a similar occurrence.

It is entirely appropriate for USAID and the JRC to review the technical merit and significance of the research proposed, particularly because of the need to assure at least three-year funding, and I have no quarrel with that provision. However I had, I think reasonably, assumed that the technical review of each proposal by 4 or 5 outside experts, and the review of all proposals by the several distinguished members of the Steering Group was adequate for the scientific aspects. Had there been any lingering doubt, AID and the JRC had all the proposals in hand last July, together with my own evaluation and recommendations, and could easily have sought additional review. Neither Dr. Roderuck nor Dr. Prothro, who did read every proposal, raised questions with me concerning methodology.

The issue of the significance and relevance of this research was properly considered prior to initiation of the planning process and the expenditure of about $250,000 to carry it forward. Highest priority was assigned to this research by Study Team Nine of the NAS World Food and Nutrition Study; relevance to policy and planning was a major criterion for assignment of priority as the Team report states. Subsequently, this topic was given the highest priority of 22 areas identified for special attention from among the numerous listings of all 14 Study groups. (In fact, four nutrition topics were rated above the CRSP agricultural research topics now funded or under development. It also should be noted that AID programs must respond to substantial sociocultural differences throughout the world and this nutrition CRSP, in contrast to the ones now funded, has addressed this aspect very effectively through its multidisciplinary and collaborative research design.)

Both USAID and the JRC made their independent judgements, in light of the NAS document and of their internal program objectives, before awarding the planning contract. I note that you have suggested in a letter to the President's Commission on World Hunger, on behalf of the JRC, that the Commission should be guided by the NAS Study.

I am quite willing to restate the case for policy relevance but the development of a series of scripts that prejudges the outcome of the research seems unwarranted. (Of course, I may have misunderstood Mr. Babb's comment in that regard.) What this research attempts to do first is to answer the "so what" question, i.e. what difference does chronic malnutrition make to people other than the person directly affected. Conventional research, particularly that of a medical orientation, has examined the relationship of one person's nutritional state to his own health. What this CRSP will do is explore the networks through which malnutrition exerts its invidious effects on individuals, families, and communities, so as to identify effective intervention measures. Conventional nutrition programs (e.g. the WIC program, milk distribution, food fortification, etc.) have a place but they have not resulted in sustained improvement of nutritional state and they are often costly, especially when the prospect is that the benefits exist only so long as the program is in place. Governmental programs could be more effectively designed if we know whose intake most needs to be raised, when, and for how long. A small family food supplement in the hungry season that would allow more labor to be invested in planting and cultivating might have far greater impact than the same sum spent on urban milk programs. We do not now have the information to make such a judgment and we shall not have it unless this research is completed.

Another point worth making is that this CRSP is virtually the only one under Title XII that gives special attention to problems of women. Not only is the mother-infant dyad a focus of the research, but the projects propose to look at women's work requirements in and outside the home and the impact of chronic underfeeding on the competency with which women (as well as men) fulfill their family, social and societal roles. This direction of the research was strongly recommended by the substantial group of LDC investigators and consultants who participated in the planning, but its continued emphasis is in part an outcome of having such a large number of women investigators involved in the research. (Six of the seven proposed US principal investigators are women.)

USAID will surely consider the effect on LDC relations if the research is abandoned now. The foreign scientists have made committments in good faith and all have justified the bilateral research to their own governments. At each stage potential investigators inquired if funds were actually allocated for the research (irrespective of which projects would be funded ultimately) and in each case they were answered affirmatively. In Egypt, the Minister of Health has elected to take personal charge of the project; the

University of Maine, Orono
College of Resource Development,
Agricultural Experiment Station, Cooperative Extension Service

Reference #2

March 25, 1980

Dr. Frederick E. Hutchinson
Vice President for Research & Public Services
University of Maine at Orono
Orono, ME 04469

Dear Fred:

The nutrition CRSP review committee met in Washington, D.C. on
*a February 18, 1980. Tony Babb and I co-chaired the meeting.

Dr. Calloway joined the group for part of the meeting and spent two and a half hours answering questions.

The committee strongly recommends the Joint Research Council approve the proposed nutrition CRSP and forward it to BIFAD. The Committee members addressed the methodologies of the various projects within the program and found them to be sound and feasible.

The following aspects of the methodologies were among those considered:

- The independent variable (food intake) has limitations but the scientists are sensitive to this and are well aware of available techniques and how to utilize them most effectively.

- The intermediate variables which are biochemical and physical measurements have been chosen on an appropriately selective basis yet are adequate. These will reinforce the independent variable.

- The dependent variables are all vitally important to the program and none should be eliminated. Some of these especially those related to work output and social competence are elusive and are not fully quantifiable. Nevertheless we believe the project is well designed with relation to these variables and will produce descriptive information that will be important to future research and policy decisions.

The committee recommends that from an ethical viewpoint any services initiated for a segment of a host country population not be abruptly discontinued at the completion of the project. Arrangements should be made to continue such services through host country agencies.

The committee urges that a management entity, including a program manager with strong managerial abilities, be appointed as soon as possible.

Notes added by planning contractor:

*a *This meeting was held on March 18, 1980.*

Also, an external evaluation panel should be made functional before the research commences.

It is important that the project administration and the program management develop effective and continuing lines of communication with USDAID/Washington, involved USAID missions, host government officials and among project scientists.

The committee compliments Dr. Calloway and her associates in the development of an ambitious program that has the potential to be highly successful even though all of its objects may not be achieved.

The committee strongly recommends that three projects be initiated at the beginning of the CRSP or as soon thereafter as possible. The three projects are:

1. University of Connecticut - Mexico
*b 2. Purdue University - Egypt
*b 3. University of California/Berkeley - Kenya

This is important to insure a diversity of cultures and food patterns as well as for vital experimental replication.

The committee recommends that two additional projects be added to the CRSP as soon as feasible. The populations involved should have as their staple foods - rice, roots and tubers.

The committee recommends significant 1890 Land-Grant involvement where possible and feasible.

It is the opinion of the consultants that this program will provide data not presently available in the U.S. or elsewhere and that such data should contribute significantly to policy decision-making in developing countries.

The JRC subcommittee would like to remind you that the JRC agreed that in a CRSP, a project director shall not also serve as a program manager.

Sincerely,

Gerald A. Donovan
Dean, College of Resource Development,
University of Rhode Island
Chairman, JRC Subcommittee on Nutrition
Project Review

Notes added by planning contractor.

**b The lead institution for the Kenya project is the University of California, Los Angeles and Berkeley. Lead institutions for the Egypt project are Purdue University, University of Arizona, and University of Kansas. Recommended sequence for funding purposes is Mexico, Kenya and Egypt.*

Reference #3

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Department of State

OUTGOING TELEGRAM

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PAGE 01 STATE 036865
ORIGIN AID-35

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TAGS:

SUBJECT: COLLABORATIVE RESEARCH SUPPORT PROJECT (CRSP) -
NUTRITION

REF: (A) BANGKOK 36367; (B) BANGKOK 31210

JRC/BIFAD TO MEET FEB. 14 TO DISCUSS FINAL PRESENTATION
OF RESULTS OF PLANNING GRANT AND TO CONSIDER RECOMMEND-
ATIONS FOR FOLLOW-ON NUTRITION CRSP. TOPIC OF CRSP
REJECTIONS BY RTG EXPECTED TO BE RAISED. REQUEST MISSION
CABLE DETAILS OF THAILAND REJECTION, INCLUDING REASON FOR
REJECTION, SO THAT AID/W CAN REPLY TO QUESTIONS.

REQUEST PRIORITY REPLY TO REACH WASHINGTON BY FEB. 13 SINCE
ITEM ON AGENDA FEB. 14 A.M. CHRISTOPHER

UNCLASSIFIED

Department of State

INCOMING TELEGRAM

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FOR DS3/N

EO 12356: NA
SUBJ: COLLABORATIVE RESEARCH SUPPORT PROJECT (CRSP)

REFS A. STATE 036865, B. BANGKOK 36367, C. BANGKOK 31210

1. IN RESPONSE TO REFTEL A. USAID WOULD LIKE TO POINT OUT THAT REJECTION OF THAILAND BASED STUDY WAS JOINT RTG-USAID DECISION. SPECIFICALLY, DECISION WAS BASED ON: (1) COMPLEXITY OF PROPOSED STUDY'S INTERDISCIPLINARY MULTIVARIATE APPROACH; (2) LOGISTICAL AND ADMINISTRATIVE DRAIN ON MISSION AND RTG RESOURCES; (3) QUESTIONABLE BENEFIT ACCRUING TO RTG; (4) LONG TERM COMMITMENT NECESSARY TO COMPLETE THE PROJECT; (5) ITS LACK OF RELEVANCE TO AID'S COUNTRY DEVELOPMENT STRATEGY; (6) COMPLEX NATURE OF THE PROPOSED STUDY INDICATES THAT IT WOULD BE EASIER TO CONDUCT IN THE UNITED STATES; AND, (7) QUESTION AS TO WHETHER OR NOT THE PROPOSED STUDY DUPLICATES RESEARCH EFFORTS THAT HAVE ALREADY BEEN WHOLLY OR PARTIALLY COMPLETED ELSEWHERE THUS INDICATING A NEED FOR A COMPLETE REVIEW OF THE LITERATURE TO WEED OUT DUPLICATIVE COMPONENTS OF THE PROPOSAL.

2. THE ABOVE CONSIDERATIONS CONSTITUTE THE BASIS FOR USAID DISAPPROVAL. IN ADDITION, WE WERE INTRIGUED BY THE COMMENTS OF A DISPASSIONATE OUTSIDE OBSERVER WITH EXTENSIVE EXPERIENCE IN NUTRITION RESEARCH METHODOLOGY. SOME OF HIS OBSERVATIONS WERE THAT: (1) THE PROPOSED PROJECT IS NOT A DOABLE ONE; (2) THE ONLY INPUT VARIABLE IS CALORIC INTAKE AND TO RELATE THIS TO ALL THE OUTPUTS SEEMS TO BE AN IMPOSSIBLE TASK; (3) THE AMOUNT OF TIME AND MONEY AND EFFORT TO BE EXPENDED WILL BE VAST AND THE REWARDS MINIMAL; (4) PERHAPS SMALL PILOT PROJECTS WITH SPECIFIC QUESTIONS ASKED AND DEFINABLE AND MEASURABLE ENDPOINTS COULD BE REASONABLY UNDERTAKEN AND GOOD RELIABLE DATA OBTAINED FROM WHICH FURTHER QUESTIONS MAY BE ASKED; (5) IT SEEMS MUCH COULD BE LEARNED FROM THE EPIDEMIOLOGIC STUDIES DONE IN FRAMINGHAM, MASS. OVER THE PAST 30 YEARS. THESE HAD MEASURABLE VARIABLES AND DEFINABLE RESULTS AND TOOK MANY YEARS AND MILLIONS OF DOLLARS TO OBTAIN VALID RESULTS; AND, THE EFFORT WAS DONE IN THE U.S. WHERE LANGUAGE AND CULTURAL DIFFICULTIES WERE MINIMAL; (6) TO DO A GLOBAL PUBLIC HEALTH PROJECT IN MANY LANDS WITH A DIVERSE CULTURAL MORES IS A WASTE OF TIME AND MONEY.

3. USAID HAD A LENGTHY DISCUSSION WITH TONY BABB, DAA/DS DURING HIS RECENT TDY HERE IN THAILAND, AND MANY OF THESE POINTS WERE DISCUSSED AT THAT TIME SO THAT CLARIFICATION OF ABOVE MAY BE AVAILABLE IN AID/W. ABRAMOWITZ

FEB 13.

สถาบันวิจัยโภชนาการ มหาวิทยาลัยมหิดล ศิริราชพยาบาล
สำนักงานชั่วคราว: ศูนย์วิจัย คณะแพทยศาสตร์โรงพยาบาลรามาธิบดี ถนนพระรามที่ 6 กรุงเทพมหานคร โทรศัพท์ 2020436
INSTITUTE OF NUTRITION Mahidol University, Salaya Campus
C/O: Research Center, Faculty of Medicine, Ramathibodi Hospital, Rama VI Road, Bangkok 4, Thailand

May 3, 1980

Dr. Martin J. Forman
Director
Office of Nutrition
Development Support Bureau
Department of State
Agency for International Development
Washington, D.C. 20523
U.S.A.

Dear Dr. Forman,

I have seen the telegram which was sent from the U.S. Embassy in Bangkok to Department of State, Washington, D.C. on the subject "Collaborative Research Support Project (CRSP)". Since the USAID in Bangkok indicated in the telegram that the rejection of Thailand Based Study was joint RTG-USAID decision, I have formally asked the Director-General of our Department of Technical and Economic Cooperation (DTEC) about this matter. I was formally informed that the DTEC has neither been consulted by the USAID mission nor offered any suggestions regarding this project.

Enclosing herewith I am sending you a copy of the first letter that USAID mission in Bangkok sent to our DTEC in response to our inquiry about the CRSP program.

I hope that this letter will clarify our position as for as the Thai party is concerned. I have discussed with the Director-General of our DTEC and he is willing to support if the Institute of Nutrition sees the benefit of the project and it is centrally funded.

It is expected that you could proceed on the U.S. side and hoped that Thailand will be able to collaborate on this project.

Yours sincerely

Aree Valyasevi, M.D.
Director
Professor of Pediatrics

cc. Director-General DTEC, Bangkok
Rector, Mahidol University
Dr. Calloway

UNIVERSITY OF CALIFORNIA, BERKELEY

Reference #5

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COLLEGE OF NATURAL RESOURCES
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF NUTRITIONAL SCIENCES

BERKELEY, CALIFORNIA 94720

May 19, 1980

Gerald A. Donovan
Dean, College of Resource Development
University of Rhode Island
Chairman, JRC Subcommittee on Nutrition
Kingston, R.I. 02881

Dear Dr. Donovan:

Dr. Kahn has just sent to us a copy of the recommendations to the JRC by the CRSP Review Committee, following the March 18th meeting. Drs. Wood, Beall and myself appreciate your commendation on our program development efforts, and I personally wish to thank you for the fair and gracious manner in which you and the committee members conducted the review.

The latest word I have had is that USAID has decided not to fund the CRSP. I find this shocking on several grounds, not the least of which is the quality of this program relative to other activities that are funded. After I left your meeting on the 18th, I went to a joint Indo-US research planning meeting in New Delhi where the Director General of the Indian Council for Medical Research joined the group in recommending a companion India project to be funded from PL 480 money. This means that the CRSP could have three projects in years 1 and 2, using the $750,000 in the FY80 AID budget and the $900,000 in FY81 (Mexico, Kenya and India). If favorable funding decisions were taken for FY82, the Egypt project could also begin in FY81.

USAID seems to think that they can defer a decision to FY81 (and divert the FY80 funds set aside to this CRSP to some other unspecified activity) but as you and I well know, academic teams will not simply wait from year to year. Junior staff have careers to develop and they will move on to greener pastures.

Whatever the outcome, I am grateful for having had your support and vindication of the program's worth by the outstanding external reviewers.

Sincerely,

Doris Calloway

Doris Howes Calloway
Professor of Nutrition

DHC:cg
cc: F. Hutchinson
S. Kahn
C. Wood
R. Beall

Dept. of Nutritional Sciences
University of California
Berkeley, CA 94720
May 19, 1980

Mr. Douglas Bennet , Jr.
Administrator
US Agency for International Development
Washington, D.C. 20523

Dear Mr. Bennet:

It is perhaps inappropriate for me to write to you directly concerning a research program still under review by your staff and I well know the hostility that can be generated among subordinates by reaching over their heads. However, when you spoke to us at the BOSTID meeting on the 5th, I had the feeling that you really would welcome counsel on program development and I believe a decision has been taken that will have serious negative consequences for your agency. The decision is not to fund a planned Title XII collaborative research support program (CRSP) in the field of nutrition that would affect projects planned with and for Mexico, Kenya, Egypt and India.

I freely acknowledge that I am biased and have, as well, a vested interest in the matter as I planned the program (under a USAID contract) and my University would hope to participate in its implementation. But leaving that aside, there are valid political, social and scientific reasons that it should be initiated and I would urge its adoption even if this University were to be eliminated from participation as a consequence.

The nutrition CRSP is the sixth program to be developed under the auspices of the Board for International Food and Agricultural Development (BIFAD) and its Joint Committee on Research (JRC). The objective of the nutrition CRSP is to determine the functional consequences of continuing food deprivation, in terms that will permit the generation of effective programs and policies for its alleviation. I should be pleased to send you a complete summary of the program but, in brief, what this research attempts to do first is to answer the "so what" question, i.e. what difference does chronic malnutrition make to people other than the person directly affected. Conventional research, particularly that of a medical orientation, has examined the relationship of one person's nutritional state to his own health. What this CRSP will do is explore the networks through which malnutrition exerts its invidious effects on individuals, families, and communities, so as to identify effective intervention measures. Conventional nutrition programs (e.g. the WIC program, milk distribution, food fortification, etc.) have a place but they have not resulted in sustained improvement of nutritional state, and they are often costly, especially when the prospect is that the benefits exist only so long as the program is in place. Governmental programs could be more

effectively designed if we knew whose intake most needs to be raised, when, and for how long. A small family food supplement in the hungry season that would allow more labor to be invested in planting and cultivating might well have a far greater impact than the same sum spent on urban milk programs. We do not now have the information to make such a judgement, and we shall not have it unless this research is completed.

The issue of the significance and relevance of this research was properly considered prior to initiation of the planning process and the expenditure of about $250,000 to carry it forward. Highest priority was assigned to this research by Study Team Nine of the NAS World Food and Nutrition Study; relevance to policy and planning was a major criterion for assignment of priority as the Team report states. Subsequently, this topic was given the highest priority of 22 areas identified for special attention from among the numerous listings of all 14 Study groups. (In fact, four nutrition topics were rated above the CRSP agricultural research topics now funded or under development. It also should be noted that AID programs must respond to substantial sociocultural differences throughout the world and this nutrition CRSP, in contrast to the ones now funded, has addressed this aspect effectively through its multidisciplinary and collaborative research design.) Both USAID and the JRC made their independent judgements, in light of the NAS document and of their internal program objectives, before awarding the planning contract. The program plan has been reviewed by external experts chosen by USAID and in March was recommended unanimously by JRC and BIFAD for funding. Although I have not been notified officially, I understand that your agency now has determined not to provide the funds requested.

Before I accepted the planning contract I was assured that $1.75 million in FY80 and a projected total of about $10 million would be made available for the projects if the American academic community were willing to join in this effort, if scientifically valid project plans were developed, and if projects could be appropriately sited overseas. All of this has been done. Funds for this CRSP were reduced from the projected $1.75 million in FY80 to $750,000 in the general budget-cutting last winter; the FY81 budget request includes $900,000 for this research. These funds are not sufficient to carry out all the work proposed but they are enough to start it.

USAID will surely consider the effect on LDC relations if the research is abandoned now. The foreign scientists have made commitments in good faith, and all have justified the bilateral research to their own governments. At each stage potential investigators inquired if funds were actually allocated for the research (irrespective of which projects would be funded ultimately) and in each case they were answered affirmatively. In Egypt, the Minister of Health has elected to take personal charge of the project; the Mexican and Kenyan investigators are among the most senior and

respected in their own countries and abroad. In March, a joint Indo-US group (the American delegation was led by Dr. John Bryant, Deputy Assistant Secretary for International Health, DHHS, and Dr. Harold Rice of your agency was a member of it) recommended placement of a CRSP project in India to be supported by PL 480 funds. This recommendation was endorsed by Professor Ramalingaswami, Director General of the Indian Council for Medical Research.

Another point worth making is that this CRSP is virtually the only one under Title XII that gives special attention to the problems of women. Not only is the mother-infant dyad a focus of the research, but the projects propose to look at women's work requirements in and outside the home and the impact of chronic underfeeding on the competency with which women (as well as men) fulfill their family, social and societal roles. This direction of the research was strongly recommended by the substantial group of LDC investigators and consultants who participated in the planning, but its continued emphasis is in part an outcome of having such a large number of women investigators involved in the research. (Six of the seven proposed US principal investigators are women.)

The research is complex: it requires multidisciplinary skills and commitment on the part of the investigators to extended, difficult work. There is high professional risk to potential investigators because of the traditional bias among university peers against interdisciplinary and team research. The proposed investigators have given generously of their time and skill in developing the projects; the universities have invested administrative effort and actual funds. It may be impossible to assemble such high quality teams again, particularly with such shared enthusiasm as we now have. In short, if we lose this opportunity there may never be another. I trust that USAID will consider the impact on the US and foreign scientific communities in reaching its decision and that the political and international implications will be reviewed.

Sincerely,

Doris Howes Calloway
Professor of Nutrition

DHC:cg
cc: C. Wharton
A. Fraser
S. Kahn

bcc: L. Allen/G. Pelto/K. Knox
C. Neumann
G. Harrison
L. Schuman
N. Jerome

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Sincerely,

Doris Howes Calloway
Professor of Nutrition

DHC:cg
cc: C. Roderuck
N. Gonzalez
J. Prothro
R. Pollard
S. Kahn
E. Kiehl
L. Allen/G. Pelto/K. Knox
C. Neumann
R. Watson
G. Harrison
E. Schuman
N. Jerome

Dept. of Nutritional Sciences
University of California
Berkeley, CA 94720
May 19, 1980

Dr. Clifton Wharton, Jr.
Chancellor
State University of New York
South Tower
State University Plaza
Albany, NY 12246

Dear Dr. Wharton:

Dr. Howard Schneider has suggested that I raise with you the matter of USAID's intention not to fund the nutrition CRSP as BIFAD recommended in March. I am, of course, dismayed at this turn of events and have finally gone completely out of channels and appealed directly to Mr. Bennet. A copy of my letter to him is enclosed; it sets forth the main reasons for my concern.

A point I did not raise with Mr. Bennet, however, must surely concern BIFAD. Of what value are prestigious public advisory bodies if agency staff can willfully, if not capriciously, ignore their recommendations? If the present arbitrary, unilateral action goes unchallenged it suggests we are all wasting our time and tax dollars in serving with such groups.

Please let me know if there is any way in which I can advance the cause.

Sincerely,

Doris Howes Calloway
Professor of Nutrition

DHC:cg
Encl.

APPENDIX II-1

Report of the Workshop on

Nutrient Intake and Disease Response

and

Background Papers by

R. K. Chandra
John Osgood Field

REPORT OF THE
WORKSHOP ON
NUTRIENT INTAKE AND DISEASE RESPONSE
September 25-29, 1978
Hyannis, Massachusetts

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REPORT OF WORKSHOP ON NUTRIENT INTAKE AND DISEASE RESPONSE
SEPTEMBER 25-29, HYANNIS, MASSACHUSETTS

A workshop convened by the Food and Nutrition Board and its Committee on International Nutrition Programs considered the need for a functional definition of nutritional status. The consensus of the workshop participants, drawn from a broad spectrum of relevant background experiences and interests, was that there is strong reason to accept the premise that severe malnutrition is associated with impairment of a number of human functions. However, there is uncertainty about the relationship of less-than-severe ("moderate" and "mild") malnutrition to these functions. There is no clear information about the level of nutritional status associated with initiation of impaired functional capacity and whether or not the response is linear. Because of the immensely large populations affected by less-than-severe malnutrition and because of the potential importance of its sequelae for individuals and for society, these relationships must be understood. Information on these points has relevance to anyone engaged in the consideration of intervention programs. Although the workshop noted that certain functions may relate most closely to certain specific nutrients, and that nutrient-nutrient interactions were possible, it was recommended that attention should be centered on the relationship between energy undernutrition and function for the purposes of this program.

The FNB Workshop identified five broad areas of human function which might be particularly relevant to those involved in food, nutrition and health planning. These were disease response, reproductive competence, work output and activity, cognitive and sensory capacities, and social and behavioral function.

Under Title XII, USAID was given responsibility for funding research in this area of human nutrition. The above five functional areas were designated as topics to be explored in a series of planning meetings. The present workshop was convened to consider the first of these areas and to offer advice on research approaches that might serve to investigate the relationshop between food intake and disease response in an expeditious and quantitative manner. The participants recognized that in actual implementation, research relating to two or more functions might be conducted with the same populations at the same time, perhaps with considerable economy, and with increased interpretive benefit. Nevertheless, discussion was focused on the one area of function on the assumption that combination and integration of the functions in research designs would be accomplished at a later stage.

The participants understood that their challenge was not to decide whether or not relationships existed between food intake and disease response but rather to determine the most critical research questions and the most effective research strategies ultimately to describe and quantify these relationships across varying ranges of food intake and varying degrees of less-than-severe malnutrition.

OBJECTIVES OF THE RESEARCH

To provide a basis for considering research design, the overall objective of the research was defined more precisely as determination of the relationship of food intake to the expression of disease in the community. For the purpose of this study food intake refers principally to energy intake. It is recognized

that when food intake is low, the intake of nutrients may also be low and that disease effects attributed to low food intake may not be consequences of inadequate energy intake *per se*. It is also recognized that at levels of food intake that satiate total energy needs there may still be marginal or inadequate intakes of specific nutrients. These possibilities will warrant consideration in experimental design and data interpretation.

Study design must also take into account the fact that food intake is only one of many variables that may affect disease expression. These other factors must be "controlled" or taken into account in statistical analyses if the objective of describing the contribution of food intake is to be achieved. Consideration of social and behavioral changes taking place during the study must be included in the design.

Finally, it is emphasized that the goal is a quantitative description of the relationship between graded levels of food intake and disease expression in the community. Obviously this imposes special demands upon the design and analytical approaches.

Specific Objective 1: To develop a functional classification of nutritional status as it relates to expression of disease.

This may be seen as an objective in its own right and as an intermediate stage in the examination of the relationship of food intake and disease expression. The primary focus would be assessment of nutritional status with regard to the adequacy of energy balance, both short term and long term. It may also be appropriate to include other parameters of nutritional assessment, particularly where it is suspected that inadequacies of specific nutrients may be confounding variables in data interpretation.

Specific Objective 2: To determine the relationship of nutritional status to vulnerability to disease and/or its expression.

The purpose is to strengthen the probability that observed relationships are valid and to provide information about mechanisms. If it is possible to identify parameters in the host that reflect both nutritional status and vulnerability, the research may result in improved health/nutrition indicators. Consideration should be given to measures of vulnerability that have been shown to be sensitive to mild/moderate degrees of food deprivation and to relate closely to disease expression. Of particular interest in this regard will be parameters of immune responses.

Specific Objective 3: To identify the specific contribution of total food energy intake to nutritional status in the presence of prevailing disease patterns.

The aspects of nutritional status that are of interest are those which may relate to vulnerability (susceptibility to and recovery from disease). It will be necessary to control for confounding specific nutrient deficiencies.* The design and analysis of research will also have to take into account the contribution of other factors associated with the biological and social

*Some micronutrients which are likely to be deficient in the diets of certain settings are iron, zinc, vitamin A, folic acid, riboflavin, pyridoxine, and thiamin.

environment which may affect this relationship.

Specific Objective 4: To establish the validity of linkages in the total system which relates food intake to disease.

If the research design follows a phased approach in which component linkages (i.e. the specific objectives outlined above) are examined sequentially or separately, then it will remain necessary to test the hypothesis in the total system--that is, to examine the relationship between food intake and expression of disease in the community. Since the underlying objective of the research is to provide information relevant to planning and ultimate improvement of human health, and well-being it follows that the final test of the hypothesis should be conducted in a setting that would have relevance to eventual operational programs.

RESEARCH DESIGN

In considering possible approaches to achievement of the above objectives, a number of potential designs can be proposed. There is a continuum of research endeavors that relate to the ultimate applied goal, improvement of nutritional health and well-being of human populations. This continuum may be considered in terms of types of research and in a sequence of stages (see Table I). As new basic information arises in the biological and social sciences, it gradually finds its way into the design and conduct of research at a more operational level. Questions arising at the stage of applied operation may in turn provide stimulus for basic studies.

To meet the stated objectives of the projected research requires a style of investigation that might be called descriptive and analytic epidemiology and systems research. At a later stage, to establish causality in the described relationships, it may be necessary to perturb the systems by experimental intervention.

Three broad approaches to the research design are outlined below together with assessments of their probable strengths and weaknesses and potential advantages and disadvantages.

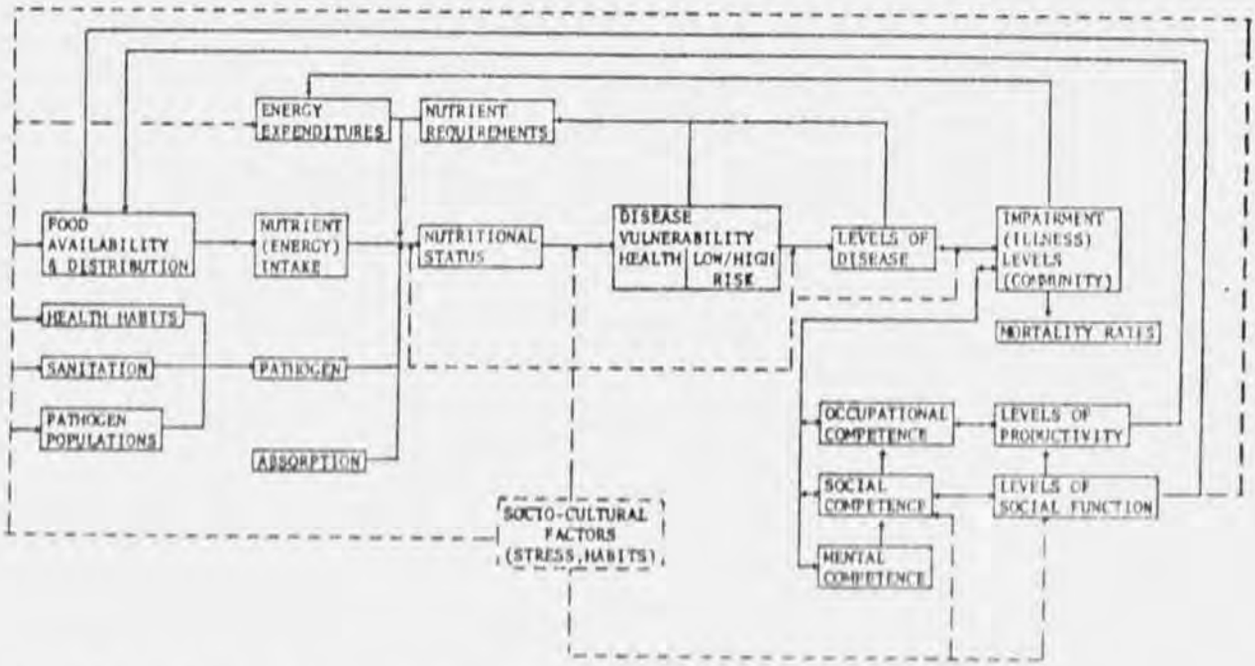
SYSTEMS APPROACH

Even the most direct physiological linkages between nutrient or energy intake and vulnerability to disease are not isolated, whether present in individuals or in communities. Rather they occur as parts of larger ecological systems which can be described and illustrated, as shown in Figure 1. Therefore it is essential in the development of a strong study design to possess sufficient understanding of the larger system to sharpen the focus of particular research questions. Since answers are likely to come piecemeal and final confirmation may require an intervention study, it becomes imperative that the research design be finely tuned for answering specific questions which will permit quantitative assessment of the hypothesis. Definition of the system has a second purpose. The system may reveal additional subjects of interest, such as the delineation of causal links, and may identify areas for intervention which were previously not suspected. This process also determines the structure of a system for evaluation of the relevance of choices over time.

TABLE 1: RESEARCH CONTINUUM*

Planned Experimental (intervention) studies	Observations	Epidemiological Studies
Test tube research Animal studies Clinical metabolic studies	Clinical experiments of nature (i.e. patients present with critical defects and symptoms which can be studied)	Descriptive Epidemiology: - Is gradient of A (putative case) across populations associated with gradient of B (outcome)? Systems Analysis: - How do gradients of different A's and their interactions correlate with (predict) gradients of B? Analytic Epidemiology: - Fortuitous experiments of nature (cohort studies) -- is there a gradient of B in those who were exposed to A? Case-control study: - Were those who now have B previously exposed to A? Experimental Epidemiology Study in Individuals: - Does B change in individuals as A is changed in individuals? Experimental Epidemiology Study in Communities: - Does the mean of B in a com[illegible]ity change when A is changed [illegible] communities?

* Public Health programs are not considered suitable for research on this topic. They may grow out of the results in the future if benefits are shown by the techniques listed above in a logical, staged manner.



General Research Procedure from the Systems Perspective

1) Identification of key variables their ranges and acceptable levels

2) Establishment of systemic inter-relationships between variables, in Biological (—) and Sociocultural (– –) terms of energy, information, rates of flow, bottlenecks in seasonal, social, structural terms.

FIGURE 1: Example of a "systems map"

The systems analysis can be expected to provide two principal forms of guidance in research design: 1) identification of key variables in the community from the perspective of both the investigators and the subjects, with estimates of the range and level of importance of these variables; and 2) a conceptualization of the relations between these variables in both biological and sociocultural terms. Of unique importance is the definition and estimation of the repercussions of disease in one individual on other members of the community.

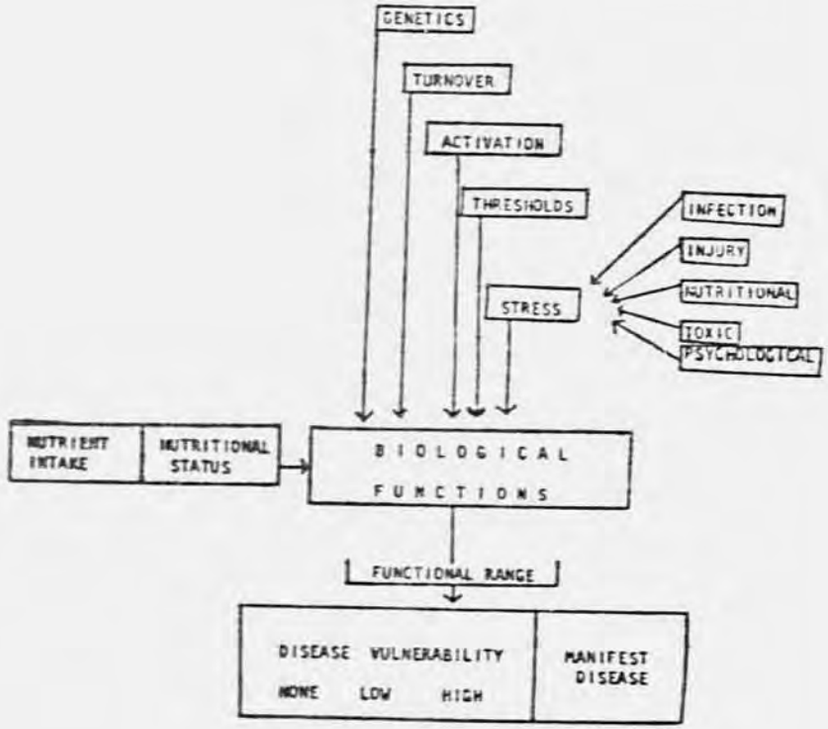
Method. Through collection of demographic, ethnographic, biomedical, morbidity and mortality experiences of the community, a working assessment of the nutritional intake-disease vulnerability linkages is made. This is not intended to be exhaustive or incontrovertibly authoritative, but rather to be a broad description of the key features of the group. From this, judgment can be made to identify the significant problems and the probable stresses which make latent disease and deficiency suddenly manifest. These problems can then be given prominence in the study design by a focused analysis of the physiological functional systems involved in the particular source of identified disease risk. These systems are studied in terms of both baseline function and functional reserve under applied stress, along a scale of vulnerability from that existing when there is optimum nutrient intake, to that of high risk (pre-disease) (Figure 2).

After the community has been selected, the first step would be to obtain available climatic, demographic, socio-economic, farming system, health care, morbidity, etc. data. Field work would be done by a multi-disciplinary team including an epidemiologist, anthropologist, nutritionist and agricultural economist. Initially, a "feel" for the village, i.e., its demography, social structure, economic differentiation, diet patterns, and sanitation would be obtained to gain a preliminary view of the nature of nutrition and disease problems, including their incidence, in different sections of the community and their perception, by the people themselves.

On the basis of this broad view, detailed case studies would be done of households from different sections of the community. The focus of household case studies would be on identification and appraisal of nutrition and disease problems and an assessment of their significance to the household. Questions such as the following would be asked: "how could behavior within the household change to reduce its nutrition and disease problem?";"Why is behavior not already modified in this way?", "What would it take to change behavior (farming practices; food selection, purchase, preparation; hygiene, etc.)?", "to what extent, and with what significance, could behavior change within the household to reduce the severity of its nutrition and disease problems?" Complete tabulations would be obtained for each member of the family from observation or estimation of such data as age, sex, height, weight, food intake, energy expenditure, health status, and disease history. Such tabulations would represent, in matrix form, information on variables serving as indicators which relate to the elements of a "systems map" (Figure 1). For each individual causal links would be postulated between food intake, nutritional status, disease and impairment. Links would also be traced between individuals to identify, for example, how one household member's infection influences another's capacity for work, nursing, eating, etc. An assessment of these links will provide the basis for determining the significance of nutrition and disease impairments within the household.

The community as a whole can be viewed in a similar way. For example one

Figure 2: Influences on Disease Vulnerability



might ask in what way nutrition-related disease could be reduced by changes of behavior within the community; which aspects of the community's nutrition and disease problems would be most important to attack and by what measures.

At this point there might be some uncertainty about the number and socioeconomic category of individuals affected by specific nutritional and disease problems. This might lead to questions concerning the contributions of nutritional and disease impairments to subsequent and wider impairments effected through different pathways (e.g. impairment affecting farm output, food availability, food intake), the significance of these impairments points in the system at which intervention would be most effective, how far "packages" of measures will be necessary, and so on. Decisions will then be required as to what information will improve confidence in the identification, design, and assessment of interventions and whether the cost of obtaining such information, including expenditure of personnel and time, will warrant its collection instead of proceeding directly to the design and implementation of an intervention.

In the event that more information and understanding is necessary, the next phase of work might include simple survey work, an epidemiological cohort study, comparative case trials, or laboratory or metabolic unit research. Whatever work is indicated, its purpose and application, the necessary degree of accuracy, and the type of information required will be clearly defined. The design of the study, or studies, will be specified accordingly. The results of the research will then have immediate application and will lead to the identification of relevant problems and design of appropriate interventions.

EPIDEMIOLOGIC COHORT APPROACH

Epidemiological can be classified as descriptive, case control, cross-sectional and cohort. The availability of resources, the questions to be answered, and the populations to be studied will determine which of these methods should be used. It is likely that descriptive and cohort studies will be of the greatest value, that the cross-sectional approach will be of little value, and that case studies may be advisable in special circumstances.

The following section describes the cohort approach, which would probably be the most effective of the epidemiologic methods for research on the relationship of food intake to the expression of diseas. in communities. However, many of the procedures stipulated apply to all types of epidemiological studies that are likely to be proposed.

An epidemiologic cohort approach to the hypothesis that energy intake is inversely related to disease expression in the community will be discussed. In this example the independent variable could be food intake, nutritional status, level of sanitation, medical care availability, etc; however, in more complicated designs combinations of these variables could be tested at greater cost and analytic demand. Such designs could prove to be necessary if the respective contributions of these latter variables are a part of the assessment of the relationship.

For this purpose a cohort approach will be described which relates the independent variable at several discrete levels of magnitude (or as a continuous function) to outcomes such as disease expression. Actually the design is not only a prospective approach, but also embodies a longitudinal component in that both the independent and dependent variables will be re-measured at pre-determined intervals, taking seasonal changes into consideration. This

will not only provide for surveillance of dietary changes but also, if the intervals are not too long, for a disease surveillance capability of greater reliability. Food intake measurements will also be made more reliable.

Method

Several communities should be selected in order to insure ranges in the independent variables, and a secure sample even if unforeseen complications prevent completion of the study in a particular community. If possible there should be enough flexibility in design that investigators could capitalize on unexpected events.

Communities selected should have comparable demographic, environmental and social attributes (i.e. size, population distribution of age and sex, sanitary status, availability of medical care). If the design includes assessment of other variables which contribute to the disease state, then the communities should encompass a range of these variables (albeit the population to be studied should be increased).

Since the diseases which may be related to nutrient intake could also be related to sanitation and available medical care, these variables must be included in the study, and efforts should be made to select communities in which socioeconomic status is not so disparate that there are significant differences in water supplies, sewage disposal facilities, and access to medical care. In populations with divergent food energy intakes, it is likely that high intakes will often be associated with increased wealth. However, it is not necessarily true that small differences in affluence which alter energy intakes, must also alter other variables thought to be related to disease expression. It will be the responsibility of investigators either to select communities in which confounding variables such as these are at such a low level that the study is not compromised or to suggest methods of controlling these variables.

Because the study will be prospective and longitudinal in design, and since spin-off or continuing research may be indicated, evidence of continued cooperation and stability of the community should be available. Reasonable assurances of community participation should be obtained by the applicant researcher before the study is funded.

There should be no other conflicting research or other promotion of health activities in the community, or nearby communities, which might interfere with the execution of the research design. In many cases communities in which other studies have been conducted may be of special value because of the existence of a data base. However, it should be cautioned that communities should be avoided in which previous studies have failed because of lack of cooperation or in which there is reason to suspect that cooperation in a new investigation may be affected by the population's reluctance to be further studied.

The measurement of nutrient intake should take the form of quantitative and qualitative dietary surveys of food consumption by families and individuals in the study population. An adequate sample of the community population, properly representative of the demographic characteristics of the populations, should be drawn and surveyed for such intakes. Nutritional status as measured by appropriate standardized historical, anthropometric, clinical and laboratory methods should be part of the initial survey and at selected intervals thereafter. The specific nutritional methods chosen will depend on the hypothesis tested.

A surveillance system for disease incidence and prevalence would be a vital component of the design. Morbidity symptoms should be recorded whether or not diagnoses have been made by health centers or visiting health personnel. A method of validation should be proposed (health centers; schools).

At the intervals of re-examination of dietary intake and nutritional status such records should be assembled, validated, and collated for systematic retrieval. These examinations and the collection of intervening illness data will permit time-series analysis of the interrelationships between these events as well as a measurement of possible feedback mechanisms.

The appropriate analyses will be contingent upon the method of sampling and the precise form in which the data are collected. However, the outcomes will be not only total morbidity and mortality but also discrete disease entities or constellations of signs and symptoms. It is obvious that before embarking on the full field study the methodologies should be tested with a small scale pilot study. Evidence of the validity of the instruments to be used should be demonstrated either by the investigator's previous experience or by such a pilot study.

EXPERIMENTAL EPIDEMIOLOGIC/INTERVENTION STUDIES

Intervention studies are not only complicated but also involve ethical considerations and should therefore only be performed when information from other sources gives evidence that the hypothesis to be tested is likely to be true. One kind of evidence stems from the elucidation of mechanisms relating dietary intake and disease expression, from animal and clinical experiments. A second concerns the finding of overlapping positions of these linkages in man. For example, in studying the relation of nutrition in pregnancy and infant mortality, there is evidence that maternal energy intake correlates with birth weight and that birth weight is associated with infant mortality. The total chain now needs to be documented. The third type of evidence relates to the magnitude of the problem, i.e. prevalence or incidence of the particular degree of malnutrition and the likely proportion of illness or death due to that malnutrition.

Intervention should be as simple as possible. For example, unless non-additive interactions are likely between various interventions, only one intervention and its controls should be tested. The nutritional deficiencies and the interventions being examined must be appropriate for the community being studied. This requires careful baseline observations of study population, under conditions carefully controlled for safety and effectiveness, and pilot testing of interventions in similar communities to assess acceptability and the extent of replacement (substitution rather than supplementation of food energy intake). One must be able to identify the effect of the intervention separately from the effects of all other (confounding) factors. This is done by randomization of interventions or matching, and use of appropriate controls such as placebos (in some circumstances ethical considerations will not allow), individuals as their own controls, cross-over designs, and double blind assessment (blind assessment may be difficult with macronutrients).

When interaction of interventions is not sought there should be a clear description or experimental control of the major confounding variable on disease. For example, in a study of measles as an expression of nutritional inadequacy, measles antibodies should be measured in different intervention and control groups, either to match for analytes or to assure that induction of

treatment was random. In study of febrile illness, there should be immunization against epidemics which might strike comparison communities, arbitrarily but not at random, and which could destroy comparibility. Note: not every putative confounding variable can be measured. A strong research design will identify the important ones and randomize the others.

When possible, "positive" controls should be designed to provide a relative measure of the intervention's effect. Assume, for instance, that simultaneously introduced general health and environmental measures are detectably effective in improving disease experience. If this is so, and the nutrition intervention results in no measurable effect, this latter finding is clearly not due to inadequate measure of outcomes (an important consideration in field studies). Positive controls also control for placebo effects.

When communities are the unit of analysis, 3 to 4 communities for each kind and level of intervention would be the minimum number of replications. Less than this number practically excludes studies of a gradient effect across communities. Analysis of gradients of intake across individuals that does not by experimental design control for self-selection and other biases will produce no better evidence than descriptive or analytic epidemiologic studies. However, when community effects are so explained they may acquire greater credibility.

As many intermediary variables (linkages) between intervention and outcome should be measured as possible. The variables should all change congruently if the outcome (including timing) of the perturbation is to be credible. The outcome measured should have public health relevance, and all results whether positive or negative should result in strong inference (power analysis).

SELECTION OF COMMUNITIES FOR STUDY

A broad sample of communities and problems should be studied in this program to cover a wide range of environments and social settings: rural and urban communities representative of particular classes of problems, comparable problems in different parts of the world, and different kinds of problems within the same geographical areas. Communities should be selected such that results will be broadly generalizable. Except where selection may illuminate some important general relationship between nutritional intake and disease it would be best to avoid communities with unique constellations of environmental-socio-cultural features, communities in the process of recovering from some prior disequilibrating stress (including previous interventions, natural disasters), and communities with reasonable likelihood of undergoing some major political-economic shock during the period of study.

Communities where prior interventions have taken place, though desirable from the point of view of having an extensive health data base, should be judged appropriate only if the effects of the interventions do not interfere with the collection of quality data necessary for the proposed research.

Communities selected should be able to be compared in demographic, environmental and social attributes such as size, demographic structure, socio-economic structure, access to markets, access to state (health) services, etc. Depending on the specific research designs, communities must meet criteria of size (large enough to evaluate research results, yet manageable, given project resources), homogeneity (differences where relevant must be identified and quantified), and feasibility (community structure is such that the project ca

be executed in the amount of time envisioned). Projects should not be placed in communities where they would be in competition with other health-related projects which might be disruptive to the community and investigators.

Communities should demonstrate potential for ongoing local participation in the project, and regional-national participation and cooperation of host country institutions should be assured. It is desirable to locate projects where there is some assurance that local participants will benefit and where projects may have some impact on the state government's sensitivity to the need for further attention to problems related to health and nutrition.

ETHICAL CONSIDERATIONS

Ethical considerations dictate that people should not be used as means alone. Further, the participants must be able to give their informed consent to the study. This requires that participants understand the harms and benefits of agreeing to participate and that they participate voluntarily. Some risk may be ethically acceptable if counterbalanced by benefits to the same individual and participation is voluntary. It is likely that risk may be limited to short term inconvenience; but if the possibility of long term inconvenience, risk, or harm exists, it must be made explicit.

If short term need is high, this need will be a strong incentive to participation and short term risk will be acceptable; long term risk will be even more acceptable. This situation constitutes coercion. Therefore the receipt of program benefits (eg. medical care) must not be tied to participation. If there is a minimum participation rate required to sustain funding, a community will bring pressures to bear on individuals; thus the voluntary aspect is impaired. The benefit/risk ratio must be increased.

The relationship between U.S. and foreign scientific colleagues is an area of concern. Foreign colleagues should be involved in research design and analysis as well as data processing. Data generated must be available to scholars in the country and also to international colleagues involved in the research.

Other issues to be considered are that health and nutritional (humanitarian) benefits should not be excluded from participants on the basis of research design; the existence of a scientific project in a community should not result in the exclusion of other benefits to the community which would otherwise have accrued to it (eg. environmental sanitation, electrification, family planning) by government; and projects can ensure that villages remain comparable by insuring that introduction of benefits is concurrent in all communities under study.

METHODOLOGICAL CONSIDERATIONS FOR RESEARCH DESIGN

Concepts of Illness and Health

Cultural definitions and attitudes toward illness must be considered and are reflected in the following questions. Does the population uniformly label central syndromes as illness? Are differential rates (eg. male/female) of certain types of morbidity due to real differences in biological-medical terms or differential reporting? Is it acceptable for males to be "ill" when they have the same symptoms as would be acknowledged as "illness" in women?

Cultural concepts of illness and health must be considered. In general, how do these affect illness reporting? What kinds of reporting of generalized syndromes (not necessarily labelled as "illness" in the culture in question) can best yield evidence on quasi-illness (possibly nutrition-related) states? How do cultural perceptions of health-nutrition illuminate problems and suggest research priorities for cooperation? What pathways are perceived between nutrient

intake and particular classes of illness? What therapeutic dietary measures are followed, conceptually and practically, for particular classes of illness (particular social categories)? How might these help establish research priorities or types of interventions or make interventions more acceptable?

Immune Systems and Disease

Emphasis is placed on the relationship between nutrition and infection, and studies commonly focus on the immune system as a functional indicator because it is seen as a protective system. Unfortunately what little evidence there is regarding immunological function in severe and mild malnutrition is not consistent. Some of the lack of consistency is probably due to variation in methods employed and their sensitivity, and in interpretation of changes noted. It is strongly emphasized that any proposal that involves immunological parameters as functional tests for nutritional state should be evaluated with caution.

Management and Analysis of Data

The usual fail-safe protection of the scientific community against improper analyses of data and incorrect inferences is the replication of the observations or the experiments. For large scale community data collection or experimental studies, this repetition usually is not possible. The possibility of incorrect analyses and inferences could be minimized by making the raw data available to the scientific community at large. However this should be done only if privacy of subjects is protected and the investigators are given adequate time to do the important analyses themselves. Wider release of data requires better description of data collection, data file building, the presentation of distributions and summary statistics for each variable, and description of the data tapes to be released. New process control measures will be needed to assure that data are so presented.

Cautionary Notes Based on Past Experiences with Population Studies

- In selecting groups for intervention studies, care should be taken to avoid using as a basis a variable which will be influenced by the intervention. This is because of the natural shift toward the mean in both groups over time which will obscure any beneficial effect.
- Intervention studies must control for all nutrition variables.
- Dietary intake studies as currently done, are very imperfect.
- Clinical-biochemical indices of many micronutrients are quite good if controlled for physiological variables, but indices of energy intakes and/or utilization are very imperfect.
- Correlations between clinical-biochemical indices of nutritional status and measurements of current nutrient intake are poor for some nutrients.
- Intervention studies in communities are generally less sensitive than controlled metabolic studies in demonstrating relationships between two or more clinical variables, particularly when cause and effect are the issue. However findings from controlled metabolic studies may be difficult to demonstrate in community studies because of the many uncontrolled variables which produce background noise. A failure to show a relationship in community studies does not imply that a relationship does not exist.

SOME EXAMPLES OF INDICES TO BE ASSESSED, ETC.

TABLE 2

Ranges of Food Intake	Indices of Nutritional Status	Indices of Disease Vulnerability
(Given factors*, ranges of energy, nutrient intake for different age, body size, sex, illness catagories) Surveys on food/nutrient Intake: (Availability Consumption), according to: age sex family structure and size social class community factors *Factors affecting absolute requirements and absorption-illness, Physiological state	Anthropometric eg. Skin-fold thickness Midarm circumference Wt-for-Ht Ht for age Hematologic eg. CBC Biochemical eg. Ferritin Al Albumin Transferrin Complement C_3 Iron Zinc Copper Folicin Vitamin A Vitamin C etc. Clinical assessment eg. Xerophthalmin Pluckable Hair Radiological eg. Bone age Metaphyseal integrity etc., etc.	Cell-mediated immunity Skin tests T cell number Humoral factors Opsonic function Antibody affinity Phagocyte function Intracellular killing* Leukocyte mobilization responses Mucosal clearance of particles Epithelial cell-receptor function Etc., etc. *Requires more venous blood samples

As far as possible, all the indices should be accurately quantifiable.

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TABLE 2 (continued)

Illness and Syndromes	Outcome	IMPACT
Infections eg. Pyrogenic parasitic viral mycobacterial etc. Deficiency disorders Diarrheal syndrome Ill-defined febrile illness Metabolic-toxic disorders Psycho-behavioral Longevity Menarche Etc., etc.	-Decline in physical activity -Anorexia -Weight loss -Permanent seq. -Impairment to mother's occupational competence -Impairment to male's occupational competence -Impairment to social competence --Impairment to financial status -Impairment to sensory function: Sight Hearing Taste	Morbidity-Health resource usage - # days out of: school work -Household mismanagement Adult Child disease Child care Adult/Child nutrition ⇓ Community Impact Loss to: -Income maintenance and growth of income -social security -educational levels -Productivity -"Quality of Life"

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ADDENDUM

After this report was drafted, UC staff wrote the following letter to each of the participants in the Disease Response Workshop:

December 13, 1978

Dear

We have by now completed the set of five workshops dealing with food/nutrient intake and the ability to function in society and we are trying to compile, edit, and integrate the reports from all of the workshops. We are planning to hold a sixth workshop January 15-17 composed primarily of nutrition research experts from countries with a high prevalence of malnutrition. They will review the integrated version of the reports, discuss the feasibility of projects in their countries, the objectives of the program, etc. We are finding that the most valuable sections of the reports for this purpose are those dealing with research questions which need to be answered (under the overall mandate of quantitatively measuring the relationship between energy intake and functional competence); the prioritization of these questions (which questions should be asked to be of the greatest potential benefit for developing countries); and with what methodological designs these questions might best be approached.

While the disease workshop was strong on research design, the prioritization of the most critical research questions was not directly addressed. Given that most of the discussions centered on infectious diseases in children, this was an indirect indication that high priority should be given to studying children rather than adults. Do you agree? What would you suggest as the second priority area?

It would be extremely helpful to us if you would give us your thoughts as to research questions and their priority. We have some more specific questions and we hope that you will find the time to respond to some or all of them so that we can do justice to the area of disease response.

The report listed four specific objectives which were never really discussed specifically or concretely.

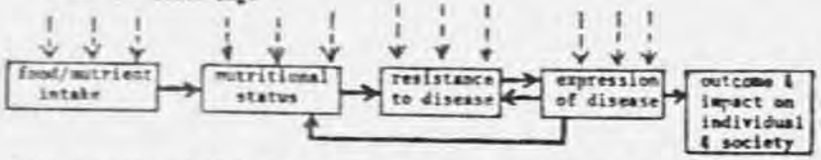
The first specific objective was to develop a functional definition of nutritional intake as it relates to expression of disease. This might be interpreted to mean the following: to measure (descriptively) levels of expression of disease (or resistance to disease) that would relate to or define levels of nutritional status associated with a range of intakes.

1. Which diseases would you consider to have the highest priority for study?
2. Which target populations would be the most critical?
3. What sort of measurements might be used to relate to levels of nutritional status? biochemical? immunological? clinical (severity, duration, frequency of disease)? We focused on immunological measures. Are there any immunological measures sensitive enough to define levels of marginal malnutrition in humans? Can you suggest other parameters/measures that might be more effective?

The second objective was to determine the relationship of nutritional status to vulnerability to stress and/or disease expression.

1. What quantitative measures of "vulnerability" do you suggest?
2. Are there host parameters that reflect both nutritional status and vulnerability? Might we want to recommend research on methodology here?
3. If we fulfilled the first objective, would not this one be taken care of?
4. How are parameters of vulnerability related to disease expression?

The fourth objective was to establish the validity of the linkages in the total system that relates food intake to disease. One might envision the following:



This objective might be interpreted to concern the linkages indicated by dark arrows or broadened to include the web of arrows (we could all come up with complicated diagrams) representing all the socio-environmental linkages.

1. Which linkages should have the highest priority for study?
2. Why?
3. How? which disease, target groups, etc.
4. What thoughts do you have on the relation of nutrition/disease expression to function in society from individual learning ability for instance to institution building?
5. What areas of "social competence" do you consider to be most relevant to the area of nutrition-disease?

Given that the overall objective is to measure quantitatively the relationship between graded levels of marginal food energy deficiency and levels of disease response (resistance or expression), what is the research question to which you would give the highest priority, or rank the most critical research questions in order of importance. For example, the workshop on reproductive competence decided the greatest need was to study lactation, specifically, the relation of maternal nutrition to the quality, quantity, pattern, and duration of lactation. The second research priority was the relationship of patterns of weight-gain during pregnancy to pregnancy outcome, specifically complications of pregnancy and low birth weight infants. And third, the timing and characteristics of supplements to human milk with regard to lactation and the health of the child. There were six research areas in all. The criteria the group used for this selection were as follows:

1. The problem associated with the research area should be both serious and widespread.
2. There should be significant potential for applying research results to government policy or practical programs.
3. The research should promise to be cost-effective.

The work output group used the following criteria:

1. Efficient use is made of available knowledge.
2. Questions are addressed which, when answered, can give rise to practical, locally relevant solutions for improvement of energy-nutritional status.
3. The project when launched has a high probability of being completed.
4. Appropriate utilization is made of qualified local manpower.

Thank you again for your contribution. We hope to complete the area of research priorities for disease response in time to include it in our report for the January 15 meeting, so we would appreciate receiving your comments as soon as possible.

Best wishes for the holidays.

Sincerely,

Doris Howes Calloway
Professor of Nutrition and
Chairman of the Department

Christina Wood, Ph.D.
Coordinator/Administrator

DHC:CW:ht

The following are excerpts from answers received by the participants:

On the first general question, should high priority be given to children rather than adults, I do not entirely agree. Most of the existing nutritional literature focuses on "vulnerable groups" but the emphasis of the systems perspective was on the functioning of the larger social units--household on up--in relation to nutritional status and disease. This would suggest research priorities not be limited to children. Certainly nutritional/disease state of female (head of household) should receive second, if not first priority from this perspective.

On the Specific Objectives:

1. parasitic infections (amoebas, helminths, flukes)
2. adults and children
3. clinical measures of disease status (parasite load), plus indications of severity, duration, frequency of disease.

We need more information about the relationships between increased caloric intake and disease (parasite load) response. Malnutrition and parasitic infections occur together in many target populations, but aside from hookworm - anemia relationships, there is little attention to the interactions between infection and energy intake, and their joint relationship (to produce "nutritional status," affected by absorption, etc.) Lack of information produces ill-advised nutritional programs (e.g. Colombia). We do not yet immediately understand the reasons for increased parasite loads accompanying supposedly better nutritional status, or their implications.

Parasite load (though not necessarily expressed as a disease state) might be one quantitative measure of "vulnerability" but we need more research on methodology here. We also need to know how chronic infection is related to only occasional disease expression. Are there "stress" or nutritional relationships to be found here?

If we fulfill the first objective, on this project priority, this one would be taken care of also. On the fourth objective, the most important linkages to pursue are relationships between nutritional-vulnerability status and outcome and impact on individual and (her) social function in the larger social unit. This will involve looking also at the relationship of nutritional-vulnerable state and expression of disease. Again, I would look at adult women (household heads), children and their status in regard to parasitic infection. If women are marginally nourished/disease vulnerable (or diseased) they cannot manage households effectively. This produces problems for the rest of the household. If apathetic, they also cannot take part fully in development "schemes," projects to improve their social "function" and the welfare of their children. From the perspective of children, if marginally nourished - illness vulnerable if not diseased, they will be apathetic or absent from school, and this affects learning, learning for the present, institution-building for the future.

Therefore, I would rank the disease-nutritional status of women (household heads) to be the target population for study. Second, the children.

The key research questions: the relationship between food energy intake, parasite load, disease (vulnerability) status, and individual (by implication, social) function.

We do not yet have enough data on questions of the interaction between marginal energy intake (deficiency) and parasite loads. Nor do we know the

relationships between these joint factors and social function.

The problems are serious and widespread. Both parasitic infection and marginal energy intake (deficiency) are endemic in many (most)areas of the developing world.

If these relationships are better understood, there will be a better possibility of applying effective nutritional programs (or judging the cost effectiveness of other programs). The research promises to be cost effective; i.e. it will help establish data for two areas of concern: nutrition and disease and contribute to a better disbursement of funds. It is a general problem area of great interest for developing countries, and should make appropriate use of qualified local manpower.

* * *

Objective 1: Functional definition of nutritional intake as it relates to expression of disease

1. High priority disease: Diarrheal diseases, specific etiologic factors to be ascertained in the particular research setting.
2. Target Population: In terms of research design, all age strata are of interest since susceptibility to infection (setting aside acquired immunity, which in itself is of research interest). Obviously, a moderately high prevalence of "disease" and a gradation of nutritional status within the population is of essence to the design. These will be important determinants in selecting the population (s).
3. Possible Measurements: - all to be considered on scaling base
   a) Nutritional status: Given primary focus upon energy, the obvious parameters are height, weight, age perhaps coupled with additional anthropometric measurements (skinfold) and, for children, history of growth pattern.

      It is recommended that some of the conventional assays of nutritional status be incorporated in the design to control for specific nutritional deficiencies.
   b) Immunological: I am not expert in this field. My distinct impression from the expert members of the group was that we cannot offer a good prediction of the best measures.

      This may be an area requiring additional research before a study design can be established.

   c) Expression of Disease: This will depend, in part, on the specific disease syndrome selected for primary study. In the case of diarrheal disease, the parameters might be: frequency and texture of stools (scaling system to be established in the field). In addition, such parameters as body temperature (duration and intensity of febrile episodes) should be recorded. Other parameters such as specific diagnoses, duration of illness (parameters of illness and measures of duration + scaling system to be established in the field)

Note: Since the objective of these studies is to establish the relationship between "less than severe" malnutrition and infection, with the latter as the dependent variable, it seems that a longitudinal design will be necessary. We already know that malnutrition and disease are associated; the direction of causality is in doubt.

If appropriate immunologic measures cannot be predicted, then the design might call for a battery of immunologic measurements and one of the objectives would become the determination of which measures are indicative/predictive of host resistance.

Objective 2: To determine relationship of nutritional status to vulnerability to stress/disease expression

1. Quantitative Measures of Vulnerability: For individual, see above.

We do not know which measures. For population (interpopulation comparisons), frequency (incidence and prevalence) of expressed disease after statistical control for other contributing factors.

2. Host parameters reflecting both nutritional status and vulnerability: Not known. This is one of the sub-objectives of the research (see above).
3. Objectives 1 and 2, if properly interpreted, are identical.
4. Relationship of parameters of vulnerability to disease expression: Not known. This is a sub-objective of the research.

Objective 4: Validity of linkages in total system linking food intake to disease.

Preamble: The objective of the entire research program (all workshops) is to approach the question of the "web of arrows". The objective of this particular piece of the research program is to disentangle the web and search for specific relationships.

1. High Priority Linkages: The linkage set of interest is: nutritional status -- resistance to disease (vulnerability of host) --- expression of disease. The direct measures may cross from nutritional status to expression of disease. The second order research priority then becomes establishment of the measures of the middle component.
4. My thought is that this question is impossible answer in any feasible research design at this time. I hope that the experts in other groups may have come up with approaches that relate any of the specific studies to the broad issues of societal development.
5. Relevant areas of "social competence": I am not sure I even understand the question. In children, I would be concerned about effect of "disease" on voluntary activity and possible learning effects of change in "play" as well as the obvious health questions. In adults, I would be interested in effect on working performance (and more specifically does it reduce performance below the effective demand of the particular society). I would also be interested in knowing the effect on "leisure time" activity. However, clearly these may also be affected directly by level of feeding without impact upon either nutritional status (by measures of physical health) or resistance to disease. Therefore, they can be examined only in a study that attempts to control for the effect of energy intake per se; this was the topic of a separate working group.

* * *

..... Any studies proposing to monitor the immune system during nutritional rehabilitation should be evaluated with caution. It is difficult to demonstrate a significant change in the in vitro cell-mediated immunity of PCM children. Proposed changes would be even more difficult to demonstrate in moderately malnourished populations.

* * *

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APPENDIX A

Nutrient Intake and Disease Response

R.K.Chandra

The availability and the provision of enough food for the continuously increasing population of the world is the greatest material problem facing mankind today. Associated with it is the stark spectrum of about 500 million people suffering from the multiple erosive effects of undernutrition; it is a rude eye opener for any serious student of global health situation.

NUTRITION, ENVIRONMENT, BIOLOGY AND GENES

The ability of an individual to achieve his/her optimal potential is dependent upon a harmonious interaction of genes, nutrition and environment. Nutritional stress affects each and every structure and function of the body. The effects of undernutrition are protean; some are adaptive changes with no apparent consequence, others are pathological and produce symptoms and signs; some are almost immediate and may be short-lived and reversible, others are prolonged or even permanent. All these effects are, however, conditioned and modulated by the genetic endowment (metabolic, immunologic, etc.) of the individual, by their timing in relation to the critical periods of growth and development of biological activities, and by the environment including socioeconomic and cultural factors. Thus there is an intimate interaction between genes, biological clocks, nutrition and environment; the effects of nutrient intake on disease response are also governed by such interactions.

The most prominent association of nutritional deficiency is with infection. However, these two inextricably intertwined problems defy easy analysis in terms of the underlying mechanisms of pathogenesis and interplay. Recent studies have revealed impaired function of a variety of host protective factors in malnourished individuals. It is possible that the clinical problem of repeated and severe infections in undernourished persons is the result of a summation of variable individual abnormalities in several key cellular and humoral immunological functions. These changes in immunocompetence may play a critical role in the effectiveness of immunization, in the susceptibility to septicemia spread of infection, and in the production of immunopathological disease. Infection itself can result in significant deficits in immunity function and in nutrition,

the latter because a sick individual has no desire to eat, intestinal absorption is impaired, and there are greater metabolic needs and heightened catabolic losses. In addition, there is sequesteration of many nutrients in an attempt to synthesize urgently needed antibodies, complement and other protective responses.

At the same time, it must be recognized that nutritional status is intricately tied to other health factors, and that the roots of malnutrition are largely economic and socio-cultural. To tackle this major world affliction, we must consider a portfolio approach of intervention at several levels, including socioeconomic development, nutrition education, promotion of breast feeding, immunizations, safe water supply, and environmental sanitation.

The task looks formidable, but that is no reason for not trying.

SUSCEPTIBILITY OF UNDERNOURISHED INDIVIDUALS TO INFECTION

The common association of malnutrition and infection does not necessarily imply a causal relationship. It must be recognized that the same economic, sociocultural and ecological factors which contribute to undernutrition may well maintain a high frequency of infectious diseases. In this connection, the role of poor personal hygiene and environmental sanitation, and early weaning with inadequate and inappropriate replacement needs to be highlighted.

A variety of evidences have been cited to support the clinical impressions of health professionals working in developing countries that infections occur more frequently and are more severe in the malnourished. Epidemiologic data from field surveys in Asia and the Americas have confirmed the intimate association of nutritional deficiencies, growth failure, infectious illness and diarrhoeal disease. In a prospective study of Mexican children followed from birth to 5 years of age, moderate malnutrition correlated significantly with the duration and severity of infectious episodes and to a lesser extent with the incidence of diarrhoeal disease in the age period from 8 to 18 months. The majority of hospitalized children with severe forms of malnutrition have an associated infection at the time of admission; this is more often observed in kwashiorkor than in marasmus. The PAHO survey of mortality patterns in Central and South America showed that 57 percent of the children who died under 5 years of age revealed signs of nutritional growth retardation, intrauterine and/or postnatal, as either the primary or an associated cause of death, often from infection.

Many diseases run a more severe course in nutritionally deprived children. For example, measles is known to produce fatal giant cell pneumonia in kwashiorkor. Interestingly, there is an unexplained geographic difference in measles-associated morbidity and mortality; the frightening spectrum of measles in African children with kwashiorkor has not been observed in Asian malnourished populations. Herpes virus infection is often generalized and fatal in kwashiorkor; autopsy studies show multiple visceral hemorrhages and there is a conspicuous lack of inflammatory response. Septicemia with Gram negative organisms and Pneumocytis carinii pneumonia frequently complicate moderate-severe protein-energy malnutrition. In undernourished populations, there is a heavier load of parasites, particularly Ascaris, Necator americanus,

Srongyloides stercoralis, Giardia lamblia and Entamoeba histolytica, and greater rates of infections with enteropathogens such as Shigella. Pneumonia and diarrhoea occur more frequently and are more severe, leading to higher death rate. Hepatitis B surface antigen is detected more often. The intimate association of tuberculosis and inanition so well described by Osler has been validated. However, tuberculosis and parasitic infestation may be the cause and/or the effect of undernutrition.

Whereas there is considerable data on energy-protein malnutrition, similar critical information for deficiency of specific nutrients is not available. This is understandable since malnutrition in man involves deficits of many elements, and each nutrient may exert a variable, possibly even opposing, influence on the occurrence of infection. Some surveys reported a decreased in infection rate among iron-supplemented infants, others have failed to detect such an association. Iron deficiency was noted to be a common denominator of chronic mucocutaneous candidiasis, and therapy with iron improved the skin lesions as well as the associated immunological changes. An association of increased infections and iron-deficiency anemia was seen in Indonesian plantation workers, although the study results were vitiated by unintentional provision of additional cash incentive, and by the lack of concurrent observations in a control group. Again, a Tanzanian study suggesting a lower infection rate in iron-deficient subjects than in those with other types of anemia had no control data on healthy subjects. In laboratory animals, deprivation of specific nutrients generally increases host susceptibility to pathogens and infection-related mortality.

IMMUNE RESPONSE IN NUTRITIONAL DEFICIENCY

In the last decade, many studies have looked at the ability of the undernourished subject to mount immune responses to specific antigenic challenge. Some have employed a uniform preplanned protocol (adapted from WHO-sponsored documents) and in a few instances, samples were analyzed or rechecked in a central reference laboratory.

The consistent demonstration of impaired cell-mediated immunity has been extensively reported. Several types of evidence were collected: Cutaneous delayed hypersensitivity to a battery of ubiquitous recall antigens or after deliberate immunization or sensitization, number of circulating thymus-dependent T lymphocytes, lymphocyte DNA synthesis induced by mitogens and antigens, production of soluble mediators of immune reactivity, mixed lymphocyte response and skin homografts.

Several methodological faults need to be pointed out for the correct interpretation and comparison of results. Skin responses require the participation of several cell types and their mediators, and depends upon nonimmunological dermal characteristics as well. Three separate components of such reactions are recognized: the afferent link of sensitization of T lymphocytes with or without prior processing by macrophages, the efferent link of antigen-recognition and proliferation of T lymphocytes and release of lymphokines, and finally the inflammatory response amplified by chemotactic factors. Impairment of one or more of these sequential steps will depress skin response. Lymphocyte stimulation in vitro depends upon the number and concentration of cells, other leukocytes and the amount of mitogen. It is ideal to plot a dose-response curve since the optimal concentration of mitogen required to produce maximal response may vary from one cell preparation to another, from one batch of mitogen to the other.

Most of the studies have shown a reduction in the number of circulating T cells, as detected by resetting with sheep erythrocytes. It is possible that a change in the surface charge or in membrane-bound enzymes, eg cholinesterase, in malnutrition affects the detectable numbers of such cells. This change in T cell number is an early indicator of nutritional deficiency and is promptly reversed within 1-6 weeks on supplemental nutritional therapy. There is a relative increase in the number of 'null' cells; these cells suppress the functions of other lymphocytes and are cytotoxic for a variety of xenogeneic tissues in culture. Mitogen-induced lymphocyte DNA synthesis is reduced, except for one report from Chile on marasmic infants. Leucocyte migration inhibition factor is normal. Skin reponses are usually depressed.

Serum levels of immunoglobulins are generally elevated and IgG turnover is increased. In a rare infant with early onset malnutrition, serum IgG level may be low with a compensatory increase in plasma half-life. In most instances, antibody response to an adequate antigenic challenge is normal. Antigens requiring the help of T cells fare less well. Secretory IgA and mucosal antibody responses are significantly decreased; this may be the result of reduced number of IgA-producing plasma cells in jejunal and other submucosal locations, or reduced synthesis of secretory component, or both. Impaired mucosal immunity may facilitate the development of septicemia and of food antibodies. Data on antibody affinity is conspicuously lacking. In animals, however, protein deprivation results in a reduction in affinity of antibody, poorer and slower clearance of the antigen, and increased incidence of immune complexes.

Opsonic activity is related to the concentration of plasma employed in the in vitro techniques. When tested at concentration of 5% or higher, opsonization is comparable for sera of healthy and undernourished subjects. However, at greater dilutions, serum of malnourished children shows reduced capacity to opsonize particles for phagocytosis. Ingestion by neutrophils is normal but intracellular killing of pathogens is reduced. The importance of using a discriminatory ratio of bacteria to phagocytes has been reported.

Recently, we have looked at the number and location of intra-epithelial lymphocytes which are thymus-dependent and probably mediate cellular reactions in the mucosa. These cells are reduced in the epithelium of malnourished subjects. Experiments in animals suggest that such a change is the result largely of thymic involution associated with malnutrition. A 'leakage' of these cells into dilated lymphatics of the villus has been postulated.

Many other nonspecific protective factors are affected by nutritional deficiency, eg complement system, interferon, lysozyme, structural tissue changes, etc.

EFFECTS OF INFECTION ASSOCIATED WITH MALNUTRITION

Infection itself can produce significant changes in nutritional status and in immunity function. The extent of such alterations is determined by the severity and duration of illness, nature of the microbe, and the health status of the individual prior to infection. Febrile illnesses increase tissue catabolism and urinary losses, reduce appetite, decrease absorption or actually cause protein-losing enteropathy. In addition, the synthesis of acute phase reactant proteins, antibodies and other protective factors results in 'sequestration' of many nutrients, causing further nutritional deficiency. Infection depresses many aspects of immunity, possibly by alterations in hormonal balance, actual invasion of lymphoid tissues, endotoxemia, altered ratios of lymphocyte subpopulations, chalones, etc. Measles suppresses cellular immunity, may precipitate edema, and be followed by secondary infections including tuberculosis. These immunologic alterations have prognostic significance. Infection-induced granulocyte dysfunction may adversely influence the outcome of infectious illness.

IMMUNIZATION OF MALNOURISHED INDIVIDUALS

Since nutritional deficiency is associated with impaired immune responses, the effectiveness of vaccination must be carefully examined. The extensive literature on antibody responses to bacterial, viral and rickettsial antigens shows that in general, serum antibody response following adequate immunization is normal and that suboptimal response in undernourished subjects can be improved upon by giving a larger dose of the antigen, choosing appropriate adjuvants and excluding serious concomitant infection. In the reports of reduced conversion rate and antibody level following poliovirus administration, there was no correlation attempted with nutritional status. Virus "take" was generally associated with positive antibody response. The response improved and was comparable with titers achieved in industrialized countries when the vaccine was given 5 times. Some malnourished children show a secondary booster response following the apparently primary immunization, thereby suggesting previous exposure and memory even though antibody was not detectable prior to vaccination.

There is a paucity of data on local mucosal antibody response in malnutrition. This has been examined only in one study, in which the presence and levels of secretory IgA-antibody to measles and poliovirus vaccines were significantly reduced.

There is limited information on cell-mediated immunity following immunization. After BCG vaccination, tuberculin conversion is observed to be less frequent in malnourished subjects. Similar data was obtained in small-for-gestation low birth weight infants.

The critical question in this area is the correlation between nutritional status and protective immunity to infection rechallenge irrespective of the magnitude of the immune response. Protective titres of antibody in man are not well defined for many infections. It is conceivable that the lower antibody levels in malnutrition may still be effective in warding off natural disease. Also, careful studies are required to look at the incidence, nature and severity of complications in immunized malnourished children following exposure to the pathogens in the natural community setting. Moreover, most studies of immunity-nutrition interactions have looked at severe forms of malnutrition, which constitute only 1-2% of the iceberg of nutritional deficiency. The responses and the immunity of individuals with mild-moderate deficiencies and of those with deficits of isolated nutrients, eg iron, vitamin A, should be evaluated. Based on current data, there is full justification for continuing mass scale comprehensive immunization programmes, perhaps with some additional reinforcing measures, and excluding only those with severe kwashiorkor.

INTERVENTIONS AFFECTING THE MALNUTRITION-INFECTION COMPLEX

While there is obvious need for obtaining more critical data on the etiopathogenetic interactions and biological significance of nutritional deficiencies and susceptibility to infectious disease, there should be attempts at tackling these twin problems by employing a variety of intervention strategies. These measures would in addition yield useful information on nutrient intake and the individual's response to stress and disease. Some of the immunologic approaches are briefly touched upon. Breast feeding is associated with reduced frequency of diarrhoea and respiratory infections, in both developing and industrialized countries. Complications such as dehydration and septicemia are prevented. Immunization schedules should be made more effective by modifying the dose of antigen, number of inoculations, timing in relation to nutritional status, type of adjuvant, and perhaps providing short-term nutritional supplements in selected instances. Immunopotentiation with biological or pharmacological agents may have some value, if it is used as a short-term measure before an imminent stress, such as infection or surgery, in malnourished subjects. Short-term nutritional supplements before or during a period of metabolic stress, eg infection, may reduce the impairment of immunity associated with such episodes. This is particularly relevant for hospitalized patients. Specific nutrients may be required in individual subjects. Prevention of low birth weight by appropriate prepregnancy, antenatal and perinatal measures, will reduce the incidence of impaired immunocompetence associated with fetal growth retardation. Such defects of immunity occurring during intrauterine life are more severe and longer lasting, particularly in those who continue to have physical growth retardation. The strategies dealing with this problem must necessarily take into account the prevalence of various risk factors for causing low birth weight (preterm, or small-for-gestation, or both) and the magnitude of risk associated with each of these factors.

NUTRITIONAL STATUS OF HOSPITALIZED PATIENTS

In recent years, there has been increasing recognition of the frequent prevalence of energy-protein undernutrition in patients hospitalized for a variety of indications. This is true of children as well as adults. In such subjects, there is a good correlation between the presence of nutritional deficiencies, and infections and mortality. In patients with lymphomas and leukemias, the occurrence of complicating P.carinii infection was related to low concentrations of serum proteins and albumin, confirming controlled observations in protein-deficient animals. Nutritional deficiency in patients admitted to hospital for elective surgery has been shown to correlate with their ability to mount delayed hypersensitivity skin reactions to common recall antigens or chemical sensitizing agents. Postoperative sepsis and mortality correlates with preoperative serum albumin and transferrin levels, and with cutaneous anergy and lower phagocyte bactericidal capacity. Nutritional support may reverse these nutritional and immunologic changes and reduce the incidence of pyogenic infections and of death.

NUTRITION AND CANCER

The possible relationships between diet, nutrition, immunity and cancer are difficult to study and to interpret. One cannot generalize since no single etiopathogenetic factor underlies all cancers. If dietary factors do contribute to the development or progression of neoplasms, it is very likely that different types of malignant tumours are susceptible to dietary manipulations to a varying extent. Much of the data in this field is derived from observations in laboratory animals in whom the etiology of cancer can be defined.

In experimental animals, diet and tumour growth are intimately linked. It has been hypothesized that malignant cells divide and grow by deriving nutrients from the host whose nutritional status should affect tumorogenesis. Chronic calorie restriction reduced the incidence and delayed the appearance of many but not all tumours. This may be mediated by the inhibitory effect of energy deficiency on mitotic activity. In the case of mammary cancer in mice, caloric deprivation influences neoplastic proliferation possibly by reducing the production of estrogen, a cocarcinogen. Changes in the levels of glucocorticoids occur in malnourished subjects and may influence the genesis and growth of cancer tissue. On the other hand, obesity and tumour risk often run in parallel. Increased total amount of fat and a high proportion of polyunsaturated fats in the diet enhance susceptibility to cancer. Fat may act as a solvent for ingested carcinogens, thereby increasing the rate of carcinogen transfer. A diet high in polyunsaturated fatty acids promotes the synthesis of bile salts which provide the substrate for carcinogen-forming microorganisms implicated in the etiology of colonic cancer. Others have failed to note such an association. Differences in intakes of energy and protein may alter the animal's ability to deal with cancer cells; animal's deficiency in protein and aminoacids may enhance tumour-inhibitory cellular immunity by reducing "blocking" humoral factors. Excess of retinoids and deficiency of riboflavin exert anticarcinogenic activity, whereas deficiencies of lipotropic factors, iodine and magnesium may enhance the growth of certain tumours. The mechanisms by which such dietary changes exert their effects on cancer are not clear; altered immunity function, restriction of available nutrients, changes in cell-surface proteins and enzymes, etc. may be important.

In man, three major types of dietary alterations have been postulated to be linked with the occurrence of cancer. One, some types of tumours occur more frequently in association with nutritional deficiency states, e.g. carcinoma of the cervix and vitamin A deficiency, carcinoma of the esophagus in association with iron deficiency anemia and Plummer-Vinson syndrome, large amounts of carbohydrates with lower intakes of vitamin C and gastric cancer. The role of alcohol in the genesis of malignancy is probably secondary; it has been linked with carcinoma of the larynx and upper GI tract in heavy drinkers and with liver tumours. Two, some tumours occur in higher frequency in the obese, eg. endometrial and renal carcinomas. There may be some dietary factors contributing to the genesis of bladder and breast cancers. It has been postulated that a low fibre diet predisposes to colonic cancer by causing fecal stasis, the increased transit time allowing longer contact with dietary carcinogens, bacterial growth and conversion of bile salts into potential pathogens. Three, food additives and contaminants, eg mycotoxins such as aflatoxin, and diethylstilbestrol, may increase the frequency of cancer.

Primary intestinal lymphoma has interesting geographic distribution. In developing countries, it occurs 2-3 decades earlier in life than in industrialized countries, and the preferential site of its occurrence is different. It may be associated with alpha chain disease, which has been postulated to result from continuous antigenic stimulation of IgA producing cells in the lymphoid tissue of the gut. A correlation between animal protein consumption and lymphoma mortality has also been reported. The concept of enhanced absorption of harmful antigens leading to tumours is supported by the higher frequency of cancer in celiac disease.

Genetic susceptibility and other environmental factors such as contamination of food with oncogenic viruses may play a critical role, however there is little data in this area.

Another facet of nutrition-cancer interaction is the frequent occurrence of nutritional deficiency secondary to cancer, and this may lead to immunodeficiency and higher incidence of infections, as has been shown for lymphomas and leukemias.

NUTRITION AND AGEING

There are several facets of interaction between nutrient intake and the process of ageing. The major health problems of old age are infections, cancer and atherosclerosis, each of which is influenced by nutrition.

The common clinical manifestations of the majority of old individuals - loss of subcutaneous tissue, cachexia and anemia - resemble those of undernourished children. The syndrome of progeria or premature senescence bears a striking resemblance with some of the clinical features of marasmus. Recent nutrition surveys in Canada have shown the frequent presence of nutritional deficiencies in senior citizens. It is possible that nutritional imbalance contributes to the progressive decline in many biological functions in old people. There is a significant impairment of immunological responses, and nutritional deficiencies may underlie such a reduction in immunocompetence. These immunologic changes may play a role in the genesis of life threatening infectionm with a number of pathogens of variable virulence. There is evidence that with advancing age, there may be an imbalance between the activity of different components of the immune system, eg cell-mediated and humoral immunity. These alterations, perhaps nutritional in origin, may determine the susceptibility to develop autoimmune diseases and malignancy.

In experimental animals, there is good evidence to support the relationship between dietary intake and longevity. In some genetically immunodeficient mice, mild to moderate undernutrition decreases the frequency of pathologic diseases, delays the onset of autoimmune processes and prolongs life. In animals allowed free access to food in terms of quantity and quality, the amount of energy intake and consumption of proteins and carbohydrates correlates with increments of growth and life span.

On the other hand, ageing is associated with changes in appetite, metabolism and nutritional requirements. This will necessitate new approaches to feeding the elderly to keep metabolic homeostasis. There is need for the quantitation of adequate and safe allowances to support

body's repletion of nutrients during and after stressful stimuli and to maintain maximum resistance to disease.

Finally, there is the possibility of a link between genetic-metabolic factors and nutrient intake over several years in the causation of atherosclerosis. Such an influence of dietary factors is likely to have its origins in early life. Both the quality and the quantity of dietary constituents may be important determinants. Interestingly, many patients with fatal ischemic heart disease have high titers of antibodies to common food protein antigens, an observation also made in undernourished subjects. The production of food antibodies is facilitated in the presence of impaired mucosal immunity.

Other diseases of old age may also be linked to nutrition. These include osteoporosis, periodontal disease, diverticulosis, hemorrhoids and varicose veins, and colonic cancer. The pathogenesis of these disorders is multifactorial and dietary influences over several years may contribute to an increased frequency. However, the epidemiological data in this area is not firm.

NUTRITION AND GASTROINTESTINAL DISORDERS

Nutritional deficiency is associated with a number of structural, biochemical and functional alterations of the gastrointestinal tract, pancreas and liver. In kwashiorkor and marasmus, the salivary glands are atrophied initially, with shrinkage and degranulation of the enzyme-secreting cells. Mucus producing cells are relatively unaffected. Amylase activity is reduced. In adults and in some children with malnutrition, the parotid glands hypertrophy and become prominent clinically. The jejunal mucosa shows varying changes of partial villus atrophy. Electron microscopy shows accumulation of lipid droplets in epithelial cells at the tips and sides of the villi, mainly in the apical cytoplasm. In marasmus, the changes are less pronounced, but there are abnormalities of the brush border, large autophagosomes and residual bodies, and the deposition of collagen filaments and a dense finely granular material below the basal lamella. These changes reverse to normal after nutritional recovery. The frequent association of malnutrition with changes in gut microflora and the common occurrence of infections, makes it almost impossible to attribute these morphologic changes to nutritional deficiency only. Functionally, varying degrees of malabsorption of fat and d-xylose, and of disaccharides have been reported. It is likely that nutrition-related absorptive defects would be more pronounced in those with a genetically determined deficiency, e.g. of lactase. In the few children studied, jejunal dipeptidases have been reduced, but absorption of amino acids using in vivo uptake techniques has been normal. The presence and contribution of any functional metabolic changes intrinsic to the enterocyte in malnutrition are not established. In the ileum, villus atrophy is associated with impaired vitamin B 12 absorption and macrocytic anemia.

Pancreas is atrophic with disruption of acinar pattern and diminution of secretory granules and organelles. Pancreatic enzyme activity in the duodenal juice is reduced, trypsin being less affected than other enzymes. The volume and pH are normal. Mild abnormalities of pancreatic function may persist for several months to years after nutritional rehabilitation.

The liver shows an increase in fat, probably a direct result of failure to transport triglycerides out of the hepatocyte because of reduced lipoprotein synthesis. Biochemical evidence of liver cell dysfunction occurs in a few malnourished subjects, and is a bad prognostic sign. The probable contribution of malnutrition to liver damage has been recently highlighted by observations on patients receiving intravenous hyperalimentation and in those undergoing bypass operations as treatment of morbid obesity. It must be pointed out, however, that the ecosystem that breeds

malnutrition also increases the risk of exposure to potential hepatotoxins, both biological and chemical.

These alterations in the structure and function of the gastrointestinal tract, pancreas and liver, in malnutrition contribute to the increased frequency and severity of diarrhoea. The episodes are more prolonged and difficult to manage.

NUTRITION AND GROWTH

There is little doubt that the fundamental effect of nutritional deficiencies is on cellular regeneration and protein synthesis, and that these basic changes underlie the consistent growth failure in undernourished individuals. The extent and the nature of growth failure, ie weight loss, short stature, etc. is governed by the magnitude and timing of nutritional deficiency, and the presence of aggravating factors such as infection. If growth failure occurs in utero, "catch up" increments are usually not adequate, so that permanent alterations in size may occur. Since short stature is a recognized predisposing factor for low birth weight of the offspring, this sets up a vicious circle. Similarly, nutritional deprivation during most of the periods of rapid growth, ie infancy and prepubertal, may be more deleterious for growth, than deficits during periods of relatively slow growth. It is likely that these intergenerational effects of nutrition on growth are part of the explanation for the ethnic-geographic variations in anthropometric measurements.

NUTRITION AND CARDIOMYOPATHY

In selected nutritional deficiencies, myocardial dysfunction may occur, eg thiamine deficiency. This may be fatal unless recognized and treated in time. In some developing countries with rampant malnutrition, there is a high frequency of obscure cardiomyopathies; the interaction of infectious agents and nutritional deficiencies may be important in the pathogenesis of these syndromes.

NUTRITION AND OSTEOPOROSIS

Bone changes are frequent manifestations of deficits of protein, calcium and vitamin D. Often, osteoporosis is one of the major manifestations of malnutrition. Permanently disfiguring malformations of the bones may occur. Pelvic changes may create difficulties during labour and higher rates of stillbirth and birth trauma.

NUTRIENT INTAKE AND DISEASE RESPONSE

Areas for future research

R.K.Chandra

1. Evaluation of the adequacy of humoral, cell-mediated and secretory immune response to conventional immunization procedures and the effectiveness of vaccine-induced protective immunity.

   The choice of the infection to be studied depends upon the prevalence of the disease in the community. In many developing countries, measles would be an obvious choice. The study could look at the immune response to live attenuated and killed vaccines and correlate it with nutritional status assessed on a number of parameters. This would be followed by a careful study of the vaccinated group for the next 2-3 years, and noting the incidence of measles.

2. Is impaired immunocompetence in undernutrition a threshold phenomenon or does it alter progressively with increasing severity of deficiency ?

   This question needs to be answered for postnatal as well as intrauterine malnutrition. There is need for the assessment of immunity function of mildly and moderately undernourished children and adults and of infection-related morbidity and mortality. For some specific nutrient deficiencies, eg iron, altered immune response is a threshold phenomenon.

3. Definition of the role of maternal malnutrition in the pathogenesis of low birth weight and associated impaired immunocompetence.

   This may be achieved by epidemiologic correlative studies, and prophylactic or therapeutic intervention studies. The difficulties of the interpretation of the data available to date should be defined and appropriate corrections built into the proposed study: eg matching of groups for antenatal care, maternal height, socioeconomic grade, family size, etc. A frequent drawback of many published reports is the lack of data on total nutrient intake of the mother, including that supplied as supplement. The many other determinants of birth weight (outlined in a recent WHO document MCH/LBW/78) should be taken into consideration. Also, incices of biological competence should be employed for assessment of the effects of nutritional supplementation, rather than birth weight alone.

4. Assessment of the nutritional and immunologic correlates of postoperative sepsis and infections among hospitalized patients

Such an evaluation would highlight the indices that point to a high-risk individual. This should be extended by studies on the incidence of infection and immunodeficiency in patients given deliberate nutritional supplements to correct metabolic balance.

5. Evaluation of the nutritional and immunologic status of old individuals and its correlation with the incidence of disease.

Epidemiologic correlative as well as intervention studies are required in this area.

6. Assessment of the nutritional and immunologic profile of patients with cancer and its correlation with incidence of infectious illness.

Prophylactic and therapeutic supplementation to bring these individuals into positive metabolic balance should be attempted and correlated with the occurrence and type of infections.

7. Complications of infectious diseases in relation to nutritional status.

There is a paucity of morbidity data in individuals with mild to moderate nutritional deficiencies. Also, subjects who have been immunized when they were undernourished may be at greater risk of developing immunopathologic complications of infections; as severe Arthus phenomenon -like illness in malnourished children previously vaccinated with live attenuated measles virus and subsequently exposed to natural virus.

8. Incidence and severity and natural history of atopic disease in populations with rampant parasitic infestations and elevated IgE antibodies.

9. Evaluation of some aspects of immunity in undernutrition that have been inadequately studied or not studied at all

NUTRITION, MALNUTRITION, AND DISEASE:

A SOCIAL SCIENCE PERSPECTIVE

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Background Paper for the Workshop on Nutritional Intake and Disease Response, Hyannis, Massachusetts, September 25-29, 1978.

AUTHOR'S NOTE

My assignment is to write about food intake and disease response from a social science perspective. This is akin to asking an astronomer to sound intelligent after peering through a microscope. One has the uncomfortable feeling of a disciplinary mismatch -- protozoa and paramecia not being the stuff of which galaxies are made -- and something of a macro-micro mismatch as well. "Functional competency," however specified, is probably best studied by meticulous observation of individual cases. A behavioral scientist with knowledge of nutrition, medicine, or both might be up to the task; not so a political scientist whose limited forte is with broad-gauged patterns and processes. Central casting may have made a mistake.

Moreover, my sense is that no "state of the art" concerning nutrition and infection exists in social science. At least I know of none. Nor do I know of any social scientists who might claim otherwise. There may be doctors and nutritionists with an acquired wisdom concerning social systems (Wray, Navarro, Scrimshaw, and Mayer, among others, come to mind). The reverse does not hold, however. What social scientists know about the food-health nexus is extremely limited, strictly nontechnical, and in no way professional. If I am correct, then it follows that the social scientist is largely irrelevant to the definition of a research agenda concerning intake and disease. A glimmer of relevance may reside in his natural tendency to look for the applications of knowledge to policy and to raise the banner of practical significance lest scientific inquiry turn totally inward.

This is a thin road on which to write a paper. Honorably, if not wisely, I have -- by and large -- resisted the temptation to stray from the topic onto more comfortable ground. The result may fail to satisfy. However useless substantively, this paper may at least provide a framework for discussion.

John Osgood Field
Medford, Massachusetts
September 11, 1978

NUTRITION, MALNUTRITION, AND DISEASE:

A SOCIAL SCIENCE PERSPECTIVE

by John Osgood Field

Studies of nutrient intake and disease response (conventionally known as "nutrition and infection") fall into three general categories, as suggested in Figure 1.

Figure 1: The Nutrition-Infection Connection: Three Foci for Research

Research Foci	Core Questions
1. The interplay of nutrient intake with the type, prevalence, and severity of disease	1. What are the dynamics at work?
2. The functional effects of malnutrition	2. What do these dynamics mean for both individual and society?
3. Policy responses	3. What can be done about the problem? More precisely, what works, under what conditions and why? Also, what do different options cost?

If this is a fair accounting, two observations follow. First, the subject matter -- to a surprising extent perhaps -- is interdisciplinary. Technical specialists may dominate the analysis of nutrition-infection dynamics; but when the focus shifts to the functional implications of

this interplay, they are soon joined by behavioral scientists, cultural anthropologists, economists, and others. With an invocation to policy and design of interventions, the canvas broadens to include health administrators, social workers, even (God forbid!) political scientists. Something which at first blush seems coherent, manageable, and rigorously scientific quickly becomes anything but. One suspects that the current state of knowledge is neither cumulative nor additive as a result.

Second, as one moves from the first research focus to the second and from the second on to the third, a rapid decline in expertise occurs. In part, this is because knowledge about nutrition and disease logically begins with research on nutrition and disease. Everyone else gets into the act rather later in the game, as the growing body of core knowledge invites humanns to expand. The three foci, therefore, represent concentric circles, with each wider circle following upon the one before. Moreover, the move outward entails a sharp diminution in scientific purity. The relatively straightforward testing of relationships at the "micro" level gives way to a profusion of influences at work at more "macro" levels of analysis, where concepts are increasingly fuzzy and difficult to measure and where the necessary data are typically either unreliable or non-existent. For these reasons, the "state of the art" may be expected to remain most developed, for some time at least, where it was initiated, in the laboratory and under conditions of well-controlled field experimentation and observation.

This paper will comment briefly on each research focus and attempt to identify issues for further investigation.

Research Focus #1: The Dynamics of Nutrition, Infection, and Nutritional States

Three general points seem to be well established concerning this critical set of relationships on which all else depends:

1. Food intake and the presence or absence of infectious disease are the two principal determinants of nutritional status. Malnutrition, as a departure from nutritional adequacy on the deficit side, is an outcome condition reflecting some combination of inadequate consumption and impaired biological utilization of ingested nutrients by the body. Granted that malnutrition has a complex etiology that is often very difficult to specify, ultimately it is the interplay of "nutrition" and "infection" which dictates a person's nutritional status.[1]

2. Inadequate intake of food and impaired biological utilization due to infection are typically found together in malnourished subjects, especially those in the most vulnerable age cohort of 6 - 36 months. A poor diet weakens the body and reduces resistance to disease, while infections result in nitrogen loss, depletion of tissue protein, depressed cell-mediated immunity, and anorexia. The two principal determinants of nutritional status, therefore, are interactive to a significant degree.

3. The effects of inadequate intake and repeated health insults are synergistic. Not only do infections make malnutrition worse while poor nutrition increases the severity of infectious disease,[2] their interaction "is more serious for the host than would be expected from the combined effect of the two working independently."[3] Each intensifies the implications of the other, and it

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[1] For example, see the model of malnutrition causality in F. James Levinson, Morinda: An Economic Analysis of Malnutrition Amoung Young Children in Rural India, Cornell-MIT International Nutrition Policy Series, 1, 1974, p. 6.

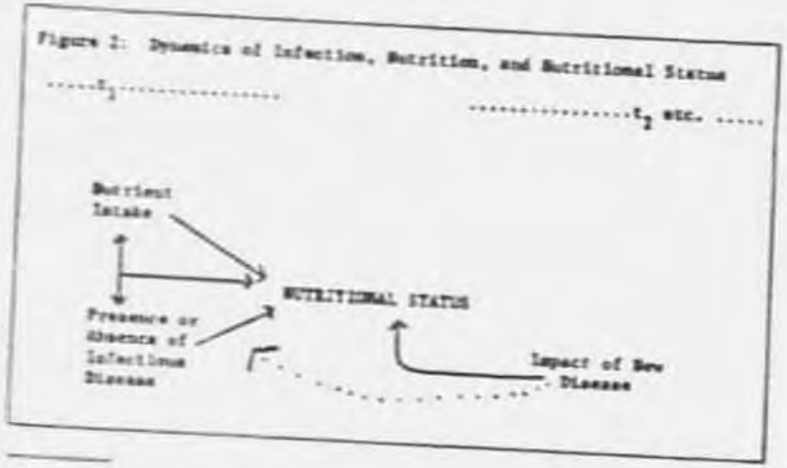
[2] Michael C. Latham, "Nutrition and Infection in National Development," in Philip H. Abelson, Food: Politics, Economics, Nutrition and Research (Washington, D.C.: American Association for the Advancement of Science, 1975), p. 69.

[3] Nevin S. Scrimshaw, "Nutrition and Infection," Progress in Food and Nutrition Science, 1 (1975), p. 394.

is this negative synergism which produces growth failure and which underlies much infant and early childhood mortality.[4]

In essence, research on nutrition and infection first examines the way in which the two together interact to produce variation in nutritional status. It then addresses the significance of new health insults for further changes in nutritional status.[5] "Infection," therefore, is related both to "nutrition" and to "nutritional status" in the manner of Figure 2.

Figure 2: Dynamics of Infection, Nutrition, and Nutritional Status



[4] See, for example, John B. Wyon and John E. Gordon, The Khanna Study: Population Problems in the Rural Punjab (Cambridge: Harvard University Press, 1971) and Ruth Rice Puffer and Carlos V. Serrano, Patterns of Mortality in Childhood (Washington, D.C.: PAHO-WHO, 1973).

[5] That miserable child in Santa Maria Cauqué whose growth failure in response to repeated health afflictions has become an international reference is a case in point. See Leonardo J. Mata, "The Environment of the Malnourished Child," in Nevin S. Scrimshaw and Moises Behar, Nutrition and Agricultural Development: Significance and Potential for the Tropics (New York: Plenum Press, 1976), pp. 52-3.

Without question, Research Focus #1 is the strongest of the three research foci in terms of effort made, findings reported, and confidence derived. Even so, the experts talk of untested theory, observed exceptions, inconsistencies, and gaps in knowledge.

Perhaps what appears on the surface to be a fairly straightforward pattern on nutrient intake and disease response in which they vary positively (the more, the better; the less, the worse) is much more complex. Perhaps, too, the impact of new disease on nutritional status is highly variable. It may be worth hypothesizing that these relationships differ significantly — and not necessarily in linear fashion — across types of nutrient, types of disease, degree of nutrient deprivation, and severity of health insult. Obviously this is as far as a social scientist can really take the subject, but it suggests that much useful work remains to be done at the core of the concentric circles.[6]

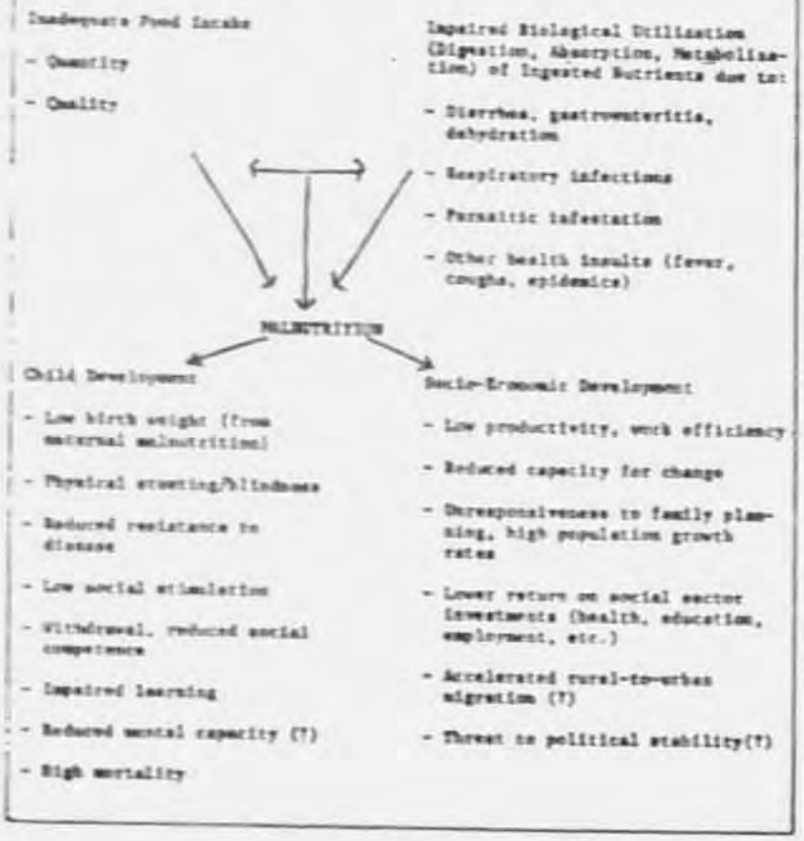
Research Focus #2: The Functional Effects of Malnutrition

As an outcome condition reflecting inadequate food intake and infectious disease, malnutrition — in turn — has functional implications for those experiencing it which are observable at both micro and macro levels of analysis. At least some of these implications are summarized in Figure

[6] Many attending the Hyannis workshop may be inclined to accept this statement as an obvious truth and accordingly devote considerable attention to the research called for. It might be more appropriate — or in any event challenging — to treat this statement as a hypothesis only, one to be defended against an alternative hypothesis to the effect that another round of studies on nutrition and infection will do no more than confirm the obvious yet again and leave researchers making intellectual mountains out of practical molehills.

3 below. Individually and together, they indicate why malnutrition has become such a developmental *cause celebre*.

Figure 3: Malnutrition as an Outcome Condition and as a Barrier to Development



A quick look at Figure 3 reveals that this research focus opens up a veritable Pandora's box of concerns, the precise parameters of which are not well established by any means but the general thrust of which is nonetheless quite clear. In terms of its effects, malnutrition ranks among the most pervasive and serious health problems in the world today. Protein-calorie malnutrition, in particular, results in physical stunting of the very young, impaired learning, possibly even irreversible brain damage, and -- of course -- high rates of infant and early childhood mortality. An indicator of under-development, extensive malnutrition is also believed by many to be a barrier to development, for it constrains human competence and productivity, inhibits a society's capacity for change, and serves as a powerful disincentive to the practice of family planning. Malnutrition does much to lock people into the very state of deprivation from which it is derived. Just as malnutrition is a key ingredient of the poverty syndrome, combating malnutrition is probably a necessary, if not sufficient, condition for breaking out of it.

So much for the glittering generalities. In fact, some of the effects imputed in Figure 3 are little more than plausible propositions on which little or no research has been done. In quite a few cases, research or no research, the precise role of malnutrition is extremely difficult to isolate. This is especially true at the macro level of socio-economic development, where so many factors come into play. Figure 4 summarizes the current state of knowledge concerning the functional implications of malnutrition.[7] However crude, this summary demonstrates

[7] As indicated, Figure 4 is an interpretation only. It invites challenge.

Figure 4. The State of Current Knowledge Concerning the Functional Implications of Malnutrition — An Interpretation

	The State of Knowledge			
	Established	Documented	Asserted	Unexamined
Health				
Low birth weight		X		
Physical stunting/blindness	X			
Reduced resistance to disease	X			
Withdrawal, reduced social competence[a]		X		
Low social stimulation			X	
Impaired learning		X		
Reduced mental capacity			X	
High mortality	X			
Socio-Economic Development				
Low productivity, work efficiency[b]		X		
Reduced capacity for change			X	
Unresponsiveness to family planning, high population growth rates[c]			X	
Lower return on social sector investments			X	
Accelerated rural-to-urban migration			X	
Threat to political stability				X

[a] Withdrawal is well established. Whether it really entails reduced competence in interacting with one's social (and physical) environment is less clear.

[b] These effects have been observed in certain labor-intensive enterprises. The case is not at all settled when, as is usually the case, individual work performance is less significant for total output. Nor is it clear that malnutrition in early childhood really results in poor work performance by adults.

[c] This is a hotly contested issue. However attractive, the "child survival hypothesis" is probably flawed in its logic. The evidence to date is indirect in any event.

the pronounced difference between what is known or even documented at the individual and societal levels. It also suggests that, overall, the state of knowledge is not especially advanced.[8]

One thing that Figure 4 does not do is discriminate between the effects of mild, moderate, and severe PCM. Indeed, quite possibly most of what is claimed about the consequences of malnutrition generally, here and elsewhere, pertains solely or in large measure to the severe manifestations of it. Of course, the more serious the malnutrition, the clearer the case and the greater the dramatic effect. Two things happen at the moderate and mild portions of the continuum: much of what is asserted is either patently false or at least questionable, and research attention fades significantly.

Joy[9] and others believe that the time has come for research to examine the implications of mild and moderate malnutrition much more specifically and concertedly than in the past. This makes very good sense if only because most malnutrition among vulnerable groups is not severe. Perhaps the dynamics linking nutrition and infection are quite different, in nature and in outcome, when the deficits in food consumption are small. Perhaps, too, the effects of additional disease on an existing state of malnutrition are also much less serious when the malnutrition is mild.

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[8] Again it may be worth putting forward a revisionist view, that more research knowledge will only confirm knowledge derived from other sources: the senses, logic, experience, intuition. The latter are not scientifically respectable, to be sure; but in practical terms they may be enough, especially at the more cacophonous macro levels of analysis.

[9] Leonard Joy, "Research into Intake and Function," FAO Bulletin, VII (1977), pp. 50-52.

Some scholars believe this to be the case.[10]

However, there may well be as yet unknown threshold effects or disease-specific effects, knowledge of which would permit a more functional classification of malnutrition than is now possible.[11] Perhaps, as Leonardo Mata argues, estimates of the prevalence of malnutrition based on weight-for-age measurements and the Gomez classification are seriously inflated and that physical stunting, in itself, should not be considered malnutrition.[12] If Mata is right, particularly on the latter point, then it might be possible to target nutrition interventions more precisely and with greater overall cost-effectiveness than is now being done.[13]

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[10] For example, Dr. S. C. Srikantia, Director of the National Institute of Nutrition in Hyderabad, India, has hypothesized that the synergistic relationships between nutrition and infection become pronounced only at relatively low nutritional levels. (Personal communication to Davidson R. Gwatkin referred to in Gwatkin's paper, "Nutrition Planning and Physical Well-Being in Kerala and Sri Lanka," Overseas Development Council, January 1978, p. 19.) Positive and negative evidence based on specific relationships is reviewed in Jon Eliot Rohde, "Preparing the Next Round: Convalescent Care After Acute Infection," position paper for the National Academy of Sciences, Food and Nutrition Board, Workshop on Effective Interventions to Reduce Infection in Malnourished Populations, 13-16 June 1977.

[11] Joy called for a functional classification of malnourished populations more than five years ago (Leonard Joy, "Food and Nutrition Planning," Journal of Agricultural Economics, XXIV (January 1973), 22 pp. as IDS Reprint #187). See also Doris H. Calloway, "Functional Definition of Nutritional Status," FAO Bulletin, VII (1977), pp. 53-58.

[12] Leonardo Mata, "The Nature of the Nutrition Problem," paper presented at the International Study Symposium on Policy Making and Planning to Reduce Malnutrition, The University of California at Berkeley, Berkeley, California, March 29-April 1, 1977, 34 pp.

[13] The more precise the targeting the better according to Shlomo Reutlinger and Marcelo Selowsky, Malnutrition and Poverty: Magnitude and Policy Options, World Bank Staff Occasional Papers, No. 23 (1976), chapters 3 and 4.

Two final points may be made regarding the implications of malnutrition, both of which refer to the connection between this research focus and the other two indicated in Figure 1. First, it is helpful to keep in mind the strong likelihood that the functional effects of malnutrition on the individual (and, by aggregation and inference, on society at large) depend critically upon the dynamic interplay of different kinds and degrees of nutrition, infection, and nutritional status. As long as this remains a valid hypothesis, research on functional effects will itself be dependent, to some meaningful extent, on knowledge produced concerning the basic dynamics. If so, Research Focus #2 assumes continued guidance from Research Focus #1.

Second, Research Focus #3 on policy responses to malnutrition should rest, in part at least, on both of the others. The dynamics produce outcomes which either are or are not serious in their implications. The thrust of research on policy and interventions is bound to be on how best to impact malnutrition at acceptable cost. However, a prior issue is what forms of malnutrition should be addressed and at what degrees of severity. The answers here depend on Research Focus #2 as informed by Research Focus #1. Ideally, the third focus is the least autonomous, as well as the least scientific, of the three. Whether this is the case, in fact, depends on the flow of knowledge across the concentric circles, which — in turn — depends on the willingness of scientists, social scientists, and programmers to interact with one another.

Research Needs for Policy Responses

Nutrition programs of one description or another may be found in most countries, at times in bewildering profusion. Nutrition planning is much more rare, but this new field promises to introduce greater conceptual order and methodological rigor to nutrition interventions while possibly also upgrading their importance in the development efforts of low income countries. Every country has a health ministry, of course, although most people in most countries receive little, if any, modern health care. What should research do under these circumstances?

One thing which should be done is being done. That is taking stock of experience. At Harvard, CARE, the World Bank, Community Systems Foundation, and elsewhere serious efforts are being made, at last, to examine what has been attempted, where and how, and to estimate effectiveness in relation to costs. In the main, the documentary evidence concerning nutrition programs and specific interventions is long on description (although good case studies are rare), adequate - if unsophisticated - on costs, weak on impact, and limited on process.[14] All of this suggests some lines of fruitful research.

One line of special pertinence to the nutrition-infection nexus concerns the role of the health sector in addressing malnutrition. Many nutrition interventions are health related, in fact, while a country's health infrastructure is often employed for transmission of supplementary foods, nutrition education, and related services to those believed to need them. For their part, many health interventions - curative and preventive - also have a direct bearing on nutritional status through their impact on the incidence and severity of disease. Effective action against the morbidity problems at early childhood is an appropriate

[14] For example, less than a quarter of the nutrition programs all over the world reviewed by the Harvard Institute of International Development reported having analyzed data on nutritional status.

means for impacting malnutrition as well. If the core problem - the interaction between inadequate nutrient intake and lowered disease response - is a negative synergism, one approach to its solution suggests itself in the potentially positive synergism of nutrition and health interventions. Health systems, in short, merit invigorated attention.

If so, we are faced with a curiosity. On the one hand, in most low income countries malnutrition - once recognized - is defined as a health problem, with the health sector given principal responsibility for dealing with it. On the other, the explosion of intellectual interest in malnutrition has been accompanied by an almost studied neglect of the health sector as a means of doing so.[15] Indeed, the recent enthusiasm for multi-sectoral nutrition planning has received at least some of its momentum from a conscious desire to escape from the imputed parochialism of the medical approach to the problem. Health specialists may be displaying a new-found interest in malnutrition,[16] but nutrition specialists have shown little programmatic interest in health.

This not-so-benign neglect makes no sense. In the first place, as Ivan Beghin puts it so well, "Nutrition cannot be separated from health, and any nutrition programme will possess a very heavy health component. Pure nutrition is out, hopefully forever."[17] No one seized

[15] To illustrate, Alan Berg's seminal book, The Nutrition Factor, contains virtually nothing on health care delivery as an approach to improving nutritional status.

[16] The World Bank, Health: Sector Policy Paper (Washington, D.C.: The World Bank, 1975).

[17] Ivan Beghin, "Improving Nutrition at the Local Level," Carnets de l'enfance, 35 (July-September 1976) p. 18.

with the seriousness of the malnutrition-morbidity-mortality syndrome could possibly disagree. Even when the malnutrition is mild or moderate, health care is often the most appropriate response, in addition to being the only operationally feasible response. Indeed, the time may have come to begin liberating the problem of malnutrition from the protective embrace of nutritionists in order to emphasize the instrumental role of people responsible for health care delivery.[18]

A second reason why the neglect of health care delivery makes no sense concerns the rather ambiguous track-record of multi-sectoral nutrition planning itself. This approach is, understandably, held up as the most appropriate response to the complexities of malnutrition since it seeks to harness the resources and capabilities of different ministries behind a coordinated plan of action. Unfortunately, however, multi-sectoral nutrition planning remains more an ambition than an achievement.[19] In many low income countries, most in fact, it might be premature and counter-productive to push it. At this stage much can be done within established

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[18] This suggestion will not be met with favor by many. It is based, in part, on personal experience in a country where the Minister of Health, a well-intentioned surgeon, wanted his ministry to do something about malnutrition. He did not know what could or should be done, and formed a committee of distinguished nutritionists to advise him. The result was a lot of words and no action, with everyone waiting for the Minister to produce funds so that he might get some for his own pet projects, typically costly research. And this in a country with an unusually well disembedded health infrastructure capable of reaching people in need. The Minister's mistake, now being rectified, was to assume that, if malnutrition is the problem, nutritional expertise must be the solution, a one-to-one relationship as it were. It simply did not occur to him at the time to call upon the specialists in his own ministry responsible for conventional health care services. He is now doing so.

[19] See page 15 for this note.

spheres of competence, particularly health, without requiring a formidable amount of administrative engineering as a precondition. "Sectoral review" may well be a more realistic first step in confronting malnutrition, with analysis of the health and agricultural sectors assuming a logical

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[19] We should no longer be surprised that this is so. The multi-sectoral approach to nutrition planning suffers from at least three major flaws.

1. It is predicated on the willingness of governments to give reasonably high priority to malnutrition as a problem calling for direct policy intervention and to set up strong planning and executive institutions for this purpose. The required level of commitment rarely exists, and established sectors (agriculture, health, education, etc.) typically have other priorities.

2. The approach assumes an abundance of accurate data and a wealth of disciplinary and inter-disciplinary expertise combined with detailed familiarity with conditions in the country. It also assumes both the hardware and methodological skills necessary to convert all this information into cost-effective decisions.

3. The approach assumes that even modest financial allocations, when combined with sophisticated planning techniques, will result in policies and interventions that successfully impact the problem regardless of anything else that may be true about the economy and polity, other policies being pursued, the overall pattern of development, and the control over resources in society.

Multi-sectoral nutrition planning, in short, is a nice idea that may not work. It is both too broad and too narrow, too broad because of its cross-sectoral ambitions and because governments rarely harness total systems behind nutrition goals, too narrow because nutrition is seldom isolated as an exclusive focus of social sector programming. Indeed, in its pristine form the multi-sectoral approach reflects the Western cult of rationality. Although designed for underdeveloped countries, it seems to forget that they are underdeveloped in data and in planning and management skills, to say nothing of the resources necessary to undertake a comprehensive assault on malnutrition. The multi-sectoral approach is unbelievably demanding. All too often it is politically naive, while also being inattentive to problems of implementation and insensitive to the wishes of its intended beneficiaries. Even at its best, multi-sectoral nutrition planning runs the risk of being more intellectually elegant than functionally practical. It also runs the risk of being coopted -- and corrupted -- by basically conservative governments unwilling to address the structural constraints on popular well-being.

priority.[20]

Not only are we faced with a curiosity; we are faced with a dilemma. If health systems have a logical relevance to malnutrition and if they are also among the better disseminated structures available to the governments of poor countries, the fact remains that most health care delivery is deficient. Not only is this so when services are matched against needs, it is also the case when services are matched against proclaimed objectives. All too often, ministries of public health provide little effective public health delivery.

There are good reasons for this performance gap, of course. Health systems typically function under a number of serious handicaps.

- Politically, health ministries are among the weakest in most governments. Every country may feel it necessary to have a health ministry, but in rather few countries is health a high political priority. In many instances, allocations to health are seen as competitive with allocations for development, and the latter prevail.
- Health ministries are often among the most poorly administered as well. Doctors rarely make good administrators, yet the medical profession dominates most health systems.

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[20] Nutritional impact of government policies is one of the foci for research recommended by Study Team 9 ("Nutrition") of the National Academy of Sciences' World Food and Nutrition Study (Vol. IV: Supporting Papers, Washington, D. C.; 1977, pp. 50 - 60). See also James N. Fines, "The Impact of Nutrition Goals on Agriculture," Food and Nutrition, 3 (1978), 2 - 4.

- The training of medical elites, often outside their own country, gives them a perspective on medicine far removed from the health needs of the great majority of people in their society. Younger doctors are similarly educated to skills and values that lack relevance to majority needs.
- Health infrastructures are usually top-heavy as a result. Pride is taken in big city hospitals with the latest modern equipment, while rural health service suffers from low prestige, insufficient funding, poor staffing, and a host of morale problems. For the individual doctor, economic incentives accentuate the urban bias that exists.
- Penetration of the rural (and urban slum) periphery of low income countries is extremely difficult organizationally and logistically.
- Even where formal structures exist, rarely do they achieve real impact on health problems within their jurisdiction. System-society interaction is often a seriously deficient final link in health care delivery. The irony is that health centers can be both overburdened and underutilized at the same time.

In sum, outreach is limited, popular participation in modern health care is low, and the capacity to produce change is - all too often - very disappointing. Most health systems are notoriously cost-ineffective. Moreover, they are typically weakest in those respects where the need for them is greatest: in addressing malnutrition, morbidity, and infant and early childhood mortality.

Much needs to be done to turn this unhappy situation around. As an increasing number of governments give more attention to rural development and seek a better balance between equity and growth while also attempting

to exist. [illegible] breakthroughs in family planning, the importance of population-based health care delivery is likely to increase considerably. Health status, nutritional status, mortality, receptivity to family planning, and productivity are all related in ways that bring health services into the mainstream of a country's development efforts instead of being on the fringe. Indeed, far from being irrelevant or only tangentially relevant to development, ministries of health can be among the foremost participants in helping the process along. For ministries of health are uniquely positioned to attend to both elements of the demographic transition: births and deaths. As the best conveyor belt for disseminating family planning information and technology to society, they potentially play a crucial role in the implementation of population policy. Here to the point, as the agency most immediately responsible for public health, including malnutrition, they are essential to a focused attempt to bring infant and early childhood mortality down. It comes as no surprise that those countries which have given priority to equity-oriented rural development (such as China, Taiwan, South Korea, Sri Lanka, Cuba, and Tanzania) have done the most to redirect and upgrade their health services.[21] They also tend to be the countries which have made the most substantial gains in combating malnutrition, lowering mortality, and reducing population growth.[22]

By and large, research on health care delivery is still conducted by members of the medical profession. Rather little has been done by social scientists, and inter-disciplinary "team" research also remains

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[21] The same applies to the Indian state of Kerala.

[22] See, for example, William Rich, Smaller Families Through Social and Economic Progress, Overseas Development Council, monograph no. 7 (January 1973), 77 pp. John M. Ratcliffe, "Poverty, Politics, and Fertility: The Anomaly of Kerala," Hastings Center Report (February 1977), 34 - 42; and Gwatkin, op. cit.

rare, although some recent initiatives look promising. The research bias, like that of most health systems, is reflective of an orientation which sees needs and problems in largely technical terms and which, accordingly, prescribes largely technical solutions to them. However valid, this thrust entails a number of distortions which can be serious. For example, when basic problems facing a health system are perceived as internal to that system, very little attention is given to how the system interacts with the society of which it is a part. The latter realm is beyond the usual analyst's competence or mandate, but it is often critical in improving the performance of a health system.

The following research topics are responsive to old needs and new opportunities. They are listed here in outline form for the sake of brevity.

1. Impact

Inasmuch as the purpose of health (and other) interventions is to improve nutritional status, it is sobering to realize how little is really known concerning the impact of the many things going on, somewhat ritualistically, all over the world. At least with regard to FCN, the core policy question identified in Figure 1 - what works, under what conditions, and why? - remains substantially unanswered.[23]

A priority need, therefore, is to analyze and document the impact achieved by alternative types and combinations of interventions in different settings. Wherever case experience permits, we simply must go for the

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[23] Incredible as it may sound, Carl E. Taylor and his colleagues were quite justified in making the following statement based on their work in Narangwal, Punjab, India. "Nutrition care can increase significantly the weight and height of total populations of children. As far as we can determine, this is the first controlled experiment of total child populations under natural conditions where this has been demonstrated" (The Narangwal Nutrition Study, Report to the World Bank, November 1977, Paper III: p. 28).

Jegular and ask: given what has been done, what difference has it made? The effectiveness side of cost-effectiveness requires a great deal of attention, if only to establish whether and when so-called nutrition interventions are - and are not - an appropriate response to malnutrition.[24] Given the importance of the health sector, impact studies might usefully focus on alternative modes of health care delivery.

2. Process

Although rarely addressed by technical experts, how programs are implemented is often a critical determinant of their success. The process effects the outcome. How well what is provided works depends, in part, on how it is provided. Research is needed on the operational characteristics of nutrition interventions and equally on how people in the targeted population respond to what, in essence, are attempts to manipulate them.[25]

Two themes relevant to health care delivery will illustrate. One has to do with system-society interaction, the other with surveillance. Concerning the former, health delivery succeeds or fails in direct proportion to how people in society relate to the health system.[26]

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[24] The author is presently engaged in a longitudinal analysis of more than 4,000 growth charts and data concerning health, family history, socio-economic status, environment, and intervention inputs from Kanyakumari District, Tamil Nadu, in India. When completed, this study should enable us to say several things about impact: to what extent it has been achieved and on whom, at what degrees of P/M, in the context of what health complications, under what family and economic circumstances, where, and in response to what. The last refers both to nutrition/health services and to broader attempts at socio-environmental engineering. More analyses of this kind would make a significant contribution to operational knowledge, especially when examining real programs that are replicable.

[25] An illustration may be found in John Osgood Field, "Development at the Grass Roots: The Organizational Imperative," paper presented at the World Food Forum: Practical Points of View, Hiram College, Hiram, Ohio, March 31, 1978, 35 pp.

[26] This observation is developed poignantly in D. Banerji "Health Behaviour in Rural Populations: Impact of Rural Health Services," Economic and Political Weekly (December 22, 1973), 2261 - 2268.

Most health systems in low income countries appear to function in ways detrimental to their mission. A major part of the problem lies in a cluster of socio-cultural variables influencing the recruitment, socialization, and operational orientation of medical personnel at the local level where contact with the population takes place. At the same time, there is evidence to suggest that popular receptivity to modern health care is largely indifferent, if not negative, and that utilization rates are low. Inconvenience is one reason for this hiatus between system and society. Professional and class arrogance is another, and mutual misperception is a third. Unfortunately, very few studies address health care delivery from a sociological and attitudinal perspective. Given the importance of this dimension, more work is needed quite urgently, if only to enable existing health systems to function more effectively in their environments.

Surveillance is a relatively new interest, and it is an important one. The National Nutrition Program in the Philippines, China's barefoot doctors, the mini-posto system in Brazil, and India's anganwadis - to mention but a few cases - are attempts to monitor health and nutritional status in village communities using designated local people as the key agents of problem identification and then solution. The objective is to identify persons at risk, children especially, and to tend to their needs before their situation worsens and the cost of treatment increases. As an "early warning mechanism," surveillance is both a means of achieving outreach and the beginnings of a referral system. It is an attempt to blend preventive with curative medicine and to bring the latter to the very people who typically receive the

least of it. Because surveillance relies heavily on paramedical personnel, it requires sensitive recruitment, suitable training, and strong administrative reinforcement and support. Very little is known about any of these facets.[27]

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[27] Surveillance is an idea that has received more exhortation and formal prescription to date than operational analysis. The need for research on the latter is underlined by Joe Rohde's very challenging ideas concerning the vital role of the mother in monitoring her own children in village settings (op. cit.). For any surveillance scheme - whether pre-illness or post-treatment - to work, there are several operational requirements. The village health worker (VHW) must:

1: Know how to detect problems (knowledge);
2: Actually do so - i.e., effectively monitor the population (conduct);
3: Be in a position to provide personal help (knowledge-materials) or to refer people to a higher level (that is, there must be an established system);
4: Actually do so.

The "at risk" family must then:

1: Accept the judgement of the VHW concerning the problem;
2: Act upon his or her advice.

If this entails referral or the delivery of services, the system must then:

1: Fulfill the promise of the VHW by responding effectively to the problem.

Moreover, all this must be at acceptable cost to the system and to the "at risk" family. This is what has to happen. How it is to happen is something else again. Neither aspect is well-understood. For some interesting thoughts on the subject, see John H. Bryant, "Community Health Workers: The Interface Between Communities and Health Care Systems," WHO Chronicle, 32 (1978), 144 - 148.

3. Health Dynamics

Health status (including nutritional status) depends not on health care delivery alone but on health care delivery in relation to a vast range of socio-economic and environmental conditions. This is well understood medically - the agent-host-environment triad - and historically, particularly with reference to the dramatic decrease in infant mortality in Western countries over the past 100 years or so. However, in a macro sense health dynamics are not at all well understood in low income countries, where health budgets are often competitive with resources for development.

A very useful role for research, therefore, would be to relate indices of health status - especially malnutrition, infection, and mortality (along with fertility) - to indices of general socio-economic development, on the one hand, and to indices of health care delivery, on the other, in the manner of Figure 5. Such an approach would indicate how responsive malnutrition and various types of infection are to different forms of development in a country (e.g. rising incomes, urbanization, literacy acquisition, electrification, availability of purified water, women entering the paid labor force, etc.), quite apart from the effects of that country's health system. It would also reveal the ways in which and the extent to which the health system is having, or might have, independent effects of its own, given an established pattern of overall development.[28]

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[28] To illustrate, using the simple model shown in Figure 5 and a body of data which is by no means exceptional, the M.I.T.-Cairo University Health Care Delivery Systems Project has unearthed a fascinating series of critical relationships (many quite unexpected) which have helped Egypt's Ministry of Health to understand better some of the health dynamics currently at work in Egyptian society and to identify the conditions in which its own services and programs are and are not having effect. In a related vein, the project has also examined variation in popular utilization of health facilities, again with some very interesting results. A third focus has been on the prevailing tendency, in Egypt as elsewhere, to under-record births and childhood deaths. (These studies are currently in draft form and will soon be available in a formal report. If interested, please contact the author for further information.) As a result of this work, the Ministry is beginning to view health problems not only in terms of medicine but in the context of development

Figure 5: Health Dynamics in a Low Income Country

4. The Political Economy of Health Care

To a very significant degree, health systems reflect the socio-cultural, economic, and political environment of which they are a part.[29] What this often means is that health care delivery in poor countries is highly skewed spatially and socially, with urban elites having access to all the medical services they might require while the rural poor lack even the most rudimentary attention to their very real, immediate, and often pervasive health needs. Health services are not only maldistributed, they are structurally and functionally distorted as well. Hospitals with over-trained staffs and sophisticated equipment are favored over small, simpler, and more dispersed facilities utilizing paramedicals. Curative medicine is practiced at the expense of preventive health care. A clinical bias inhibits attempts at outreach and widespread coverage. Initiative for attention to health needs is left with the public, while the system remains passive. In general, such health systems may do justice to the standards

[29] Vincente Navarro, "The Underdevelopment of Health or the Health of Underdevelopment: An Analysis of the Distribution of Human Health Resources in Latin America," International Journal of Health Services, 4 (1974), 5 - 27.

set by developed Western countries, but they are inappropriate to the circumstances of low income countries and, hence, are very cost-ineffective. Moreover, the political will necessary for reorienting health care, redistributing services, and training health personnel for practical, population-based, and assertive service is typically lacking. In this way, elitist health systems having little popular impact are perpetuated.[30]

That, at any rate, is the stereotype. Both the stereotype and the performance gap conveyed by it suggest a number of openings for useful research. Studies are needed on the origins of existing health systems in low income countries; on their structure, priorities, and resource allocation (spatially and functionally); on their personnel recruitment, training, and deployment; on their identification of and response to problems; and on their knowledge of health needs in the society, their modus operandi and performance. It is important to learn how different systems reconcile modern with traditional medicine, how and for what purposes doctors are trained, to what extent and how paramedicals are incorporated into modern health delivery, what blends of preventive and curative services exist, how different components and combinations of "integrated delivery" of nutrition-health-family planning services have been put together, where initiative for health care lies -- with the public or with the system itself, whether and how outreach is achieved,

[30] See, for example, Nancy Birdsall, "Health Planning and Population Policy in Africa," African Studies Review, 19 (April 1976), 19 - 33; and Ichak Adizes and Paul Zukin, "A Management Approach to Health Planning in Developing Countries," Health Care Management Review, 2 (Winter 1977), 19 - 28.

what records are kept and how they are used, and -- most critically -- what impact on basic health problems is being achieved.[31]

All of this suggests the need for a practically grounded nutritional review of the health sector. While research on nutrition and disease will continue to inform what health care delivery should do to alleviate malnutrition, more broad-gauged analyses of actual systems in operation will help to define what they are capable of doing in fact, given the assets and constraints that apply in each case. If at a general level it is useful to establish, quite precisely, what reasonable expectations are concerning the role that health infrastructures can play in meeting malnutrition, granted that malnutrition is more than a health problem as such, it is also appropriate to define how they can best play that role and then see what might be done in specific settings.

Conclusion

It is hoped that the three research foci discussed in this paper represent a fruitful way of outlining an agenda for the further study of nutrition, malnutrition, and health. Some of what is broached here may seem, at first glance, to have little to do with nutrient intake and disease response. On the other hand, if the topic is perceived broadly, even the items identified under Research Focus #3 are relevant. Moreover, it then becomes clear that many disciplines come into play and

[31] Model analyses include Oscar Gish, Planning the Health Sector: The Tanzanian Experience (London: Croom Helm, 1973), and Peter Hakim and Giorgio Solimano, Development, Reform, and Malnutrition in Chile (Cambridge: MIT Press, 1978).

that at least a modicum of interaction among them is desirable. Specialists working in the different concentric circles will have to share knowledge and insight with one another at the same time that they pursue their individual lines of inquiry. The challenge for research is to combine cross-fertilization with specialization. This is the key to developing new knowledge that is not only intellectually exciting but useful in the practical, policy sense as well.

APPENDIX II-2

Report of the Workshop on

Nutrient Intake and Reproductive Competence

and

Background Paper by

John Bongaarts

REPORT OF THE
WORKSHOP ON
NUTRIENT INTAKE AND REPRODUCTIVE COMPETENCE
October 23-27, 1978
La Jolla, California

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The scourges of malnutrition are probably no more keenly recorded than in the high rates of infant mortality and morbidity that are one of the hallmarks of many of the less developed countries. Decreased energy supplies undoubtedly contribute to the high numbers of illnesses observed in economically deprived populations. It is striking how little is known about some of the most basic relationships of food intake and fetal and child growth and development. Particularly at a time when industrial development is occurring, and when new marketing strategies are having a powerful effect on the types and quantities of food available in the less developed countries, it is necessary to acquire as much information as possible about mechanisms and confounding factors of pregnancy and infant development.

The participants in the workshop on reproductive competence recognized the contributions to knowledge of previous research in this area but observed that there has been a lack of communication between different disciplines studying nutrition and reproduction so that there has been little integration of knowledge generated within various biological and social science fields. This situation should be corrected by research designs that encourage cooperation among researchers from different disciplines and pose questions within an holistic framework.

Several other aspects of previous research efforts have limited advancement in this field. Specific aspects of reproduction have been studied without relating them to previous or subsequent events in the reproductive cycle and in the life span. Conditioning factors in prior histories of sexual partners have not been adequately considered, pregnancy and lactation have not been treated as integrated processes, and single pregnancy has been examined without due attention to the continuing effects of previous pregnancies on functional competency of women and their children and on future prospects for successful reproduction. Finally, although we have fairly well catalogued the effects of severe malnutrition on pregnancy outcome, we know little about the effects of mild/moderate, chronic malnutrition which is the prevailing form of undernutrition in the less developed countries.

The workshop started its deliberations with an examination of all the areas in which more or better information is needed. A wide range of topics under the general rubric of reproductive competence was identified including: genetics, sexual development, libido, fecundity and fertility, food availability and behavior, pregnancy outcome, birth weights, lactation adequacy, infant survival, rate of growth and development, parenting, caregiving and others. From this list the areas of highest priority were extracted. Having stated that the goal of research in this area should be the identification of levels of nutrient intake that predict levels of functional outcomes, and therefore guide the selection of the most appropriate interventions, the participants attempted to identify the main determinants of reproductive competence in malnourished societies. Research approaches followed from this amid the recognition that methodologies for answering most of the posed questions are lacking in almost every area, and that a great deal more funding should be available for the development of better measures of food intake,

nutritional status, and the other topics named as needing special attention by the workshop participants.

IDENTIFICATION OF RESEARCH GAPS

There are specific gaps in knowledge for which new research is needed as well as areas in which the existing information should be reexamined. These have been categorized below into four periods: the time from birth of the prospective parent to a first conception; the interval of pregnancy; period of lactation/infancy, and the inter-reproductive interval.

Birth to first conception

1. The relationship of nutritional status of girls at menarche and of boys and girls at maturity, including weight and height.
2. The relationship of age at menarche and reproductive outcome.
3. The relationship between childhood and adolescent growth patterns and reproductive outcome.
4. The effects of undernutrition on pelvic growth and the growth of reproductive organs, including the mammary glands.
5. The influence of pre-gravid nutritional status on fetal wastage.
6. The effect of food substances on genetic changes.

Pregnancy

1. Changes in appetite, taste acuity, and eating behavior (including pica)
2. Socioeconomic and cultural determinants of food intake during pregnancy
3. Nutritional determinants of women at gestational risk
4. The energy needs of pregnancy, taking account of physical activity patterns.
5. Adequacy and rate of weight gain according/in relation to pre-pregnancy weight.
6. Changes in maternal body composition during pregnancy.
7. The ways in which different levels of nutrient intake alter normal physiological adjustments during pregnancy.
8. The relationship of nutritional status to certain complications of pregnancy (abruptio placentae, pre-eclampsia, infectious diseases).
9. Nutritional determinants of fetal wastage.
10. The effect of maternal nutritional deprivation on the timing and type of fetal growth retardation.
11. Mechanisms by which maternal size at conception influences the size of the conceptus.
12. The effect of food intake during pregnancy on the nutritional status of the mother after delivery.
13. Correlation of post-partum nutritional status with lactation competence.

14. Influence of maternal nutritional status during pregnancy on the infant's potential for normal growth and development.

Lactation

1. Energy needs of lactating women as related to their milk production, taking into account physical activity and nutrient reserves.
2. Range of variation in milk production and nursing practices of lactating women according to nutritional status.
3. Nutritional status of the mother at cessation of lactation.
4. Nutritional consequences of the use of hormonal contraceptives during lactation.
5. The relation of maternal nutritional status to successful breast feeding.
6. Role of supplements to human milk in the maintenance of successful breast feeding, infant growth and maternal nutritional status at the end of lactation.
7. The relationship of lactation practices and nutritional status to the reinitiation of the menses, of ovulatory cycles, and conception.

Inter - and postreproductive interval

1. The relation between birth intervals and nutritional status.
2. Patterns of food distribution within households.
3. The relation of birth intervals to pregnancy outcomes.
4. The relationship between reproductive history and maternal health status and life expectancy.
5. The influence of nutrition on the age at last pregnancy and at menopause.

PRIORITIES FOR RESEARCH

While there are knowledge gaps in many areas, research priorities should be set by attention to the following criteria, in order of importance:

1. The problem associated with the research area should be both serious and widespread.
2. There should be significant potential for applying research results to government policy or practical programs.
3. The research should promise to be cost-effective.

In applying the above criteria, lactation and maternal nutrition during pregnancy clearly emerged as the most important research areas under the general heading of nutrition and reproductive competence. The six research priorities outlined below explore different specific aspects of the two major topics. The six are arranged in order of priority according to the above listed criteria.

Developing countries suffer major problems due to high levels of infant and maternal mortality and morbidity. The workshop identified early childhood malnutrition and low birth weight as two of the most significant factors influencing these figures. Research topics are therefore identified in the order in which results would be most closely applicable to the solution of those problems and most likely to be used in the practical world of policy and program.

The relation of maternal nutrition to the quality, quantity, pattern and duration of lactation was selected as the topic of highest priority because inappropriate and/or inadequate infant nutrition is one of the major underlying causes of high infant mortality and morbidity rates. Human milk is central to proper infant nutrition, yet there are large research gaps in our understanding of the determinants of patterns of lactation and their effect on infant health, growth, and development.

Experimental animal studies show that maternal nutritional requirements are greatest during lactation and that lactational performance is a sensitive index of

nutritional deprivation. It should be ascertained whether or not these findings obtain in humans, given such a wide range of possible environmental factors.

The relation of maternal nutrition to the quality, quantity, pattern, and duration of lactation.

The significance of breast-feeding for the health and development of infants, particularly in developing countries, has been amply documented. Less well-known are the factors that affect the quantity, quality, pattern and duration of lactation, particularly as these relate to maternal nutrition. In exploring this research area, studies must control for the fact that variation in lactation performance may be influenced by a host of social and psychological as well as physiological factors. In addition to maternal nutritional status before pregnancy, during pregnancy, and during lactation, attention should be directed to the following variables which may influence lactation:

maternal characteristics:	parity age body size endocrine function health occupational patterns attitudes and beliefs stress
infant factors:	birthweight sucking characteristics health birth order sex
social/environmental factors	psychosocial support systems clinical/medical practices availability and promotion of infant formula modernization government policies urbanization attitudes and beliefs

Two subtopics for research under this heading were mentioned as deserving special attention:

a. the meaning of reported "lactation failure" in studies of lactation performance;
b. the effect of timing, amount, and content of nutritional supplementation of the mother on lactation performance.

The relationship of patterns of weight gain during pregnancy to pregnancy outcome, specifically complications of pregnancy and low birth weight infants.

It is accepted that there is a relationship between maternal nutrition

and the course and outcome of pregnancy. On the other hand, there is little information on patterns of weight gain, factors influencing the pattern, and consequences of the pattern. Since high levels of maternal and early infant mortality and morbidity are among the most pressing problems of developing countries and since these problems may be closely associated with poor nutritional status during pregnancy, the group felt that research in this area should receive high priority.

Factors which need further elucidation in relation to weight gain and pregnancy outcome include:

- maternal nutritional status prior to pregnancy
- maternal age and parity
- maternal food intake and factors which affect food intake
- maternal energy expenditure
- maternal health status
- rate of weight gain in different trimesters
- indices of placental function
- composition of weight gain
- metabolic characteristics of the mother

The timing and characteristics of supplements to human milk with regard to lactation and the health of the child.

Current intense debate about the introduction of supplements to human milk suggests that knowledge about this important topic is inadequate. Further work is required to document the normal patterns of growth for breast-fed infants.

There is at present insufficient information on the appropriate timing of the introduction of supplements to human milk to maintain satisfactory infant health and growth. Further investigation is required to define supplements appropriate where fuel availability, water supplies and economic resources are not optimal. The contribution of late lactation in meeting nutritional needs after the first year of life also needs investigation. Similarly, research is needed to elucidate the effects of supplementation on lactation, including its effect on feeding patterns.

Significance of weight at birth.

The lower range of birth weights has been associated with less favorable health conditions. There is however little specific information to link birth weights with subsequent growth and development of children in developing countries. The workshop recognizes that smallness of size may have quite different significance in different environments; therefore, research in the area of birth weight would add important information to the store of practical knowledge which can be used to address problems of developing areas.

It is suggested that studies focus on birth weight in relation to future morbidity, mortality, neurological development, behavior and growth. All these outcome measures also may be profoundly altered by many other postnatal circumstances. The task of this particular research is to disentangle from among the other factors, the specific influence of birth

[illegible] on the short and long term outcomes described above.

[illegible] of pregnancy and lactation on maternal nutritional and reproductive status

[illegible] biological effects of reproduction on women, particularly women in underdeveloped countries, is a seriously neglected topic. The effects of successive pregnancies and lactation on women of different nutritional status need to be more thoroughly understood as a prerequisite to more effective health care policy. Required work includes research to [illegible] "maternal depletion syndrome", and to quantify the effect of [illegible] criteria of lactation on the return of ovulation and menses. [illegible] variables that should be taken into account are the mother's [illegible] history, health history, reproductive history, work [illegible] culturally and biologically defined food patterns.

The effect of family planning on lactation and maternal and infant health.

The [illegible] improvement of maternal and child health has frequently been a [illegible] research on methods of fertility control and a goal of family [illegible]. On the other hand, little is known about the specific [illegible] associated with the use of some family planning techniques in [illegible] countries. Even less is known about the effects of family planning programs on outcomes, such as health and nutritional status, which fall outside the traditional measures of fertility reduction.

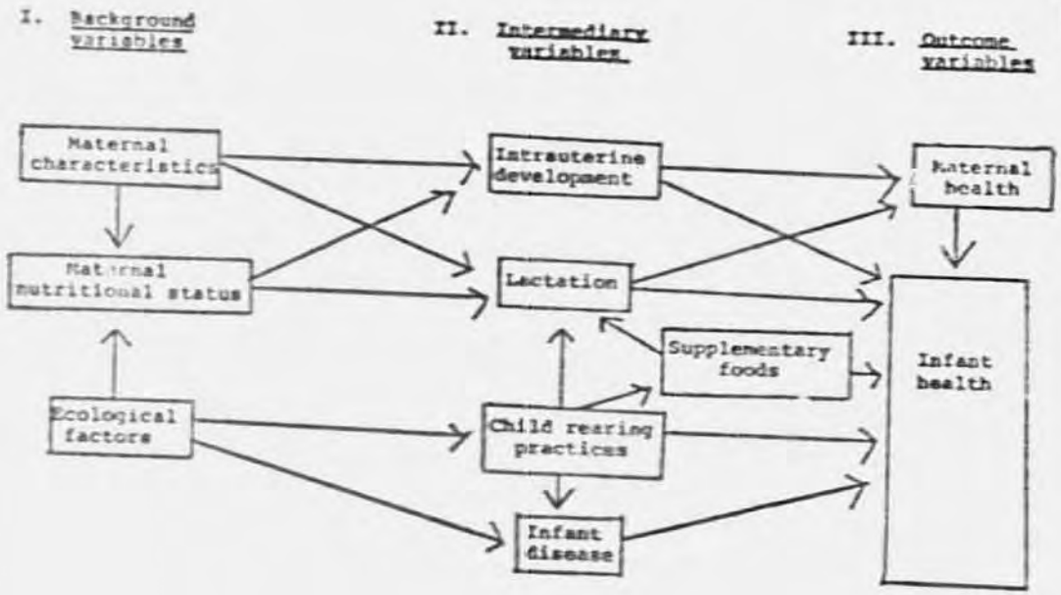
Some [illegible] areas of important research include:

- [illegible] effect of hormonal contraception on maternal nutritional status in developing countries
- [illegible] effect of hormonal contraception on lactation.
- [illegible] effect of hormonal contraception given to lactating women on [illegible] health of the infant.
- [illegible] effect of the number of children and their spacing on the nutrition and health status of mothers and infants.
- the development of family planning program design (including choice of methods offered and timing of initiation of contraception after parturition) consistent with successful lactation.
- methods of integration of nutrition and family planning programs.

INDICATORS AND CRITERIA OF REPRODUCTIVE COMPETENCE

Reproductive competence can be defined as the capacity to conceive and deliver healthy infants and sustain infant growth through successful lactation. Because of the overriding importance of the period of pregnancy and lactation for survival and subsequent development, the operational definition may be restricted to the period of gestation and infancy and includes the health of mother and infant during this period. The probable interrelationships among the determinants of status in utero and in early postnatal life are shown in Figure 1. Following the figure variables that might be studied for their usefulness as indicators of high risk of retarded growth and development are listed. Such indicators would be useful criteria for the allocation

Figure 1 Interrelationships among the determinants of reproductive competence



of limited resources and would thus serve to increase the effectiveness of public health programs. These indicators would share the following general characteristics:

- They predict outcomes early enough to permit prevention.
- They have high sensitivity and specificity.
- They are reliable.
- They are simple to collect.
- They are inexpensive.

A. Outcome variables

1. At birth:
- birth weight, birth length, head circumference, body composition
- gestational age
- physiological maturity (i.e. APGAR)

2. Infancy:
- mortality
- physical growth patterns in body weight, length, muscle, bone, and fat
- motor and neurological development
- immunological competence

B. Intermediate variables

1. Intrauterine development:
- placental function
- fetal growth (as measured by techniques such as ultra sound, weight gain during pregnancy and uterine height)
- fetal mortality

2. Lactation
- volume of the milk (nutritional and immunological properties)
- duration of lactation
- nursing patterns

3. Supplementary foods

4. Child rearing practices:
- degree of contact and stimulation of the child
- hygiene practices
- lactation patterns
- beliefs and practices regarding supplementary feeding
- care during illness
- general care of child (i.e. clothing, etc.)

5. Infant disease
- prevalence of communicable diseases, diarrheal diseases, respiratory illnesses and other ailments of regional importance

C. Background variables

1. Maternal characteristics:
- age
- parity
- illness
- birth interval to previous birth
- ethnic background

2. Maternal nutritional status:
- anthropometric indicators
- nutrient intake measures

3. Ecological factors:
- wealth, education, occupation
- quality of the living environment (i.e. dirt floors, etc.)
- urban/rural setting
- physical environment (i.e. altitude, climate, etc.)

The final topic in need of study and delineation of useful risk indicators is fertility. Fertility, as measured by the number of live births at the end of the reproductive period, is a function of the biological and behavioral factors listed in Table 1. Some of the biological components are largely outside the control of women, but the behavioral components can be varied to attain a desired family size. All these factors may in turn be influenced by background variables (e.g. socioeconomic, cultural, nutritional, environmental).

Studies of the relationship between nutrition and reproductive competence should attempt to measure as many of the factors in Table 1 as is convenient or economically feasible. For example, if lactation performance and infant development are observed for two or three years after birth, it is a relatively simple matter to record the time of the first postpartum menses. It is important however to measure physical as well as behavioral factors, in order to interpret the results.

RESEARCH APPROACHES

The five areas of human function designated as topics for the workshops i.e. reproductive competence, disease response, work output, cognitive function and social and behavioral function, are highly interrelated. They are all affected by inadequate energy intake. They are all extremely complex issues conditioned by many of the same environmental factors. Therefore, it would seem more efficient to design research where possible to study questions from all five functional areas. This would decrease the costs of measuring the same confounding factors and allow the same input to be used to study various outputs. It might also be the case that by studying the full range of outcomes in one study, a more realistic evaluation of the impact of malnutrition on function will result. This, of course, has to be tempered by a concern for not overloading the study population with excessive requests for information and physical tests.

Persuasiveness of the findings will be enhanced if the study is carried out by a number of study teams in various countries. The research design and methodology should be similar in all study areas. The execution as well as the analyses of the results should proceed in an independent but coordinated manner. After a reasonable time for analyses of the data by the investigators, the data and all documentation should become available to interested and capable researchers.

The desirability of large collaborative projects in no way implies a lack of necessity for independent research projects on many of the proposed topics.

As noted by participants in the other workshops, the choice of study design is wide-varying. Descriptive, prospective, retrospective, field experimental, case controlled, and others from the epidemiologists' lexicon present themselves for consideration. Although many of the subjects discussed at the workshop might best be studied with one of these

Table 1 Behavioral and biological factors which influence fertility.

	Biological	Behavioral
[illegible]	menarche	marriage
[illegible]	menopause	marital disruption
[illegible]	lactational inhibition effect of lactation	infant supplementation; duration and intensity of breast feeding
[illegible]	[illegible]	contraception; temporary separation of spouses
[illegible]	spontaneous fetal mortality	induced abortion

methods, the participants more fully discussed the cross-sectional or descriptive study, the prospective or longitudinal study, and basic and applied physiologic and metabolic studies. One or more approaches may be required to obtain the necessary information about specific questions. Individual projects may involve one or all of these research modes.

Descriptive, cross-sectional surveys

Cross-sectional, descriptive studies provide data about the prevalence of characteristics and conditions at one point in time and are of value for several reasons:

- To quantitate the magnitude of nutrition and reproductive problems;
- To contrast nutritional and reproductive patterns in developing countries;
- To define the population base for prospective studies.

A series of cross-sectional studies in different parts of the world would serve to identify sites for a collaborative, prospective study and would facilitate meaningful comparisons between countries or communities. Study areas should be characterized by malnutrition as a common problem with a range of nutritional deprivation. Populations within the overall program should represent the diversity of staple foods in different geographic areas, e.g. a wheat, rice, corn or tuber culture. The populations should be sufficiently characteristic of their region to allow generalizations to the country or area. Study populations should be accessible to the parent institution, potentially cooperative, and, preferably, should have census and regional nutritional surveys available.

Sample size and selection must be sufficient to allow generalization to the population under study in both independent and outcome variables. Sample size will also be determined by stratification requirements according to economic resources, rural-urban residence, and ethnic characteristics.

Prospective, longitudinal field studies

Prospective studies consist of longitudinal follow-up of populations, individuals or processes (such as pregnancy or lactation) over time. They permit more detailed measurements of variables as prediction of outcome and can potentially yield better estimates of causal relationships. There are two kinds of prospective studies: those which involve experimental intervention and those which do not. The research preference might be for settings where the range of nutrient deprivation is adequate to test the study hypothesis or where confounding variables associated with nutritional deprivation can be more easily separated from the effects of nutrition. If these conditions are not met, intervention studies such as supplementation of mothers' or infants' diets must be considered. These studies can provide greater control of variables and a better measure of specific functions across a range of intakes. However, they are usually expensive and time-consuming. They also demand careful evaluation of ethical issues. The workshop participants felt that some of the oft disregarded basic aspects of field nutrition experiments should be listed.

1. Baseline data in experimental and control groups: all interactions with experimental populations should parallel those with the control group.
2. Consideration should be given either to randomization or replication of results in comparable studies.
3. The sample sizes should be large enough. The issues of expected effects and statistical power should be faced before the study is begun.
4. Pilot tests are essential.
5. The analytical plan should be known before implementing the study. This will aid in specifying the kinds of measurements required.
6. A safety and data monitoring plan should be used to permit discontinuance of the study if it proves to be unequivocally effective or harmful to study subjects.

Physiologic-metabolic research

In designing a model for physiological research on the relationship of maternal food intake and nutritional status, we are guided by an idea expressed earlier in the workshop that heretofore specific aspects of reproduction have been studied without relating them to previous or subsequent events in the reproductive cycle and to the life span. We have therefore not attempted to isolate specific research questions from one another in this field. The mother's pre-pregnancy status anticipates her pregnancy status, the size of her baby and her lactational competence. The research question is to identify the range of nutrient intakes that predicts a range of outcomes in order to carry out appropriate interventions.

Obviously, the significance of this approach will depend on sampling techniques and choices. Longitudinal research in either large or small populations that attempts to measure a number of parameters will necessarily call for subsampling and stratifying. Also, there is a tradeoff involved in having studied one population in some depth where these values, e.g. biochemical indices, may not be reliably transferred to other populations. This transferability will differ on different parameters.

It is clear that many of the physiologic-metabolic questions cannot be answered by human studies both because of ethical considerations and practical limits. In some instances non-human primate studies would be most appropriate. Also laboratory and metabolic ward research that contributes to the development of useful field techniques and measures should be encouraged.

Because of the interdependence of various phases of the reproductive cycle, studies investigating the influences of maternal nutrition on reproductive competence should be conducted prospectively. Still, if the longitudinal approach is not possible, studies focusing on the different aspects can also provide important information.

Baseline data are essential for the adequate assessment of subsequent events, thus evaluation of nutritional status before conception and during early pregnancy is essential. Women enrolled in family planning clinics that express the desire to have a child could be enrolled in the study.

There are certain variables which ideally should be monitored through the entire reproductive cycle starting with the pre-pregnancy state through pregnancy and lactation to assess the changing nutritional status of the mother. These variables include food intake, energy expenditure, anthropometric measurements, body composition, and certain biochemical measures of

nutritional status.. The infant should also be monitored throughout the duration of lactation. Other variables should be studied which are pertinent to the three phases: pre-pregnancy, pregnancy and lactation.

Measurements across the reproductive span:
- Food intake
- Energy expenditure
- Anthropometric measurements - height, weight, pelvimetry, skin folds
- Body composition (LBM, percentage body fat)
- Biochemical indices of nutritional status

Phase measurements:

Pre-pregnancy
- Charting menstrual cycles
- Hormonal levels

Pregnancy and pregnancy outcome
- Physiological adjustments
- Placental hormones
- Post-natal assessment of the infant
- Placental weight and morphology

Lactation
- Milk production
- Milk quality
- Duration of lactation
- Lactogenic hormones

FOOD INTAKE MEASURES AND NUTRITIONAL STATUS INDICATORS

The need for accurate food intake measures and reliable indicators of nutritional status arises from the basic assumption that the range of pregnancy outcomes and child development varies along a continuum of food intake. Innovation and improvement in the methods currently used to determine food intake are greatly needed, irrespective of the particular research design in which they are incorporated. In fact, one research approach for many of the studies being suggested might be to define cohorts at different food intake levels.

Since the individual food intake measures currently used are fraught with problems, any research funded must rank new approaches for measuring intakes high in its priorities. It is important to realize that the major sources of data now available are derived from household surveys, integrated rural surveys and a few nutrition surveys. Individual intakes should be related to household intakes in order to develop predictive measures from the more easily gathered household data.

Individual intake studies should be obtained from a sample drawn to represent a range of household intakes. It is important to realize the necessity of obtaining a range of intakes which allows the full expression of normal function. The consequences of suboptimal function can only be evaluated in light of such information.

If the population being studied does not present an adequate range of intakes, it is possible to perturb the system in some way, e.g. by food supplements, by increasing commodity subsidies, by feeding families, etc.

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October 23-27, 1978
La Jolla, California

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Nutrition and Human Reproduction: A Demographic Perspective

by

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Background paper prepared for the Title III Workshop on Nutrient Intake and Reproductive Competency, La Jolla, October 23-27 1978

Introduction

The possible effect of undernutrition on reproductive performance has recently become the focus of a number of investigations by biological and social scientists. While there is little doubt that nutrition has some impact on fertility, the strength of the relationship and its demographic significance are highly controversial issues. If it exists, a strong nutrition-fertility link would have important policy implications. For example, improving nutrition in poor developing countries would then increase their rate of population growth which is already excessive. It is therefore imperative that the scientific study of this subject be thorough and that hasty conclusions based on incomplete evidence be avoided.

The objective of this article is to review existing evidence for a link between nutrition and reproduction and to point to areas where further research is needed. Because findings vary with the degree of malnutrition, a clear distinction will be made between chronic moderate malnutrition as is typical in the poorer classes of a number of developing countries and severe malnutrition found in famine and starvation. Primary attention will be given to the fertility effect of the nutritional status of women in the reproductive years, but infant nutrition will be an important factor in the discussion of lactation.

Before proceeding, it is useful to review briefly the reproductive process and the many factors through which nutrition can affect fertility.

The reproductive process:

The fertility of women is determined by a number of biological and behavioral factors which demographers call intermediate fertility variables. The biological fertility determinants are largely outside the control of women, but the behavioral determinants can be varied to suit preferences and needs of individuals or couples. A complete set of these intermediate fertility variables is given in Table 1. To simplify the discussion a distinction is made between the determinants of the duration of the reproductive years and the determinants of birth intervals within this period.

a) The duration of the reproductive years.

The limits of the potential reproductive years of women are given by menarche and menopause. Menarche occurs in the early or mid-teens, with an average age at menarche equal to about 13 years in the contemporary Western world (1, 2) and slightly higher in developing countries and in historical populations. Menopause, the complete cessation of menstruation, signals the end of the reproductive years. Population means of the age at menopause are typically between 45 and 50 with substantial variations among individuals, ranging from below 40 to near 60 (3, 4). From the mean ages at menarche and menopause one could, by subtracting, obtain an estimate of the duration of the potential reproductive years. Unfortunately, this procedure is inaccurate because a woman only rarely becomes fully fecundable (able to conceive) at menarche. Much more common is a period of up to several years with irregular menses and a relatively high incidence of anovulatory cycles following menarche. A similar period of menstrual irregularity precedes menopause and functional sterility can set in years before menstrual bleeding stops completely.

Table 1 Summary of behavioral and biological intermediate fertility variables

		Intermediate fertility variables	
		Biological	Behavioral
Determinants of the duration of the reproductive years	1) start	menarche	marriage
	2) end	menopause	marital disruption
Determinants of birth intervals	3) duration of post-partum amenorrhea	ovulation inhibiting effect of lactation	infant supplementation; duration and intensity of breast feeding
	4) time to conception	maturation of ova and production of sperm; sexual drive	Contraception; temporary separation of spouses
	5) intra-uterine mortality	spontaneous fetal mortality	induced abortion

Although childbearing can theoretically begin at menarche, reproduction in virtually all societies is limited to women who are married (marriage is defined here as any stable sexual union, i.e., consensual unions are included). In many traditional societies marriage takes place shortly after menarche and the mean age at first marriage is often under 20 years. In contrast, the mean age at first marriage in a number of European countries is near 25 years, thus substantially reducing the time available for childbearing. Within marriage, reproduction can continue until marital disruption or permanent sterility intervene.

b) Birth intervals during the reproductive years.

While married and before becoming permanently sterile, women reproduce at a rate which is inversely related to the time between births, i.e., short birth intervals are associated with a large number of births at the end of the reproductive years and vice versa. The length of a birth interval is determined by

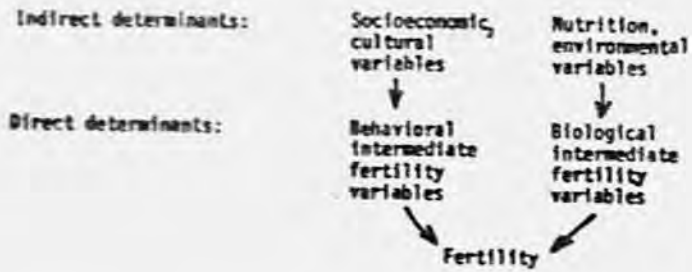
- the duration of postpartum anovulation. After every birth the normal cyclical pattern of ovulation and menstruation is absent for some time. It is now well established that the duration and intensity of breastfeeding are the principal determinants of this postpartum anovulation interval (5, 6, 7). In the absence of breastfeeding, the first ovulation after birth takes place within a matter of weeks, but in societies where lactation is prolonged the return of ovulation can be delayed by as much as two years.

- waiting time to conception. Once the normal ovulation pattern has been reestablished, women are at risk of conceiving if they engage in intercourse. This risk can be reduced to a very low level by using contraception and to zero in the case of sterilization. In the absence of contraception the risk of conception per month is typically between 0.1 and 0.3 depending on frequency of intercourse and age (5, 8). This risk is substantially less than 1.0 because fertilization can only take place during a short period of approximately two days around the time of ovulation in the middle of a cycle. In addition, some cycles are anovulatory and a substantial proportion of fertilized ova fail to implant or abort spontaneously in the first two weeks after fertilization. These aborted fertilizations are not counted as conceptions in the demographic literature, because they cause little or no disruption in the menstrual cycles and women are often unaware of such brief pregnancies. The low conception risks per month imply that many women do not conceive for a number of months even if they have regular intercourse. Typical average durations of intervals from the first postpartum ovulation to a recognizable conception range from 5 to 10 months (5).

- intrauterine mortality. A conception ends in a live birth if no spontaneous fetal death or induced abortion takes place. The occurence of a spontaneous abortion is largely a matter of chance. It has proven difficult to obtain accurate estimates of the risk of a spontaneous fetal death per conception, because early

conceptions often go unnoticed. A typical average risk is 0.2 or 0.25 with higher values for the youngest and oldest women and lower values in the mid reproductive years (5).

The biological and behavioral components of these direct determinants of fertility are in turn a function of other variables. The behavioral intermediate fertility variables are determined by socioeconomic and cultural conditions and the biological intermediate fertility variables are influenced by nutrition and other environmental factors. The following diagram summarizes the principal causal links among these variables:



Demographic research has established that the behavioral intermediate fertility variables are far more important than the biological variables in determining variations in the fertility levels of populations (9). In fact, most demographic studies of the determinants of fertility completely ignore biological factors. The importance of the behavioral intermediate

fertility variables can be demonstrated with the following simple numerical illustration. If in a hypothetical population all behavioral fertility inhibiting effects were removed by eliminating contraception, breastfeeding and induced abortions and by having a high frequency of intercourse and universal marriage, one could expect women to give birth at a rate of about 1 per year. Over a reproductive lifespan of 30 years (15 to 45) the average number of children per woman would then be around 30. In reality no population has even come close to this figure. Typical total fertility rates (average number of children per woman at age 50) range from 6 or 7 in the least developed countries to around 2 in western industrialized nations. The highest reliably recorded values in a few subpopulations are between 9 and 10 children per woman. Clearly, the observed fertility is only a fraction of its theoretical biological maximum due to the powerful fertility inhibiting effect of the behavioral intermediate fertility variables. This fact greatly complicates the task of the researcher who wants to study the link between nutrition and fertility because the influence of the behavioral intermediate fertility variables has to be controlled before one can demonstrate that nutrition can cause changes in fertility.

Moderate malnutrition and the direct determinants of fertility

1) Start of reproductive period

While there is substantial disagreement about the importance of the various possible determinants of age at menarche, most investigators of the subject consider nutrition to be a major factor. This conclusion is based on four types of direct and indirect evidence. First, a direct

link between nutritional intake and age at menarche was found in a U. S. study in which wellnourished girls reached menarche two years earlier than undernourished girls (10). Similarly, an Indian study concluded that girls who received diets higher in calories and proteins had earlier menarche (11). Second, nutritional status as measured by anthropometric indicators is correlated with age at menarche. A number of studies from different societies report that the probability of having reached menarche by a given age is positively related to body size and weight (10, 12, 13, 14, 15, 16, 17). Third, in western societies which have relatively reliable historical data on menarche, a decline in age of menarche of 2 to 3 years has taken place since the turn of this century (16, 17, 18). This decline is associated with an increase in body size and an improved diet. Fourth, socioeconomic status and age at menarche are negatively related in a number of countries. Differences ranging from a few months to about two years have been found between urban and rural populations and between high and low income groups (18, 19, 20, 21, 22).

Although nutrition appears to have an effect on age at menarche, this does not necessarily imply that a population with a higher level of nutrition has a lower age at menarche, because genetic and other factors are also important (3, 18, 23). This explains why some developing countries (e.g. India, Cuba) have the same or even slightly lower ages at menarche than are found in developed industrialized countries (3, 23).

Age at menarche signals the beginning of potential child bearing, but actual reproduction starts at marriage which usually takes place years after menarche. From the demographic viewpoint, the crucial question therefore is whether the nutritional variations in age at menarche affect the timing of marriage. Unfortunately, very few studies have addressed this issue. Good evidence of a correlation between ages of menarche and marriage are only available in societies such as Bangladesh where marriage takes place relatively soon after menarche (13). Even in that case however it is likely that the difference in age at marriage between well-nourished and undernourished girls is substantially less than the difference of approximately two years in the ages at menarche because the correlation between age at menarche and age at marriage is far from exact. Since, in addition, the fertility of teenage women makes only a small contribution to the total fertility rate, one can conclude that nutritional variations in age at menarche have at best a very small effect on the lifetime fertility of women.

2) <u>The end of the reproductive years</u>

The available evidence regarding the determinants of age at menopause is conflicting and inconclusive. Several studies report a time trend in age at menopause or an effect of nutritional or socioeconomic status (3, 4, 19, 24), but other investigations failed to find the same relationships (4, 25, 26). These confusing results are probably in large part due to major methodological limitations including inappropriate or even erroneous statistical analyses, recall errors in retrospective data, age misreporting and differences in definitions of age at menopause (3, 4, 26). The comparability of the studies is consequently severely restricted.

Nutritional variations in age at menopause would only be of demographic interest, if the timing of a woman's last birth is affected. The small amount of available evidence suggests very little impact of nutrition on the mean age at last birth. This mean age is 40.9 among the well-nourished Hutterites (27) and 41.7 years in a poorly nourished mid-19th century English population (28). The use of contraception and induced abortion was virtually absent in both populations. The mean age at last birth is also close to 40 years in a number of other historical natural fertility populations (29).

3) Postpartum amenorrhea

Recent studies of rural populations in Guatemala (30, 31) and Bangladesh (32, 33, 34) have found only a weak effect of nutritional intake or nutritional status on the duration of the postpartum amenorrhea interval. In Bangladesh, women were divided into three nutritional status groups on the basis of weight: less than 38.5 kg, between 38.5 and 42.4 kg and over 42.5 kg. The observed mean durations of amenorrhea in these groups were 17.9, 17.5 and 16.8 months, respectively. Although there is a decline with increasing weight, the differences in duration of amenorrhea were not statistically significant. The relationship between duration of amenorrhea and height and arm circumference also proved insignificant. It should be noted that these analyses do not control for duration of lactation. However, it is unlikely that this substantially affects the results, because women in rural Bangladesh usually breastfeed their infants until the next pregnancy occurs and the large majority of women are still lactating when their menses return after a birth.

In the Guatemalan study women were also divided into three nutritional status groups on the basis of anthropometric measures (31). The low and high nutritional status groups had mean weights (standardized for height) of 43.7 and 55.6 kg, and mean amenorrhea durations of 14.8 and 13.2 months, respectively. The difference in amenorrhea duration was statistically significant and slightly larger than in Bangladesh possibly because the Guatemalan population is more heterogeneous with respect to nutritional status. Data on total caloric intake were also available and its relationship with postpartum amenorrhea is summarized in Table 2 which controls for the duration of lactation (30). Although not statistically significant, there is a fairly consistent difference of the order of 1 month between the groups with high and low caloric intake.

These findings seem to be inconsistent with the results of a study by Chavez in Mexico (35, 36). In a comparison of two groups of women, one with and one without dietary supplementation, the supplemented group of women had a much shorter postpartum amenorrhea interval than the control group. Wray (37) has proposed a plausible explanation for this finding. It appears that many infants of the supplemented mothers also received dietary supplements. As a result, these infants needed less milk from their mothers which in turn shortened the amenorrhea duration independent of the mothers nutritional status.

None of the above studies were able to measure nursing patterns. Differences in the pattern or intensity of lactation may well explain the slight increase in amenorrhea among undernourished women. If, for example, undernutrition reduces the volume of milk produced by lactating

Table 2

Mean Duration of Postpartum Amenorrhea in Three Different Total Caloric Intake Groups Within Categories of Duration of Lactation

Total Caloric Intake	Categories of Lactation (Months)				
	0 - 6	7 - 12	13 - 18	19 - 24	25 & more
	Months	Months	Months	Months	Months
Low	-	6.54 (13)	12.03 (35)	16.44 (45)	19.93 (14)
Middle	-	6.31 (13)	11.64 (33)	15.47 (57)	18.90 (10)
High	-	5.47 (14)	11.13 (30)	14.60 (47)	19.64 (11)

(Numbers in parentheses are number of cases)

mothers, then infants may attempt to compensate for the decrease in milk flow by increasing the intensity and frequency of sucking, thus increasing the ovulation inhibiting effect of lactation (7).

4) Waiting time to conception

The two prospective studies in Bangladesh (33) and Guatemala (31) which measured the duration of postpartum amenorrhea also measured the interval from the return of menses to conception (conception ending in a live birth in the Guatemalan case). Neither study found a correlation between the length of this interval and the nutritional status of women as measured by anthropometric indexes including weight, height, arm circumference and skinfold. In Bangladesh no significant relationship existed both before and after controlling for absences of husbands, but the Guatemalan study did not have data on temporary separations of spouses. The incidence of contraceptive use and induced abortion was negligible in both populations.

5) Intra-uterine mortality

Although maternal nutrition is one of the determinants of birth weight (38, 39), existing evidence for a link between moderate undernutrition and fetal mortality is inconclusive in spite of a voluminous literature on the subject (40, 41, 42, 43, 44, 45, 46). This is largely due to difficulties in sorting out the contributions of various biological, genetic, health and environmental factors that are believed to be of importance. Another major problem is the inaccurate measurement of the proportion of conceptions that fails to end in a live birth. Carefully planned prospective studies in developed

countries yield estimates ranging from 12.5% to 33.9% (5). It is likely that these estimates contain substantial measurement errors. The reporting of early fetal deaths is especially subject to error. Similar investigations in developing countries with low levels of nutrition report risks of fetal wastage within this range (47, 48, 49, 50), suggesting no major influence of nutrition.

This tentative conclusion is supported by the results of the Guatemalan study discussed earlier (31). In this population maternal nutritional status did not affect the duration of the interval between the return of menses after a birth and the time of the next birth. Any increase in intrauterine mortality would have lengthened this interval and the absence of a nutritional differential therefore implies that the link between maternal nutrition and the incidence of fetal wastage is either absent or very weak. Of course, confirmation from other studies is needed before one can have confidence in this conclusion.

Severe undernutrition and fertility

Famines are invariably accompanied by large but temporary reductions in birth rates (34, 51, 52, 53, 54, 55). The most common explanation for this finding is an impairment of sexual function and a decrease in libido which have been found during starvation in humans and animals (55, 56, 57). However, all of the following factors have also been present during famine: 1) out migration of husbands in search of food or work (34, 35); 2) amenorrhea induced by anxiety and physical or psychological stress (55, 58, 59, 60); 3) voluntary fertility control by contraception or

induced abortion (34) and 4) increase in fetal wastage (51). A lack of sufficiently detailed data makes it impossible to sort out the contributions to the fertility reduction from each of these factors.

Conclusion

This brief review suggests only a weak and possibly insignificant overall effect of moderate malnutrition on fertility. The exact magnitude of this link is still unclear, because the available evidence is in part inconclusive and incomplete. The age at menarche and the duration of the postpartum amenorrhea interval appear to be the intermediate fertility variables that are most sensitive to moderate variations in nutrition. This finding is probably not of demographic importance, although it may be of interest to biologists.

In contrast, extreme nutritional deprivation as is found during famines, does lead to a substantial reduction in fertility. It is uncertain which of several biological and behavioral explanatory mechanisms is primarily responsible for this effect.

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APPENDIX II-3

Report of the Workshop on

Energy Intake, Performance and Work

and

Background Papers by

C. J. Bliss
F. E. Viteri

REPORT OF THE
WORKSHOP ON
ENERGY INTAKE, PERFORMANCE AND WORK
October 30-November 3, 1978
La Jolla, California

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This workshop dealt primarily with the relationship between energy intake, work output and the physical and mental performances that comprise the range of human activities. These include activities in the physical, psychomotor, perceptual, cognitive and sensory domains of human performance. Throughout the report the word "performance" is used in this broad sense. Other technical terms relating to work are defined in the appended background paper by Viteri. This was one of a series of workshops addressing the overall question of the effects of food energy intake on the ability of individuals to function in their own societies. The meetings focused on the effects of marginal rather than severe food energy restriction since mild-moderate malnutrition is widespread throughout the world and relatively few data exist on the consequences of this condition. Energy restriction rather than specific nutrient deficiency was emphasized in light of the fact that research dealing with food energy deficits will necessarily entail consideration of the various nutrients--so the purpose was to focus on the more general problem of food energy intake.

Most of the other workshops did not debate whether or not a relationship exists between moderate malnutrition and the particular function, but accepted this as given for the purposes of the workshop and proceeded to discuss research approaches for the elucidation of the realtionship. This workshop, however, recognized that while severe energy deficits will curtail activities, theoretically there should be measurable effects of moderate restriction as well, but there is very little evidence to support the latter. (See the background papers by Bliss and Viteri, which are appended.) The establishment of this relationship was therefore addressed in the research questions.

A related issue is whether or not there is an effect of energy nutrition on productivity in different ecosystems. If there is, it would be important to determine how increased intake could be linked to development efforts that would assure self-sustaining improvements for deprived populations.

An important concern of some of the participants was that it should not be implied that the outcome of increased productivity by means of increased energy intake will always have beneficial results for all segments of a population (i.e. there may be negative economic, social, and biological ramifications for the target groups as well as for non-target groups). The purpose of the workshop was simply to plan ways of providing data as to whether or not incremental changes in energy intake have observable effects on activity and work performance.

IDENTIFICATION OF RESEARCH NEEDS

Since the major emphasis of research on malnourished populations has dealt with the status of severe undernutrition, there are major knowledge gaps in situations of mild-moderate malnutrition, particularly with respect to energy deficits. Significant gaps exist in our knowledge concerning the relationships among energy intake, activity and work output. Activity is broadly conceived as describing ways in which people utilize their time. Necessary research questions are expressed in the following paragraphs.

What is the relationship between energy intake and performance? Are there critical levels of habitual energy intake necessary for performance of different kinds of work? Do different nutritional states in childhood affect work capacity and physical fitness as an adult? How does energy intake at different stages of life affect body composition and size? Are there population groups in which different body sizes and composition resulting from various levels of energy intake confer advantages or disadvantages? How does the body maintain energy equilibrium at various levels of energy intake? Is there an effect of energy intake on the capacities for physical activity (e.g., coordination, strength, endurance, etc.)?

There is a need to consider the relationships among physical performance capacities, physical activity, and work output. To what extent do levels of performance capacity relate to physical activity and work output? Are there population and occupational groups whose work output is affected by their work capacity?

Further, what are the relationships among energy intake, activity, and work output? Will incremental changes in energy intakes result in incremental changes in quality of performance and quantity of work performed? Do changes in energy intake affect absenteeism and turnover of the work force? What are the consequences, economic and noneconomic, to the individual, family and community? At different habitual energy intake levels, are there differences in the nonoccupational activities (optional work tasks and recreations) performed, and what are the consequences for the individual, family and community? What is the resulting behavior profile and activity pattern of the community? Do the beliefs of people in different societies concerning food intake, energy expenditure, and work output influence or shape behavior?

RESEARCH PRIORITIES

The area of research given the highest priority is the relationship between energy intake and performance; specifically, what are the critical levels of energy intake needed to enable individuals to perform different activities?

The second research priority is the question: does nutritional status of an individual in childhood affect that person's work capacity and physical fitness as an adult? The next priority topic is to what extent do levels of performance capacities relate to physical activity and work output? Finally, are there differences in the activities performed at different habitual energy intake levels, (i.e. in the behavioral profiles of the community) and what are the consequences for the individual, family and community?

The criteria for establishing priorities for specific projects are the following:

1) Efficient use should be made of available knowledge.
2) Questions should be addressed which, when answered, will give rise to practical, locally relevant solutions for improvement of energy-nutritional status.
3) The project when launched should have a high probability of being completed.
4) Appropriate utilization should be made of qualified local manpower.

ENERGY INTAKE AND STATUS

One of the first requirements of this research will be the measurement and characterization of energy input in relation to energy requirements, expenditure patterns and balance. Adequacy (deficit or excess) of energy intake in population groups should be viewed in the context of the nature of the food supply, the socio-culteral setting, the make-up of the population and the ecological conditions in which the population lives.

Different methods should be appropriately applied to measure energy input in relation to energy turnover in individuals, families/living groups and communities. At the individual level, survey methods for the assessment of energy intake include food weighing, diary records, interview and observation techniques. Repeated estimates must be made of daily intakes over a reasonable time and across seasons. Research is needed to determine the accuracy and validity of various survey techniques in different sociocultural settings. The energy contribution of foods as consumed must be known, and digestibility of diets typically consumed by study groups should be determined.

At the family level, inventory methods are usually employed. These should be supplemented with measures of individual intakes as adequacy of intakes can be assessed only in relation to the physiological needs of each member. The sum of the individual intakes and household inventories provide desirable cross-checks of validity. Knowledge of family food distribution patterns is necessary in order to predict the probable assignment or division of food when its availability changes because of economic or other reasons.

At the community or population level, the flow of food energy may be estimated by considering food energy produced, imported, exported, diverted to non-human food uses and wasted. Only with knowledge of the distribution of available food is this information useful in the present context.

It has been suggested that a diet composed mainly of coarse, fibrous foods and cereals with high water-binding capacity, and very low in fat content, sheer volume, and/or other satiety factors will limit the amount of food consumed. Data on intake of energy from specific foods should provide clues concerning the validity of this hypothesis that the nature of the food supply itself may restrict food energy intake.

In characterizing communities it is desirable to know the non-energy inputs which may influence human energy resources. Among these are the use of fertilizers, pesticides, and other agricultural inputs; agronomic practices; environmental conditions; food prices(in relation to income); and the prevalence of disease.

Attention should be given to local conceptualizations of the energy prob-

lem focusing on the terms, models and theories concerning food energy prevalent in local sociocultural systems. For example, information will be needed on what are considered desirable and preferable foods, how these foods yield energy, strength, or vitality to the body, how these characteristics are believed to function, and how changes in energy wants and needs are thought to occur.

Consideration must be given to both past and present nutritional status because each may affect, directly or indirectly, performance capacity and productivity.

Past nutritional intake is a determinant of adult height and skeletal development, and thus of maximum desirable adult body weight. Early nutritional deficiency may also affect intellectual capacity and the time at which adulthood is reached. Thus, past nutritional status can be estimated from height for age, head circumference, and among young adults and older adolescents, by biological maturity, in association with nutritional and health histories.

Present energy-nutrition status can be inferred from body weight/height ratios, limb circumferences, skinfold thicknesses, and body composition. To rule out confounding nutritional and health factors, clinical examination, biochemical determinations and dietary intake measurements are required.

METHODOLOGICAL APPROACHES IN THE STUDY OF MODERATE UNDERNUTRITION AND WORK

The following items figured in our discussion of the methodology. Order and apparent emphasis do not imply priorities. The types of research approaches include epidemiologic and experimental. The epidemiologic methods are sometimes categorized as descriptive or analytic, or as intervention trials.

Epidemiologic (Population) Studies

The epidemiologic method attempts to discover the existence of associations between factors in the hosts (or in the environment) and diseases or other outcomes. It observes the experiments which nature has performed (case-control; cross-sectional studies) or is performing (prospective or cohort studies). The associations derived through the several available approaches do not in themselves constitute proof of causal relationships. They do, however, provide the first steps in a judgment of causal inference. Such a judgment becomes possible if several studies under differing conditions yield similar results (consistency of the association); if the relative risk is found to be extremely high (specificity of the association); if the independent variable is found to have occurred or existed before the advent of the outcome (temporal relationship); and if the relationship between the independent and dependent variables is biologically (physiologically, anatomically, pathogenetically, etc.) consistent (coherence of the association) and the dependent variable is found to vary in intensity in those subgroups of the population in the same degree as the independent variable is found among them (dose-response).

Satisfaction of these criteria leads to a judgment of causality. "Proof" as such, in the conventional sense, requires a well conducted intervention

trial in which manipulation of the independent or input variable with suitable controls, yields the expected result.

Descriptive studies/surveys. The aim is to provide baseline information such as included in the discussion of energy intake and status and concerning activities, behavior, socio-economic, cultural, demographic and other factors. It is intended that these types of information be studied by multi-disciplinary teams using appropriate methods or combinations of methods. This information is basic to the selection of suitable communities and the assessment of the variables under study and their range.

Activities and behavior are concerned with the uses of time for various purposes in daily life. The uses of time can be divided broadly into two categories: obligatory and discretionary. These categories are not dichotomous or mutually exclusive but are intended to indicate their multidimensional character. Obligatory activities are typically centered around the production of goods and services, e.g. wage and subsistence work, traveling to work, preparing for work. Discretionary activities are essentially those which are freely chosen, e.g. leisure, "free time", recreation, play. Specific activities can be either obligatory or discretionary according to the values and motivations of the individual, i.e. what is work to some is leisure to others.

There are various ways of defining and measuring activities. These include frequency, duration, and intensity of participation in the activity as well as its cultural or local definition and meaning. The techniques of measurement include historical record, questionnaires, interview surveys, time budgets, diaries, participant and non-participant observation. In the analysis of these activity data, it is anticipated that the results will be aggregated in terms of time and frequencies. This aggregation describes the behavioral profile of individuals, groups, and populations which can then be used for comparative purposes.

Socio-economic information is concerned with specifying the position of the individual in relation to the means of wealth production and distribution. In some societies, socio-economic position is intimately connected with cultural position. The categories of socio-economic position include wage worker, subsistence farmer, dependent, supervisor/manager, proprietor, etc. The relevant cultural categories include those derived from domestic, kin, religious, and community position. The measurement methods include use of historical and local records, questionnaires, participant and other observation.

Demography is concerned with collecting and analyzing the distribution of characteristics in populations. These include age, sex, marital status, births, deaths, morbidity, migration, population density and distribution. These data can be in terms of individuals or aggregates. Measurement methods will vary according to the type of information desired and its availability, e.g. from population and other types of historical and local records or by sample surveys. Careful attention will need to be paid to the quality of available information and the desirability of mounting special inquiries designed to provide more reliable and up-to-date information.

Other types of descriptive data include an assessment of any available data on the nutritional status, food intakes, and energy expenditure of relevant populations. (See section on Energy Intake and Status.) Note should also be taken of any special local circumstances, e.g. droughts, floods,

climatic and meteorological conditions, industrial and tourist development.

Analytic studies. These studies are directed to the determination of associations between the independent variable (energy intake) and the dependent variables (outcome variables such as activity, work capacity, performance and output). These studies permit inferences about possible cause and effect relationship. Such studies include:

1) Case-control studies-- populations are categorized into "cases" (populations with medium to high energy expenditures) and "controls" (populations with low to medium energy expenditures)-- or other dichotomies of a gradient of activity and the proportions among them of low (or high) energy intakes determined for each.
2) Cross-sectional studies-- since the energy intake and expenditure variables are continuous variables, a cross-sectional approach in this problem would be virtually co-terminous with the so-called retrospective or case-control method. (If past intake data are ascertained for current activity levels then the case-control or retrospective method is more nearly approached.)
3) Cohort studies --
- Prospective design -- these identify independent variables in a population and relate them to outcomes over time. They provide best estimates of relative risk.
- Retrospective-prospective design -- a variant of the prospective study. This type of study allows for the examination of current outcomes in cohorts for whom data have been collected earlier in time.

Necessary to the analysis of several of the above questions is more knowledge of energy expenditure and intake for moderately malnourished populations. The chances are that the magnitude of the effort will imply stratified random samples of selected sub-populations with the stratification variables including for example: age, sex, socio-economic level, and occupation. In view of the fact that we wish to ascertain familial constellations of intake and output patterns, sampling must utilize complete households.

Irrespective of whether one or another epidemiologic technique will be used, the energy expenditure variable can be treated by means of currently available technology such as time allocation studies coupled with measurement of energy cost of particular activities. Energy intake will need to be treated by similarly reliable methods, suitable for measurement. Anthropometric variables including body composition should also be measured both to derive indicators of the past and present nutritional status of the sample and to permit adjustment of energy requirements.

Physical performance and other capacities will be measured. In so far as possible reliable standard measures should be utilized but adapted where necessary to the local situation. For example, measurable capacities required for determination of needs in selected occupations and the energy cost required for these activities would include physical, psychomotor, perceptual, cognitive and sensory domains of human performance as well as the energy cost of these activities and the resting metabolic expenditures.

Examples of capacities to be measured in the physical domain are strength measures (static, dynamic, explosive and trunk); stamina; flexibility (static and dynamic); balance; and gross body coordination. Special attention should be paid to the need to generalize the effects of the intake

variable from the performance measure examined to other performances.

As there are natural fluctuations in energy intake, repeated observations of most of the variables should be made in order to evaluate the effects of seasonal and other fluctuations. Such repeated observations would also make it possible to assess the differential effects of energy intake on separate human capacities. For example, one capacity might show a small or earlier response to a fluctuation in energy intake, while other capacities may show a larger or later response to such a change.

The feasibility of approaching the relationship between energy intake and nutritional status of childhood to work capacity and physical performance as adults would be contingent upon a data set from the past in a community available to investigators today. The alternative would be the development of a prospective study with its cost of long-term follow-up. This last would be desirable if time and resources allow.

Given the execution of these studies and the revelation of distinct associations between energy intake and work capacities, then an exploration is needed of the relationship of energy intake to work and non-work activities and their effects on productivity and the quality of life. This study will have to consider such modifying and or etiological factors as motivation and cultural values.

Intervention field trails. These studies allow application of the knowledge about the relationship between independent and dependent variables by administration of an independent variable in a community and evaluatino its outcome(s). The main purpose of these trials is to determine if laboratory findings and results from restricted experimental population groups are reproducible in larger populations. Moreover, there is a need for objectivity in translating research outcomes in the area of energy intake and productivity to policies for improvement of society as a whole. Field trials can provide such objectivity. The overall aim is to generate answers which can be used to define nutritional and developmental policies within specific ecological settings.

Experimental population studies (field trials) constitute the most reliable method of providing answers to the basic questions of whether alterations in energy intake and/or past nutrition in population groups result in concomitant changes in human performances and, possibly, in productivity.

The following questions are outlined as sequential steps in performing field trials:

1) Define the effect of past and/or present nutrition in terms of work potential in population groups.

2) Indicate how this potential can be effectively used for developmental efforts within population groups.

3) Provide objective evidence to allow translation of evidence obtained from field trials into nutritional policy formulation.

Requirements for field trials

1) Definition of hypotheses: the hypotheses and aims of the study should be stated in such a manner that they can be understood by policy makers.

2) Selection of suitable populations:

a) Evidence of past and/or present energy deficits should be ascertained by methods outlined in this workshop.
b) The population should be selected in such a way that its characteristics are amenable to study.
c) The same individuals should remain in the population under study irrespective of the locale of the activity (thus migrant workers for example, could be included).
d) The population group under study should be primarily engaged in types of activities that are to receive emphasis in the study.
e) The size of the population must correspond to the needs of the hypotheses and the time required for investigation.
f) The population should be selected so as to ensure maximum compliance and adherence to the protocol.

3) Methodology:

a) Detailed description of characteristics of the population under study must be available in order to allow possible extrapolation of results to other population groups.
b) Detailed plans for analysis of the data must be defined in advance and must correspond to the stated hypotheses.
c) The investigating team must at the very minimum include those from the disciplines of nutrition, biostatistics, epidemiology, behavioral sciences and economics.
d) Methods to measure compliance and adherence to the program must be included in the design of the study.
e) Magnitudes of precision and accuracy should be ascertained in advance for each indicator to be used.
f) The design should include provision for measurement of the cost-effectiveness of the intervention.
g) The cost and benefits of study results must be clearly described so that they are meaningful to policy-planners and extrapolation to similar populations can be made.

Experimental Studies

These studies clarify the associations between variables through direct manipulation of independent variables in other than total populations. Such studies include human experimental studies in laboratory and field settings, and animal experiments.

Human experimentation. It is important that laboratory studies be carried out in subjects who have the same characteristics as the populations included in epidemiologic studies. For some purposes it may be necessary to study subjects who are otherwise similar to the target population but are well-nourished. It would be reasonable to select these subjects from other strata of the same broad population or to improve states of studied undernourished subjects by supplementary feeding. It is the view of this workshop that research designs should not require chronic underfeeding of adults or children. Other considerations are included in the section on ethics.

There is a need to develop laboratory models of various major occupational and nonoccupational tasks in order to determine body size, mass and performance

interrelationships. The variables of age, sex, stage of growth and development, pregnancy, lactation, body composition and resting metabolism, are important to consider in the development of these models.

We do not have adequate data on resting energy expenditures of those who are chronically undernourished from a range of different environments. Collection of such data should have a high priority for it will be used as reference information for a variety of applications.

The energy value to be assigned to oxygen uptake should be thoroughly evaluated in those who are malnourished, and especially during different portions of work/feeding cycle, as respiratory quotients (R.Q.) may differ in those who are adapted to low planes of intake.

Reliable energy expenditure methods are needed that can be employed in field situations. Validation and reliability studies should be conducted in the laboratory prior to field testing.

New and better indicators of mild/moderate undernutrition are needed. It would be useful to derive standards for indicators that are reliably linked to energy intake and that can be measured easily, quickly and at low cost in the field. Refined methods of assessment of energy reserves, particularly body fat, and other components of body composition are needed.

Another suggestion, offered by the Workshop on Cognitive and Sensorimotor Function to the effect that R.Q. in response to a metabolic load (meal) may be different in well- and - nourished individuals, should be explored and other biochemical markers should be sought. The mechanisms of physiologic adaptation to undernutrition, if known, would provide useful clues for the development of indicators--this research is certainly warranted.

Standards should be derived for reliable indicators that can be measured in field studies to evaluate characteristics relating energy-nutritional status and performance capacities. Practical performance profiles (strength, coordination, endurance, etc.) need to be developed for subjects in whom habitual energy intake is altered in order to determine effects of energy intake on these capacities under controlled conditions. The outcomes may be quite different from those found in the field but this information is needed for reference purposes. Of main concern are standards for women and older adults of both sexes as they have not been studied extensively.

It is important to assess task trainability in relation to energy intake with alterations in training methods and levels at fixed energy intakes and in relation to fixed training regimens with different energy intakes. Such training could well be job- or task- specific.

The assessment of the effects of environmental conditions and physical conditioning regimens is required on subjects habitually maintained at different levels of energy intakes, e.g. the ability to expand plasma volume during exercise in the heat may be compromised in those chronically undernourished.

Data to assess the biological availability of energy in the diets available to the population of interest are needed. This work can best be done in the laboratory, because the absorption/digestibility picture is often confounded by co-occurence of parasitism, etc.

Animal Research. A wide variety of pertinent animal experiments are possible. However, any animal model selected should be appropriate to man and the experiments selected should have clear relevance. Of major concern is

the effect of different levels of nutrition and physical activity on growth, development, maturation, susceptibility to disease, longevity, etc. Information can be gained from animal research about mechanisms which may provide guidance to human experimentation.

ETHICAL CONSIDERATIONS

The ethical considerations addressed by the previous workshops are accepted in principle, but the following additions and modifications are offered.

Informed consent must be obtained without coercion or duress. The community as a whole must be aware of the research and of the benefits and risks that may occur in the community and for each individual participant. This implies that informed consent is obtained in the language of the individual and at the level of understanding of the individual participant. In obtaining informed consent, care should be taken to avoid coercion through political influence, unreasonable rewards or promises to either communities or individuals, or provision of any non-continuous medical or other health service.

The research itself must be ethical. Benefits must outweigh risks. First, no manipulation of reduced food intakes may be administered to humans that could be considered a long-term deprivation. In children even short-term deprivations should not be permitted. In the field, various levels of intakes already occuring can be monitored, but reductions may not be induced. Second, the confidentiality of the subjects must be maintained. Third, customs and traditions should not be altered in ways that are unacceptable to the local population. Fourth, results of the research will be made available in the language of the country or community involved. Fifth, any intervention project considered should incorporate the potential for ongoing local participation when the research is completed so that some long-term benefit will accrue to any community involved in this research.

The long-term use of the research itself must also be considered. The knowledge accumulated in this research should be used only in ways which aim to improve the quality of life, not by application of this research to a policy of maximizing production at the expense of the quality of life.

A single Committee on Human Experimentation should review finally all proposals in order to maintain consistently high standards.

The following extract comes from a letter sent by one of the workshop participants commenting on the above report.

Very little appears in the text of the report relative to the choice of the appropriate indicators of physical fitness. The appropriate indicators of physical fitness are still a subject of debate and controversy; however, as the rate of transport of O_2 from air to muscle has been recognized to be the limiting factor in the replenishment of working muscle phosphagens, agreement has been reached among qualified investigators that VO_2max represents the best single indicator, and it is also the most widely used, and thus the one on which most information is available.

Although a standardization of the method to be used is highly desirable, I wish to draw to your attention the following points:

1) Direct VO_2max measurement implies exhaustive physical work, and the criterion for the subject having reached his maximal capacity is described by:"nausea, severe breathlessness, cyanosis progressing to an ashen-gray pallor, incoordination, a confused response to questioning and impending loss of consciousness". This is applied independently of the age of the subjects, be they children or adults.
2) The literature suggests that, while it has been recommended that this test be performed in the presence of a doctor and a direct current defibrillator, and while it is recorded that "in the coronary-prone middle-aged man the risk of ventricular fibrillation or cardiac arrest is about 1 in 3000", it is apparent that investigators, when operating in underdeveloped isolated areas tended to neglect this precaution. This is understandable as physicians are generally unwilling to make themselves available for such long stretches of time for this type of activity.
3) Alternatively, submaximal tests are available and have been recognized to provide reasonable indices of VO_2max for population groups.

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PHYSICAL ACTIVITY
October 30 - November 3, 1978
La Jolla, California
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APPENDIX A

NUTRITION, PHYSICAL ACTIVITY AND WORK OUTPUT

by C. J. Bliss (Nuffield College, Oxford)

Background paper prepared for the meeting at La Jolla, California, 30th October to 3rd November, 1978, organised by the University of California, Berkeley, and funded by USAID under Title XII.

§1. Introduction

Not withstanding an apparently circumscribed title, this paper cannot escape confronting very wide-ranging and largely unresearched questions. To say this is to say that no author will be wholly competent to offer anything but the most speculative views on the issues concerned. However the present author is further incompetent in that he has no professional training in nutritional science on which area, as it happens, many of the key issues turn. It is suggested that the emphasis should be on pinpointing areas for research. This might seem to provide a useful let-out for the ignorant author: what he does not know he can volunteer as a research area. However, so wide is our ignorance that even this is not easy to do.

The paper will be arranged as follows. In §2 I shall review some work by economists on the link between productivity and consumption (which is not always the same as nutrition) including my own work with Stern. This work has rather special orientations and in §3 I shall detail some broader questions, including the economic consequences of the long-run relation between nutrition and productivity in a population. There has been little research done on this area and I shall allow myself to speculate. The economist's approach to work and activity is not the same as the nutritionist's and §4 will be concerned with explaining the differences between the

two approaches. Section §5 will be concerned with the energy balance or Calorie accounting approach to nutrition and particularly with the problems involved in using that approach to estimate the extra work that a higher level of nutrition would make possible. Section §6 will be concerned with various influences of nutrition on work output not having directly to do with energy balance, in particular morbidity and physical and mental development. Section §7 draws together various strands of the argument into the form of suggestions for research and §8 contains some concluding remarks.

§2. Productivity, consumption and wages

One of the oldest ideas in the theory of development is the 'vicious circle of poverty', which says that people stay poor because various consequences of their poverty make them unable to make themselves richer. In the context of nutrition this would translate to saying that ill-fed people produce less food and hence remain ill-fed. Although no one to my knowledge has seriously proposed a strict vicious circle in the case of nutrition, with the implication that simply giving poor people more food for a few years would make them subsequently able to produce enough extra food to overcome malnutrition, the vicious circle emphasis is represented by Myrdal (1968), who writes:

> "The main cause of undernourishment and malnutrition in South Asia is, of course, poverty and, in particular, the low productivity of man and land in agriculture. The remedy is development, but the way will not be easy, partly because the dietary deficiencies themselves have reduced people's ability to work. On the other hand, as the nutritional deficiencies tend to lower labour input and efficiency and to decrease vitality in general, they themselves constitute one of the obstacles standing in the way of development, particularly in agriculture."

An idea which springs naturally from this one is that a link between productivity and consumption might play an influence on private wage bargains. According to this line of argument, competition will not push wages down to a level as low as some workers would be willing to settle for rather than go without work, because those wages would not provide the worker with enough consumption to make him an effective worker. The first person to investigate this idea in detail was Leibenstein (1957) who reaches the following conclusion:

> "What all this implies is that at very low wages there may be a labour deficit because the units of work produced per man are so few. But at higher wages the units of work per man increase so rapidly that a labour surplus is created. For underdeveloped areas this may mean that the allegedly observed manpower surpluses in agriculture do not really exist when wages are very low, but that they do indeed become a fact when wages rise sufficiently."

Leibenstein's theoretical treatment was far from complete but he did attempt an assessment of the likely empirical importance of his model by comparing levels of calorie intake commonly observed in poor countries with estimated calorie requirements for certain types of work.

The implications for the economic theory of wage determination have been examined by Mirrlees (1976), Stiglitz (1976) and Bliss and Stern (1978). The first two of these papers also address the important question of the allocation of food within a family unit, particularly the question of how food is divided between working and non-working members. All these writers are concerned with the so-called efficiency wage theory. According to this theory wages will settle at that level at which the cost to the employer of purchasing one efficiency unit of labour is minimized.

If L men be employed at wage w, and let output measured in the same units as the wage be y. Suppose that y depends upon L and w as:

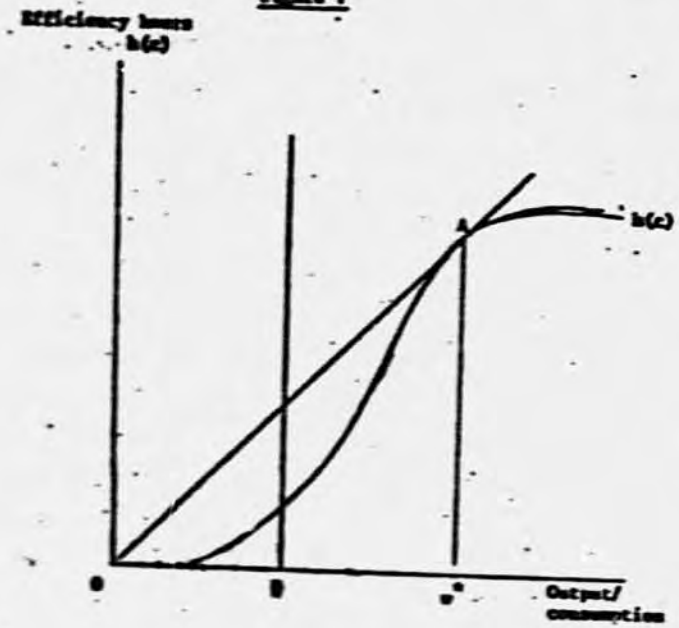
$$y = f[Lh(w)] \qquad (1)$$

The function $h(.)$ can be interpreted as indicating the manner in which consumption influences the 'efficiency' of labour. It is helpful to distinguish from the outset between what we will call 'clock hours' of labour and 'efficiency hours' and to interpret (1) accordingly. The number of clock hours worked is L, which is proportional to the number of men employed if each man works a standard number of clock hours. The number of efficiency hours of labour produced in one clock hour is $h(w)$. In supposing it to depend on the wage we are implicitly assuming that the wage is all consumed. Note the distinction between the 'daily wage', which is the wage received by a man for a day's work, and the 'wage per efficiency hour', which is the cost to the employer of buying an efficiency hour of labour. Suppose the labour is freely available to an employer at any wage not less than $\bar{w}$. It might seem that no rational employer would pay more than $\bar{w}$ but this is not the case. Since different wages buy different quantities of 'labour power', which we shall refer to as 'efficiency hours of labour', an employer facing an unlimited supply of labour will choose to pay that wage which minimizes the average cost of one efficiency hour of labour. Thus w will be chosen to minimize $w/h(w)$ regardless of the level of L, provided only that the optimum cost-minimizing level of w exceeds $\bar{w}$.

In Figure 1 the efficiency wage solution is illustrated. A plausible form of the relation $h(.)$ is chosen for the sake of

illustration. The exact shape of this relation interpreted as a relation between calorie intake and work output has been the subject of investigation by Bliss and Stern (1978), and see below §3.[7] The

Figure 1



solution for the minimization of $w/h(w)$ at $w = w^*$ is the point of tangency of a line through the origin to the curve $h(.)$.

If it is the case that this model of wage determination correctly describes the state of affairs in many low wage countries then there are a number of important implications. Bliss and Stern have shown how the model would imply that monopolistic employers of

labour would pay lower wages to workers with a source of consumption apart from the wage, say output from own land, than to workers with no such outside source. Another obvious implication is that employers will tend to favour long-term contracts of employment since it is these that will enable them to capture the full benefit of any beneficial effects of consumption on productivity, as some of these effects are likely to be medium or long-term. Moreover, employers would be expected to pay higher wages to permanent labour as the efficiency effect would be stronger. Another implication of the model is that wages would be stable at the efficiency level, whatever that might be, at different times and in different places, even if the balance of supply and demand is variable.

Casual empirical testing of these predictions produces variable results. In India (at least in 1950-57, the year to which figures made available by Professor P. K. Bardhan apply) it seems that permanent labourers have higher incomes than casual or unattached labourers (about 10 per cent higher according to the figures). However, one can think of other reasons to explain the gap. Permanent labour may work more hours per annum or do heavier work.

Less favourable to the theory is that permanent labour contracts seem relatively unusual. In village Palanpur in West U.P. in 1974-75, where I was engaged in a research study with R. E. Stern, out of a village population of 750 and with an active labour market there was only one such case. For further evidence see for example the Indian Government (Ministry of Agriculture) annual publication Agricultural Wages in India. There are, of course, less formal long term arrangements (see, for example, Bell (1977)) which may be overlooked by those who gather official statistics. Rodgers (1975) (p. 68) discussing

the Kosi region of Bihar found that tying of labour to the same employer was a common practice. Nevertheless the incidence does seem very much less than would be predicted by the theory, for many parts of India and, certainly in the part of West U.P. where Stern and I were working.

Perhaps the most striking implication of the theory is that wages will tend to be constant for workers with similar consumption backgrounds notwithstanding variations in demand for labour and various factors affecting productivity, such as cooperating inputs and season. However this prediction seems contrary to what one observes. In India, the country I know about, agricultural wages vary a great deal from region to region, and over the agricultural season. Ignoring wage rates for harvesting, which must be supply and demand determined, wage rates in Palanpur in the 1974-75 winter fell from around Rp. 5 per day (I have included the cost of a meal) in October to Rp. 3.75 in February, a reduction of 25 per cent in the money wage. The low page corresponded with a time of high grain prices, so the real wage varied even more. Rodgers (1975) claims wage stability in the villages he studied in the Kosi region of Bihar. However the theory would predict stability of the real wage. Thus if prices have big seasonal movements, seasonal stability of money wages, which is what Rodgers reports, is evidence against the assertion that wages are, throughout the year, as determined in the theory. Small changes in the level of work activity do not produce large proportional variations in the calorie requirements, thus one cannot use the theory together with changes in the type of task over the season to account for fluctuations in the real wage. It is quite possible of course that the theory could be relevant for

some periods in the year, when any work was on a steady basis, but not for others where it was more casual.

If it is nutrition as such that accounts for the productivity of high wages, then the theory would predict the payment of kind wages, particularly meals, where possible in an attempt to raise the proportion spent on food. Rodgers (1975) and Bell (1975), for example, found kind wages to be important in Bihar. Rodgers (1975) shows that the wages provided in the form of meals on the job constitute around half the wage. We consulted 30 farmers in Village Palampur in 1974-75 as to why at that time they usually paid 4 Rupees plus meal per day rather than 5 Rupees (the meal was value approximately one Rupee). The large majority who offered a reason said that it was to save working time since the worker would go home for his meal if it were not provided by the employer, whereas if it were provided the meal would be eaten in the field. Only one farmer mentioned in addition to the reason given that it might make the worker perform better.

Bliss and Stern in their assessment of the theory use the arguments above and arrive at a rather negative assessment of its empirical importance. Their most telling arguments, however, come from their attempt to interpret the function h(.) as a relation between energy intake and work output, on which see below §5.

§3. Economic implications of long-run links between consumption and productivity and work output

The work reported in the previous section is potentially of considerable importance but its focus is somewhat narrow, mainly on the positive theory of wages. The problem of explaining how nutrition

influences the wages that get arrived at in private market wage bargains is not to be dismissed but it is to be doubted whether the most important influences of nutrition are to be seen in this particular field. As many, perhaps the majority, of wage bargains in the labour markets of poor countries are short term casual contracts, they will only be influenced by considerations of nutrition if the nutritional factor makes its influence felt in the short-run. Whether it does, and if so how, is a complicated question on which I shall have more to say below. However, to anticipate the conclusions of Section §5, there is reason to doubt whether a simple short-run link can be established between work output and food requirements, at least not a link that would make a consequent effect on wages quantitatively very important. In the long-term it will be argued that the link is firmer and quantitatively more important, but then it is not clear what influence it will have on the calculations of private, profit-maximizing employers.

Most people think that the long-term effects of nutrition on the work output of the population are quite important although, to my knowledge, precise evidence on this matter is scant. To cite an obvious example, the relation between nutrition and disease, about which people often talk, is obscure except in extreme instances of severe malnutrition or the lack of an essential constituent in the diet. Nevertheless, it seems to be the case that a number of populations in which nutrition has improved markedly in the last 50 years have, at the same time, been getting taller – Japan is a notable example, and this does suggest that nutrition may have an influence on stature and perhaps also on strength and fitness. I shall mention this possibility again in §6.

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The first term is the direct effect on output in the future, the second the indirect effect due to enhanced labour productivity. The net social rate of return is conceived as the ratio of consumption gained in the future to consumption given up today less 1, which is

$$\frac{\$100(1+R) + \$100(1+R).h_2.m_2}{\$100 + \$100.h_1.m_1} - 1 = (1+R)\frac{1+h_2.m_2}{1+h_1.m_1} - 1 \quad (3)$$

This reduces to R, the technical rate of return, when $h_1 = h_2 = 0$, as we would expect. As can be seen from (3), it is not clear whether the effect of consumption on productivity lowers or raises the rate of return to saving. However, one might plausibly suppose $h_2 < h_1$ (i.e. the productivity effect will be weaker in the future when it is hoped people will be better off). On the other hand, a plausible hypothesis is $m_2 > m_1$ (the marginal productivity of efficiency units of labour is increasing) in which case the comparison of (3) to R is ambiguous.

These examples could be added to but probably enough has been said to make it clear that the influence of consumption on productivity has many ramifications, some of which economists have yet to investigate.

§4. The economist's and the nutritionist's views of work and activity

The economist tends to think of consumption, meaning all forms of consumer expenditure, rather than nutrition alone. There is something to be said for this where work output is concerned as many items of consumer expenditure could influence productivity, not just expenditure on food. This is a problem for research into the influence of nutrition since badly-nourished populations are usually

ill-housed in unhygienic conditions, lack medical care, and so on, so that attributing low activity and ineffective application of labour effort to nutrition alone is difficult. Also, the economist is usually interested in the fruits of labour so that work is often defined by him in terms of tasks carried out, as a field ploughed or a house painted. The nutritionist, on the other hand, will often have in mind the notion of work in its scientific sense as measured by foot-pounds and produced by muscular contractions. There is quite a wide gap between the two concepts. Thus a man walking about aimlessly trying to decide how to do a job is doing work in the physical sense but not in the productive sense. As work above a certain level is onerous, the human being applies his mind to producing a desired outcome with minimum effort. In this sense mental alertness and reasoning power play an important role. Furthermore motivation and application are of great importance in determining how much work will be done. Such issues tend to be suppressed in discussions of energy expenditure. However, energy expenditure is so important that some attention must be paid to it.

§5. Energy balance and energy accounting

This is a technical subject outside my professional competence. However the literature as it stands does not deal with the question of whether the frontier h(.) of Figure 1 can be interpreted as a relation between work output and energy intake. This issue was discussed by Bliss and Stern (1978) and I have drawn heavily on that paper.

Nutritionists have paid much attention to the energy requirements of individuals (see, for example, FAO/WHO (1973) and Durnin and

Passmore (1967)). However, they have not been concerned explicitly with the relation $h(.)$.

The frontier $h(.)$ is intended to describe the limit of an individual's possible performance. His maximum feasible number of tasks per day, n, will be determined inter alia by his strength, skill, intelligence, psychology, and general health as well as food intake. Further these causes will be inter-related - especially in the long-run. In this section, however, I concentrate on the ability to translate food calories into work for an individual of given skill, intelligence, psychology and so on.

The economic theory under discussion requires that we formalise this approach into a functional relationship relating tasks performed to calorific input. This more formal approach seems rare in the nutrition literature. I draw rather heavily on a recent paper by Payne and Dugdale (1975) but we shall see that the relationship we require is extremely difficult to identify.

When food is absorbed by the body the available energy may be used in different ways. The individual may perform work, he may put on weight and he has to maintain the fabric of his body. Assuming constant body temperature the energy absorbed must be equal (by the first law of thermodynamics) to the sum of the energy involved in these different uses. The determinants of the amount of energy involved in the different uses, and the functional forms associated with these determinants, are matters for both theory and experiment and will vary across individuals but the accounting equation remains the same in the sense that we add across the different uses to get the total used. Let the calories absorbed by an individual (net of those that are excreted from the system) in some period be c. Suppose

the weight of the individual is W (in kg). Then we have (assuming constant body temperature)

$$c = \frac{1}{e}f(n,W) + \alpha\Delta W + kW^{\beta} \qquad (4)$$

For expository purposes I have offered a particular form of the equation. I shall explain it first and then go on to describe the difficulties of specification and estimation. It is important to realise that equation (4) is not, as it stands, the relation we are trying to identify. It is a vital first step, however, and I shall discuss the further steps involved in transforming (4) into the relation between productivity and consumption when I discuss the implications of the nutritional evidence for the theory at the end of this section.

The first term on the r.h.s. in equation (4) $\frac{1}{e}f(n,W)$, is the energy used up in performing n tasks: the work done is $f(n,W)$ and e is the efficiency of the body in converting energy into work - e is often thought (see Mountcastle (1968), p. 532) to be around 0.25. The work done by the individual is, say, digging: would be the raising of soil, overcoming friction in loosening the soil, moving around the field and so on. The second term represents the energy retained by the body in weight increases over the period (so that for a decrease $\Delta W < 0$). The constant α will depend inter alia on the form in which the energy is stored, in particular, the proportion stored as fat - to give orders of magnitude however (see Davidson et.al. (1975), Ch. 3), one might expect α to be about 5000 (or 5 calories gives 1 g).

The third term represents the maintenance energy required at minimum activity levels merely to maintain the fabric of a body at

given weight. This was taken by the FAO/WHO committee (see FAO/WHO (1973), p. 37) as 1.5 x BMR where BMR is the basal metabolic rate or the energy used (thus heat produced) under resting and fasting conditions. The extra 50 per cent is for the heat generated in the absorption of food, a 'minimum' level of voluntary muscular activity, such as dressing and washing (I return to this notion later) and the synthesis of tissue (see below for further discussion). This maintenance energy divided by weight in kg. to the power 0.75 shows a striking constancy across different animals (FAO/WHO (1973), p. 37), including humans, and seems to give k around 105 cals.kg$^{-0.75}$. The third term is much the most important constituent of daily calorie recommendations. For example the FAO/WHO (1973) report suggests (p. 38) 2500 calories for maintenance and 400 calories for moderate activity for a 65 kg. male, at mean ambient external temperature 16°C, aged 20-29, to give a total of 3000 calories per day. I shall, following the FAO/WHO, call him the reference man.

I now turn to the problems of specification and estimation and take the three terms in (4) in increasing order of difficulty. The issues raised by the second term are relatively straightforward although both precise and reasonable estimates should not be expected. The value of a will depend on the proportion of energy stored as carbohydrate (giving approximately 4 cals/gm.) and that as fat (which is approximately 9 cals/gm.). This varies across individuals. The value of a will be lower for an increase in weight than a decrease, so that strictly speaking our notation aW is illegitimate (see Payne and Dugdale (1975)).

The problems increase when we turn to the third term. Davidson et.al. (1975), p. 31, suggest that, across humans $\beta = 1$ seems to do

as well as $\beta = 0.7$ (the figure they give across species) and indeed the FAO/WHO Committee (1973), p. 79, eventually base their recommendations on $\beta = 1$. But for an individual losing weight these values of β do not seem appropriate. Payne and Dugdale (1975), p. 13, show using data from a semi-starvation experiment that $\beta = 2$ models the decline for this energy requirement rather well. This number would not necessarily be appropriate for maintenance requirements for given W in the long-run since adaption takes place (see below). The experiment (see Keys et.al. (1950)), conducted in the U.S., involved volunteers on low food intakes for 24 weeks.

The allowance of 50 per cent above BMR in the calculation of maintenance energy at 'minimum' activity levels may itself be reduced if food is cut back. It is worth quoting here at length from Davidson et.al. (1975), pp. 39-40, since it will also be relevant for my discussion of the first term $\frac{1}{a}f(a,W)$ the energy expended at work.

> "When European men in prisoner of war camps in the Far East were given a ration providing only 1600 cals. daily, they lost weight at first rapidly, but later slowly (Smith and Goodruff, 1951). After an interval of many weeks and when the body weight had been reduced by 20 to 25% the losses ceased and many of them survived till liberation three years later with their body weight stable at this low level. In the Minnesota experiment on volunteers subjected to partial starvation, Keys and his colleagues (1950) showed a similar adaption to a low energy intake with stabilisation of body weight at a new lower level. They were able to demonstrate that this adjustment was in part due to a fall in metabolic rates, consequent upon the reduction on cell mass, but the main factor was a marked reduction in voluntary physical activity. Here is an example of the control of body weight by a variation in energy expenditure."

Given that, of the 3000 cals/day for the FAO/WHO reference man, 400 is for moderate activity over and above 'minimum', 1700 for the BMR and 900 for the 50 per cent above BMR (working in round numbers),

the natural interpretation of the remarks of Davidson et.al. is that one can cut into this 50 per cent by a reduction in 'minimum' activity.

I have been concerned so far in this section to synthesize the nutritional literature on energy and work around equation (4). I have ignored certain important topics in order to concentrate on the bare essentials of (4) and to keep the length of the discussion within reasonable bounds. For those who require a discussion of the nutritional literature in more detail I would recommend as a starting point the chapter on energy (Ch. 3) in Davidson et.al. (1975), for an examination of the problems of randomness, Payne and Dugdale (1975), and for measurement of the energy costs of various activities, Durnin and Passmore (1967). Further sources of evidence are given in Bliss and Stern (1978).

We now examine the connection between (4) and the frontier of §2.

It is clear from the calorie approach of this section that we must consider the relation as a fairly long-run phenomenon. In the short-run one can perform work without any food intake by reducing body weight although of course, for stable body weights, on average over time, the energy stored in the body must be replaced.

The energy from ingested food is available quite quickly. A graph of available energy from food against time from ingestion of food would show a peak after an hour or so with the majority of energy available within three or four hours (see Garrow (1974), pp. 146-147). However, unless energy usage is perfectly synchronised availability from the food there will be storage in, or extraction from, the body. It is this role of the body as a store which implies that the energy relation cannot be a short-run phenomenon.

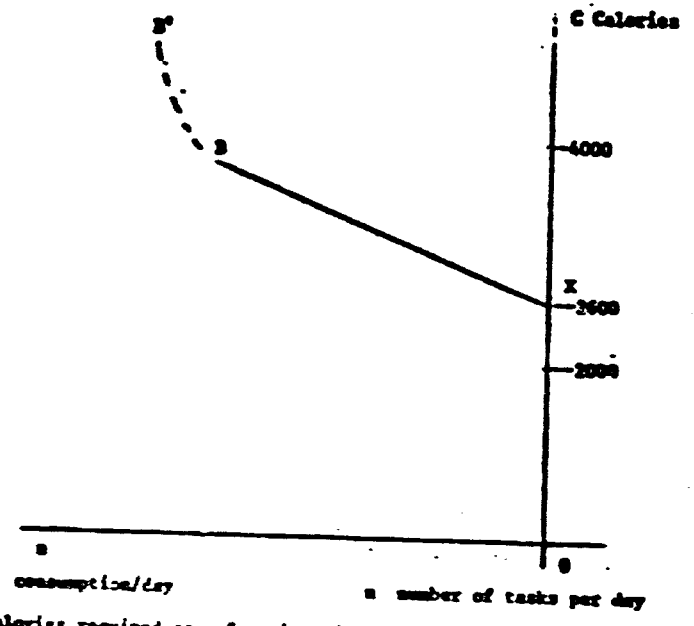
A body weight which is on average stable may fluctuate over quite long periods. A study of naval cadets (provided with as much food as they wished) showed daily intake of food loosely correlated with activities two days previously (see Mountcastle (1968), p. 509). Davidson et.al. (1975, pp. 38-39, quote a careful study (1962) of a woman who had a weekly cycle losing on average 1 lb. per day on weekdays and replacing at weekends. And she was unaware of this until the results were analysed. Haswell (1975) shows in the village she studied in Gambia that there was a yearly cycle in body weight given the agricultural work calendar and availability of food. Given the behaviour of the body as an energy store we must consider the theory, in so far as it is based on energy rather than psychology, as referring to a period longer than a few days and frequently much longer.

But what should we assume about the long-run weight adjustment? Let us now turn to equation (4) and examine alternative approaches. Since we are taking the long-run we assume that (on average over a few days) ΔW is zero, and thus that weight has settled down to a steady level for given (c,n). Thus we have

$$c = \frac{1}{a} f(n,W) + kW^{\beta} \qquad (5)$$

The assumption of $W = \bar{W}$ independent of (c,n), together with $f(.,.)$ linear in n, would give the relation shown in Figure 2. Employers would show unambiguous preference for lighter workers since both the fixed cost kW^{β} and marginal cost would be lower. Further the employer would select a very high number of tasks per worker since his optimum the minimum cost per task, is given by the tangent from the origin to the relation or frontier (see §A.1 and

Figure 2



Calories required as a function of tasks performed for the reference man at constant weight and with fixed method of performing tasks.

Figure 1), and thus cannot occur on the linear portion XB. Certainly the former conclusion seems implausible.

Suppose now that we abandon the assumption of given weight $\bar{W}$ and go to a different extreme, namely that given (c,n) the weight adjusts to a long-run equilibrium value determined by (4). But this would seem to imply no relation at all between (c,n). We could pick any (c,n) pair we wished and there would be a long-run equilibrium W. This again is most implausible – a very low c for given n would merely imply a low long-run W, even if it happens to be 5 kg.

The implausibility of the two specifications we have tried so

far must lie in their ignoring the notion of strength or muscle power. We think of a person as being too weak to perform a certain task or more than a certain number of tasks. This idea is best captured in terms of a relation between $W(n)$ which would describe the minimum weight required to achieve a number of tasks n. Indeed many nutritional standards are now measured in terms (see, for example, Gopalan and Vijaya Raghavan (1969)) of weight (usually in relation to height) as the most appropriate summary measure of strength (it is obvious in this context that we are not concerned with problems of obesity and that one should discuss proteins in the building of muscle). The idea of minimum weight $W(n)$ seems important for the theory and requires further research.

Let us suppose, then, that a $W(n)$ function can be defined. Equation (5) becomes

$$c = \frac{1}{a} f(n, W(n)) + bW(n)^{\beta} \qquad (6)$$

This is now a relation between c and n and we take it to be the definition of the relation or the frontier of the consumption set. We have discussed β and the $f(.,.)$ function, so to determine the shape of the frontier it remains to discuss $W(n)$. It is clear that the function $W(n)$ will vary across individuals and will not be easy to define for any one individual, but it does seem indispensable to the relation we seek. Presumably W increases with n and $W(0)$ is positive.

I shall not discuss the $W(n)$ relation further here (see Bliss and Stern (1978) for some additional comments) but it is clearly a topic for further empirical research.

§6. Influences of consumption on productivity not having directly to do with energy balance

So far, in discussing the interpretation of the relation between productivity and consumption as being due to nutritional factors I have considered only the calorific value of food intake as compared to energy expenditure in doing work. An obvious reason for focussing on this aspect of food consumption is that the relation to work is direct and allows of precise quantification, at least in principle. However, there are probably many other influences at work, and I have chosen two for mention although I shall not be able to say anything precise about them. Everyone knows that there are some people who feel faint and find it hard to concentrate if they miss a regular meal. A possible cause is depletion of the level of blood sugar. Blood sugar level is regulated by the pancreas by its release of insulin and (excepting cases of mal-function such as diabetes) is not necessarily linked to recent food ingestion. However, in the case of some individuals it seems that blood sugar level falls markedly when they fast.

The importance of blood sugar is not that it provides directly for energy by means of muscular contractions. In order to be oxidised in muscle cells sugars must be turned into lipids. Nevertheless, blood sugar is oxidised directly in the cerebral cortex and thus might be regarded as 'fuel for the brain'. When blood sugar level falls the result is not dissimilar to that which follows a decline in blood oxygen level: the subject feels drowsy and cannot

concentrate, reactions are slowed and lethargy results. In the case of a person in this condition the marginal productivity in terms of effective work output of a small quantity of food intake could be very high. Even if blood sugar is an important factor for only one in ten of workers, but supposing that the employer cannot identify which these workers are, it could still be worthwhile to pay higher wages to ensure an adequate level of current food intake. Note that the employer would want to ensure if possible that the extra wages were consumed by his worker during the course of the working day, including ideally breakfast.

All this is very speculative. Very little is known in quantitative terms about blood sugar and food intake and until more is known it will not be possible to make the link to the theory of wages more precise.

Another vital area is the influence of nutrition on physical and mental development. In particular it is known that malnutrition in infants influences brain size and hence, it is assumed, mental powers (see Goldblatt (1975)). This effect is important because irreversible: enhanced nutrition later in life does not enable the cortex to recover its normal size. Parental awareness of the importance of feeding at certain critical ages is very low so that there is a possibility that given resources are seriously misallocated.

There may be other examples of an influence of short-run or long-run nutrition on physical and mental development. There are potentially huge rates of return to attacking some of these problems but effective communication with the populations concerned will not be easy.

§7. Research

The most important gap in our knowledge, which it would be very reassuring to see research fill, is that we know very little about the relation between food intake and the ability to perform work. In the short-run that link is tenuous because the body acts as a store of energy. Even so there may be short term links, for example through blood sugar level. But for policy and the assessment of the consequences of poverty, what matters is the long-run link and its form and size. I know of no work directly addressing itself to this issue. True, there has been work involving the measurement of such anthropometric statistics as height, weight and arm circumference. But until these factors can be related precisely to the ability to perform work we will not have the knowledge we need to assess the consequences of being in poverty and malnourished.

What I am suggesting implies an alternative approach to the traditional way of relating work to calorie intake. The traditional approach is short-run and sees work as adding to the basic energy requirement of BMR plus an allowance for voluntary expenditure of effort. In that case, as has been shown, extra work imposes low demands on energy. What the nutritionists are measuring here is a partial derivative of the function (6),

$$c = \frac{f}{e}(n, W(n)) + kW(n)^{\beta}; \qquad (6)$$

that is

$$\frac{\partial c}{\partial n} = \frac{1}{e} f_1, \qquad (7)$$

where f_1 is the partial derivative of f with respect to its first

argument. But the long-term energy demand of extra work over and above n are equal to:

$$\frac{dc}{dn} = \frac{1}{e} f_1 + \frac{1}{e} f_2 \frac{dW}{dn} + k\beta W(n)^{\beta-1} \frac{dW}{dn} \qquad (8)$$

Whereas the first term is relatively small the second and third terms are much larger and it is therefore important to quantify them as precisely as possible, although they will not be measured as accurately as f_1 which of course can be measured very accurately by means of oxygen intake.

My discussion in §5 has shown that, while there is a good deal of suggestive evidence that increases in energy intake can have important effects on work output, there have been very few careful experiments to quantify these effects. Given the potential importance of the productivity-consumption link for development policy in general and food policy in particular the paucity of precise empirical knowledge is worrying. In this connection it is worth mentioning the work of Viteri and his associates, who since 1974 have been conducting experiments on food supplementation and work performance amongst cane-cutters in lowland Guatemala (see Viteri (1975)). This work provides a good example of the kind of studies that should be undertaken shall describe it briefly, for this reason and because it raises some interesting problems.

In the study reported in Viteri (1975) two cane-cutting communities 2 km. apart were selected. Workers in community 2 received an energy supplement and those in community 1 acted as a control. The head of the family received the supplement in the form of sucrose in a sweetened drink (taken twice daily) which also contained certain vitamins. Workers in community 1 also received drinks

which contained the vitamins but a low calorie synthetic sweetener was used instead. There were 64 workers involved in community 1 and 96 in community 2. The additional intake in community was 650 cal/day. Both communities work and live on estates operated by the same private company.

The dietary intake of the male workers under study was recorded for random sub-samples. Cane-cutting activities, which are paid by weight of cane cut, were monitored and there were periodic anthropometric and haematological surveys of subjects and their families. For example, workers' physical capacities were evaluated for a sub-sample, using a bicycle ergometer or a treadmill. Heart rates and oxygen consumption were also recorded.

The report Viteri (1975) is preliminary and the authors emphasised that the experiments and analysis of results were still in progress. I am grateful for permission to quote from this report. Further reports are expected soon. However, certain provisional results have emerged.

Viteri (1975), p. 23, concludes

"The available measurements of total productivity, work intensity and performance in the field, indicate that the energy supplemented workers show a consistent tendency towards greater work intensity, energy expenditure and productivity than the control workers belonging to community 1. The psychological effect of distributing a cold drink while the labourers are active in the field working under the sun, was evident in both groups of workers during the initial part of cane harvesting. However, this effect disappeared quickly in the low energy supplemented group who also lost some weight during cane harvesting. The group that received the high energy supplement, in contrast, maintained a high work intensity and also maintained stable weight throughout the cane harvesting season. Furthermore, the high energy supplemented group during the off harvest season performed their work with greater intensity as clearly manifested by the shorter time it took them to perform a standard task."

Further results are expected on changes in family consumption and off-the-job activities. There is also some indication that community 2 workers may have been substituting quantity for quality of cutting.

I have described Viteri's study at length as this seems a good example of the kind of work that needs doing.

§8. Concluding remarks

My argument has served to bring out some of the difficulties in examining the relation between nutrition, physical activity and work output on the one hand, and social and economic factors on the other. Human activity is goal-directed and responds in complicated ways to the environment and the physical and mental condition of the subject. Very poor people spend income on apparently dispensible expenditures and undertake avoidable exertions, such as sexual intercourse. The economist will insist that activity is not an end in itself and that work should be related to productivity. This is to place the emphasis on physical dexterity, mental alertness, and so on, and away from the nutritionist's traditional emphasis on the maintenance of the body and energy output.

Finally, I should mention a large gap in my own discussion, that I have neglected almost entirely the composition of the diet. This is only because I know nothing about the subject and should not be taken to imply the view that the issue is unimportant.

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APPENDIX B

PHYSICAL ACTIVITY AND WORK OUTPUT. BIOLOGICAL PERSPECTIVES.

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INTRODUCTION:

The primary purpose of this document is to generate research guidelines and specific projects based on our present knowledge of the interrelations between nutrition and productivity. Rather than describing in detail the present available data in this area of human endeavor, statements on the present "state of the art" are put forth primarily to serve as the basis for future research with emphasis on the variables needed to be considered in the biological sphere as well as their interactions with social conditions which influence the individual's ability to function in a society. The possible repercussions which nutrition-work situations of groups of individuals have in social and economic development can only be touched peripherally.

In spite of the fact that in recent years work in the area of nutrition and productivity has increased, there is a tremendous scarcity of data which can solidly relate nutrition and productivity. It must be realized from the beginning that in order to relate these two variables, a series of intermediate steps which exist between one and the other must be accounted for. These steps involve biological and other factors related to

physical environment and social structures which often are more important than nutrition as determinants of productivity.

There is no doubt that severe nutritional deficiencies of energy, protein, vitamins and minerals affect the individual's capacity to perform work. Severe nutritional deficiencies, although important from the stand point of the health and well-being of populations are, however, not important in terms of productivity simply because severe undernutrition is seldomly seen under natural non-stress conditions. Individuals suffering from severe nutritional deficiencies must be considered sick, require medical attention and should not be even considered as adequate subjects for research in the area of work. On the other hand, mild-moderate nutritional deficiencies affect large segments of populations who survive, in an "adapted" state, and function within their societies. We understand that research should be addressed towards understanding the functional repercussion of these nutritional states with the aim of proposing solutions which are understandable to the nutrition planner and policy maker who must consider the effectiveness of nutrition interventions in the allocation of restricted resources.

For our purposes, human work can be considered in three categories:

1) Energy demanding activities such as those in non-mechanized agriculture, construction, transportation, mining, etc.

2) Activities which are less energy demanding because of mechanization, and most often coupled to the rhythm of work of the machine, and

3) Minimum work sicuations.

With few exceptions, the first type of work is characteristic of poor socioeconomic groups of workers in developing countries where marginal nutrition states and chronic mild - moderate undernutrition are prevalent. The other two are more characteristic of industrialized populations where only exceptional nutritional deficiencies are observed and on the contrary, problems of overnutrition are more common.

Another point that is considered as a fact is that, under normal conditions, within various ecosystems where social function depends on energy intensive activities, populations tend to maintain energy equilibrium. In these populations, obesity is not a problem. Excessive weight from deposition of adipose tissue exists when the homeostatic mechanisms for maintaining energy equilibrium are disrupted; a very important factor in this regard is the replacement of work demanding physical activity by sedentary work.

The discussion that follows centers among populations engaged in the first category of work that belong to poor socioeconomic strata. In these groups, the relation between nutrition, work capacity and output has been explored primarily with regard

to energy intake and anemia.

Studies relating nutrition to performance of minimum work situations and activities coupled to mechanization will not be considered. Suffice it to say that there is adequate evidence to indicate that vitamin deficiencies and fasting (morning work without consumption of energy at breakfast) result in poor performance in tasks requiring attention, adequate visual perception, coordination of fine movements and performance of skilled tasks requiring little energy expenditure above maintenance.

In the evaluation of nutrition-work relationships data areas must be clearly defined. On the one hand, the nutrition variables must separate present nutrient intakes and bioavailability, which determine present nutritional status (steady or unsteady state), from previous nutritional condition. Having defined these situations, their interactions can be determined.

On the other hand, work capacity, physical fitness, physical activity, work performance and Gork output have precise meanings and reflect different variables. Work capacity in terms of physical output is greatly dependent on the subject's lean body mass, muscle mass and oxygen transport capacity. Adiposity may determine work capacity under famine or near famine conditions. Maximal oxygen consumption reflects this characteristic. Physical Fitness measures the individual's capacity to withstand various activity levels: again, the fitness to withstand short-term near-maximal activity demands has a different implication than fitness to withstand prolonged work periods at lower activity demands (endurance) although both are intimately related. Responses to dynamic measurements reflect fitness. Physical activity relates to the expenditure of energy at set periods of time (short-term or long-term) and may be related or not to actual work as part of "productivity" in the economic sense. Time-motion studies coupled to energy cost of activities and other measurements of energy expenditure (cummulative heart rate coupled to oxygen uptake/heart beat measurements or direct calorimetry) are indicators of energy expenditure. Work performance implies effectiveness of physical activity in producing a result, and/or work-time to spontaneous resting periods while performing an activity. This term implies also work-effort and output per unit time. Finally, Work output measures the results obtained in produce as outcome of work.

Furthermore, the relationships between nutrition and productivity are highly conditioned by psychological (motivation) and other inputs as indicated above.

Having these terms in mind, it is easily realized that many studies in the area of nutrition and productivity address themselves to specific variables and must be interpreted in light of the actual variables measured and can not easily be interpreted in or extrapolated into other terms.

Present knowledge in the relationship between iron deficiency and anemia, and work output.

The data available in this area seems consistent in showing:

a) That even mild anemia in humans and animals significantly reduces the physical fitness of the individual when measured as the capacity to perform near maximal exercise of short duration. Moreover, the decline in physical fitness is proportional to the degree of anemia and follows a near linear relation, and the heart rate for the same oxygen consumption increases also as anemia is more severe. Correction of anemia improves the physical fitness.

b) Animal studies indicate that iron deficiency impairs the utilization of energy substrates by muscle and results in a decreased capacity to perform maximal work even in the absence of anemia. This suggests that iron deficiency per se produces muscle dysfunction. This dysfunction reverts to normal in 4 days of iron administration.

c) In a study of a population in Indonesia, iron deficiency anemia also appears to reduce work output in rubber-tappers. Again, this effect is abolished by iron administration and correction of anemia. A confounding effect was observed by the fact that a control population who only increased the intake of green leaves, also improved hematologically and in work output, although less than the treated group. A monetary incentive was

given to both groups and apparently energy intake did not change substantially. Other workers have not been able to detect an effect on productivity because, apparently, other factors such as work intensity, skill and work organizational effects play a very significant role in productivity of certain populations.

d) Work performance, measured as output per unit time of activities requiring severe exertion is also impaired in subjects with anemia.

e) Whether iron deficiency and anemia can reduce work output because of greater morbidity among iron deficient populations is not yet clearly established.

In summary, a consistent inverse relationship between anemia and physical fitness has been demonstrated but there is controversy in the work-output issue. In the human, the effect of iron deficiency per se in the absence of anemia on physical fitness or on any other measurement related to physical work has not been established.

Present knowledge in the relationship between energy deficit and work output.

This relationship is very unclear still although several facts can be mentioned as well established:

a) Work capacity is definitely related to body size, lean body mass, muscle mass and cell residue (mostly reflecting body protein). On the other hand, energy deficiency in infancy and even in utero (maternal energy deficit) results in a reduction in

growth. This, in turn, can give rise to smaller adults.

b) Total circulating hemoglobin, which in the absence of anemia is directly related to lean body mass, also determines work capacity. This factor can be aggravated by anemia.

c) There are suggestions that present energy deficit does not decrease physical fitness in short-term activities but can adversely affect endurance.

d) Physical activity and energy expenditure over time appears to be related to energy intake, both in children and adults. This "adaptation" results in relative inactivity in children, thus limiting their social interaction and exploratory activity in their environment. Recent work also suggests that relative inactivity impairs the normal growth-rate potential of children during periods of rapid growth. In the adult, decreased physical activity can, theoretically, result in lower productivity and social interaction after work. However, a decrement of actual productivity in populations consuming marginal or even clearly inadequate amounts of energy (> 60% of requirements) has never been documented.

e) Work performance, measured as the percent of maximal aerobic power sustained at regular work, is reduced in cane cutters whose energy intake is sub-optimal. Also, work output per unit time is reduced. These variables are, at the same time, related to body size and lean body mass.

f) Work output is a very complex function and no definite and clear information on the effect of inadequate energy intake on productivity is available. Most populations whose energy intake is reduced at the time of observation either have had chronic energy deficit with its negative consequences on body composition or are being subjected to other situations which confound the interpretation of results. On the other hand, studies that have been performed on the effect of energy supplementation on work output have been few and are inconclusive because they have been of short duration or have been fraught by confounding effects. Among these are work organization patterns, social interactions and other environmental factors which alter productivity.

However, by reviewing the previously described interactions between energy intake and variables which are biologically determinant of productivity a high probability emerges that chronic energy deficit reduces productivity.

Another question is whether increased energy intake in population groups "adapted" to a certain pattern of life can result in greater productivity. Related to this question are others such as: how soon such an effect would be apparent? with how much of an energy increase? at what time and in what form? is it necessary throughout work cycles or only at times of greater energy demands? and is it economically sound and feasible on a self-sustaining basis? These questions omit considerations on

humane rights and quality of life independent of productive activities.

It would seem difficult to foresee along time an effect of correction of anemia on productivity in an energy deficient population except if a) the productive activity demands near maximal effort and, therefore, is performed in short bursts; b) iron deficiency and anemia increase the energy cost of the majority of activities performed throughout the day as well as the basal metabolic rate, so that the correction of anemia would reduce energy expenditure. The literature does contain data showing increased energy expenditure in anemic subjects but only at high work intensities where ventilation is markedly increased; c) there is a reduction in morbidity and a sense of well-being with the correction of the deficiency. The available data does not allow a conclusion on whether correction of anemia would result in increased productivity spontaneously; although it is suggestive. On the other hand, it may be that anemic and energy deficient populations do not respond adequately to increased energy availability because anemia can impose a limit to the higher energy demanding activities and/or could be accompanied by tiredness and elevated morbidity.

This interaction between energy and iron can apply to the majority of nutrients so that it may be very difficult in a field setting to demonstrate an effect of an intervention designed to correct a single deficient nutrient unless it is the only deficient

one or is much more deficient than the rest. This may be the case of iron deficiency and possibly of energy deficit in the case of populations engaged in heavy work.

Research needs, design and methodology.

Based on the previously described present knowledge, the relationship between nutrition and productivity is still very poorly defined and requires a systematic and standardized approach. This must consider biological as well as a combination of other variables in order to define the ecosystems (in its widest connotation) in which this relationship is being explored. The magnitude of the task, in order to provide quantitative and clear answers, is formidable if the conditions of the population investigated are not to be modified.

Alternative approaches to the problem must be, then, sought. The most logical ones are those of controlled interventions, however these are also very complex and to date there is no data which solidly supports the idea that productivity is enhanced only by nutrition interventions.

Two general alternative plans of intervention can be conceived:

1. One which involves a nutrition factor alone, and
2. One which involves nutrition within a more general development plan of population groups.

In spite of the fact that the second approach is more complex in

its performance. I favor it because the final interpretation of the data ought to be simpler and more applicable if the concept used is that nutrition is part of integrated development rather than a vertical action.

The general idea would be to promote development under as similar conditions as possible and include a nutritional component at one or different levels in the experimental communities while excluding it in control communities.

The conditions required to carry out such an intervention can be briefly outlined taking energy as a single nutritional variable in control and experimental communities:

a) Conditions of the subjects (adult men and women, and younger age groups engaged in productive activities):

1. They must belong to a homogeneous population in terms of physical parameters, morbidity, and developmental and social structures.
2. They must have similar dexterity in performing the work which leads to productivity measurements.
3. They must be free to work in a piecework payment system. Social and economic concepts must be considered in measuring the incentive to work and earn more.

b) Energy intake should be sub-optimal prior to any intervention, taking into account the type of work involved in productivity measurements.

c) Studies must be long term (greater than 5 months) and must take into account the conditioning factors which may influence the productivity of tasks requiring similar effort. In agricultural populations several agricultural cycles must be studied.

d) Control and experimental groups should have different energy intake as the only variable. Ideally all groups should consume food preparations differing only in energy content and the study should be done in a blind fashion.

e) Total energy intake should be carefully measured at repeated times to detect cyclical variations in intake.

f) Energy output measurements and changes in weight (ideally estimates of body composition) should be performed periodically, aiming at estimating energy balance at different times requiring varying intensity of work.

g) Careful measurements of other conditions and inputs which may influence productivity should be periodically performed considering, at the same time, their cost-effectiveness in terms of produce.

h) Various kinds of estimates related to work output should ideally be performed, including work effectiveness and outside of work activities.

In summary, research in the area of nutrition and productivity is extremely complex, requires a multidisciplinary approach, should be long term and, in my mind, should not be

isolated from other inputs leading to socio-economic development. Only so will the planner and policy maker have solid data on which rational decisions (rather than emotional ones) can be made. Simultaneously, biological data in the area of nutrition and productivity must be obtained in order to understand the mechanisms which are operating at the individual level.

APPENDIX II-4

Report of the Workshop on

Nutritional Status and Cognitive Functioning

and

Background Papers by

Henry Riciutti
Josef Brožek

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REPORT OF THE

WORKSHOP ON
NUTRITIONAL STATUS AND COGNITIVE FUNCTIONING
HELD OCTOBER 2-6, 1978, WASHINGTON, D.C.

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Appendix A: "Malnutrition and the Development of Intellectual Competencies: Research Issues and Priorities", by Henry Ricciuti	
Appendix B: "Energy Intake and Functional Competence--Cognition and Sensory Activities: Biological Aspects", by Josef Brožek.	
Appendix C: List of background readings suggested by participants.	

I. Introduction

A large part of the world's population does not have access to food in quantities sufficient to meet energy and protein requirements. The deficit in food intake, under these conditions, does not result in severe impairment of function or in death but may limit the individual's ability to adapt to his/her environment.

It is almost a self-evident question to ask: How is the ability to function as a member of society influenced by undernutrition?

This question includes a great many issues: (a) There are many forms of undernutrition; how do their effects differ? (b) Undernutrition affects the individual at different ages and in grossly different social, cultural and physical environments. Hence, the interrelations of nutritional and other factors are likely to be complex and variable in their effect on the individual's ability to function. (c) Functioning as an individual and as a member of society subsumes performance of many kinds, such as learning, working effectively, and developing satisfying relationships.

The interrelationships between nutrition and the capacity to function are diverse and complex. The goals of research should aim not only to identify associations among these variables but also to arrive at an understanding of the processes or mechanisms which produce aberrant performance. At both the descriptive and explanatory levels, the output of several disciplines, ranging from the neuro-biological and biochemical sciences to the psychological and social sciences, is needed to answer the questions. This is both a strength and a difficulty for research in this field: Multi-disciplinary perspectives and expertise

are needed for fruitful conceptualization and execution of research on the effects of undernutrition on the quality of human life.

This report is concerned with cognitive function of children and adults in the face of mild to moderate malnutrition. This type of malnutrition is chronic and affects all segments of the population. Moreover, it is likely to be intergenerational; malnourished children are likely to be the offspring of mothers who themselves were malnourished during childhood and through the child-bearing years.

Cognitive function as considered in this report includes memory, learning, problem solving, language acquisition and use, and abstract thinking. As applied to human development, it is useful to distinguish perceptually based abilities--speed and efficiency of information processing, immediate visual and auditory memory, cross-modal sensory integration--from higher-level cognitive processes that involve the production and utilization of verbal mediators or abstract reasoning abilities.

What are the implications of cognition with respect to other aspects of competency? A delay in the development of a particular cognitive process (be it attention span, communication skills, or reasoning) may have important implications for the ability of the individual to learn from his environment, to communicate with and socialize with others, and, in general, to profit from experiences encountered. Work performance and success at school are also dependent on cognitive skills.

II. Background

When nutritional deficits are severe and occur early in life, there are significant impairments present in physical growth and cognitive function. Although such effects have been clearly demonstrated under conditions of severe undernutrition, there is a paucity of information concerning the specific effects of mild-moderate malnutrition. This is true largely because until recently mortality among malnourished infants and children was high, and therefore attention was given primarily to methods of treatment of the severely ill. As treatment improved and survival rates increased, attention has shifted to the problems of those who suffer mild-moderate malnutrition.

The available evidence suggests that mild-moderate malnutrition interacts with socio-environmental factors. Thus, it has not been possible to determine the effects of undernutrition independently of the effects of adverse social and environmental conditions in which undernutrition occurs. That is, evidence of a direct causal relationship between mild-moderate undernutrition and impaired intellectual competence has not been established.

Most of the research evidence to date suggesting that mild-moderate malnutrition is associated with cognitive deficits is based upon animal studies and neurobiological evidence. Although one cannot extrapolate directly from such studies to the human condition, laboratory evidence provides the direction for investigation in human populations. Animal studies have involved both primates and lower species, particularly the laboratory rat. Primary learning deficits have not been demonstrated in primates which were mildly malnourished--however, these animals did demonstrate evidence of passivity, apathy, a shortened

attention span and a failure to habituate to repetitive stimuli, impairments which may secondarily impair learning. Lower species show a decreased tendency to explore, less curiosity, avoidance of new stimuli, failure to respond normally to social initiatives from other animals, increased nonpurposive behavior, increased excitability, emotionality and aggression. There are also disturbances in mother-child interactions. Cognitive studies are not consistent and vary with the experimental procedure. Animal studies of intergenerational, mild-moderate malnutrition have provided a model for studying conditions more closely resembling those of undernourished populations. Behavior in these animals is affected in a different way from that in animals malnourished for short periods of time. While dietary rehabilitation reverses growth retardation and morphologic lags in animals with intergenerational malnutrition, behavioral deviations including impaired cognition are not reversed and may require other types of intervention.

Neurobiological studies provide an additional base of evidence on the effects of undernutrition. A compilation of many studies can be summarized as follows:

(1) Chronic mild or severe undernutrition has little effect on the structure of an already formed brain but when applied to the developing brain, the consequences are severe.

(2) Severe undernutrition early in life results in decreased brain size, especially in the cortical region.

(3) The decrease in brain size is not as great as the decrease in the size of other organs and the whole body.

(4) In humans, neurons are formed in most cases before birth, and

therefore prenatal undernutrition is likely to reduce the number of neurons, while postnatal undernutrition reduces their size.

(5) Myelination is impaired by undernutrition.

(6) Recent work on the morphological development of synapses in undernourished rats demonstrates an altered profile of development of the pre- and post-synaptic membrane components that constitute the junctions between communicating elements in the brain.

III. Major Research Objectives

Three major areas are of high priority in research on interrelationships between chronic, mild-moderate undernutrition and cognitive function:

A. What are the ways in which biological and social-environmental factors act synergistically to alter cognitive function?

B. What aspects of intellectual competency are affected by undernutrition; by what mechanisms are these effects brought about?

C. How can adverse effects produced by the combined conditions of undernutrition and social-environmental disadvantage be prevented or ameliorated? We are concerned with the development of interventions appropriate to specific conditions of impairment and to specific populations.

Each of these research areas is elaborated upon in the following discussion.

A. Interrelations between nutritional and socio-environmental influences on intellectual function

One of the major problems to which future research should be directed is the question of how mild-moderate malnutrition and socio-cultural, economic, and other environmental influences combine in affecting

mental development and cognitive capacity. One important aspect of this question is whether the consequences of mild - moderate malnutrition and of improved nutritional status due to supplementation vary as a function of the individual's social and physical environment. Recent research on severe malnutrition suggests, for example, that its effects are greater in an unfavorable environment than in a supportive environment.

Other examples of important interrelationships between malnutrition and environment are a) evidence that the infant's or young child's altered nutritional status, as reflected in physical appearance and behavior, affects the manner in which primary caregivers respond to the child, b) the quality of child care and child rearing is affected by the parents' nutritional history and present nutritional status.

While the examples of interaction mentioned thus far have tended to focus on factors influencing the development of children, the same issues must be addressed in adults.

Future research should emphasize the interrelationships between nutritional and socio-environmental influences and cognitive competencies and mental development. Since malnutrition and adverse socio-environmental circumstances typically occur together in populations at risk, there is a great deal more to be gained by increased understanding of their combined effects.

Fruitful investigations will require that systematic attention be given to more refined assessments of nutritional status (see Section III) and to the development of more comprehensive and precise assessments of the social and physical environment, particularly with regard

to home and family. In this connection, while simple demographic indices such as family size, parental education and income, type of housing, etc. are important, we need to go beyond such indices to the assessment of the family's capacity to nurture and provide environments which are supportive of both physical growth and psychological development. Conceptual frameworks to guide research planning in this area, as well as methodological guidelines and strategies, are available in the child development literature. It should be mentioned, also, that research dealing with these issues needs to be particularly sensitive to the role of culturally determined child rearing and feeding practices and values. Basic aspects of child care practices should be identified from a cross-cultural perspective. An attempt should be made to identify essential environmental and caretaking factors which promote optimal growth and development.

In addition to dealing with the intra-familial environment, it is also important to assess variations in the coping strengths and strategies employed by families in dealing with the adverse conditions of the larger social, economic, and physical environments in which they live. It should also be remembered that these coping strategies may themselves be affected by the nutritional history and present nutritional status of the family as a whole.

B. Aspects of cognition likely to be affected by changes in nutritional status

In research on undernourished children, cognitive assessments have tended to be global, composite measures using the IQ mode. However, it is now evident that such assessments are likely to add relatively

little new information on nutrition-behavior relations, and are not likely to provide insight into the mechanisms by which nutrition and cognitive function are related. Measures of specific cognitive processes offer a better chance of obtaining useful data.

In specifying cognitive processes that have special relevance to the malnourished organism, it should be recognized that cognitive processes cannot be isolated from other factors that influence behavior. Cognition subsumes a range of specific processes, all of which involve the organism's utilization of sensory information, but not all of which have identical determinants or are closely interrelated. From past research on malnourished animals and children, a number of cognition-related behaviors appear to be of significance: (a) the organism's ability to mobilize and maintain attention, (b) memory, both the acquisition phase and the retention phase; (c) the organism's exploring and information-seeking behavior; and (d) the organism's over- or underreaction to stimuli. It is apparent that in each of the above behaviors, motivational or affective variables (e.g. apathy, emotional lability, etc.) are variously involved.

Some of the questions related to cognitive function that are relevant to malnutrition are developmental in nature; others concern the same physiological processes throughout the life span. Two important developmental areas are (a) the child's acquisition of language, and (b) the child's progression through "stages" in the structure of thought (following the Piagetian model). For an approach to universal underlying processes over the life span, the information processing paradigm provides a useful organization of functions

from acquisition to utilization of cognitive information.

One of the more useful approaches to the study of cognition may be found among contemporary theories of information processing. Some of these theories focus on the different stages of information processing from input to output. That is, they identify and analyze separately the different processes and structural features involved in the attention to, encoding and decoding of information.

The information processing approach is guided by a large body of literature. This literature is both theoretical and empirical in nature. In connection with the latter significant advancements have been made, for example, in the understanding of cognitive derangements found in mental retardation. A cognitive processing approach has helped identify specific attention-memory deficits among mental retardates with organic impairment.

In nutrition and behavior research, a cognitive processing approach has been used successfully in the detection of intellectual deficits in iron deficiency. In this study the research design made it possible to localize the stages of information processing most vulnerable in sideropenia. In addition to defining and providing means for determining both the separate and combined effects of each process, the theory distinguishes between "structural features" and "control processes". Structural limitation determines how much information is processed and how much information is stored.

Control processes are modifiable and under the individual's direct control; they determine how a particular set of data will be processed at a given time. For example, regardless of the size of a memory

system, an invividual may or may not remember the information presented, depending on whether or not he pays attention to what he sees and whether or not he rehearses the information in memory. Both the capacity for processing information and the choice of processing strategy will determine what is learned. Thus, although both structural deficits and processing deficits can lead to behavioral deficits, differentiating between these two aspects is most important if the aim is to disentangle the exact nature of the cognitive impairment and its relationship to mild-moderate undernutrition.

Other processes underlying intellectual performance must also be considered in evaluating the effects of malnutrition:

(1) Sensory ability--including sensory acuity, inter-sensory integration, and taste preferences.

(2) Psychomotor function--including speed of response, activity level, and motor coordination.

(3) Temperament--apathy vs. striving, emotional lability, aggressiveness, impulse control, attitudes, self-expectations, and responses to stress.

Some standard tests are available for measuring cognitive function. However, most techniques used to measure cognition are not standard in the usual sense. Measures must be modified to take into consideration the age of the individual, the culture of the individual, field conditions, and so on. The conceptual and methodological principles that underly the development of these measures are standard.

Because behavior is an evolving process in which functions mature and change, the individual accumulates experience and thereby arrives at different ways of interacting with his environment. In many cases, serial measurements provide more important answers to the relation between behavior and nutritional status than do measurements obtained at a single point in time.

C. Reversal of cognitive deficits

The ultimate goal of research in this area is to prevent or reverse impairments of cognitive function that may be caused by mild - moderate undernutrition. Large scale intervention programs without a sound research base and strategy should not be undertaken. Sufficient information must first be gathered to establish the appropriateness of the particular intervention selected. If adequate resources were available, the problem could be readily solved by improvements in existing economic, social and physical conditions. Since this is not the case, it is especially important that the available resources be directed toward the problems of those sectors of the population at highest risk and toward those problems for which the solutions have the greatest potential for improving the quality of life.

Utilization of intervention strategies represents one of the most potent research approaches in this field. The treatment of individuals with malnutrition represents a basic and widely used form of intervention, which should be more fully integrated into systematic behavioral research. It is encouraging to note that in the past few years there has been an increasing utilization of nutritional intervention as a research strategy, particularly in connection with

efforts to prevent malnutrition in populations where the problem is a chronic and endemic one. Because such studies are carried out within a longitudinal, prospective framework, they provide the opportunity to document changes in cognitive function as related to changes in nutritional status. This contrasts with the situation characterizing retrospective studies of malnourished individuals in which the systematic study of relationships between nutritional status and cognition cannot be done.

Tailoring the modes of intervention to the specific needs of the population will strengthen the study design. The same mode of intervention is likely to yield different results when applied to different populations having the same prevalence of malnutrition. The long-term benefits of intervention may overshadow an initial high cost.

An important by-product likely to result from the intervention strategy is that it will also serve as a demonstration project to interested governments and agencies. Most important, such programs represent the most ethical form of work with economically deprived populations, as long as all possible side effects of the intervention have been considered and evaluated.

IV. Indicators of Nutritional Status

Nutritional status is determined not only by nutrient intake but also by other factors, such as physical activity, heredity and illness. Thus, the capacity of any system that is responsive to changes in nutriture will depend on all of these factors; cognitive function is no exception. Although nutritional status is not the consequence of nutrient intake alone, it is nevertheless important to obtain information

about food intake that is as accurate as possible. Both nutritional status and current food and nutrient intake affect performance on tests of cognitive function.

While individual nutrient intake is measurable with precision in a metabolic ward--over a period of days or, very rarely, of months--it is not measurable at present in free-living populations. The common dietary methods currently employed utilize interviewing techniques for recall of food consumed over the past day or several days, or of habitual use of individual foods or food classes; or require individuals to record their own or others' weighed or measured food intake. Household food consumption is often assessed by inventory techniques. Even in the hands of skilled investigators these methods lack reliability and validity: memory is faulty, the ability to estimate serving size varies, communications barriers exist, the process of recording food intake alters food intake (kind and amount), days sampled may be unrepresentative, etc. Accurate information on individual food intake is desperately needed if the contributions of various factors to growth and body state and to functional competency are ever to be unraveled. Research in this area commands high priority.

In the interim, field studies should garner as much information on food intake (and food composition) as is feasible, at minimum repeated one-day intakes over time and across seasons. With good methodology the coefficient of variation within age/sex categories will be on the order of 20% and this should be taken into account in research design. It is important in doing this to estimate as closely as possible the

severity of deficit of energy intake, the duration of any deficits and when they occurred during the life cycle.

Different individuals (and different populations) can maintain energy balance, reflected in stable body weight, on dramatically different levels of energy intake. Therefore, nutritional state cannot be estimated from information on energy intake alone. It is energy balance, not intake per se, that is critical for growth of children and maintenance of body weight and appropriate amounts of soft tissues (adipose tissue, muscle and viscera) in adults and children.

Measurements that reflect output and other factors, as well as energy intake, are essential for evaluation of nutritional status. Operationally, various indirect measures of nutritional state are used together with measurement of nutritional intake.

Anthropometric (morphological and compositional) measures

While anthropometric measures are simple, to make their interpretation is complex. In spite of this, body morphology and composition have served and will serve as the best presently identified indicators of nutritional state. In adults, height and weight are the best indicators of past and present state, respectively. In children, height measures are of value only if age is known accurately but relative weight for height is a useful indicator irrespective of age.

Where needed the contribution of specific tissue (adipose tissue, musculature) may be determined using approximative methods (skinfolds, limb circumferences) or by a variety of more complex methods for the measurement of such components as total body fat or extracellular fluid.

In children we are also concerned with the retardation of skeletal growth, measured in terms of relative height for age and sex. The relevance of measuring head circumference, in addition to linear growth or stature, needs to be further examined.

"Undernutrition-overnutrition" are continuous variables, a gradient of energy balances producing a gradient of physical states. Relative weight and relative height are derived from normal values arbitrarily scored as "100" and values for individuals are expressed as percentiles. The specification of cut-off points separating "normal" from mildly/moderately/severely undernourished and growth-retarded individuals has been a matter of judgment. The crucial issue is the relation of the degree of malnutrition in ambulatory populations to the degree of impaired function.

Other potentially useful indicators of nutritional state

There are no proven reliable indicators of past or contemporary energy intakes (and none of the state of body energy balance other than the morphologic and compositional measurements noted above). However, adaptation to chronically low intakes is effected by physiological mechanisms and behavioral characteristics. Identification of these offers some prospect for development of other, perhaps more reliable and sensitive indices.

Metabolic state

Laboratory studies in man and animals show that basal metabolic rate (BMR) falls with a decrease in food energy intake. The decline occurs early, even in the case of mild energy restriction (-15%), and BMR does

not return to pre-restriction levels unless intake increases. The decrease with mild restriction results in BMR levels in the lower range of normal values, so BMR may not be a valid index in individuals but may well be for populations. However, when the individual is chronically underfed and has reached the limit of behavioral adjustment, BMR may be depressed to an even greater extent. There is reasonable evidence to indicate that body core temperature (and possibly skin temperature) is also lowered under these conditions. These possibilities need to be explored as indicators of nutritional state and deserve priority attention.

One study of chronically underfed Indian men showed that the respiratory quotient (RQ) changed from the low value, ~ 0.75, obtained under basal conditions, to an exceptionally high value, > 0.95, within minutes of feeding a mixed meal. This suggests that an energy load is handled differently by underfed than by well-fed subjects. If this difference in post-prandial RQ proved to be consistent, it would suggest possible leads to more refined metabolic/biochemical measures.

Biochemical measurements

The adaptability of the body is such that, during periods of moderate nutritional deficit, biochemical changes (which are known to serve as indicators of severe malnutrition or undernutrition) are unlikely to occur. Furthermore, we are not concerned with transient variations in the nature of the metabolic pools, but with stable measures. Nevertheless, from metabolic studies on malnourished animals and from studies of human subjects who have been moderately depleted of some of the water soluble vitamins, there is evidence that the capacity to metabolize

a load of a nutrient may be impaired, even though no metabolic abnormality may be detected in the absence of a load. Investigation of the capacity of individuals considered to be mildly to moderately malnourished to metabolize loads of certain nutrients or non-nutrient substances may help to establish the relative degree of malnutrition and to identify the degree of recovery from prior malnutrition.

In investigations of mild to moderate malnutrition or undernutrition, there may be reason to suspect complications, e.g. from knowledge of composition of the food consumed, from the occurrence of specific deficiency diseases. Specific biochemical tests have been developed for detection of many of these and should be used where there is sufficient evidence to support such a hypothesis. The possibility of development of new, more sensitive biochemical methods for detection of less than severe malnutrition should also be explored.

Diet and Neurotransmitter Changes

Evidence from animal studies indicates that blood amino acid patterns and concentrations can be influenced for several hours after a meal by the amino acid composition of the foods consumed. Changes in the blood concentrations of amino acids that are precursors of neurotransmitters and changes in blood concentrations of amino acids that compete with the precursors of neurotransmitters for uptake into the brain can lead to changes in brain neurotransmitter concentrations. The relationship between brain neurotransmitter concentrations and behavioral responses is undoubtedly complex and remains to be established. Nevertheless, measurements of blood amino acid concentrations may be

done during metabolic studies of the effects of diets which cause moderate malnutrition. These may serve as indicators of conditions that will result in changes in the concentrations of brain amino acids, some of which may be precursors of neurotransmitters.

Sensory/Hedonic Changes

Animal experiments show that chronic food deprivation and acute hunger produce:

(a) Significant changes in activity in chemoreceptors that respond to food stimuli throughout the oral and gastrointestinal tract, and in the brain.

(b) Significant changes in nutritionally relevant physiological processes, including salivation, gastric acid secretion and blood glucose.

(c) Behavioral changes to specific food stimuli, including discrimination, preference, and choice.

The taste changes are usually for sweet stimuli, and olfactory shifts are limited to food stimuli alone. Two studies in man show (a) shifts in sweet preference in insulin-induced hunger, and (b) shifts in sensitivity for sweet and sour stimuli in chronically deprived Indian laborers.

Since these phenomena consistently accompany chronic and acute food deprivation, they might be used as indicators of "mild malnutrition", to be correlated with the other measures listed here as part of the battery of measures of nutritional status. Culture-free psychological testing procedures would be needed to scale sensory and hedonic

intensity for simple taste stimuli (sweet, sour, bitter, salty) and for food-related olfactory stimuli selected from the diets of the target group.

Food attitude changes

In addition to the biologically based changes in taste and olfaction outlined above, chronic "mild" malnutrition can produce changes in food attitudes in the individual-family nexus within a particular culture. Experimental food deprivation in man and historical discussion of national famines clearly show qualitative shifts in food preferences, cooking styles and general attitudes toward food. These phenomena should be clearly documented and analyzed in the target groups used in this program, using observation, questionnaire and interviewing techniques appropriate to the particular cuisine and culture. This will be especially important in those studies focusing on the interaction between malnutrition and sociocultural environment.

A Methodologic Note

Food intake over time determines nutritional state but there are also immediate effects of food ingestion that need to be taken account of, especially in testing cognitive and sensorimotor functions. The nature and amount of food eaten in the past several hours needs to be known to control for effects, for example, of caffeine or of fasting.

V. Research Design

The choice of appropriate research designs cannot be separated from the specific objectives of the research, the abilities and experience of the investigators, the setting of the research and the specificity of the variables to be measured, including the availability of measures of them. Other parts of this document discuss most of these crucial elements in the area of mild-moderate malnutrition and its association with cognitive and intellectual functions.

What may be most important in assessing or suggesting appropriate research designs for the objectives contained here are the problems in specifying and measuring the variables (i.e. cognitive function and the social, environmental and experiential factors that interact with them.) Previous studies appear to have been deficient in choice and measurement of these variables. There are, however, theories and bodies of knowledge that should lead to improvement. It is important that test instruments be carefully standardized in each culture in which they are used. Also, in order to develop community-specific definitions of the socio-experiential factors, a detailed investigation of the community is essential.

Pilot Studies

The minimal requirement for community selection is that the population contain individuals who show evidence of marginal malnutrition. These mildly to moderately malnourished individuals would then be compared to well-nourished subjects in small scale case-control studies. The purpose of these studies would be to develop measures sensitive to

deficits in cognitive function associated with mild-moderate malnutrition. The case-control studies should also include measures of the environmental and social factors hypothesized to interact in influencing nutritional status and/or cognitive functioning.

This stage of research involves the testing of research instruments and is primarily exploratory. However, findings in this initial study would determine what factors, nutritional or social, should be studied further. Both their independent effects and the interrelationships would be important in interpreting the results and in designing subsequent studies. Appropriate designs that would focus on the most important variables include longitudinal cohort studies and intervention studies.

Cohort Studies

Cohort studies of small, selected groups of people followed over a period of time would provide information on the "natural history" of cognitive functioning in the groups selected. The cohorts should be representative groups and include sufficient numbers of individuals known to be malnourished and known to vary in the socio-environmental variables of concern--sufficient to analyze the data. Such groups might be newborns, children approaching puberty, pregnant women and their families. The period of time necessary to follow them would depend upon the group chosen and the specific objectives of the research.

Intervention Studies

Intervention studies that focus on individuals, and on groups that are well-defined in terms of the independent variables are valuable,

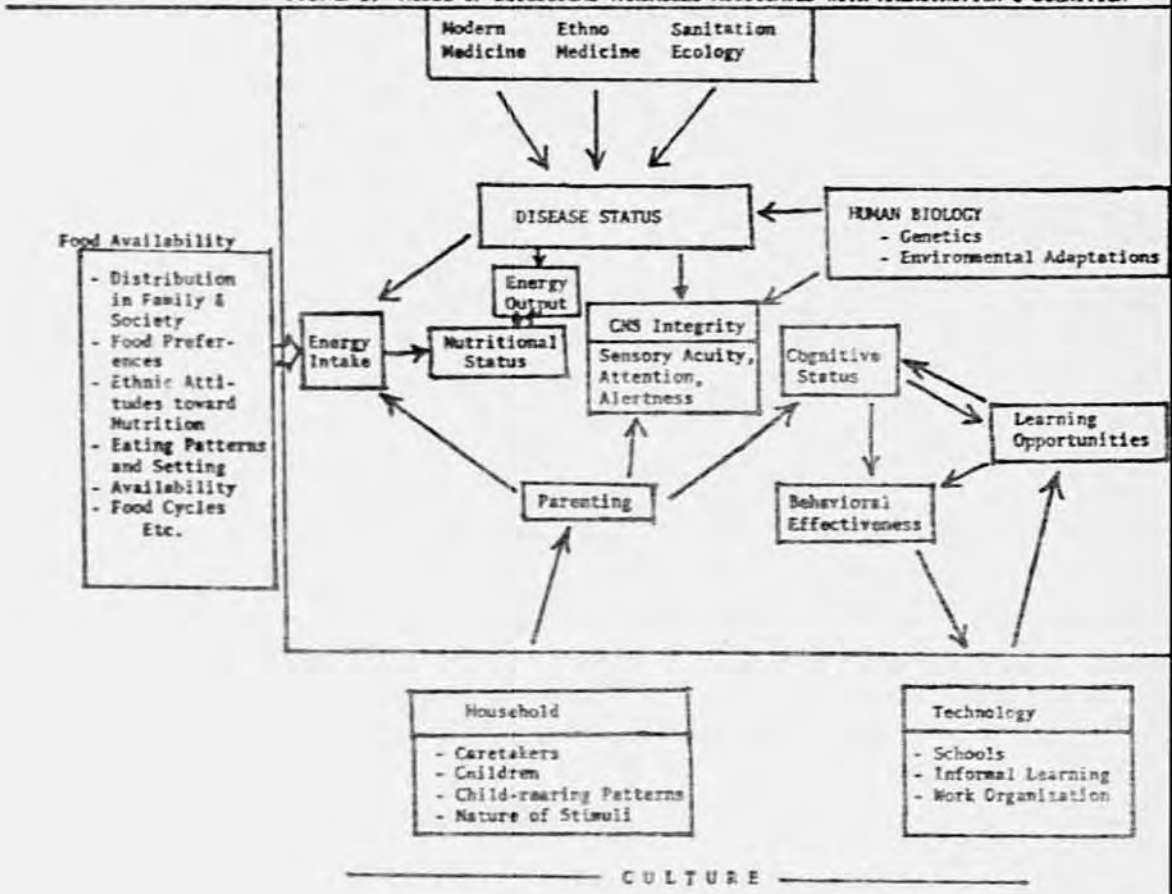
in fact essential, in some research areas. Some problems associated with intervention studies are particularly pertinent to the objectives of assessing the interactions between malnutrition, experiential factors and cognitive function. These problems include the difficulty in assessing whether or not the intervention hit its target and in assessing unintended effects of intervention. A matched pair design may obviate some difficulties but the specific design will depend greatly upon the research site, the community's cooperation and the ethical implications of the intervention procedure (see also Section III C).

Systems Analysis

A systems analysis can be used to conceptualize relationships between nutritional status and cognition, and to identify confounding variables. The use of a systems analysis can be better explained in terms of its broad implications: Systems analysis permits hypotheses to be generated in order to determine how, where and why community intervention is needed. Components of the system are derived from data, experience, and observation of potsible interrelationships as presented in a "systems map" (see Figure 1). By observing these interrelationships in the system studied it may be possible to determine where intervention is appropriate.

The systems model (Figure 1) provides a rationale and guidelines for collaborative interdisciplinary research. For example, in mildly malnourished populations religious fasting, food preference, food distribution in family and society, and seasonal food cycles may place developing individuals at greater risk at certain times of the year.

FIGURE 1: MODEL OF ECOLOGICAL VARIABLES ASSOCIATED WITH MALNUTRITION & COGNITION



Here formal collaboration between the nutritionist, psychologist and anthropologist may provide the best approach to identifying the significant variables.

VI. Ethical Issues

Ethical issues include the conscience of the investigator, the ethical standards of the scientific and medical community, and the ethical standards of the granting agencies. There are also social and political concerns and considerations. Many ethical issues arise from the type of research and the kinds of measurement to be made.

Any research undertaken as part of the program must meet at minimum ethical standards specified by scientific and professional societies and the governments concerned.

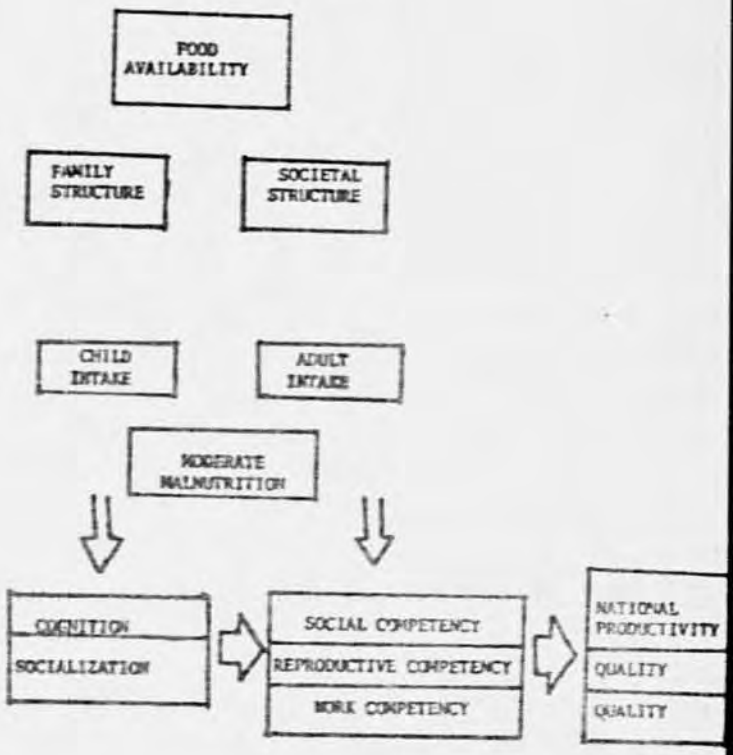
VII. Summary

This report presents the results of a workshop on the relation between moderate malnutrition and behavioral competence, with special emphasis on the chronic deprivation of food in general, the major shortage occurring in calories, the effect of this on cognition and an evaluation of the role of sociocultural factors in this relationship.

Figure 2 is a flow chart summarizing the input-output relationships in a prototypical model of a country where moderate malnutrition is endemic.

Although agricultural and economic conditions set the amount of food available to a particular community, the structure of local society and the family determines the actual proportions that are eaten

FIGURE 2
INPUT-OUTPUT
MODEL OF RESEARCH MILIEU



by adult family members, sold or bartered, fed to animals, or to children.

Continuing in Figure 2, moderate malnutrition, caused by limitation of food intake, can influence the child by modifying cognition and the socialization pattern so critical in adaptation to family and societal structure, and in the adult by influencing his social, reproductive, and work competence, all so critical to his contribution to national productivity. Note that these factors are major topics for other workshops in this series. Although this workshop recognized the importance of the behavioral competence of the adult in national productivity, as shown in this figure, it is this division of labor among the various workshops that led to our emphasis on the child in this report.

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COGNITIVE AND SENSORY DEVELOPMENT
October 2-6, 1978
Washington, D.C.

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MALNUTRITION AND THE DEVELOPMENT OF INTELLECTUAL COMPETENCIES: RESEARCH ISSUES AND PRIORITIES[1]

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This paper is intended to provide a background framework to facilitate discussion at the forthcoming USAID-UCal Research Planning Workshop dealing with malnutrition and cognitive development. The paper will be concerned primarily with a statement of research needs and priorities based on the extensive body of research literature which has accumulated in the past 10 to 15 years, and our present understanding of the complex relationships between malnutrition and behavioral development, with particular reference to intellectual or cognitive competencies.

Since a number of very recent, extensive reviews of the literature in this area are available (1-6), it did not seem necessary to incorporate a comprehensive literature review in the present paper. A brief summary of our present state of knowledge will be presented at the outset, however, and appropriate literature will be referred to in the discussion of particular research issues.

[1]A background paper prepared for USAID-Univ. of California Research Planning Workshop: Washington, D.C., Oct. 2 - 6, 1978. The writer acknowledges with appreciation the assistance of Mary A. Crawford in critical review of very recent literature.

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Brief summary of present knowledge

The most common nutritional problem occurring in children in poor populations in developing countries is protein-calorie malnutrition (PCM), more recently referred to under the general rubric of energy and protein deficits. This condition may vary considerably in age of onset, severity, and duration, as well as in the specific nature of the nutritional deficit. While early and severe malnutrition requiring hospitalization occurs with considerable frequency in these poor populations (up to 20%), the most widespread type of malnutrition is that of mild-to-moderate, chronic undernutrition which is most readily noted in some retardation of physical growth and development. Protein-calorie malnutrition tends to occur in poor families living under the generally adverse socio-economic and environmental circumstances associated with poverty, including inadequate health care, poor housing and sanitary conditions, exposure to disease, limited educational and occupational opportunities, etc.

It is generally well known that PCM may lead to substantial impairment of physical growth, including altered brain development, particularly if the nutritional deficits are early, severe, and long lasting. It has also been apparent for some time that children having experienced PCM tend to show reduced levels of intellectual development and school performance. However, a substantial body of research during the past ten years or so has shown that it is extremely difficult, if not impossible, to evaluate the independent effect of malnutrition as such on mental development, apart from the influence of various adverse social and environmental conditions typically associated with malnutrition, and capable of having a substantial impact on children's intellectual development in their own right (4,6). There has been a tendency, therefore, to move away from the assumption of

a direct, causal relationship between early malnutrition, altered brain development, and impaired intellectual functioning or mental retardation. Rather, there is increasing acceptance of the view that malnutrition may well be implicated in important ways as one of the contributing factors leading to sub-optimal or impaired mental development, particularly in the case of early, severe, and long-lasting malnutrition, but we don't yet fully understand its role or the mechanisms through which it may adversely affect psychological development. Moreover, the possible effects of mild-to-moderate, chronic undernutrition on intellectual development are even less clear.

Much recent research reflects a growing concern with understanding how malnutrition and various aspects of the child's social environment may interact in combination to jointly influence psychological development. It has been shown, for example, that within very poor populations at risk of early malnutrition, variations in particular features of the child's home and family environment may substantially increase or reduce the likelihood of severe malnutrition occurring in a given family (6). At the same time, a developmentally supportive and facilitative home environment may substantially attenuate or prevent the potentially unfavorable consequences of even severe malnutrition (2,6).

Additional evidence of important interactions between the child's nutritional status and aspects of his social environment and early experience can be found in several recent nutritional supplementation studies. Thus far, there appears for the most part to be relatively little evidence that the provision of nutritional supplementation for children exposed to moderate to mild malnutrition can substantially enhance their intellectual development. However, in several instances where modest positive effects of supplementation

are suggested, they appear to be tied closely to social and environmental influences. In a rural Guatemalan study of nutritional supplementation beginning in pregnancy, for example, slightly improved cognitive test scores at three years of age were found in highly supplemented children, but only if they came from the most adverse home environments (7). An intervention study with urban poor families in Bogota, indicated slight improvements in developmental test scores during the first eighteen months of life for children who received either nutritional supplementation or home visits to promote maternal encouragement of the child's intellectual development. However, somewhat more favorable gains were found for children in families provided with a combination of both nutritional supplementation and the home visiting program (8).

One of the major themes emanating from the illustrative studies just mentioned and other recent research is the continuing necessity of our recognition of the fact that the behavioral consequences of malnutrition, or of improvements in nutritional status provided by supplementation, cannot adequately be assessed or understood without careful and detailed consideration of the concurrent, sometimes synergistic effects of related social or environmental influences.

Research priorities and strategies

As already indicated, there is a large body of literature indicating that malnutrition is typically associated with reduced levels of intellectual functioning. There would certainly be very little to be gained by additional studies which again showed that malnourished children perform less well on various intellectual tests than adequately nourished children from the same general population, or even from families with the same educational background. Generally speaking, what is needed at present is a

much sharper delineation and analysis of these relationships, with more precise assessments of nutritional status as well as behavioral outcomes, a fuller understanding of how malnutrition and other environmental influences interact in combination to influence development, and a more complete understanding of the mechanisms through which altered nutritional status may affect psychological development and behavior. Such research would not only substantially enhance our understanding of the basic scientific issues involved, but at the same time provide a sounder knowledge base on which to build systematic and effective programs of prevention and remediation.

In the paragraphs which follow, research needs and issues which seem to this reviewer to be of particularly high priority will be discussed under the following general headings:

1) Research concerned with a fuller understanding of ways in which malnutrition and other aspects of the social and biological environment interact in combination as potential determinants of mental development;
2) Research directed at identification of the mechanisms or channels of influence through which variations in nutritional status may affect the course of [illegible] development and cognitive functioning;
3) Research concerned with the effectiveness of various forms of experimental interventions, including health care, nutritional supplementation, enrichment of the child's social and learning environment, supportive services to families, etc.

For each of these three broad areas, a number of more specific research objectives and problems will be discussed, and suggested research strategies for reaching these objectives will be briefly outlined.

1. Analyses of patterns of interaction between malnutrition and socio-environmental influences

As mentioned in the initial summary, in recent years there has been an increased recognition of the significant role played by various social and environmental conditions typically associated with malnutrition in shaping the course of psychological development in children. Various research and analytic strategies have been employed in an effort to evaluate the relationship between nutritional status and intellectual competencies, independent of these socio-environmental influences associated both with malnutrition and behavioral outcomes. These efforts have sometimes taken the form of comparing the performance of malnourished and better nourished children from the same neighborhoods or general socio-economic levels. Such a strategy, however, does not take into account the likelihood that these poor families whose children are better-nourished may also be living under less adverse socio-economic circumstances than the experimental families, and may be providing a social and learning environment which is more facilitative of their children's intellectual development (9). Other investigators have employed somewhat more refined but still relatively simple indices of variations in family and home environment (type of housing, income, education of parent) and incorporated them in partial correlation or regression analyses aimed at determining how much of the variance in cognitive performance can be accounted for by nutritional status alone, by socio-environmental variations alone, and by the two combined (10,11).

From this reviewer's perspective, these kinds of analyses are heuristically useful up to a point, but they are of rather limited value in advancing our understanding of the interactive influences of nutritional and socio-environmental variations on intellectual development. First, the

indices of nutritional status and of the family and home environment are typically quite simplistic and hence may be capturing only a small portion of the developmentally relevant variations in each domain. Moreover, obtained estimates of the independent contribution of nutritional versus socio-environmental factors will vary greatly depending on various characteristics of the samples employed (such as age, homogeneity or heterogeneity with respect to environmental and nutritional variation), and also depending on the particular outcome measures outlined (6). Most studies employing this analytic approach typically find that simple indices of nutritional status (ht., wt., h.c.) and of socio-economic background are positively correlated (r's in the .20's to .30's), with correlations of about the same order of magnitude being found between each of these predictors and measures of intellectual competence. Regression analyses tend to show that both social factors and nutritional history make some independent contribution to intellectual competence, with the percentages of variance presumably attributable to each source of influence varying substantially from study to study (e.g., 29% for social factors versus 5% for severe early malnutrition in a study of 6 to 10 year old Jamaican boys (12); 18% versus 32% in a study of 6 to 30 month old Colombian children (11).

At this point in time, there would appear to be little to be gained by further studies concerned primarily with the question of how much of the variation in intellectual competence can be attributed to nutritional status alone or to socio-environmental factors alone. Rather, we need to go beyond such analytic strategies and systematically direct our research at increased understanding of how malnutrition and the child's social environment interact in jointly influencing the development of intellectual competencies, employing more refined measures of nutritional status, as well as more precise

and detailed analyses of relevant features of the social and physical environment in the home, neighborhood, or community.

The potential value of this line of approach is strongly suggested by several recent studies indicating that within very poor populations where children are known to be generally at risk of early malnutrition, variations in particular features of the child's home and family environment may either increase or reduce substantially the likelihood of severe malnutrition occurring in specific families (13,14). It is important to note also, that these features of the child's social environment associated with the occurrence of malnutrition include environmental influences which can have a substantial direct effect on the child's mental development (e.g., mother's competence, degree to which child care practices provide nurturance and support for psychological development). For example, in a longitudinal study of several hundred infants born in a poor rural Mexican village (13), those children who experienced severe malnutrition in the first three years of life were found to have lower IQ's than controls at five years of age, and tended to come from homes which, as early as the first year of life, were observed to be lower in the quantity and quality of social, emotional, and cognitive stimulation provided to the child. Moreover, these same features of the early home environment were also related to IQ at five years of age among children without a history of severe malnutrition.

In the present context, it is particularly important to note that once a child has suffered from early malnutrition, even of the severe type, the risk of subsequent impairment of mental development will also depend very much on the quality of the child's home and family environment. On the basis of both human and animal studies, it has become increasingly apparent that a developmentally facilitative social environment may

substantially attenuate or even prevent the potentially unfavorable consequences of early, severe malnutrition (12,15,16,17).

The studies just summarized clearly emphasize the importance of our directing more systematic attention toward more precise evaluations of those aspects of the family environment or family functioning which make some families less vulnerable to the occurrence of severe malnutrition than others in the same "at risk" population, and also more capable of "buffering" or attenuating the potentially adverse behavioral effects of malnutrition when it does occur. The approach suggested here involves going beyond the well known demographic indicators of increased bio-social stress and risk such as maternal age or health history, family size, parental education, income, exposure to infectious or parasitic disease, accessibility of health care, etc. What is needed is a more refined analysis of the coping strengths and strategies used by families as well as their capacity to provide developmentally facilitative child care or child rearing environments which are supportive of both physical growth and psychological development, in the face of generally adverse socio-environmental circumstances. The identification of these intra-familial strengths or vulnerabilities should certainly enhance significantly our basic understanding of important interactions between nutritional and socio-environmental influences on growth and development. At the same time, from the perspective of prevention and remediation, this added knowledge should provide helpful guidelines or avenues of approach in the development of effective programs of intervention and support for families coping with adversity.

Another example of important inter-relationships between malnutrition and salient aspects of the child's social environment or early experience is reflected in the growing evidence that the infant or young child's altered

nutritional status, as reflected in physical appearance and behavior, may affect the manner in which primary caregivers respond to or care for the child, thus potentially altering his early experience in developmentally significant ways [18,19]. Further systematic investigation of these interrelationships should shed additional light on the question of why some children in a given family are severely malnourished while siblings are spared. As our knowledge concerning these developmentally significant patterns of child care and parent-child relationships expands, we should better be able to plan effective preventive or remedial approaches to families where the risk of malnutrition is particularly high.

While the emphasis in the discussion thus far has been upon the interaction of malnutrition and social factors in the child's experience and environment, it would similarly be very important to examine more carefully the manner in which malnutrition of various types and degrees of severity might combine with other biological risk factors, such as low birth weight, prematurity, congenital or genetic anomalies, etc., adversely affecting the development of intellectual competencies.

Suggested Research Strategies

Severe malnutrition

One of the best strategies here would be to conduct prospective studies of children who develop severe malnutrition during the first two to three years of life, and whose course of treatment and recovery can be well documented. Careful study of these families, including detailed analyses of patterns of child care and parent-child interaction, and a comparison with families having similar demographic characteristics but with relatively better nourished children, should provide data relevant to the question of

why some families are more vulnerable to malnutrition than others confronting essentially similar adverse circumstances of living. Studies of this sort should also shed additional light on the matter of why some children experience severe malnutrition while their siblings do not.

During recovery and follow-up, a comparison of behavioral assessments of intellectual development and cognitive competencies in the two groups would provide data pertinent to the question of the impact of malnutrition on cognitive development, with the analyses taking into account differences between the two groups, as well as variations within each group in those aspects of the home and family environment likely to be related to the development outcomes under study. The most important analytic questions here would deal with the issue of whether variations in the consequences of malnutrition observed during several years follow-up can be related to the quality of the family environments of these children.

In some settings, prospective studies of the sort just discussed could also deal with the effect of age of onset, severity, duration, and course of treatment and recovery. Such information might be available in situations where families at risk of severe malnutrition make periodic use of health centers where growth records are kept.

Mild-to-moderate malnutrition

With regard to mild-to-moderate malnutrition, cross sectional studies of pre-school and school aged children could be conducted at various age levels, in which careful nutritional assessments would be employed to identify groups of clearly contrasting nutritional status. The family backgrounds and social characteristics of these families, in terms of coping strategies, patterns of child care, parent-child interaction, and other

salient features of the developmental environments provided to children could be probed in more detail and depth than has been done thus far in a search for a better understanding of the specific characteristics differentiating those families which are most and least vulnerable to the occurrence of moderate malnutrition, and probably to sub-optimal intellectual development as well.

Here too, with appropriately sensitive measures of intellectual and cognitive competence, the potential effect of moderate malnutrition could be examined separately for those children growing up in the most favorable and least favorable environments. In the case of school age children, the question of whether school attendance compensates for or attenuates the potentially adverse effects of malnutrition could also be examined.

2. Identification of mechanisms through which altered nutritional status may affect intellectual competencies

One of the most important research questions still confronting us in this field is the problem of specifying the mechanisms, or channels of influence, through which malnutrition might exert its impact on the development of various behavioral competencies. In human studies, this problem is being approached in part by efforts to assess a wider array of potential behavioral outcomes of malnutrition in order to determine whether various specific perceptual-cognitive, learning, or motivational processes might be particularly vulnerable to the impact of nutritional deficits (7,20,21). The same general approach is being followed in much of the recent animal research, where investigators have also been able to manipulate experimentally the conditions of nutritional deprivation, recovery, and treatment (including added experience) (17,22).

When the concerns about malnutrition as a possible major cause of mental retardation reached a peak in the late '60's and early '70's it was assumed by many that the brain changes produced by malnutrition led directly to an impairment of learning ability and thus to retarded intellectual development, which was often irreversible. On the basis of much human as well as animal research since that time, however, most investigators have tended to discard this view in favor of the hypothesis that malnutrition may exert its major influence on behavioral competencies through dysfunctional changes in attention, responsiveness, motivation, and emotionality, rather than through a more direct impairment of basic ability to learn. In short, the malnourished child's interaction with his environment may be altered in ways that make him less likely to seek out, utilize, and respond to available opportunities for learning and social interaction available in his environment. This state of events would imply quite hopeful prospects for reversibility or remediation, since it should be possible to manipulate the environment so as to make the child's interaction with it more intellectually facilitative, as some investigators are beginning to do in both human and animal studies (discussed further in section on Intervention Research).

This general problem of more precise identification of the mechanisms through which the behavioral effects of malnutrition might be mediated certainly deserves much more systematic attention with human subjects at different age levels, and with different types and severity of nutritional deficits. As indicated earlier, one approach to this problem is to broaden our behavioral assessments so as to include measures specifically intended to determine which psychological processes or competencies are particularly vulnerable to various kinds of malnutrition. Although a good many recent studies have indeed gone beyond general IQ or DQ assessments, particularly

with pre-school or school-aged children, it is difficult to find consistent patterns of differential nutritional vulnerability for various perceptual-cognitive functions across studies. Much of this inconsistency is to be expected, since the particular competencies or skills which seem most affected by malnutrition are likely to vary with the age of the children, the severity of the malnutrition, the particular tests used, the degree to which socio-cultural or environmental influences on performance have been controlled, etc.

Nevertheless, perhaps the most common suggestion derivable from much of the research, but particularly from studies of early and severe malnutrition, is that the nutritional deficits seem to alter the child's attentional competencies and responsiveness to the environment. For example, the commonly reported clinical observations of reduced activity or apathy in severe early malnutrition, particularly of the marasmic type, are supported by recent experimental studies indicating reduced alerting or orienting responses to simple auditory stimuli (23). On the other hand, while these malnourished infants or toddlers seem less responsive to low or moderate levels of stimulation, they appear to be hyper-reactive to higher stimulus levels that are more "intrusive." Non-supplemented young infants, for example, responded more irritably to a moderately stressful stimulus than did supplemented infants (24), a finding paralleling reports of heightened "emotionality" and difficulty in extinguishing conditioned responses in malnourished animals. It is interesting to note that this same pattern of reduced attention to moderate stimuli and hyper-reactivity to more intense stimuli is also being found in very recent studies of premature or low-birth weight infants in this country (25). Accompanying this pattern of altered responsiveness in children with early malnutrition are reports of reduced

curiosity and exploratory behavior in infants and toddlers (18,19).

Although the data are much less consistent and clear, there are some suggestions from studies of pre-school and school age children that tasks which require the capacity to mobilize and sustain attention may be particularly affected by malnutrition -- e.g., simple tasks of short-term memory, tasks in which incidental learning is possible. These suggestive findings, which need much more systematic replication, come both from studies of mild-to-moderate malnutrition (7,26,27), as well as a recent study of teen-age children with history of clinical malnutrition in the first two years of life (20). The importance of further systematic research directed at the impact of malnutrition on the child's attentional and motivational competencies is also supported by recent reports of altered work styles, or responses to cognitive demands shown by pre-school children having experienced early clinical malnutrition (13), as well as less favorable performance on tasks requiring sustained attention by Boston children with iron deficiency (21).

Virtually all the research just discussed has involved behavioral assessments of children performing in structured test or experimental situations. There is great need to extend systematically the beginning efforts that have been made recently to examine the potential consequences of malnutrition on various adaptive, intellectual, or learning competencies manifested in various real life settings (20,28,29). Assessments of functional competence based on observations or performance in these natural settings would complement the more common test or laboratory assessments in important ways, not the least of which would be to shed some light on the ecological or functional validity of these more controlled measurements. It is interesting to note that current early intervention research in this country

strongly rei ..s a similar movement away from a heavy dependence on psychological tests or laboratory observations, toward more utilization of evaluations of competence manifested in natural situations.

Suggested Research Strategies

Severe malnutrition

The same general strategy previously suggested for dealing with the question of interactions between nutritional and environmental influences on intellectual development could profitably be employed here: namely, detailed prospective studies of children who develop severe malnutrition in the first two to three years of life, whose nutritional status during treatment and recovery can be well documented and whose growth and development can be followed longitudinally for some time thereafter. Detailed behavioral assessments of these children could be made during the period of acute illness, treatment, and recovery in order more fully to explore the various hypotheses suggested by research thus far with regard to altered attentional competencies, responsiveness, and motivation. Hypotheses derivable from recent human and animal research should provide a guide for selection of the most appropriate experimental, test, or observational procedures to be utilized. Several reviews dealing with problems of behavioral measurement and testing in nutritional research should also be helpful in this regard (4,30,31). It would be particularly important to examine interrelationships between obtained measures of attention, responsiveness, or motivation, and more "performance" oriented assessments of problem solving or other cognitive competencies.

These detailed behavioral studies of infants or toddlers with severe early malnutrition could best be done with the same families being studied

in the previously suggested research concerned with nutrition-environment interactions. The advantage of this would be that the home and family environments of these children would be very well known., so that there would be a much greater likelihood that one could evaluate the role of differences in early experience in accounting for apparent effects of malnutrition on particular behavioral responses, particularly during the follow-up phase which should continue for at least several years after treatment.

In dealing with the general problem of mechanisms through which nutritional effects on behavioral development might be mediated, it would be particularly important to include strategies for investigating the previously mentioned question of the impact of the malnourished child on primary caregivers, and on the evolving pattern of mother-child relationships. This would require detailed comparative observations of caregiver-child interaction, particularly in natural settings, involving mothers of malnourished and non-malnourished children (including sibs) and an examination of changes in these interactions over time.

Moderate malnutrition

In order to make any real progress in dealing with the question of whether moderate-to-mild malnutrition may have a differential impact on particular perceptual-cognitive competencies, motivational or attentional characteristics, etc., several requirements must be met: more precise specification of variations in nutritional status, more precise specification of relevant features of the child's experience and environment, utilization of measurement procedures based on a well articulated theoretical rationale, and replication of findings across studies.

Having identified groups of pre-school and school-aged children clearly differing in nutritional status (including presence or absence of specific

deficiencies), and with detailed information concerning salient features of the home environment and family background, it should be possible to investigate the potential differential impact of moderate-to-mild malnutrition on various specific competencies. Analytic strategies should examine the possibility that the profiles of differential outcomes may well vary as a function of the quality of the child's developmental environment.

As mentioned previously, it would be especially important to examine concurrently possible behavioral outcomes observable in real life settings such as the day care center or school situation, as well as those in test or laboratory situations.

3. Effectiveness of nutritional and social interventions in fostering the development of intellectual competence

The systematic utilization of experimental intervention strategies represents one of the most potent research approaches in this field. The hospitalization and treatment of clinically ill children with severe malnutrition obviously represents a basic and widely used form of intervention, which could be more fully exploited for systematic behavioral research purposes than it has been thus far (as suggested earlier in this review). It is encouraging to note that in the past few years there has been an increasing utilization of nutritional intervention as a research strategy, particularly in connection with efforts to prevent malnutrition in populations where the problem is a chronic and endemic one. Because such studies are carried out within a longitudinal, prospective framework, they provide the opportunity to follow the physical growth and psychological development of children whose nutritional histories have been systematically influenced through the provision of added health care and nutritional supplementation,

beginning pre-natally in some instances (26,32). One of the major advantages of the intervention strategy is that changes or contrasts in children's dietary intake and nutritional status can be monitored prospectively as they occur, along with concurrent social and environmental factors, so that their relationships to contemporary or subsequent developmental outcome measures can be more meaningfully evaluated. This contrasts rather sharply with the situation characterizing many retrospective studies of malnourished children, in which information about previous nutritional and developmental histories is often very limited and unclear.

A few recent nutritional intervention studies have begun to incorporate procedures for enrichment or enhancement of the child's social and learning environment as components of the intervention program, along with nutritional supplementation and health care. This intervention has sometimes been provided as an enrichment of experience, or "stimulation" during treatment for severe malnutrition, sometimes as a pre-school program for children typically exposed to chronic undernutrition, and sometimes in the form of a home visiting program to support the mother as caregiver and promoter of her infant or toddler's development (32). In my view, this general strategy represents an extremely important approach since it recognizes the fact that the child's health and nutritional status, and his opportunities for learning and social development represent integral components of developmentally supportive child care or child rearing environments.

Let us briefly consider some of these recent intervention studies in somewhat more detail. With regard to severe and early malnutrition, it has been apparent for some time that the earlier the treatment and rehabilitation, the less the risk of severe developmental impairment (4). Also, ensuring that the child is not deprived of adequate social and physical stimulation

during treatment and rehabilitation, or providing added experiences during this period, seem to offer some facilitation of the recovery process (33,34). The long term benefits of these early treatments and interventions, of course, are very much influenced by the nature of the enduring environments to which the children return after hospitalization. The importance of the later developmental environments of children having experienced early and severe malnutrition is emphasized by recent findings indicating that if these environments are favorable and supportive of development there may be a substantial recovery of both physical growth (16,35), as well as intellectual development (15,16).

In so far as mild-to-moderate malnutrition is concerned, research thus far suggests that the provision of freely available nutritional supplementation to children and families at risk of mild-to-moderate undernutrition in rural Guatemalan villages has relatively little impact on the enhancement of mental development, particularly when compared with the role played by socio-environmental influences (7,26). In an experimental intervention study with urban poor families in Bogota, during the first 18 months of life children who had received either nutritional supplementation or home visiting to promote maternal encouragement of intellectual development showed rather slight advantages in developmental test scores over control children receiving only health care (8). Children who received both treatments showed somewhat more favorable gains in both physical growth and developmental test performance.

While the results just summarized, and a few other behavioral advantages reported for supplemented infants early in the first year of life can be considered somewhat promising, they represent quite modest effects, considering the scope and cost of the interventions involved. On the other hand

there may be more subtle but important effects on the families provided with the combined health care, supplementation, and home visiting program, which have not yet been fully assessed.

The recent report from the Cali project (36) indicates that some facilitation of cognitive functioning can apparently be produced by a highly structured, cognitively oriented all day pre-school program, which also provides health care and nutritional supplementation. As is the case with many pre-school intervention programs in this country, it is not clear at this point to what extent these apparent benefits will be maintained when the children continue on in the public school system, particularly if no systematic efforts have been made to enhance the continuing environment of the home and family.

In considering the general implications of these recent intervention studies one is inclined to conclude, on the one hand, that the results thus far are mildly promising, at least in the case of the studies which have included social or environmental intervention as well as health care and nutritional supplementation. At the same time, however, these studies also reflect the difficulties of designing and implementing effective early intervention programs which can be shown to produce functionally meaningful enhancement of intellectual competencies. Nevertheless, this reviewer remains convinced that more of our research efforts must be aimed directly at the issue of intervention strategies for optimizing the growth and development of children who live in adverse environments and are at risk of both malnutrition and sub-optimal intellectual development, or have already experienced severe malnutrition. Obviously, in the long run the most effective forms of "intervention" would involve major improvements of the developmentally threatening economic, social, and physical conditions

under which large populations of the poor live. Short of these long term political, social, and economic changes, however, and working within the framework of resources potentially available in the immediate future, we need to continue to develop and systematically evaluate the effectiveness of various forms of intervention which could eventually be incorporated into realistic, ongoing social programs.

Given this over-all objective, some of the more specific research questions which would need to be addressed include the following:

a) What specific forms and strategies of nutritional and/or psycho-social intervention are most effective in producing functionally significant and enduring improvements in the cognitive competencies of children at risk?

b) What are the most appropriate and effective forms of intervention for fostering the development of children with different types and severity of nutritional and environmental risk? What kinds of children and families are most responsive and least responsive to various forms of intervention?

c) In the case of preventive programs particularly, are there particular age levels at which intervention is likely to be most effective?

d) Can we estimate the balance of "real life" benefits versus costs for various forms and strategies of intervention?

In developing plans for dealing with these intervention research issues, one should keep in mind that the most effective intervention strategies are likely to be those which are simultaneously concerned not only with nutritional and health needs, but also with ensuring necessary socio-environmental supports for optimal psychological development. Our major research goal, then, should be to determine how best to combine these elements

in programs which meet the special needs of particular groups of children and families, given our goal of facilitating cognitive development. It seems reasonable to assume, also, that intervention is most likely to be effective, (as well as more feasible economically), if it can be focussed so as to reach particularly those children and families considered to be at greatest biological or socio-environmental risk of impaired development.

Intervention and research strategies

There are some studies involving short term nutritional or environmental/experiential intervention in which the "interventions" really represent carefully controlled experimental manipulations intended to answer very specific research questions. Examples include controlled studies of the effects of different dietary regimes or of added stimulation in the treatment of marasmus or kwashiorkor, or research on behavioral changes following individualized treatment for iron deficiency. These types of experimental manipulations represent powerful strategies which obviously can be employed very profitably. The present discussion, however, will deal primarily with research on forms of preventive or remedial intervention which (after their effectiveness has been demonstrated and replicated in field settings) would be capable of being utilized more widely in ongoing field programs.

While the major objective of most intervention, whether it be primarily nutritional or "psycho-social," is to enhance the health, nutritional status, or psychological development of the individual child, there are a number of different avenues of approach or general strategies for reaching this goal, which may vary in their effectiveness. These can be generally grouped as follows:

a) Out-of-home based programs - major approach is to reach the child directly with appropriate "treatment" provided in various out-of-home settings, such as the hospital, day care center or day care home, pre-school, public school, etc. Such approaches tend to be concerned primarily with directly affecting the child rather than the family, although this need not always be the case.

b) Home based programs - this approach usually involves efforts to improve the child's developmental status by enhancing the child-rearing and child-care environment in the home, mainly through home visits intended to influence the child's primary caregivers in the family.

c) Combined programs - often use out-of-home base both to provide services for children, and to involve family actively in educational and participative experiences to strengthen parental child care and child rearing competencies; often combined with some home visiting.

Which of the various approaches just outlined is likely to be most appropriate and effective will depend very much on such matters as the nature and severity of the developmental risk involved, the age of the children, the child care needs of the families, as well as their socio-cultural characteristics and the nature of the ecological settings in which they live. Obviously, much will depend also on the specific form or "content" of the treatment or intervention.

Future intervention research will need to be concerned with determining the suitability and relative effectiveness of these various forms and strategies of intervention for dealing with particular sub-groups of children and families. It may well be, for example, that children recovered from severe early malnutrition could best be helped by the structured and enriched learning experiences of a full day pre-school or infant nursery, which also provides nutritional supplementation and health care, along with training and supportive services to strengthen parental child care practices. On the other hand, it may be that the maximum beneficial impact for large numbers of children with mild to moderate undernutrition could be achieved by substantial improvement of the learning opportunities available in the

school, which could also be used as a base for improving health and nutrition.

Generally speaking, while it is possible to promote children's health, nutritional status, and psychological development through appropriate out-of-home intervention programs based in day care centers, schools, rehabilitation centers, etc., there is reason to assume that in the long run, unless one can also help to make the continuing environment of the home and family more fully supportive of development, it will be difficult to achieve enduring gains solely through such out-of-home programs. Among the additional strategies available for attaining this goal are a number of less formal approaches for working with groups of families or with neighborhoods, rather than with individual families (e.g., the provision of neighborhood educational programs, encouraging mutual assistance or self-help family groups, facilitating greater utilization of available supportive services, both formal and informal, etc.). Systematic evaluation research should also be concerned with these less formal interventions, in addition to those already discussed, in part because in the long run they may represent some of the more cost-effective ways of providing child development support to large numbers of the less severely stressed children and families in poor populations.

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ENERGY INTAKE AND FUNCTIONAL COMPETENCE
COGNITION AND SENSORY ACTIVITIES: BIOLOGICAL ASPECTS*

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* Presented at the US AID Workshop, Washington, D.C., 2-6 October 1978

Preamble

Behavior, including the cognitive aspects, is a complex resultant of the interaction between organisms and their environments, physicochemical and sociocultural.

In this communication we shall address ourselves to five topics:

(1) Nutrient intake and nutritional status
(2) Behavioral and organismic criteria of function
(3) Beyond sensory thresholds
(4) Are adults immune to malnutrition?
(5) The role of biological (nutritional) and social factors in malnutrition

Literature on "malnutrition and brain development" was summarized by Myron Winick (1976) and will not be reviewed here, even though it deals with an important aspect of the biological bases of behavior and of potential impairment of behavior by severe malnutrition experienced in early infancy.

While the point has not been made explicitly in the communications we have received, I believe I am correct in assuming that the project is to involve a study (or studies) on man, not on subhuman species. For this reason alone I have not dealt with the extensive animal literature.

In the context of the present discussions, nutrient intake means "energy intake" (or at least primarily energy intake). Such an emphasis is justified, both in terms of the needs of the developing nations and as a counterbalance to recent overemphasis on protein deficits. This should not be interpreted as disregard for the role of protein in the diet. While energy ("food") deficits will be of central importance in the research that we are to consider, we cannot lose sight of the behavioral significance of nutritional deficiencies involving minerals and vitamins (especially iron, iodine, and vitamin A) and their frequent co-existence with energy deficits.

I have encountered several kinds of problems in preparing this report and in attempting to relate the activities of this workshop to the project as a whole.

For one, I have the uncomfortable feeling that our model of the behavioral aspects of "functional competence" is Cartesian, bipartite,

reductionist. Comte (a mid-19th-century French thinker) negated the right of psychology to existence: in August Comte's view, what we call "psychological" is, in reality, either the subject of biology or of sociology. In this perspective, the two "state of the art" reports are to deal with the biological and the social aspects of cognition.

I favor a tricomponental, tripartite model. The three components or aspects are the intraorganismic processes, individual behavior, and interpersonal (social and, more broadly, environmental) interactions. Clearly these are all aspects of the activities of organisms-in-the-environment. Only for purposes of analysis does it make sense to consider them separately. Cognition is a class of behavior of individual organisms. My point is that in the scheme of job assignments this critical, central, "psychological" component is missing.

The focus of research that we are to consider is on the relationship between nutrient intake and the ability to function in society. In a vague sort of way, this has been the concern of all research on malnutrition and behavior. In reality, we have limited ourselves -- with exceedingly rare exceptions -- to the criteria of statistical significance.

I found it useful to think in terms of what I call the "biological" significance of a change resulting from a deficient diet. The biological significance may be assessed by relating the magnitude of the change (Δ) to the variability of a given measure under control conditions. Thus an "index of biological significance" of a change may be computed as:

$$I_{BS} = \frac{\Delta}{SD_C},$$

where the SD_C refers to the standard deviation of the values of test scores for a given variable during the pre-experimental, control period.

Let us consider in this framework the data on changes observed in a variety of psychomotor functions after 6 months of severe food restriction (Keys et al., 1950, p.705).

Statistically, all the changes were highly significant. The index of "biological significance" helps us to separate the test into two groups: the tests of strength that were markedly affected, reflecting the loss of muscle mass, and the various tests of speed of movements

Table 1. Biological significance of changes in motor functions. C = control data, S24 = mean scores in the 24th week of severe food restriction, Δ = [C-S24], SD_C = standard deviation of the test scores at the end of the control period.

Test	C	S24	Δ	$\frac{100\Delta}{SDC}$
Hand dynamometer, kg.	58.2	41.8	-16.4	2.2
Back dynamometer, kg.	165.6	116.1	-49.3	1.8
Gross body RT, in 1/100 sec.	42.3	45.6	+3.3	0.9
Speed of arm movements, no./min.	75.3	71.4	-3.9	0.7
Tapping speed, taps per 10 sec.	66.6	63.2	-3.4	0.6

Table 2. Estimated general magnitude of semi-starvation effects resulting from different average losses of body weight in adult populations (derived from a variety of sources).

Percentage of Body Weight Lost	Magnitude of Semi-Starvation Effects		
	Civil Disorder and Strife	Capacity for Prolonged Physical Work (%)	Actual Work Performance (%)
5.....	Slight	(?)	-10
10.....	Moderate	-10	-20
15.....	Serious	-30	-50
20.....	Very serious	-50	-80
30.....	Moderate	-80	-90
40.....	Slight	-95	-95
50.....	None	None	None

for which the effects were substantially less severe.

Beyond the biological significance lays the murky realm of "practical" (or social) significance. We have climbed on this very fragile limb when we asked (Keys et al., 1950, p.917): What is the probable relationship between the magnitude of weight loss resulting from deficient food intake and 3 socially relevant "outcome" variables: civil disorder and strife, capacity for prolonged physical work, and the probable actual performance of physical work. Our best questimates are indicated in Table 2.

While going beyond the "safe" tests of statistical significance means skating on thin ice, we cannot escape, for ever, the legitimate questions "What does it all mean?", asked by the planner and, more and more, by administrators of research funds. Improved nutrition is a part of public health, and we must give serious attention to the "cost-benefit ratio," uncomfortable, yes, painful as this may be.

1. Nutrient intake and nutritional status

The ultimate goal of the AID project has been defined as the exploration of the relation between nutrient intake and functional competency. The workshop is focused on the cognitive area, including the special senses.

It may be useful to remind ourselves that, for present purposes, "nutrient intake" means primarily the intake of energy, of calories.

We can measure, precisely and dependably, the energy intake in a metabolic ward and, when due precautions are taken, in a physiological laboratory.

In the field we must be satisfied with approximations which are, typically, rather gross. This is a compelling reason why in research on malnutrition and behavior we have related behavior to the outcome of nutrition, i.e., nutritional status, "nutriture." Furthermore, and very importantly, information on energy intake is of very limited value unless we know also, with reasonable precision, the energy output. Man can maintain body weight at remarkably different levels of energy intake. People can become fat on an intake of 2,000 calories

per day, and lose weight on an intake of 5,000 calories per day. The critical aspect is not the absolute intake but the balance (or the lack of it) between intake and output.

I am not arguing against the need to pay more attention to nutrient intake. I am arguing for the clarification of concepts and improvement of procedures for the assessment of nutriture. The amount of confusion is distressing, even with reference to such basic criteria of nutritional status as "stunting and wasting," applicable to children living under conditions of chronically deficient or at most marginal nutrient intake: "stunting" refers to retardation (deficit) in height for age, while "wasting" indicates that the child's weight is too low for its height.

The techniques vary over a wide range along the simplicity-complexity dimension, from a "QUAC stick" to assessment of nutriture in terms of a sophisticated analysis of body composition (Brožek 1974).

In the area of clinical malnutrition of the young child, a novel approach to the synthesis of biochemical and clinical data obtained at the time of hospitalization for energy - protein malnutrition was used in a study carried out in East Africa (Hoorweg 1976, p.49).

On admission the condition of the children, 8 to 27 months of age, was characterized in terms of 7 variables. Their factor analysis yielded two principal components which I prefer to call a "K" component ("K" standing for "kwashiorkor") and an "M" component ("M" for "nutritional marasmus"). The "K" component (or dimension) of clinical energy-protein malnutrition is characterized by the presence of edema and skin changes, high overall ratings of clinical severity of the patient's condition, low level of serum protein, large weight loss after admission (reflecting primarily the loss of water), and small difference between actual body weight and body weight expected for age. By contrast, the dominant feature of the "M" factor is dramatic wasting (reflected in very low body weight) and low hemoglobin level. Skin changes are absent, as is edema. The serum protein is not markedly depressed. The author, J.C. Hoorweg, has chosen — unfortunately, in my opinion -- to call these 2 components "acute malnutrition" and "chronic malnutrition."

For each child the magnitude of these two components, indicating the severity of the kwashiorkor-like and marasmus-like aspects of

"nutritional status," is computed as a weighted index, using the values of the original seven variables and the weights given in Table 3 (from Moorweg 1976, p.49):

Table 3. Medical indicators at admission: varimax rotation of first two principal components (mal-malnourished groups pooled; N = 3 x 20).

	dimension 1	dimension 2
percentage of expected weight for age[a,b]	.07	-.80
percentage of weight lost after admission	.58	-.55
haemoglobin level[b]	-.28	-.66
serum protein level	-.59	-.10
edema	.73	-.17
skin changes	.69	.00
overall clinical severity[c]	.73	.23

(a) Waterlow standards (Dean, 1954; Rutishauser, 1965).
(b) lowest level during hospitalization.
(c) as judged by the attending doctor.

The scores computed for each of the two components were then used as a point of reference for the analysis of the behavioral data obtained in these children some 12 years later.

It came as a surprise -- at least to me -- that the correlations between the children's "X" scores and 9 psychological tests administered to the children in their teens were low, statistically not significant, and random in direction: four indicated a negative, and five a positive relationship.

By contrast, the "X" scores correlated negatively with test scores obtained later in life: the greater the "X" scores, the lower the subsequent performance on Raven matrices, block design test, memory for designs, and arithmetic (Moorweg 1976, p.75). Children with high "X" scores in infancy tended to be somewhat less energetic and more docile in their teens.

2. Behavioral and Organismic Criteria of Function

The behavioral methods used in the comprehensive Minnesota study on the effects of severe energy deficits, imposed on young adult male volunteers over a period of 6 months and resulting in the loss of one-fourth of the pre-experimental body weight, described in detail elsewhere (Keys et al. 1950, pp.1094-1104), may be grouped into 4 categories:

I. Special senses: Auditory acuity, visual acuity, flicker fusion frequency, perceptual fluctuation (reversals of perspective in which a geometric cube design was seen).

II. Motor functions: Strength, speed of movements (tapping, hand plus forearm movements, gross body reaction time, speed of leg movements), and coordination of movements.

III. Intelligence: The Institute of Educational Research (Columbia University) CAVD Scale (Completions, Arithmetics, Vocabulary, Directions), test battery based on Thurstone's factorial studies of intelligence, and test of learning ability ("Crossing out 4's; 18 successive 1-min. trials per test session).

IV. Personality: Interviews, diaries, Minnesota Multiphasic Personality Inventory, Guilford's Inventory of Temperamental Traits, self-ratings, complaint questionnaire, man-by-man ratings, drive ratings.

Standard methods used in research on malnutrition in children, frequently with local modification, have been described (Klein and Adinolfi 1975; Hurwitz 1976) and will not be listed here.

Additional tests and measuring techniques have been devised ad hoc, e.g., a technique for the characterization of the activity level of the very young child (Chávez, Martínez, and Bourges 1972). A number of the procedures are "biological" in nature or have a biological component. Among these methods, applied in the context of research on malnutrition, are procedures for the study of the habituation of the orienting response in terms of the magnitude of deceleration of the heart rate (Lester 1975), the characteristics of cry sounds (Lester 1976), level of arousal and latency or response to an auditory stimulus (Griesel 1972), as well as the electrical activity of the brain and speed of nerve conduction (Coursin 1974, Rhodes and Snyder 1975, Taori and Pereira 1974).

3. Beyond Sensory Thresholds

We have noted (Keys et al. 1950, p.675) that the special senses provide information about the environment and that their adequate functioning is essential for effective interaction between the organism and the changing environment. Consequently, receptivity to sensory stimuli is an important aspect of cognitive function -- taking the term in a broad sense. In addition, some of the sensory functions provide a valuable physiological avenue to the functional status of the central nervous system (cf. Beck and Dustman 1975, esp. pp.205-206, Callaway 1975).

Following the Second World War, dimness of vision (amblyopia), deterioration of visual acuity, and narrowing of the visual field were frequently reported in Allied prisoners of war and civilians interned in the Far East (Keys et al. 1950, pp. 676-679). Occasionally, nerve deafness was noted. It is very probable that in these situations severe vitamin deficiencies (and perhaps the presence of toxic factors) were superimposed on energy deficits. Such an hypothesis is supported by field reports from areas of Europe in which severe food deficits were present. These reports contained little reference to disturbances of special senses, except for night blindness -- a peripheral rather than a central phenomenon -- due to the changes in the light sensitivity of the receptors (Keys et al. 1950, pp.675-676).

The hypothesis that visual disturbances observed in the Far East were due to factors other than deficits of calories is further strengthened by the fact that in an experimental study of the effects of severe food deficits (Keys et al. 1950, pp.684-658) the changes in visual functions were either absent or negligible. Visual acuity, measured at two levels of illumination at the plane of the test patch (1 and 100-foot candles respectively), remained unaffected by the loss of one-fourth of body weight. Similarly, perceptual fluctuation did not change. The frequency at which successive light flashes appear to fuse into an uninterrupted light served as the indicator of the resolving power of the retino-cortical system. In the Minnesota study there was a very small but consistent (and, consequently statistically significant) decrement of the fusion rate.

No deterioration was observed in the acuity of hearing. In fact, the measured acuity improved during the period of food restriction. Reports of the subjects (who were not aware of their audiometric scores) were consistent with the audiometric findings. A number of the men reported that their tolerance for loud music, speech, and noise was lowered. The observed decrease in auditory thresholds (indicating increased acuity) could be interpreted as a random effect or as a result of instrumental artifact, were it not for the fact that the trend was reversed during the period of nutritional rehabilitation. After 12 weeks of controlled refeeding the level of auditory acuity returned to the pre-experimental, control values.

In research on the effects of energy and protein deficits we have to go beyond the study of sensory thresholds and examine more "cognitive," perceptual (rather than sensory) functions. One of the processes that has attracted the interest of investigators of the behavioral effects of generalized malnutrition is "intersensory integration." The technique for the study of "intersensory development" was developed by Birch and Lefford (1963). Under the label of "neuro-interactive functioning," the phenomena of cross-modal matching of patterns (auditory-visual, visual-kinesthetic, haptic-kinesthetic, visual-haptic, kinesthetic-visual) are considered at length, in nutritional context, by Cravioto and DeLicardie (1975, pp.46-70).

The approach was covered, in the section on "specific function tests," in Hurwitz's review (1976, esp. pp.95-96) of tests used in research on the behavioral effects of malnutrition. Hurwitz notes that findings, reported in the literature and indicating that children with a documented history of clinical energy-protein malnutrition during infancy perform less well on intersensory tasks than controls, may reflect differences in the mastery of language and need to be interpreted as being conceptual rather than perceptual in nature.

Recent data on the effects of clinical energy-protein malnutrition in infancy on cross-modal matching were reported by Srikantia (1979, in press). The differences between the index children and the controls (Table 4) in visual-kinesthetic, visual-haptic, and haptic-kinesthetic comparisons are statistically highly significant at the age 8-9 years but decrease markedly during the next 5 years. At the age of 15-16 years the test no longer possesses discriminatory capacity since at

Table 4. Mean differences between the error scores of the index children (N = 19) and the control children (N = 19) on tests of intersensory integration. SE = standard errors of the means; t = tests of statistical significance of the mean differences, associated with 36 degrees of freedom ($t_{0.05} = 2.03$, $t_{0.01} = 2.73$, $t_{0.001} = 3.60$).

Age (years)		COMPARISONS					
		Visual-kinesthetic		Visual-haptic		Haptic-kinesthetic	
		Equivalence	Non-Equivalence	Equivalence	Non-Equivalence	Equivalence	Non-Equivalence
8 - 9	M	7.2	3.1	5.3	1.4	9.1	3.4
	SE	2.35	0.85	0.96	0.34	2.2	0.90
	t	3.06	3.65	5.52	4.12	4.14	3.78
13-14	M	0.6	0.5	1.0	0.5	1.2	1.45
	SE	0.38	0.28	0.32	0.31	0.64	0.74
	t	1.58	1.78	3.12	1.61	1.88	1.96
15-16		At this age none of the children in either group made any errors					

this age the performance of all children was error-free. The test, at least the form that has been used, is "age-specific," i.e. is applicable only to younger children.

The Bender Gestalt Test (Bender 1938, Koppitz 1964, Tolor and Schulberg, 1963) is classified by Hurwitz (1976, p.96) as a paper-and-pencil visual (perceptual) motor test, involving the copying of geometrical figures.

Green (1979) used the test effectively in studying the behavioral correlates of iodine malnutrition. The severely affected individuals (deaf-mute cretins) had dramatically higher error scores than the "normal" adults of the community (see Table 5).

Table 5. Mean number of errors on the Bender-Gestalt Test

	Deaf-Mute Cretins		"Normal" Adults	
	Males	Females	Males	Females
$\bar{X}$	9.8	15.9	1.8	3.8
SD	5.7	4.6	2.1	2.9
n	25	20	111	165

4. Are adults immune to malnutrition?

One of the considerations I sorely miss in the preliminary discussions of "the research project" that the workshops, jointly, are to help to design is the consideration of age. Age of the potential subjects has far-reaching, many-sided implications. The majority of behavioral methods is age-specific. The age of applicability of a test is frequently quite narrow, and one of the problems in the study of young children is that we have to change the tools as children increase in age.

Age of the subjects has important ethical implications: On

ethical grounds, no dietary deficits can be imposed on children, and any "experimental" manipulation of the diet has to be limited to the kinds and amounts of supplements -- and even then there are problems, a plethora of them. The cessation of supplementation, in field studies, is one of the thorniest.

On the positive side, longitudinal studies in children make it possible to use rates of physical growth and mental development as a valuable dependent variable.

One of the unresolved issues is the long-term significance (if any) of the age at which infant malnutrition occurs, i.e., operationally, of the age at which the child is admitted to the hospital.

But, in connection with the considerations of age, the single most important, greatly overlooked issue is the significance of malnutrition (primarily caloric undernutrition) in the adults. The perusal of the literature clearly indicates that in the last 20 years or so the human studies on the effects of energy and protein deficits have been heavily concentrated on the young child. This is fully understandable since this age group is particularly vulnerable to deficits of energy-yielding food stuffs and of protein. It is at this age that the severe, clinical forms of energy-protein malnutrition -- kwashiorkor, nutritional marasmus, and marasmic kwashiorkor -- occur.

Investigations of the effects of undernutrition in school children are few and, typically, represent follow-up studies of children who experienced clinical malnutrition early in life.

Experimental investigations on the behavioral effects of calories and vitamins in adults were stimulated by the needs of the Second World War and, to a lesser degree, the Korean conflict. This type of research all but disappeared in the last 2 decades, and most of the studies on adult man that have been reported are concerned with the physical aspects of work capacity in iron-deficiency anemia (Viteri and Torún 1974, WHO 1975), with emphasis on cardiovascular functions and energy cost of work.

Adults are breadwinners. They are fathers and mothers, and their interaction with the infants and children is a critical factor in the child's mental development.

A widely-spread myth seems to have developed that malnutrition affects only the behavior of children. As is typically the case, there is a grain of truth in this myth: Except under conditions of famine, in adults we rarely see extreme wasting and/or excessive body hydration manifested in edema. Kwashiorkor, nutritional marasmus, and a syndrome combining the features of the two is typically seen in early childhood. So far so good. But is is woefully misleading to state, as has been done in print recently (Manocha 1975, p.403) that "there is no evidence that the adult population suffers from any mental impairment under the influence of malnutrition."

While in severe undernutrition (Keys et al. 1950) the most dramatic decrement was observed in endurance in tasks requiring a large though brief output of energy, there was also a marked decrease in strength as well as in the level of self-initiated activities. The latter phenomenon reflected a profound change in motivation, not in capacity.

In research involving performance we cannot disregard the simple-looking equation:

$$P = C \times M,$$

i.e., performance involves both capacity (C) and motivation (M). This is a symbolic equation, note mathematical formula. Yet it is of fundamental importance, whether we deal with physical work or with cognitive, intellective activities.

In our study on the behavioral effects of severe undernutrition (Keys et al. 1950), in investigating the area of cognitive (or, more precisely, intellective) functions, we utilized all the major tools then available and added some "home-made" ones for better measure. We used tests ranging from a minute in duration to a test for the completion of which the subjects took between 8 and 10 hours, divided into several (usually 3) sessions. We have examined the effects on the subjects' "mental level" (using "power tests," i.e. tests without predetermined, strict limits) and speed tests, short in duration and with rigorous time limits. We measured "learning ability" by following improvements in the performance on a short test (Crossing out 4's) repeated 18 times during a test session, with 90 seconds between the separate trials.

What did we find? As time went on, during the "experimental" (restriction) phase of the study, complaints of inability to concentrate for any period of time and of difficulty in developing coherent thoughts became numerous. Toward the end of the 6-month period of severe energy deficit a large proportion of men felt that their judgment had been impaired. They reported that their general alertness and comprehension declined.

By contrast, measured intelligence did not change importantly during either the period of food restriction or the subsequent period of nutritional rehabilitation.

At the same time, let me repeat, spontaneous mental effort and achievement (such as writing letters) declined markedly during food restriction, remained at a low level during the early phase (the first 12 weeks) of rehabilitation, and only gradually returned to "normal."

It was the narrowing of interests (heavily centered on food), apathy, and lack of initiative in carrying on conversation or other kinds of intellective activity which led the men to feel that they had suffered actual loss of intellective power. Importantly, the study program initiated by the group itself and designed to train the men for reconstruction service in Europe failed to hold their interest and had to be discontinued.

Did this study, unique -- in many aspects -- in the annals of nutritional research, answer all the questions about the effects of energy deficits? It did not and could not. The study had built into it a desideration of a loss of one-fourth of initial, pre-restriction body weight in a group of "normal-weight" individuals. The weight loss proceeded at a predetermined, decelerating rate, with the weight-loss curve reaching a zero slope toward the end of the 6th month. Different rate of weight loss would almost certainly affect the functional changes.

While 6 months felt like eternity, both for the subjects and for the experimenter, it is a period close to semi-starvation experienced during war-time, and this is what we wanted to "model." But what happens under conditions of chronic and -- to make matters more complex yet -- multi-generational food deficits? We have seen a multiplicity of "adaptive" changes taking place during six months, including decline in basal metabolism. This response was prompt and steady.

This is a favorable, "adjustive" change since it reduces the net calorie deficit, i.e., the deficit compared with the enery deficit which would have prevailed in the absence of a reduction in the basal metabolism. To an individual on a severely restricted food intake the reduction of basal metabolism means that, at a given food intake and energy output, not only his rate of weight loss but also his rate of the loss of strength and endurance is diminished and that, if the condition persists, he will live longer. In the Minnesota study, at the end of the 6th month of the deficiency, the total rate of basal metabolism was almost 40% less than in the control period. It was calculated that this represents the saving of almost 600 calories per day.

Other indicators of the general slowing down of the machinery of the body included the decrease of basal pulse rate from 56 to 43 beats/minute and the decrease of systolic blood pressure from 105 to 97 mm. Hg.

It should be noted that the weight loss curve reached a zero slope at the 24th week of food restriction, even though the average daily energy intake (1642 calories) was very close to the initial intake of 1658 calories, compared to the 3500 calories required for the maintenance of steady body weight during the control period. The subjects were able to maintain a steady body weight on less than one-half of the energy input.

How was this achieved? What were the mechanisms of the adaptation? We have discussed one of the factors: the reduction of basal metabolic rate. A small reduction in calorie expenditure is due to reduced food intake; we calculated specific dynamic action (S.D.A.) of the ingested food as 7.5% of the caloric intake. By far the largest contributor was reduction in physical activity. The data are given in Table 6.

The decrements, as percentages of the control (pre-restriction) values, were as follows: Energy intake (and S.D.A.) decreased by 53%; the calorie equivalent of basic metabolism, by 39%; physical activity, calculated by difference [Energy intake maintaining a steady body weight - (S.D.A. + B.M.)], decreased by 66%. For comparison, body weight decreased by 24.2%.

Table 6. Breakdown of calorie expenditure in the Minnesota Experiment

	Control	S24	S	S%
(1) Energy intake	3432	1642	1850	53
(2) S.D.A.	262	123	(139)	(53)
(3) B.M.	1576	961	615	39
(1)-(2+3) Physical Activity	1654	558	1096	66
Body weight, kg.	69.4	52.6	16.8	24.2

This is the best physiological estimate of the overall decrement in physical (muscular) activity of initially normal young men over a period of 6 months of severe restriction of food intake. It is the single, most comprehensive "biological" (metabolic) indicator of the profound changes in gross motor behavior that take place in "chronic" situations calling for the conservation of energy expenditure: In popular language we would be tempted to call a severely, chronically malnourished individual "lazy." In first encountering the working population in under-developed countries, maintaining a precarious balance between energy input and output, such a temptation is almost irresistible.

5. The role of biological (nutritional) and social factors in malnutrition

In the early studies on the behavioral aspects of malnutrition, the underlying model was simplicity itself: M → B. In time the model became much more complex by the addition of other factors and the incorporation of feedback loops.

The most important added factor was the impact of the socio-economic environment. I fully agree with Jack Tizard (1974) and others that the impact of malnutrition on behavior is an "ecological" problem. I have been impressed by Herbert G Birch's moving comment (1972, p.781): "Malnutrition never occurs alone, it occurs in conjunction

with low income, poor housing, family disorganization, and climate of apathy, ignorance and despair." But we must avoid two pits into which it is all too easy to fall:

1) We can readily forget that Birch is talking about malnutrition as it occurs in the field.

2) We must avoid the temptation to elevate the complex of the " SES " (socio-economic status) variables into the driver's seat and essentially disregard the nutritional input and metabolic mechanisms.

To tease out the single etiological strands from an interlocking etiological fabric is by no means simple but we cannot give up too readily if we wish to understand the phenomena with which we are to deal on a practical level.

I shall note two recent efforts to unscramble the nutritional and the social components within the socio-economic matrix of poverty.

The first effort was directed to the study of "experiments in nature," i.e. of illness resulting in severely impaired nutrition in children, in industrially developed countries and in families in which access to food was not limited by financial considerations. I am referring to studies on the behavioral sequelae of infant malnutrition associated with neonatal resection of the ileum (Valman 1974), pyloric stenosis (Berglund and Rabo 1973; Klein, Forbes and Nader 1975) and cystic fibrosis (Ellis and Hill 1975; Lloyd-Still et al. 1975)

The second effort at the assessment of biological (nutritional) and social factors may be illustrated by two different approaches.

The first of these deals with the sequelae of energy-protein malnutrition requiring hospitalization. The subjects were Jamaican boys hospitalized, with a primary diagnosis of malnutrition, at the ages of 6 to 24 months. Taken as a whole (Richardson 1975), at school age these children were significantly smaller in height (but not in weight) and head circumference than their unrelated classmates and neighbors matched for age and sex, had a lower intelligence, and did significantly less well in school. They were rated by their parents more often as backward, withdrawn, and unsociable. At the same time, consideration of the characteristics of the social environment of these children (specifically, the caretaker's level of capacity, the quality of home furnishings and appliances, and intellectual

stimulation) indicated that the children who had suffered from malnutrition in early childhood came from more disadvantaged backgrounds than the peer controls.

But the really interesting and new facts emerge when one segregates the index cases in reference to the 2 sets of factors: nutritional (using height at follow-up at the age of 6 to 10 years as an index of chronic adequacy of nutrition) and social background history (Richardson 1976).

For children who are tall and whose social background is favorable, the mean I.Q. of the index and the comparison children are almost identical (69 vs. 71).

For children of shorter stature (regarded as indicative of chronically poorer nutrition) but whose social background is favorable the differences are still small (62 vs.65), although the level is lower.

For children who are tall ("better nourished") but whose social background is unfavorable the differences are more marked and the level still lower (55 vs. 62).

The combination of low stature (chronically poorer nutrition) and unfavorable social background yield, as one might expect, the lowest level and the largest differences between the index and the control children (49 vs. 58).

While the sizes of the four subgroups are small and the findings call for confirmation, the results are compatible with a model according to which an episode of clinical malnutrition in infancy has different consequences for intellective function depending on: 1) nutrition (and, one should add, health) in the years following recovery from clinical malnutrition, and 2) social background.

The two -- or more precisely 3 -- sets of factors are synergistic: severe malnutrition during infancy, and nutrition and social environment during childhood.

The second set of data refers to a longitudinal study (Brozek, Churchill and Read 1977) carried out at Guatemala (Irwin et al., in press). This study was carried out at four isolated Ladino (Spanish speaking) villages of rural Guatemala where moderate energy-protein malnutrition is endemic. The residents of the villages, matched on

a number of demographic, social and economic characteristics, are engaged in subsistence farming. The median family income corresponded to about $200/year. The average family size was 6.5 members.

The mothers and young children of 2 of the 4 villages were offered a beverage referred to as "Atolé," containing about 100 calories and 11 grams of protein per cup. Two other villages received "Fresco," a beverage substantially lower in calories (60 calories per cup) and no protein. Both beverages contained vitamins and minerals. Apparently the supplementary beverages had very little effect upon customary home consumption.

The supplements were provided to mothers starting early in pregnancy -- as soon as they chose to come to the distribution centers. Children were given supplements as soon as the mothers brought them to the centers, usually around 9 months of age or later.

The cognitive aspects of mental function were assessed by several test batteries, appropriate for children of different age levels: neonates, infants, and preschool children.

In the Guatemala study the independent (nutritional, interventional) variable was the amount of supplemtary calories ingested by the mother during pregnancy and lactation, and by the child up to the point of test administration. The amount of individual supplementary nutrient intake, correlated positively with prenatal and postnatal physical growth. What effects, if any, did it have on mental development? Furthermore, what was the relative contribution of the supplementary intake of calories and of the quality of the home environment? The latter is the critical question for the present purposes.

Mental development was measured by two batteries of tests: 10 tests were administered at ages 3 and 4, and 22 at the ages of 5, 6, and 7 years. The tests were chosen to tap a variety of intellective abilities including reasoning, learning, and memory, as well as perceptual analysis. The tests,constituting the "Preschool Battery," were adapted to the local setting by a team of North American and Guatemalan psychologists and a Guatemalan cultural anthropologist.

The index of the quality of home environment is based on variables related to 1) nutrition (home diet, diarrhea), 2) the economic situation of the family (characteristics of the family dwelling -- its

size, number of rooms, and type of construction; type of clothes worn by the parents), and 3) the personal-social characteristics of the child's micro-environment: Mother's vocabulary score, years of schooling, literacy level, and "modernity"; the amount of time the father spends with the children; provision of toys by the parents; attempts to teach children at home; and the presence of decorations on walls and availability of printed matter in the house. This third group of variables is an indicator of the amount of intellectual stimulation available to the child at home.

We shall limit ourselves to a single issue: What are the percentages of the variance of the composite test scores accounted for by the Quality of Home Environment (QHE) and by the amount of supplementary calories ingested by the mother during pregnancy and lactation and by the child up to the point of the administration of mental tests?

Table 7. Percentage of variance in Composite Test Scores accounted for by 1) Quality of Home Environment (QHE), considered alone, and 2) the supplementation calories (SC), with the effects of QHE first removed. The degrees of freedom vary for boys and girls, and for different ages.

Factor	Age, in years				
	3	4	5	6	7
BOYS					
1) QHE	4.9*	7.6**	21.6**	14.0**	13.7**
2) SC	6.0**	4.2**	5.4*	5.2*	4.2*
GIRLS					
1) QHE	6.9*	6.5*	9.8*	14.8**	22.6**
2) SC	5.2*	2.1	3.6	2.7	4.2

p values: + < 0.10
* < 0.05
** < 0.01

The Quality of the Home Environment makes a substantial contribution to the Composite Score variance (Table 7). The contribution tends to increase with the age at testing. This tendency is particularly marked in the girls.

After controlling for the effects of QHE, supplementary calories still make an important contribution to the test scores, more so in boys than in the girls.

The authors (Irwin, Klein, et al. 1979, in press), referring to the presence of a small but not negligible contribution of supplementary calories to the variance of the Composite Scores, stress that "This is a particularly important point, since many early studies of the relationship of nutritional status to mental development have not been designed so that one could decide whether the quality of the home environment was not in fact responsible for observed associations between malnutrition and poor mental-test performance."

Full results of a complex, stepwise regression analysis, including the effects of treatments (Atolé vs. Fresco) and interactions, will be reported in the authors' published account.

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APPENDIX II-5

Report of the Workshop on

Malnutrition and Social Functioning

and

Background Documents by

Philburn Ratoosh
David E. Barrett and Marian Radke-Yarrow

REPORT OF THE

WORKSHOP ON
MALNUTRITION AND SOCIAL FUNCTIONING

November 27 - December 1, 1978
Tucson, Arizona

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Appendix A:

"Malnutrition and Social Competence"
by Philburn Ratcosh

Appendix B:

"A Review of Literature on the Effects
of Malnutrition on Behavior and Development"
by Dr. David E. Barrett and Dr. Marian Radke-Yarrow

Severe malnutrition has long been recognized as a problem. Increasingly attention is being directed to the functional significance for individual, families, communities and societies of less than severe states of malnutrition. There is suggestive evidence that the less severe levels of malnutrition are associated with vulnerability to disease, reproductive competence, work performance and cognitive abilities. The possibility that past and current food intake may influence a broad range of social behaviors and psychological conditions that are of profound importance in the functioning of individuals and societies has given rise to the need for research on the relationship between food intake and social functioning.

The term "social functioning" encompasses a broad range of individual and group behaviors. It is not a specific variable, but many variables which reflect how individuals perform in their social and cultural environments, how they act on the environment in which they live, and how they act on one another. No matter whether the focus of research is reproductive competence, response to disease, work production, school performance, or cognitive functioning, the behaving individual, alone and as part of groups and social institutions, is an ultimate concern.

For this purpose, the working definition of social functioning includes behaviors involving responsiveness to stimulation, change, and stress, capacities to adapt to complex environmental demands, and skills used in interpersonal relations in the many and diverse roles in which the individual operates. Social functioning ranges from interactions between the individual and family to interactions between family and community including institutions.

Research on food intake and social functioning is complicated conceptually, methodologically, and culturally. As discussed elsewhere, food intake and nutritional status are difficult to determine. Also, specification of behavioral variables and availability of instruments and procedures of measurement continue to constrain this research. Further, cultural and subcultural differences are major considerations that enter into both the nutritional and behavioral assessments. That which constitutes competent and incompetent social functioning may vary from society to society and among different subcultures in one society.

Interrelationships between food intake and social functioning are likely to be diverse and complex, and modified by many factors of biological, social, and environmental origins. The effects of inadequate food intake on social functioning is a primary research issue, but the possible effects of behavioral variables on intake are also to be considered. The "confounding" effects of nonnutritional factors (e.g., family organization, "culture" of poverty, etc.) on either food intake or behavior make the assessment of pure nutrition-behavior relations very difficult. Many of the consequences of nutrient deficiencies may be cumulative and long lasting, and are likely to involve a continuum of "casual" relationships. Thus, hypothetically, malnutrition during pregnancy may complicate fetal growth and also delivery. The child of this pregnancy suffers impaired brain development and vulnerability to disease. The malnourished mother must now cope with a "damaged" child, but she is ill equipped to provide adequate nutrition or psychological care. She and the child bring cognitive deficiencies and emotional problems into their

relationship; and so on. It becomes apparent within this example that assessment of functional relationships and effective interventions are exceedingly complex. The background literature of research relating to social functioning and malnutrition has been examined for the purpose of this program. A base of findings and hypotheses from which future research can fruitfully proceed has been identified and translated into a formulation of future general research objectives. These objectives lead to issues of research implementation, mainly issues of research populations, designs, and measurement. Ethical considerations are discussed, and alternatives for research management or coordination are briefly addressed.

STATE OF THE ART

Although it is difficult to disentangle the influences of nutritional status from the effects of poverty, illness, and other risks to well-being, research on malnutrition has led to the accumulation of a body of findings on the consequences of malnutrition to the individual's ability to function in his social environment. From extensive research on humans and animals in acutely and severely malnourished states, serious lasting impairments have been identified, such as impairment of defenses against disease, retardation of growth, and reduction in the neural cell growth.

Experimental evidence on the behavioral characteristics of malnourished organisms comes primarily from animal research. With some regularity and replication across species and studies, malnourished animals have been found to behave differently from their nourished peers. Passivity and apathy and an inability to sustain attention are widely reported. Malnourished animals show reduced exploration and curiosity, fearful avoidance of new stimuli, failure to respond normally to social initiations from other animals, all of which would appear to indicate a kind of functional self-isolation from environmental stimulation. Compared to animals without a history of malnutrition, malnourished animals show more nonpurposive behavior, more excitability and emotionality, and manifest more unpredictable aggression. In studies of malnourished animal infants and their mothers, disturbed interactions are reported. There is, then, compelling evidence of widespread effects on critical dimensions of the animal's functioning in its physical and social environment.

A body of experimental research on humans that parallels the animal work does not exist. In nonexperimental, retrospective studies of humans, investigators have reported some findings consistent with the animal literature; namely, findings of apathy and deficits in attentive capacity in malnourished children, and disturbed or deficient maternal caregiving. Beyond these retrospective findings, knowledge of the behavioral properties of children and adults who are chronically undernourished is limited, except in the areas of intellective capabilities. There is little information concerning the effects of nutritional deficit on the social and emotional functioning.

The behavioral impairments identified in the animal research, and suggested in the retrospective studies with humans, comprise a critical complex of behavioral

properties that have implications for a broad range of dysfunctions. Failure to sustain attention, lack of impulse control, aimless activity, and heightened emotionality are serious dysfunctions which, if characteristic of malnourished children and adults may be associated with learning disabilities, impaired coping with environmental demands, disordered emotional responding, and generally incompetent social functioning.

In addition to previous research dealing directly with questions of malnutrition there are several bodies of research knowledge that are very relevant to studies of malnutrition. Four in particular are directly relevant: research on mental retardates, research on infancy and infant-mother relationships, research on children at "high risk" for psychopathology, and research on social competence. The concepts, research designs, and research instruments in these areas can well be considered and applied in investigations of the behavioral consequences of malnutrition. There are a number of collected papers in these research areas that can be useful in nutrition research planning. Two examples are: N. R. Ellis, Handbook of Mental Deficiency: Theory and Research, Second Edition, Hillsdale, N. J. Erlbaum Associates, Inc., in press, 1979; and Primary Prevention of Psychopathology. Volume I The Issues (Part II Genetic, Prenatal, and Perinatal Factors in Primary Prevention. Issues Pertaining to Prevention and Intervention of Genetic Disorders Affecting Human Behavior, L. Erlenmeyer-Kimling: Prenatal, Perinatal, and Post-partum Factors in Primary Prevention of Psychopathology in Offspring. Thomas F. McNeil and Lennart Kalj. Part III Identifying High Risk Children and Adolescents and Intervening for Primary Prevention. Identification of Preschool Children at Risk... Jon E. Rolf and Joseph E. Hasazi: Intervention in Children at High Risk for Schizophrenia, Sarnoff A. Mednick and Georgia Hope Witkin-Lanoil; etc.) Eds. for Volume I George W. Albee and Justin M. Joffee. Volume III Social Competence in Children. Martha Whalen Kent and Jon E. Rolf, editors. (Part I The Nature of Competence in Normal and Deviant Children. Norman Garmezy, et. al. Part II Promoting Social Competence in Pluralistic and Changing Society. Edward Zigler and Penelope K. Trickett. Part III. Social and Biological Bases of Social Competence. Michael Rutter: Biological Bases of Social Development, Melvin Konner. Part IV. The Role of Peer Relations in the Development of Social Competence. Peer Relations and the Growth of Social Competence. Willard W. Hartup, 1978. Volume IV Competence and Coping During Adulthood, Eds. Lynne A. Bond and James C. Rosen. Available Winter 1979. Publisher: University Press of New England, Hanover, New Hampshire.

In summary, the effects of malnutrition on the structural integrity of the organism are more firmly established than are the consequences of malnutrition for the functional integrity of the individual -- his adaptive behaviors, capacities for learning and for dealing with environmental demands and with social and interpersonal events. Because behavioral impairments are likely to involve continua of "causalities" of many kinds, there is need for research that takes into account diverse roots of pathogenicities, and complex interrelations of influences. The collective expertise of a variety of disciplines is required for such research.

MAJOR RESEARCH OBJECTIVES

The kinds of impaired physiological, psychological and social functioning resulting from moderate malnutrition are not adequately understood. In particular, the social and economic ramifications of malnutrition are poorly comprehended and they risk being entirely overlooked. Hence there is need for research into the relationships between nutritional intake and social functioning. Major objectives of such research are the following:

1) To investigate the existence and the nature of relations between specified energy intake and specified kinds of social functioning;
2) To attempt to assess the complex relationships among sets of biological, behavioral and environmental variables; to develop understanding of processes or mechanisms linking intake and performance;
3) To investigate interrelationships among levels of social functioning, individual, family, community, and society; and,
4) To use research as a source of information that can aid in planning effective intervention programs.

One of the important questions to be addressed in research is whether or not specific dimensions of social functioning are influenced by nutritional deficits. Past research, particularly animal work and field studies of early child development, suggests some likely areas of vulnerability which were mentioned above. Little systematic investigation has been directed to identifying these relationships, or to sorting out questions such as when in the l[illegible] cycle do nutrient deficiencies (of what kind) have an impact on a specif[illegible] behavior; can effects of malnutrition be remedied by food interventions ([illegible] and by what means); and how do specific impairments in diverse aspects of fun[illegible]ioning, brought about by malnutrition, act cumulatively in producing far-reaching individual dysfunction?

Some, but not all, of the slow progress in this area of research arises from difficulties of measurement and in achieving good research transfers across cultures. The absence of studies of social functioning reflects both the preoccupation of the disciplines in the 1950's and 1960's with cognitive and intellectual development, and the disciplinary lag in development of research tools for the social and emotional aspects of individual and group behavior. Both of these conditions have changed and research now increasingly emphasizes the close links between cognitive and social functioning. Likewise the surge of interest in problems of behavioral medicine has led to much current research on interrelations of health and the "behaving" child or adult. Nutritional stress and behavior is an area that falls within this framework.

Slow progress in unraveling the connections between malnutrition and social and emotional behavior also reflects a reluctance on the part of nonbehavioral sciences to regard "man" as anything other than a rational being, and to make serious use of the tools of the social sciences. Increasingly, multidisciplinary research teams have entered into research on malnutrition.

Investigation of relationships between energy intake and social functioning needs to be focused at levels other than that of the individual. Competencies and dysfunctions within the family, the community and the overall society need to be studied. For example, the effect of a particular level of energy intake on

social functioning may be different in an American nuclear family, and Indian extended family, an Israeli kibbutz, or a Chinese commune. Research on the impact of energy intake on social function at the level of the group, the community and the society poses particularly difficult problems of strategy and design. Despite such difficulties, some research attention should be centered on the relationships between energy intake and social functioning at the level of the social group. It is suggested that because conditions of undernutrition affect functioning at individual and group levels, there may be important interactions. Thus, under conditions of nutritional stress, trade-offs may be made that impinge on social performance at several levels. For example, families with limited nutritional intake make choices about employment or about a child's schooling which may enhance family viability but may reduce community cohesiveness.

A further example illustrates how deficits in nutritional intake may affect functioning at different levels of social organization: A mother's nutrient intake for herself and for the child she is nursing may be dependent upon internal family organization (influence of a mother-in-law, for example), her wider relations to the neighborhood(i.e., the farmer's cooperative), the village and its interlinkage with the district, state, and the nation. It is through such interdependent clusters of roles that interrelationships between nutrient intake and social competence may be illustrated. A mother with improved nutrient intake may not only be better able to feed her child but also better able to take care of her family members. She may become interested and active in the children's schooling and be cooperative in village affairs, thereby improving the overall performance of her family in the village community. Her more active role in the family may influence the productivity of her husband at the farm and other wider levels of social performance. An improved energy intake may therefore show up in social improvements at the village level as a whole.

In this report no attempt is made to present a comprehensive inventory of the classes or categories of behavior to be investigated in relation to conditions of malnutrition. However, previous workshops in this series and previous research suggest a diversity of capacities that may be impaired by malnutrition. These include attentional and cognitive capacities; social interactions with role-appropriate behaviors;nurturant and cooperative behavior; aggressive, disruptive and impulsive behavior; emotional and motivational qualities such as levels of apathy, purposive or aimless behavior, mood states, and emotional control; response to stress and change; and problem solving behavior including the capacity to evolve institutions that facilitate effective organization for social action. It is emphasized that choices of variables be guided by (although not limited to) the leads provided in existing knowledge.

RESEARCH POPULATIONS

The choice of appropriate populations for the investigation of the relationships between nutritional intake and social competency clearly depends upon the formulation of specific research questions. There are, however, several general concerns which the investigator may find helpful to consider:

1) There should be present within as well as between populations sufficient variability with respect to the conditions under study. The range of the variability present should be broad rather than narrow.
2) Because a very heavy research investment is involved in the study of

any set of variables, careful theoretical and practical attention should be given to the possible inclusion of other variables. Thus, populations to be studied should also be chosen with regard to characteristics relevant to the studies of work performance, disease, reproductive competence, and cognitive functioning. For example, a population with a known disease pattern might be suitable for investigation of other functional areas at the same time as the gradient of intake and disease states is being investigated.

3) Aspects of nutritional intake are relevant in the choice of populations. These include:
   - The nature and rate of change in food consumption patterns;
   - The presence of clearly discernable levels of nutritional states including under, over, and adequate nutrition;
   - Food balance patterns such as those in which certain percentages of intake are attributable to specific foods enabling the recognition of food intake mixes, and
   - Food availability variations such as those where conditions may vary among acute, chronic or cyclical for individual foods and dietary intakes as a whole.

4) There are considerations of an ecological/cultural character which may influence the choice of study populations. These include, but are not limited to:
   - Subsistence patterns of various kinds;
   - Broad rural/urban patterns such as migration between and within each, the ratio of rural to urban populations for various age cohorts, etc.;
   - Geographical dispersion patterns with respect to various topographical, climatic and soil conditions, and,
   - Social differentiation patterns such as cultural bases upon which differentiation exists including ritualistic and religious concerns.

5) It is also conceivable that a population might be appropriately chosen not because of its value for generalizing to other populations but because its investigation provides an opportunity to uniquely elucidate a specific problem.

In choosing populations for study, a range of research issues should be considered in addition to practical opportunities or limitations. Generalizability of findings is a top priority, as is the possibility of being able to investigate interrelated biological and behavioral conditions in the same population.

RESEARCH DESIGN

In the choice of research design, the problem, the site, the available tools, and ethical issues are major considerations. In so complex an area of investigation, in which so many "layers" of variables and scientific disciplines are likely to be involved, it is all the more necessary for the designs of research to be critically assessed with respect to the best scientific standards for each of the variables and disciplines, and with respect to multiple cultural considerations.

A design does not have a reality independent of a research problem; hence, it does not seem useful to develop at great length issues of design in the abstract. It seems likely that, in investigations of the concomitants and consequences of

malnutrition, researchers will most often take advantage of existing variations in the populations being studied. Thus, such naturalistic designs would identify populations in terms of food intake, make use of variations associated with seasonal differences in food supplies or even natural disasters, take advantage of policy or program interventions, such as government feeding or food rationing program, and so on.

In the naturalistic designs, as elsewhere, research essentials include precise specification of the concept being investigated, the indices used to measure it, and the technique or method of measurement. Since observational methods are likely to be used in the naturalistic study of behavior, it is imperative that such observations be made according to systematic observational techniques with specified behavior sampling and methods of recording.

While experimental designs might be desirable to achieve greater precision, they will be precluded in many projects because of constraints imposed by ethical considerations. If ethical objections have been satisfied, experimental procedures and standard testing procedures are likely to be highly useful in measuring specific psychological or behavioral variables. For some research questions, animal laboratory studies may be appropriate.

The possibility of employing historical analyses should also be considered in attempting to gain understanding of the consequences of malnutrition on human functioning. For some purposes, such as attempts to understand the impact of chronic, periodic or acute nutritional stress on the functioning of whole societies, historical approaches may be the only form of research and analysis that is available. For example, in a number of countries, there are historical data which would allow the examination of the effects of events such as droughts and famine on the functioning of individuals and society. Such analyses may provide ideas useful in prospective research.

In both naturalistic and experimental designs in this field, a number of general considerations are important:

1) In addition to cross-sectional assessments and comparisons, longitudinal, cohort, and follow-up designs should be encouraged. This is of particular importance since the effects of malnutrition may be quite different at various ages; moreover, immediate and long term effects of nutritional interventions may not be the same.
2) The modes of research assessment should be appropriate to the culture being studied; they should be attuned to the values of and the institutions of the particular society.
3) Wherever possible, within or across cultures, the replication of findings is to be encouraged in order to test their stability and overall generalizability.
4) Rarely if at all can the effects of nutrient intake be fully disentangled from the conditions concomitant with nutritional stress (poverty, disease, etc.). The investigator needs not only to be very aware of the sets of possible interacting variables, but to have methods for taking these effects into account.
5) Regardless of research design, an ethnographic analysis of the research populations is to be encouraged, in order to provide assistance for the conduct of the research, the interpretation of the research findings, and the implementation or application of research findings.
6) Research designs which incorporate a two phase approach to field work

are to be encouraged. The considerable difficulties attached to instrument development, standardization and application across cultures make it almost imperative that there be an initial phase comprised of extensive field testing before the final data acquisition phase is entered.

7) In the selection of variables and their measurement, there may arise ethical as well as pragmatic considerations. These are carefully considered in the section on ethical concerns, and research designs should be examined with these in mind.

MEASUREMENT CONSIDERATIONS

The measurement of food/nutrient intake and nutritional status has been a problem of long standing. "Energy intake" is used here to describe in a general way those aspects of food consumption that are the major determinants of nutritional status. Energy intake has been found to be the factor which most often limits physiological capacities of the malnourished. Also, food energy is the parameter which best covers the notion of total food consumption. However, this should not be interpreted to mean that energy intake will always be the independent variable or the only independent variable measured. For example, it is the difference between energy intake and expenditure which is related to physical growth and health in a child, and this in turn may be related to some aspect of behavioral response. In addition, the level of difference may change not only through a shift in intake, but as a result of altered expenditure. As another example, a new well may reduce the work needed for carrying water so that even without a change in intake, women may increase the energy available for expenditure for social interactions, work or other activities.

The temporal aspects of energy and food consumption patterns may also be important to consider, and these may range from a concern with seasonal changes in intake and in energy intake-output differences to very short term aspects such as meal frequency, the effects of bulk, of consistency, and of the variety of flavors and textures available, all of which influence in one way or another sensation of pleasure, satisfaction and variety, which in their turn may influence social interactions.

These examples serve to illustrate that a concern for identifying the effects of level of energy intake on social function must include not only valid measurements of food energy, but will require the development of a fairly wide range of other parameters relating to consumption.

Tools for the measurement of behavior are of three general kinds:

1) Standard instruments (illustrated by tests of reaction time, attention span, physiological indicators, cognitive or intelligence tests, personality tests, behavior inventories ; also, certain experimental procedures, such as "visual cliff" for assessing depth perception or "stranger anxiety" for assessing infant development, etc.)
2) Methods or techniques developed for a specific problem and population, but conforming to certain well-established rules and criteria of construction and administration. Such techniques include systematic observational techniques, rating scales, interview schedules and questionnaires, and laboratory and "field" experimental situations. The validity and reliability of these instruments need to be established before use in a given study.
3) Clinical assessments (especially through interview methods).

In studies involving diverse populations and cultures, investigators in most instances need to adapt or remake behavioral measures to make them applicable to the particular groups and cultures being studied. Thus, intelligence cannot be assessed by one kind of probe for all persons. Aggression has different content for the four and the forty year old. The value and interpretation of different forms of response will vary by culture. This is not to deny that universal patterns of behavior also exist that override the kinds of differences mentioned. Some examples are expressions of pain or anger, infant expressions of distress, and overt manifestations of apathy.

Since in both naturalistic studies and in "field" experiments there is likely to be heavy reliance on observational methods, it is important to emphasize that the variables used in observation be well conceptualized and tested in advance and that categories and units of observing and designations of behavior samples be fully specified. The requisites for sound observational data include high standards of observer and coder reliabilities. This is especially important in cross-cultural comparisons, comparisons between differing nutritional levels, as well as comparisons of data across disciplinary lines.

ETHICAL ISSUES

It is not possible to conduct a research program in this subject area without encountering ethical issues which implicate the investigative team(s) and the sponsoring agency (ies) before, during and after the investigations. These ethical issues may arise from a variety of sources such as the ethical standards of the individuals and populations studies; the history, present policies and administration of a host country and all countries involved; and the nature of the research findings and their consequences.

It is essential that ethical issues be conscientiously considered by the research teams at every stage of their work, with emphasis on empathy for those studies and those potentially affected by the research findings. In their proposals, researchers should identify the anticipated ethical issues (such as those involving policies and guidelines of the countries involved) and describe how they intend to resolve them. A number of guidelines are suggested:

1) The principal investigators should assume personal responsibility and invoke institutional responsibility insofar as possible for ethical conduct of the research by U.S. and non-U.S. participants in the study.
2) In all cases, the relationship between the investigators and the subjects of studies should be that of informed consent, and this should be subject to review during the course of the research. When communities or groups of people are under study, the investigators must provide details of the manner in which information about the study has been imparted to the subjects through which a consensus for consent has been obtained.
3) The design and execution of the research should be consciously framed so as to do no harm (in the Hippocratic sense non nocere) to the populations studied.
4) If the research imposes any inconvenience or discomfort to the subject, the benefits of the research should accrue to the same individuals and

and communities that experience the inconvenience or discomfort.

5) Points 1-4 above should be considered applicable before, during, and following the actual research and would include direct and indirect consequences of the study.

6) Health, nutritional and other humanitarian benefits from any source should not be excluded from participants on the basis of research design. The research team cannot withhold such health and nutrition service, as it is capable of providing; and services provided during the course of the research which prove beneficial should not be withdrawn at the conclusion of the study.

7) The research should be pursued with the intent to increase social awareness of the human condition and societies' effectiveness in response to this condition, especially with respect to the amelioration and reduction of malnutrition.

8) Research should be formulated, executed and communicated with concern for and involvement of academic and administrative colleagues in the country concerned. All materials and data gathered and analyzed should be made generally available after reasonable provision of time for the investigators to complete their analysis. Effort should be made to design and conduct research so as to strengthen local resources and capabilities.

SUMMARY

Whatever the effects of mild-moderate malnutrition, they are not likely to be confined to isolated, independent dimensions of biology and behavior. The interdependence of impairments, their cumulative nature, and their long lasting effects make this area of research a difficult one, and also make the substance of this research of wide significance. It would seem in the long run, that the most practical and sound approaches to questions of intervention and policies would be based on an understanding of the mechanisms by which food intake influences human functioning. Understanding of this functioning derives from neurobiological and neurochemical analyses as well as analyses at the level of motor behavior.

The following are edited excerpts from an essay on "Nutrient Intake and Social Competency" prepared at the planning contractors request by Dr. Eileen Messer, Yale University.

Social competency, the ability to meet effectively all responsibilities appropriate for one's social status, includes both biological and psychological (cognitive, behavioral) factors. Drawing on the research priorities of the "cognitive function" workshop, the objective appears to be to discover the ways in which biological and social-environmental factors combine to produce social competency of the individual, family, and community...

Cognitive function may be defined as the ability to learn social categories, process and structure information, learn and react to social cues, to environmental and to social factors. It includes the ability to ask appropriate questions and give appropriate answers within a given social and physical environment and to identify appropriate problems and solve them. This is usually called "problem solving" but it includes general conceptual ability, appropriate actions within a given culture, and the flexibility of mind to entertain new categories and to see new possibilities. These are all important aspects of "social competency" but difficult to measure and even harder to link directly to nutrient intake.

Behavioral function may be defined as the ability to act appropriately within a given culture, which follows from cognitive function, and includes the ability to give and take social cues and information, to act in such a manner that one contributes to the intellectual development and behavior (the material and emotional maintenance) of others. It encompasses the following:

A. Work competency--the energy and the conceptual ability to contribute to material and social maintenance and growth of individuals and social groups;

B. Social activity--emotional stability and conceptual ability to behave appropriately as a member of a social group at the levels of

   1) Household--to perform effectively as a parent (or child) so that physical and social needs of oneself and of others are met;

   2) Subcommunity groups--to form and maintain kinship, fictive kinship, friendship, neighborhood, and work networks: again, to form those ties and act effectively so that social, and physical needs of others are met;

   3) Community--perform leadership (or follower) roles for the maintenance of satisfactory person-land, person-to-person, and person-institutional relationships;

   4) Nation--form ties which will help individual and community adjust to inevitable integration, in one form or another, to the nation.

Health status (including nutritional status) of the individual is also critical to the cognitive and behavioral function of the individual, and aggregately, the community. In many societies (including our own) health, with or without physical impairment, is defined as the ability to perform all of one's ascribed social and physical responsibilities. In "folk definitions" of health, any impairment to function--be it uncontrolled anger, aggressiveness, or lack of energy which interferes with expected social relations, any physical or emotional impairment which interferes with physical work or fulfillment of other social role expectations--is classified as illness. Obviously, there is the problem of defining when one is ill; there is a fine line between impaired function or stressed social relations and the labelling of one party as "non-functional." Function

and performance --lies along a continuum and social competency is best viewed in the same way. At what point someone is labelled socially competent or incompetent depends on how the various factors of mental and behavioral "function," are weighted...

Though this describes in general the definition of "social competence" the key factors and their weighting will differ according to culture, age, sex, status of the individuals and populations under study. The problem then becomes to identify discrete aspects of social competence which seem to be related to deficient nutrient intake, to see how the nutritional (biological) status of individuals affects their social competence, and in turn, how the social competence of particular classes of individuals affects the social competence (and nutritional status) of others.

From this perspective, the target group for research would be household management heads, in particular, mothers. Understanding their ability to function and its relationship to their nutrient intake would be a key to understanding the well-being of other household members, particularly infants and children who are often singled out as "the" vulnerable groups for study.

Research priority should be set on studying various aspects of behavior over cognitive function, since from the former, links can logically be drawn to the latter. Also, from the points of view of feasibility and cost effectiveness (i.e. what kinds of research will lead more directly to successful interventions), the direct relationships between nutrient intake and behavior can more easily be seen...

RESEARCH PRIORITIES

A major priority for research would be to address the question of how the nutrient intake of women (household management heads/mothers) affects their individual and group social competency and function. Women household heads are the logical category to study since they provide the food (from the breast onwards) for the children and the rest of the household; in most instances they also make the major nutritional decisions. The nutritional well being of children is tied to their mothers. They also maintain, in many instances, the cleanliness of the household, i.e., sanitation which interferes with health, and nutritional status. Often their work provides income for food and maintenance: thus, their work competency contributes to the well being of others. They provide the emotional and social stimulation for other members of the household.

Social competence should be considered at two levels. At the individual level, linkages between nutrient intake, nutritional status, vulnerability to disease, amount of energy, emotional state which will affect social function, etc., should be explored. At the societal level the question to be addressed is how does impaired function of one class of individuals (household management heads-mothers) affect the well-being of others?

Other priorities would include investigation of the relationship between nutrient intake and lactation (the first priority of the reproduction group) as well as the effects of mother's inability to provide sufficient milk on the development of the youngster, its effects on household budget and other household members.

The relationship between nutrient intake, disease status, and ability to perform remunerative work could be explored, or the effect of nutrient intake, in a particular nutritional/disease state, on emotional stability and child-rearing).

2) the need to understand the linkages between disease vulnerability and expression and other manifestations of social competency: work ability, household management, emotional stability, and so on.

Cognitive function would come later. I would suggest that one research priority in this area would be to develop meaningful instruments to measure behavior and cognitive function, to be used after preliminary collection of behavior data.

Pregnancy and lactation are important problems, but for the purpose of this general research question may prove less valuable than the disease/nutritional status -- social competency research.

Attention should be given to developing research methodologies to identify measurable criteria of function and nutritional-vulnerability statuses. How is function identified once standard measures of morbidity have been exhausted; for example, depression may be nutrition-disease related.

In focusing on the mother, it should not be implied that the children and other adults will not be thoroughly studied, but that their functional competence might be better understood after studying how the household functions and contributes to the child's well-being, including nutrient intake and health status.

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APPENDIX A

Malnutrition and Social Competence[1]

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[1]Prepared for the University of California - USAID workshop on nutrient intake and social competency, November 27-December 1, 1978, Tucson, Arizona.

The Concept of Competence

It is common for scientists in any area to regard the problems in their own field as the truly difficult ones. While admitting that investigators in other areas may be dealing with complex issues, they tend to think that compared to their own, these conceptualizations are relatively simple. I shall begin by confessing that I feel exactly the same way.

For although nutritional scientists may argue about the definition of malnutrition, the concept of social competence is a bit more fuzzy. Social competence must be defined simultaneously in many contexts. It is relative to family, class, social role, occupational role, ethnic, racial and economic strata, culture and nation.

Social competence is a concept that has been of greater, but still small, interest to the sociologist than to the psychologist. Like many of the concepts in the social sciences it is complex because its definition changes with different levels of analysis. Applied to an individual, it refers to the ability to cope with one's environment. (There is a bit of circularity here because to cope means to operate effectively or competently.) But an individual obviously lives in many environments at the same time, and as Weber pointed out a long time ago, effective behavior in one context may not be effective when seen from a larger one. A person may create and use a bureaucratic structure in a way that leads to individual

benefit but collective harm.

Competence means effective performance in one's social role. It therefore belongs in the area of goal seeking and decision making and shares the conceptual difficulties of that field.

Let us take as a working definition of social competence the ability to function in one's social environment. Inkeles (1966) makes an analysis of the concept by asking what societies require of individuals who fill important roles in the social structure. He includes among the chief requirements: general information about the environment, understanding of the politics of personal interaction, a cognitive style characterized by abstract analysis and relativity, and a deep concern with time. The capacity to live by a schedule is a good indicator of a person's ability to function in modern society. Marxists have suggested that a principal function of compulsory education when it was first introduced in the United States was to train workers to get to work on time by training promptness in school attendance.

Although interest in the concept of competence is still small in the social sciences, it is growing because of the widespread criticism of aptitude and intelligence testing. And measurers need something to measure.

Aptitude and intelligence tests have been under attack (Sundberg, et al., 1978) because, it is alleged, they discriminate against ethnic and racial minorities, they are culturally biased, they have low validity and lack realism (McClelland, 1973).

Competence is an attractive concept because it has the appearance of being more democratic and egalitarian; implicit in its definition is the idea of assessment within one's microenvironment rather than by a yardstick arbitrarily applied from a larger, and possibly alien, cultural setting.

The Relationship between Nutrient Intake and Social Functioning

Many writers have speculated about the relationship between diet and social vigor. Frederick Travis believed that the Irish were unproductive largely because a great part of their diet consisted of potatoes, which were thought to cause scrofula. White (1967) mentions Ralph Linton's conjecture that the introduction of the bean to Arizona and New Mexico stimulated the development of the culture of the Cliff Dwellers and his own speculation that an enlarged supply of protein might have contributed to the cultural vitality of Europe in the later tenth century.

Speculations of this kind are intriguing but difficult to make convincing. It would seem that controlled, rigorous animal experimentation, at the other extreme of the complexity continuum, might provide fruitful information. In a survey of studies of the effects in the rat of malnutrition during infancy on the behavior of the adequately fed adult animal, Levine and Wiener (1976) con-

clude that the behavioral changes in the adult attributable to malnutrition cannot be isolated from effects that are a result of the experimental manipulation of the mother-infant environment.

For example, one way of restricting the amount of milk available to the infant can be accomplished by removing the mother from the nest for a period of time. This procedure obviously deprives the young of the mother as a source of social, tactile, thermal and other sensory stimulation as well as of a source of nutrition. When the non-nutritive components of the mother's stimulation are controlled, by providing the young with a virgin, adult female, the malnutrition experiences lead to no measurable effect.

Efforts have been made in studies of human malnutrition also to disentangle the effects of malnutrition from social and economic factors. The study by Susser (1975) of victims of the Dutch famine during the German occupation is an example. This was an attempt to study effects of prenatal malnutrition. A sample of 400,000 births were analyzed, half of which were from the famine area and half from areas not affected by the famine. Although the birth data showed differences, there was no evidence of psychological deficit among adult survivors at the age of 19 (Stein and Susser, 1976). Many investigations (e.g., Cravioto, DeLicardie, and Birch, 1966) have demonstrated that an insufficient supply of protein in infancy adversely affects later cognitive development. But, in some cases (McKay, McKay, and Sinisterra, 1973) rehabilitation can

be accomplished only if an enriched psycho-social environment in daily nursery school activity is provided along with dietary supplements.

A number of studies (Brozek, 1978) investigated the consequences of malnutrition on hospitalized infants whose malnutrition was not associated with socio-economic status but was a consequence of neonatal resection of the ileum, pyloric stenosis, or cystic fibrosis. These children were shorter, less intelligent, did less well in school, were more often considered backward, unsociable, and withdrawn than their matched, never hospitalized controls. Conclusions drawn from another work in this area (Cravioto and Robles, 1965) are that the cognitive and behavioral effects of the malnutrition decrease after the hospitalization except for those whose malnutrition was suffered in the first six months of life. These children appeared to sustain irreversible psychological deficit. But as Bowlby's work on separation anxiety (Bowlby, 1960) makes clear, the impact of hospitalization on a young child is severe, and in studies of this kind (Lloyd-Still, 1976) the effect of the prolonged hospitalization is a variable that has been overlooked. That is, the impact of the experience of hospitalization may be more drastic than the physiological consequences of malnutrition. However little we know about the relationship between malnutrition and social competence, this much is clear: the better able we are

to partial out the influence of social psychological variables, the smaller the amount of the variance that can be accounted for by malnutrition.

Indeed it is conceivable that it may not be possible methodologically to disentangle social-economic -political factors from the effects of malnutrition. This may be an example of what Churchman (1978) referred to as the paradox of experimentation--the logical impossibility of testing in a specific situation whether the experimental conditions make a difference, for this would require a second experiment to test whether the experiment itself made the difference, and so forth.

Margaret Mead (1977) points out that in a population in which a high proportion of the population have suffered severe malnutrition that leads to a large number of retarded individuals, the standard for what is normal goes down and social expectation of behavior is much lower than it would have been if more moderately deficient individuals were the least competent in the society. She speculates that a poorly nourished community would have fewer flexible individuals than the number needed to foster and adapt to change.

Other Voices, Other Rooms

In this section I should like to consider a wider range of topics, some clearly outside the area of my title. My justification (or rationalization) is that I feel they need emphasis.

There is a practical question that is addressed by the studies discussed above on childhood malnutrition. If it were economically, politically, and socially feasible to improve the diets of children at risk without altering the psychological impoverishment that is the handmaiden of poverty, would it affect cognitive and social development? The empirical answer seems to be that the effects would be small without the addition of a psychologically and socially enriched environment. Freud pointed out that the child's first erotic object is the mother's breast and, therefore, that love has its origin in the satisfaction of the need for nourishment. Then it should not be surprising that food and food deprivation would have profound psychological meaning. One of the unconscious determiners of anorexia nervosa (Bruch, 1978), for example, is a need to reject parental offerings. Therefore malnutrition in children will always have detrimental psychological consequences, and rehabilitation, if it is possible at all, must be psychological as well as nutritive.

My second point concerns the economic and social context of malnutrition. With few exceptions, such as anorexia nervosa, or, sometimes, alcoholism, malnutrition exists in a matrix of poverty.

Although this is generally recognized, it is usually the practice in studies of malnutrition to treat degree of malnutrition as an independent variable and variables such as "disease response" or "functional competency" as dependent variables.

It seems to me that studying the effect of malnutrition on cognitive functions or social competency is like studying the effect of cancer on depression. It makes an experimental distinction without a practical difference.

I see two tendencies at work here. As experts we are reluctant to admit that our individual specialties are inadequate to deal with a very important problem, and so we believe that chopping up the problem into manageable pieces can succeed. We are easily led to collude in a widespread social view that says essentially that the problem of poverty lies in the poor—it is a way of blaming the victim or stigmatizing the poor (Valentine, 1968).

Is there an alternative? One is suggested by changing our point of view about the relation between malnutrition and social competence. We might regard malnutrition in children as an indicator of social incompetence in their families and ask what can be done about decreasing incompetence in families. Or more broadly, we might look at malnutrition in a nation as an indicator of incompetence on the part of the nation's economic and political leaders. This view would lead us to a different set of research and action strategies. Instead of focusing on changing the abil-

ities, customs, or values of the malnourished, it would lead us to look at ways of altering the nation's (or a community's) economic, political and social structures that permit malnutrition to occur.

One final word: during the food shortages in Europe after World War II Orwell(1946) pointed out that food is a political weapon and an instrument of foreign policy. I think we all know this. If we choose not to speak about it, then we are choosing to ignore a variable we all realize may outweigh in practical importance those we choose to study.

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APPENDIX B

A Review of Literature on the Effects of Malnutrition on Behavior and Development*

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Research literature relating to the effects of malnutrition on behavior and development is summarized. The nonexperimental studies of human subjects are reviewed first. In these studies groups of malnourished and nourished children are compared on selected behavioral variables. A second section of the review concerns experimental studies on human malnutrition, studies in which investigators have attempted to establish functional relations between protein-calorie deprivation and human behavior by differentially feeding groups of malnourished children, and comparing the supplemented and non-supplemented groups with respect to selected measures of physical, intellectual and personality development.

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*From an appendix to a research protocol "Chronic Malnutrition and Child Behavior"...Animal studies included in the original paper are not included here.

Non-experimental Studies of Malnutrition in Children

There have been a large number of non-experimental studies examining the correlates of malnutrition in human subjects. These studies are quasi-experimental; they compare "index" subjects sampled from one population with "control" subjects sampled from a different population. This type of design (often called a "static-control group" design) has been used to compare the physical and intellectual development of children who suffered from severe malnutrition early in life with children who have not suffered from nutritional deprivation. It has also been used to compare children from populations "at risk" for chronic malnutrition with children from well nourished populations.

The non-experimental approach depends upon the control of extraneous variables; i.e., factors not specifically related to malnutrition. Ideally, the index (experimental) and control groups should be adequately matched on all relevant (potentially confounding) non-nutritive variables. Gross failure to meet this condition has often complicated the interpretation of results. Nonetheless, non-experimental studies of human malnutrition supply much of the data which suggests that malnutrition may seriously impair the physical and psychological development of the child.

Studies on severe malnutrition

Several studies have compared the psychological development of children who experienced severe malnutrition with control children who did not suffer from early nutritional deprivation.

Stoch and Smythe (1963; 1967; 1976) conducted a longitudinal study of 20 lower SES South African children, malnourished between the ages of 10 and 16 months. Gross retardation of intellectual performance was found in the undernourished group when measured at later ages, beginning in infancy and extending into early adolescence. When tested at school age (over the age of six), malnourished children scored significantly lower than matched controls on subtests for vocabulary, pattern completion, blocks and form board. It should be noted that the findings of the Stoch and Smythe study have been questioned (Scrimshaw & Gordon, 1967) on the grounds that control children experienced superior living conditions to the index children, with respect to parental employment, family stability, and sanitary conditions. In addition, Stoch and Smythe have themselves indicated (1976) that their data are subject to question, since control children were not adequately matched with index children on EEG readings. These ambiguities severely limit the interpretability of the study.

Champakam, Srikantia, and Gopalan (1968), assessed the IQ's of 19 severely malnourished Indian children several years after they had recovered from malnutrition. The 19 children ranged in age from eight to 11 years at the time of measurement. Differences between malnourished children and a larger control sample were marked on both IQ tests and intersensory integration tasks. Poorer performance was most apparent for younger malnourished children while differences between groups tended to diminish for older children. The largest differences were found on tests of perceptual and abstract abilities.

Chase and Martin (1970) identified nineteen children who had [illegible]ered from malnutrition during the first year of life and compared them at ag[illegible] and one half with controls matched for age, sex, race and social background. The mean developmental quotient for children who had suffered from severe malnutrition was significantly lower than that for matched controls. The investigators also found that age of hospitalization was significantly and negatively correlated with later IQ among the index children, a finding to be discussed in more detail in a later section of this review.

Birch, Pineiro, Alcalde, Toca, and Cravioto (1971) reported on intellectual differences between 37 children with previous severe malnutrition and 37 siblings who had never experienced malnutrition. WISC IQ scores were obtained on the malnourished children and their sibling controls at least 3 years after the malnourished children had left the hospital. Birch et al. reported that malnourished boys had significantly lower IQ's than their siblings and suggested that these data were evidence for the view that severe malnutrition in infancy causes cognitive dysfunction later in life.

Several recent studies in India have reported IQ deficits in children malnourished during infancy. Parekh and her coworkers (Parekh, Udani, Naik, & Shah, 1974; Parekh, Udani, Shah, Naik & Exhuthachan (1973), in a study of 26 previously malnourished children and 19 controls found that the greater the deficit in height and weight in later childhood, the greater the deficit in IQ. In a separate study, Parekh (1975) reported that 10 children who had kwashiorkor as infants could not make up their IQ deficits ten years later. A third study (Mehta, Teja, Wig, Thukral & Pasricha, 1975) that followed-up 50 children hospitalized for severe malnutrition supports this finding. In contrast, Chai (1975) reported no differences in Wechsler IQ between a group of 45 preschool children who suffered from nutritional marasmus during infancy and a group of matched controls. However, Chai did report specific deficits in malnourished children in relation to well-nourished children on equivalence relationships including visual-haptic and visual-kinesthetic sensory integration.

Gupta, Dhingra, Singh and Anand (1975) have examined the relation between level of malnutrition and intelligence test performance in a large sample study involving 204 well-nourished, sub-clinically undernourished, and severely malnourished children between the ages of five and eight. The authors identified a monotonic decreasing relationship between degree of malnutrition, based on the Gomez classification system, and Stanford-Binet IQ. This inverse relation was obtained even when social class was held constant.

In a study carried out in Jamaica, Herzig and her colleagues studied the social behavior and psychological adjustment as well as the intellectual functioning of 71 school children who had suffered from malnutrition during infancy (Herzig, Birch, Richardson & Tizard, 1972; Richardson, 1974; Richardson, Birch & Ragheer, 1975). The study utilized two control groups: a sibling control and a matched school mate control. Intelligence data were based on the WISC while behavioral assessments were based on parental observations. Results indicated that malnourished children were less mature, more labile in activity, and less social than the matched comparison group. There were no differences between siblings and malnourished children on the behavioral measures. In analyzing the intelligence test data, the investigators attempted to control for possible floor effects which would minimize group differences. Results indicated that malnourished children performed more poorly than the matched controls on the WISC Full Scale and Performance IQ. Richardson (1974) has indicated that the malnourished boys differed significantly from the comparison boys on a number of unmatched but relevant variables; he concluded that emphasis needs to be shifted away from nutrition

as a primary cause of impairment to a broader concern for the total ecology of child development.

DeLicardie and Cravioto (1974) have studied the responsiveness of 22 five year old children who survived clinically severe malnutrition to the "cognitive demands" of an intelligence test administration. Using a method developed by Herzig, Birch, Thomas and Mendez (1968), they attempted to determine (a) how often the child responded to a task requirement by work (as opposed to non-work), (b) if the child did respond by working on the task, whether he showed any spontaneous "elaboration" of the task or whether he responded in a limited manner, and (c) if the child responded by non-work, what form (i.e., passivity, negation, request for aid) the non-work took. The investigators compared the performances of the previously malnourished children with controls matched at birth and also with a group of controls who were matched retrospectively with the index children for sex and IQ. Since the group matched for IQ and sex was a more comparable control group than the group matched at birth (which showed higher IQ's and higher home stimulation scores than the other groups), the most appropriate comparisons are between the index children and the control group matched on sex and IQ. Results indicated that survivors of malnutrition showed a lower proportion of work responses than controls matched for IQ and sex. No other comparisons between these two groups were significant. The controls matched at birth showed the highest proportion of work responses. Also, their non-work responses were more likely to be verbal than the non-work responses of index children and the control group matched for sex and IQ. Finally, given a verbal non-work response, the controls matched at birth were more likely to respond with a statement asserting competence and less likely to ask for aid than the other groups.

A recent study which differs somewhat from those cited previously was carried out by Klein, Forbes and Kadar (1975) in the United States. In this study malnutrition had a clear organic cause: pyloric stenosis. The investigators examined the learning abilities and social adjustment of fifty children between the ages of five and fourteen years who had had pyloric stenosis as infants. Index children were compared to 44 siblings and fifty matched controls. Results indicated that pyloric stenosis had no measurable effects upon physical development. However, learning abilities and general adjustment were affected. Short-term memory and attentional capacities were impaired by the early disease, and "high severity" children in the index group showed lower scores on the Vineland scale of social maturity than siblings or matched controls.

Similar studies have also been reported by Valman (1974) and Lloyd-Still (1974, 1976). Valman compared 8 children who had had neonatal resection of ileum with 8 sibling controls and 13 children with cystic fibrosis on the "Draw-a-man" intelligence test. Age at the time of testing ranged from 3 to 14 years. There were no differences between the groups in average Draw-a-man scores. Recently, Lloyd-Still (1976) has reported results of a similar study of children with cystic fibrosis and other neonatal disorders. Among subjects tested between two and five years of age, previously malnourished children scored significantly lower on the Merrill-Palmer test of intelligence than sibling controls. Above the age of five, there were no significant differences between the index and control groups. The most marked abnormalities in the younger children who had experienced intestinal disorders were in fine motor function.

Chronic undernutrition. Two recent studies have examined the effects of undernutrition as opposed to severe malnutrition in young children. Patel, Parekh, Krishnaswamy, Krishnaswamy, Desai, Jadeker, Dave, Dangerwalla, and Idnani (1974) have reported the results of a study on the total milieu surrounding malnutrition. Their test findings indicated deficiencies in intersensory integration for chronically undernourished children when compared with siblings under institutional care. In a separate correlational analysis examining age, nutrition, and intellectual performance, IQ was positively correlated with nutritional status in the upper class while in the lower class IQ was negatively correlated with nutritional status. However, a substantial number of children in each class showed reversals to these trends. The authors concluded that this pattern of opposite directions in correlations yet with many individual reversals indicated that nutritional status is only one contributing environmental influence on intelligence. Another possible influence observed in the same study was the mother's role in child-rearing. Patel et al., described the mother's role as "mostly passive", and "mainly physical" and her attitude as "apathetic" (p. 158). This evidence suggests, as these authors also concluded, that any nutritional intervention program must also consider factors other than nutrition that might serve to rehabilitate deficiencies initially caused by poor nutrition.

Graves (1976), in an observational study of mother-child interaction conducted both in free activity settings and standard settings, found that under-nourished boys maintained closer physical contact with their mothers and engaged in less overall activity than well-nourished boys. Similarly, mothers of undernourished boys had lower scores on measures of proximity to child and behavior initiations to child than did mothers of well-nourished boys. When mother-child scores were intercorrelated, correlations between individual mother and child scores were higher for well-nourished boys than for undernourished boys. This observational study is one of the few studies that speaks directly to the question of social behavior in malnourished children.

One of the most frequently cited studies in the malnutrition literature was carried out in Guatemala by Cravioto, DeLicardie and Birch (1966). 143 children from a rural village population were rank ordered by height. The upper and lower quartile groups were then compared on a number of cross-modal sensory integration tasks: visual-haptic sensory integration, visual-kinesthetic sensory integration, and haptic-kinesthetic sensory integration. The rationale for comparing the upper and lower quartiles was that the upper quartile children were assumed to represent the group with the least likelihood of having experienced "a significant degree" of malnutrition earlier in life while children in the lowest quartile were assumed to have the greatest likelihood of having been at earlier nutritional risk. Similar comparisons were made in an urban, upper-middle class population, where there was assumed to be no correlation between height and previous nutritional history (i.e., height differences were assumed to reflect primarily quantitative genetic factors). Thus, if upper versus lower quartile differences were obtained in the rural population but not in the urban population, results could be interpreted in terms of the effects of malnutrition on the criterion behaviors.

The authors found that for children in the rural village, subjects in

the lower quartile for height showed poorer intersensory integration with respect to the visual, haptic, and kinesthetic modalities than children in the highest quartile. These effects were not apparent in the upper class group. Results were interpreted as consistent with the hypothesis that malnutrition results in a lag in the development of sensory integrative capacities.

It should be noted that Cravioto t al. attempted to show empirically that differences in height quartile (and neurosensory integration) among subjects in the rural village were not simply a reflection of differences in more general social-class or genetic factors. They did so by comparing children in the upper and lower quartiles for height on a number of relevant background measures. Height classification was not significantly related to the height of either parent, parents' personal hygiene, quality of housing, family income, family expenditures, or father's educational level. The single significant positive association was between mother's educational level and child's height. On this basis, the authors inferred that the low heights and poor sensory integrative abilities in the smaller children from the rural sample reflected differences in previous nutritional histories and could not be attributed solely to social class or genetic factors.

Effects of malnutrition as a function of age of onset

One type of non-experimental study which differs somewhat from the studies discussed above is that in which all subjects have suffered from acute malnutrition but differ in the age at which illness occurred, or in the age at which they were first hospitalized. Such a study can be viewed as a quasi-experimental design which attempts to approximate an experiment in which the manipulated variable is time of onset of illness. The purpose of this particular type of study is to determine whether the effects of malnutrition on a selected criterion behavior depend on the age at which malnutrition was experienced. This is in contrast to the typical non-experimental study where the "manipulated" variable is incidence vs. non-incidence of malnutrition, and the investigation is concerned more generally with the question of whether malnutrition influences a particular class of behaviors.

In view of the findings from animal experimentation which have indicated that severe malnutrition may have irreparable effects on organ development when malnutrition occurs during the period of hyperplasia (see Winick, 1976, for a review), it has been hypothesized that the effects of malnutrition on intellectual development in the human child may be greatest during the first year of life, since the process of cell division in the human brain is for the most part complete by nine months of age. Two studies which have attempted to determine whether the effects of severe malnutrition on intellectual development depend on the age at which illness occurred are those conducted by Cravioto and Robles in Mexico (1965) and by Herrig, Birch, Richardson & Tizard (1972) in Jamaica.

Cravioto and Robles studied 20 children who were being hospitalized for kwashiorkor over a period of approximately six months. Six of the children were less than six months of age at the time of hospital admission, nine were between 15 and 29 months and five were between 37 and 42 months.

The Gessell tests for motor, adaptive, language, and per[illegible]ocial deve[illegible]nt were administered to each subject every two we[illegible] from the time of admission to the end of hospitalization. To determine the relationship between recovery of adaptive and motor skills and time of onset of illness, Gessell test scores were plotted as a function of days of hospitalization for each of the three groups of children. Results indicated that for each of the four categories of Gessell scores--motor, adaptive, language and personal social--there were marked differences in the slopes of the recovery curves among the three groups. Specifically, recovery curves were steepest for children who had entered the hospital between the ages of 37 and 41 months and flattest for those who entered the hospital prior to six months of age. Further, in the two groups of children admitted [illegible] the hospital after 15 months of age, differences between the performance levels of the children in the sample and the expec[illegible] performance levels for same-age normals diminished over the course of the ho[illegible]pitalization period. The authors interpreted their findings as indicating that protein-calorie deprivation suffered before the age of six months is more likely to result in a loss of intellectual potential than deprivation occurring at an older age level.

However, several methodological issues must be raised about the study. First, sample sizes were extremely small, precluding a meaningful statistical analysis of differences between the slopes of the recovery curves. Second, there were no overlapping data points across the three groups. At the time of the last measurement, the oldest child in the youngest group was approximately 12 months of age, which is younger than the youngest child in the middle age-group was at the beginning of the hospitalization period. Similarly, at the time of the last measurement the oldest child in the middle age-group was approximately 35 months of age, which is younger than the youngest child in the oldest age-group was at the beginning of the study. Therefore, since there was no common age range at which the three sets of curves can be compared, one can not eliminate the possibility that group differences were due to differences in time of measurement, rather than differences in time of onset of illness. Finally, as Herrig et al. (1972) have noted, children in the Cravioto and Robles study were not followed up beyond the six month hospitalization period; thus, there is no information as to whether any of the children did in fact "catch up" (to theoretically expected normal levels) in intellectual development.

The Herrig et al. study was cited earlier as one of several studies comparing the intellectual development of children malnourished during infancy with children who did not experience severe deprivations. In addition to comparing the later intellectual performances of normal and malnourished infants, Herrig et al. attempted to determine whether the age at which the malnourished infants were hospitalized was predictive of their IQ's during later childhood. The age range of the children at time of hospital admission was 3-24 months. The authors found that correlations between age of admission and WISC full scale IQ, verbal IQ, and performance IQ were all nonsignificant. Moreover, when children who entered the hospital before 8 months of age were compared with those entering the hospital after 8 months of age, no differences were found in any of the IQ measures. Thus, the Herrig et al. data did not support the findings of Cravioto and Robles;

no systematic relationship between age of onset of severe malnutrition and later intellectual development was identified.

Herzig et al. have acknowledged that the failure to establish an empirical relationship between time of onset of illness and later intellectual performance may have been due to extraneous factors; for example differences between older and younger children in their vulnerability to the detrimental effects of institutionalization, or, differences in the severity of illness. These alternative interpretations notwithstanding, the results of the Herzig et al. study argue against the hypothesis that the effects of severe malnutrition on mental development are greatest if the malnutrition occurs very early in infancy, before the process of brain cell division is completed. In interpreting their findings, the authors have noted that there are structural features of the nervous system (for example, dendritic arborization and synaptic formation) which continue to develop after the first year of life, and which may also play an important role with respect to the "functional integrity" of the central nervous system.

It should be noted that Chase and Martin in their previously cited study of children who had suffered from malnutrition during the first year of life found that age of first hospitalization was significantly correlated with later (age three and one half) developmental quotient. The direction of the relationship was opposite to that which would be predicted by a "critical period" hypothesis. Children who had entered the hospital prior to four months of age all had developmental quotients over 80 while only one of ten children who had entered the hospital after four months of age had a developmental quotient over 80. Moreover, follow up studies of the children (Chase, 1973) have indicated that the mean developmental quotient of children who were hospitalized after four months of age has remained below 80, significantly below that of children hospitalized earlier in life. However, the authors have interpreted their findings not in terms of age of onset of illness, but in terms of duration of severe malnutrition; i.e., children entering the hospital at later ages were subject to malnutrition for a longer period of time than those having earlier hospital admissions.

Experimental Intervention Studies

To date there have been four studies which have attempted to establish functional relationships between malnutrition and child behaviors using an experimental approach. The method has been to study the effects of a food intervention program on the physical, cognitive, and/or social development of chronically malnourished children or children at risk for under-nutrition. Each of the studies raises important methodological or substantive issues with respect to experimental research on human malnutrition.

The INCAP Guatemala Study

The Guatemala study (Klein, Yarbrough, Laskey & Habicht, 1974; see also Klein, Habicht & Yarbrough, 1970 and Habicht, Yarbrough, and Klein, 1974) is a seven year longitudinal study concerned with the effects of protein-calorie deprivation on children's physical and mental development. The experimental design of the study provided for the feeding of a protein-calorie

supplement to children from two villages in Eastern Guatemala, and a non-protein, low-calorie supplement to children in two neighboring villages. Supplements were roughly equivalent in other nutrients such as vitamin A, niacin, and iron. The supplementation program began immediately after birth. In addition, mothers of subjects had been provided during pregnancy with the same food supplement that their child would later receive.

The food supplements were administered twice daily but attendance at feeding sessions was voluntary. The authors have estimated (Habicht et al., 1974) that approximately 10% of all children assigned to the high protein-calorie condition could be described as "well-supplemented" from birth to seven years.

Over 600 children were included in the two feeding programs and administered one or more tests of cognitive abilities at ages five or seven. Data analyses were designed to consider (a) relations between indices of nutritional status (height and head circumference) at ages five or seven and measures of cognitive abilities at the same ages, and (b) the effects of food intake (i.e., participation in the high protein-calories supplementation program) between the ages of five and seven on the development of cognitive abilities during that same age interval. Cognitive measures used in these analyses included tests of short-term auditory memory, memory for designs, reasoning, and vocabulary.

The investigators found generally positive and significant correlations between each of the cognitive measures and the two indices of nutritional status at ages five and seven. The magnitudes of the relations tended to be higher for girls than for boys. However, because these analyses did not explicitly examine relations between measures of food intake and cognitive test performance, they do not provide a basis for inferences concerning the effects of undernutrition on mental development.

The second set of analyses showed that differences in food intake over the two year period from age five to seven, whether defined in terms of home nutrition, food supplements ingested, membership in experimental (protein-rich or protein-free) feeding groups, or attendance at supplementation centers, could not predict changes in psychological test performance on any cognitive measure between the ages of five and seven. That is, given information about children's test performance at age five, one could not predict differences in improvement on that test over the next two years on the basis of information about protein-calorie intake over the two year period.

However, a failure to predict changes in psychological test performance between the ages of five and seven on the basis of food intake over the same period does not preclude significant relations between food intake prior to age five and psychological test performance. In fact, the latest reports from Guatemala (see Read, 1976) have indicated consistently significant relations between food supplement ingestion and cognitive performance up to the age of four years. The correlations are stronger for the manipulative and motor ability items than for cognitive and linguistic items.

[illegible] ..ts indicated that experimental children spent more time out of their cribs than control children, particularly after 8 months of age. Mothers of exp[illegible]ental infants [illegible]rbid their infants less than did control mothers between the ages of six months and one year. Also, experimental infants spent more time out of doors than control infants at age six months, and spent more time playing at age eight months. By one year of age, differences between the two groups in time out of doors and time playing were negligible. Finally, experimental infants spent significantly less time asleep than control infants between the ages of 6 and 16 months.

The quality of mother-child interaction in the two types of homes was not dramatically different. In general, mothers in both groups showed little affect (i.e., hostility, affection) toward their children, and there were few reciprocal social exchanges.

The investigators did find, however, that parents of supplemented children were more attentive to their children's cleanliness than parents of non-supplemented children, with raters indicating higher degrees of cleanliness for experimental subjects between 24 and 96 weeks. Also, fathers of supplemented children were rated as more attentive to their children than fathers of the non-supplemented children. The investigators also reported, on the basis of parental reports, that experimental children tended to be more demanding than children in the control group, both for attention and for food. In fact, the demands for food resulted in higher levels of feeding in the home for the supplemented subjects, a factor which must be considered in attempting to understand and interpret the effects of the intervention program.

The Tezonteopan study is noteworthy for several reasons. First, it specifically considers the impact of a nutritional intervention program on the social as well as cognitive behaviors of undernourished children. Second, it suggests the importance of examining the immediate effects of food intervention on the child's physical orientation towards his environment. Results of the study indicated that children supplemented with proteins and calories were more independent and active than those not supplemented, and elicited greater stimulation from their environments. It may be that a primary effect of undernutrition is to cause the child to withdraw from active participation with his environment, with the result that changes in cognitive abilities and perhaps patterns of social interaction occur. The Tezonteopan study suggests the need for specifically gathering data which can be used to test this hypothesis.

The Bogota Study

The Bogota study (Mora, Amosquita, Castro, Christiansen, Clement-Murphy, Cobos, Cramer, Dragastin, Elias, Franklin, Herrera, Ortiz, Pardo, DeParedes, Ramos, Riley, Rodriguez, Vuori-Christiansen, Wagner & Stare, 1974) was concerned specifically with the effects of protein-calorie deprivation on intellectual development. Carried out in Bogota, Colombia, the study examined the impact of a nutritional intervention program on developmental quotients of previously well-nourished and malnourished preschool children.

Subjects were 93 pairs of siblings in which both the older and the younger sibling were well-nourished and 96 pairs in which both the older and

younger sibling were malnourished. Children were consider[illegible]urished if they were less than .95 of the age-sex norm for height a[illegible]s than .85 of the age-sex norm for weight. Subjects were classified as well-nourished if they exceeded .95 of the age-sex norm for height and .90 of the age-sex norm for weight. All younger siblings were less than two years of age at the time of the beginning of the intervention, and all older siblings were less than five years of age. One subject in each family was assigned to either a supplemented or a non-supplemented condition. Children in the supplemented condition received weekly supplements at food centers. Each child received an average of 90 g. of skim milk, 75 g. of bread and 50 g. of guava paste (or 30 g. of cake) per day. Also, each family received one gallon of vegetable oil per month. The supplements provided more than 100% of the proteins and more than 2/3 of the calories in the recommended allowances for Colombian children under age five. In addition, iron supplements for home administration and vitamin A supplements were given directly to the child. Subjects in the nonsupplemented condition received no additional food.

Food intake was monitored by several procedures including household visits, 24 hour recall surveys, food purchasing questionnaires, urine analyses for d-xylose, and urea-nitrogen creatinine analyses. Medical care was provided to all families in the study.

Anthropometric data (i.e., height, weight, head circumference) were obtained every two months for each child. Interviewing the mother, investigators also collected extensive parental background information, such as socioeconomic status, parents' reading habits, emotional status of the mother, and amount of mother teaching of the children. In addition, investigators collected information about the mother's medical history during her pregnancy, and obtained medical ratings of the child's present health. The Griffiths test of mental abilities was administered at the beginning of the study and at the end of the first year.

Analyses provided for a determination of empirical relations between the several social, physical, health and intellectual variables. Most importantly, they allowed for a determination of the effects of the experimental intervention on intelligence test scores.

The investigators found that malnourished children scored lower on every "social" variable than well-nourished children. But they also found that the height and weight measures significantly predicted initial status on the Griffiths for both younger and older children, even with the social and "current health" variables controlled. This analysis suggested the importance of nutrition, independent of other social and medical factors, with respect to cognitive development.

The next step in the analysis was to examine directly the effects of the nutritional intervention on changes in intellectual performance. It should be noted that the investigators were careful to determine whether the food supplements were actually used to supplement normal diets, or were instead used to "substitute" for normal diets. Results of food purchasing surveys indicated that the food supplements more often served as food substitutes among the well-nourished children than among the malnourished children; 40% of the supplement substituted for previous expenditures among

In summary, the Cantgenis study has provided experimental evidence of the rehabilitating effects of nutritional supplementation on the sensori-motor and cognitive functioning of young children from an "at risk" population. The findings suggest a functional relation between chronic undernutrition and intellectual deficit. Further analyses examining relations between supplement intake and psychological test performance at the higher age levels may provide additional information about the importance of nutritional status to cognitive development.

The Cali Preschool Nutrition, Health and Education Study

The Cali Preschool Study (McKay, McKay, & Sinesterra, 1974) is examining the effects of a combined program of nutritional supplementation, cognitive stimulation, and health care on the cognitive development of lower-class preschool children in Cali, Colombia. The cognitive measures used as criterion variables in the study include tests of immediate memory, verbal reasoning, and color and object recognition.

The study utilizes a multi-treatment, "three-wave" design. Two hundred and forty 3 year old subjects have been assigned to either a nutrition + stimulation + health care condition or to a nutrition + health care only condition. Within each of these two general groupings, subjects receive either 1, 2 or 3 years of continuous intervention. For example, the first "wave" of subjects in the comprehensive treatment condition receives three years of nutrition, cognitive stimulation and health care, while the second wave receives two years of intervention and the third wave one year. In addition, the study includes a control group of low SES children who receive no intervention and a comparison group of upper income Colombian children, whose test performances may be compared with the low SES children at any point in the study. Each of the 8 groups included in the design consists of 60 children with the exception of the three nutrition + health care only groups, each of which includes 20 children.

The elaborate design described above provides a basis for inferences not only about the effects of nutritional rehabilitation on children's cognitive development, but also about the importance of [illegible] stimulation (i.e., the non-nutritive aspects of the intervention program) with respect to behavioral change. Moreover, it allows for an examination of differential treatment effects related to duration of intervention.

Unfortunately, reports of the study published to date have not specified the nature of the cognitive intervention except in the broadest of terms. They indicate only that the cognitive stimulation program emphasizes social interaction, verbalization, and reinforcement for attempted problem-solving and problem solutions achieved. Also, the program of nutritional rehabilitation has not been described in any detail. For this reason, the results of the study which have been reported may be interpreted only with respect to their most general implications.

Results obtained at the end of the second year of the study show that subjects experiencing two years of the comprehensive intervention have improved in verbal reasoning and general knowledge, while children in the

nutrition + health care only groups have not shown comparable improvements. Moreover, the performances of the nutrition + health care only groups on the above measures are not substantially different from those of low SES subjects in the control group. In no group have subjects shown significant improvement in tests of immediate memory.

Despite the inadequacy of the reporting of the study, the Cali preschool study is important because it introduces an experimental design of potential value. Most importantly, it demonstrates that in designing a program of nutritional intervention, it is necessary to provide a means for identifying treatment effects relating to "general stimulation," as well as to nutrition per se.

The Tezonteopan Study

Chavez, Martinez and Taschine (1974) have been conducting a study in Tezonteopan, Mexico, which examines the effects of a nutritional program for mothers and their children on the child's physical, social and mental development. Reports published to date have examined the effects of the food intervention program on social behaviors during the first two years of the child's life, particularly, aspects of mother-child interaction.

The study involves two groups of mothers and infants. Initially, all pregnant mothers in the total village community were examined. The first 20 mothers who gave birth to a normal infant, had 1-4 previous children, and fell into a specific range for age and height constituted the non-supplemented group. 20 women matched on relevant variables were chosen one year later, at the time that they were just beginning their pregnancy, to be the experimental group. These women received 64 g. daily of powdered skim milk, vitamins and iron, beginning at the sixth week of pregnancy and continuing through lactation. Infants of these mothers were supplemented with whole milk and various prepared baby foods beginning at 3 months of age.

The investigators noted early physical differences between the groups. Mothers in the supplemented group were heavier and healthier during pregnancy, and infants in the supplemented group were heavier at birth than the control infants. In addition, differences between the groups in growth rates (based on changes in weight) were evident by six months, with experimental infants showing more rapid physical development. Experimental infants also had higher test scores on the Gessell tests for adaptive, personal-social, language and motor behavior at three months of age, and differences were sustained over a two year period.

The primary concern of the study is the effect of the feeding program on mother-child interactions and child behaviors in the home. To measure such behaviors, one of the investigators lived in the subject's house for a 72 hour period on each of eight different occasions during the first two years of the infant's life. Observation sessions were spaced approximately eight weeks apart. Using a systematic time sampling procedure, the investigators noted the presence or absence of selected social behaviors on the part of the mother and child. They also obtained ratings on "family action" toward the child and measures of the child's physical activity in the home.

well-nourished families, compared to only 10% for the malnourished. The net level of food available in the two intervention groups during the intervention program was approximately the same.

Results of the analyses for changes in Griffiths test scores showed that there was a general tendency for scores of well-nourished children to decline over the one year period, regardless of experimental condition, and scores of malnourished children to increase. Since initial scores of well-nourished children were significantly higher than initial scores of malnourished children, these results were interpreted as due to a "regression to the mean" effect. However, the increase in Griffiths scores for the malnourished children in the supplemented group was significantly greater than for children in the non-supplemented group, a difference which the investigators inferred to be attributable to the effects of the food supplementation program.

The Bogota study provides evidence for the effects of chronic malnutrition on intellectual development. Not only does it demonstrate that a one year food supplementation program administered during the preschool years may significantly improve children's intelligence test performances, it indicates that the effects of such a program may be specific to children who are otherwise malnourished. Considered together, the findings strongly suggest that adequacy of nutrition may influence level of cognitive functioning in early childhood.

Summary

The preponderance of data from which we must make inferences concerning relations between malnutrition and human behavior come from indirect sources; there have been only a few experimental investigations concerning the effects of human malnutrition on later behavior and much of the data from these studies has yet to be reported. From the animal literature, it is clear that malnutrition during critical periods of brain growth can permanently impair the development of certain neural structures and processes. In addition, those animal studies which have focused more specifically on the effects of malnutrition on learning and on social behaviors have demonstrated that severe protein calorie deprivation early in life is related to motivational and attentional deficiencies and behavioral abnormalities.

The evidence from retrospective studies of children who suffered from early malnutrition strongly suggests that early nutritional deficiencies may significantly retard intellectual development. Although the precise nature of the abilities which may be impaired has not been thoroughly investigated, it appears that sensory-integrative capacities (i.e., cross-modal sensory integration), short-term memory, and attention may be implicated. While the implications of chronic undernutrition are less clear, the few relevant studies to date suggest that cumulative nutritional deprivation, like severe malnutrition, may interfere with optimal cognitive functioning during later childhood.

Relatively few human studies have examined the effects of either severe or chronic malnutrition on behaviors in the affective or social-emotional domains. However, results reported in the Jamaica study (Richardson et al., 1975) and also in the study of children who suffered from pyloric stenosis (Klein et al., 1975) are suggestive. Children in these studies who had experienced early severe nutritional deprivation were socially immature, relative to their peers, and had difficulty controlling their behaviors. Although the bases for these difficulties in adjustment were not specifically investigated, it may be that some of the problems observed in the social-emotional sphere were due to the same type of "performance" factors known to influence cognitive functioning: apathy, reduced curiosity, inability to attend to and utilize complex stimuli, and lack of persistence. Such impairments might qualitatively affect the child's interactions with the relevant others in his environment and thus retard the development of social skills and interpersonal competencies.

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APPENDIX III-1

Letters of Invitation

to January, 1979 Meeting

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF NATURAL RESOURCES
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF NUTRITIONAL SCIENCES

BERKELEY, CALIFORNIA 94720

January 5, 1979

The steering group for the planning phase of the USAID/Title XII collaborative research program on nutrient intake and functional competence met December 17-19, 1978, to review the responses to the form sent out October 19, 1978. Steering group members present were Dr. Doris Calloway (University of California at Berkeley), Dr. Janina Galler (Massachusetts Institute of Technology, Boston University), Dr. Lawrence Greene (University of Massachusetts), Dr. R. Gaurth Hansen (Utah State University), Dr. Alfred Harper (University of Wisconsin), Dr. Michael Latham (Cornell University), Dr. Harold Sandstead (USDA), and Dr. Leonard Schuman (University of Minnesota). Another member, Dr. Marian Radke-Yarrow (NIMH), was absent. Present also were representatives of the Board for International Food and Agricultural Development, Dr. Glen Beck; the Joint Research Committee, Dr. Charlotte Roderuck; and USAID, Dr. Samuel Kahn.

The questionnaire which your institution completed and returned to us was designed according to a set of criteria developed at an earlier steering group meeting. The original list of eight criteria was condensed into the following list of five for evaluation of institutional responses:

1. Ongoing research should be directly and clearly relevant to this collaborative research program as presently envisioned, including orientation toward human research and problems experienced in less developed countries.

2. There should be considerable experience in and linkages with less developed countries and evidence in the form of published papers and reports that past associations have been productive.

3. There should be evidence of the required range of competencies in each program area proposed, or indications that such arrangements would be made (consultants, etc.).

4. The principal investigator should have sufficient time available to devote to this program, in light of competing commitments.

5. The institution (or group of institutions) has the capability to carry out research in several or all designated program areas and evidence that the proposed investigators can form a coherent working team.

Each application was read in detail by one member of the steering group. The entire steering group then met and considered each form as it was presented by the steering group member who had made the detailed evaluation. Members were not present during consideration of responses received from their own institutions.

The questionnaires from the following institutions were judged adequate in that they met at least four of the five criteria (meeting criterion number 3 was essential):

All/Most Research Areas	Contact Person
Columbia University	Myron Winick
Cornell University	Michael Latham/Jean-Pierre Habicht
University of California	Doris Calloway
University of North Carolina/	Tony Whitehead (Chapel Hill)
North Carolina State University	Ronald Schrimper (Raleigh)

One-Three Research Areas
(I. disease response; II. reproductive competence; III. work output and physical activity; IV. cognitive and sensory development; V. social competence.)

Iowa State University (I,IV)	Jacqueline Dupont
Pennsylvania State University (III,V)	Helen Guthrie
Purdue University (I,II,IV)	Ronald Watson
Tufts University (V)	Stanley Gershoff
Tulane University/Medical College of Wisconsin (II,III)	James Carter
University of Arizona (I,II)	Gail Harrison
University of Connecticut (II)	Lindsay Allen
University of Kansas (I,IV,V)	Norge Jerome
Vanderbilt University (I)	George Mann

The group recognized that some institutions did not provide complete information and while they may in principle be qualified to carry out research in the area of nutrient/food intake and functional competence, the materials submitted did not provide a sufficient basis for making that judgment. The group also identified some individuals whose qualifications seemed particularly relevant to the work envisioned. These individuals and institutions are urged to associate themselves with the institutions listed above or to form aggregations with other U.S. institutions so that all criteria may be met in a final proposal for participation in the collaborative research program.

This fall, workshops were held focusing on each of the five program areas to determine the most critical and feasible research questions for this program. We are now in the process of integrating the reports of the five workshops. We will present this report at a sixth workshop in mid-January to a group of nutrition and allied research experts from various developing countries to obtain their suggestions and views of the program plans and objectives. A final report will be ready immediately thereafter for institutions intending to submit a research proposal. Complete, unified proposals covering most or all of the program areas should be received at the University of California at Berkeley no later than April 18, 1979.

We plan to hold a meeting to discuss with interested institutions the scope and overseas locations of research, on January 31, 1979, in Washington, D.C. at the Dulles Marriott (Dulles Airport). This meeting is optional and may include one representative from each institution or group of institutions intending to submit a complete proposal; representatives would be responsible for their own travel and accommodation arrangements. We would appreciate it if each institution or group of institutions intending to submit a complete proposal would inform us of their intention soon. Also, any institution planning to send a representative to the January 31 meeting should notify us by January 22.

We appreciate your continued interest in this important research area.

Sincerely,

Doris Howes Calloway
Professor of Nutrition

DHC/cmc

UNIVERSITY OF CALIFORNIA, BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

COLLEGE OF NATURAL RESOURCES
AGRICULTURAL EXPERIMENT STATION
DEPARTMENT OF NUTRITIONAL SCIENCES

BERKELEY, CALIFORNIA 94720

January 18, 1979

A number of potential investigators have asked which institutions have indicated an interest in this research in addition to those indicated in our last letter. A list is attached of all institutions (with a contact person) that have indicated an interest at any stage. A document providing detailed information on the potential collaborative research support program and considerations for research design will be available by January 31. We shall discuss the potential CRSP with interested investigators on January 31 from 9:00-5:00 at Dulles Marriott in Washington, D.C. You are invited to send a representative to this meeting or, if you wish, we shall send the program guideline. We encourage everyone to participate in this program.

Sincerely,

Doris Howes Calloway
Professor of Nutrition

DHC/cmc
Enclosure

APPENDIX III-2

Site Visit Reports

Bangladesh

Barbados

Brazil, Peru, and Colombia

Egypt

Haiti

Honduras

Indonesia

Kenya

Mexico

The Philippines

Senegal

Sri Lanka

Tanzania

Thailand

Tunisia

Zaire

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BANGLADESH

While it was not possible to make a site visit to Bangladesh, we have prepared this brief report based on interviews with Dr. Sheldon Margen, University of California at Berkeley, and Dr. Gerald Combs, NIH, who visited the institutions involved in 1976-77.

Bangladesh is a country of about 80 million people: 90% live in rural areas and 78% are illiterate. Thirty-five percent are under the age of ten. Farm owners comprise 16% of the population; rural landless comprise 37% (Bangladesh Times, Jan. 23, 1977). Malnutrition is a serious problem. The dietary staple is rice; when the price of rice decreases the farmers turn to mustard seed.

Dr. Kamaluddin Ahmad (University of Wisconsin) is the Director of the Institute of Nutrition and Food Science at the University of Dacca. Dr. W. Henry Mosley heads the Cholera Research Laboratory.

INSTITUTE OF NUTRITION AND FOOD SCIENCE, UNIVERSITY OF DACCA

The Institute conducts mainly biochemical and some food analyses as well as some field surveys. The 1976 Annual Report indicates clinical studies on urinary L-ascorbic acid among subjects of different socio-economic groups; storage iron in liver (from medico-legal cases); liver reserve of vitamin A; hypoalbuminemia in nephrotic hyperlipidemia; and field studies in nutrition evaluation of WFP project feeding of vulnerable group; the relation between rural development, population growth, and food and nutrition; and dissemination of nutrition knowledge and delivery of nutrition service in rural Bangladesh through secondary schools.

The Institute has a staff estimated at about 25. There are facilities for animal and laboratory work. Current research interests include thyroid

function, goiterogens, antibiotics, iodine supplementation, and vitamin A intake. The Institute would have access to interviewers and transport, but "local" interviewers would have to be found and trained in Dacca. The Institute uses a government computer.

The Institute has few cooperative efforts with medical school faculty or social scientists (although it is possible some social scientists were involved in their community studies). However, it is thought that Dr. Ahmad would welcome collaboration with U.S. investigators. There is apparently a national coordinating committee (representatives of various ministries) for nutrition research which should not in principle be opposed to the CRSP.

CHOLERA RESEARCH LABORATORY

The Cholera Research Laboratory has recently achieved its desired status of "international research unit." (Until 1976 about 80% of its funds came from USAID.) It is staffed by about 20 well-trained professionals, one or two of whom are Bangladeshi.

The laboratory facilities are excellent, and probably a bit underutilized. The Lab does biochemical, clinical, and epidemiological studies. It is highly service-oriented but also has excellent research facilities. The Lab has extensive community involvement and has been working for many years in the Matlabarm and more recently in the Teklad area.

The orientation of the work is towards diarrheal disease, infection, population, reproduction, and nutrition. However it seems the staff does not include any clinical nutritionists. In reality it appears that nutrition is not a prime focus, but investigated only in its relation to other areas of study. Apparently the Lab does not collaborate with other local institu-

tions, including the University.

***

This report is not intended to be comprehensive. It represents selected recollections of the situation two years ago.

Christina Wood

The following papers were prepared by Bangladeshi investigators for the Third Bangladesh Nutrition Seminar, March 22-24, 1979:

Nutrition, Development, and Mother-Child Interaction Patterns by Maureen Black, Ph.D.; Feroza Khatun, M.A.; Hasina Muktader, M.A.; Feroza Begum, M.A.; Hamida Akther Begum, Ph.D.; Psychology Department, Dacca University.

On Sampling and Measurement Error in Anthropometric Indices by R. Bairagi, Institute of Statistical Research & Training, University of Dacca

Anthropometric Study of School Going Children of Dacca City Up to the Age of 12 (Twelve) Years by Dr. S. Mirza, Clinical Nutritionist, Institute of Public Health Nutrition, Mohakhali, Dacca.

A Comparative Study of Developmental Growth Schedule Among Rural and Urban Children of Bangladesh, by Dr. Sultana Sarwatara Zaman and Dr. Sultana Ferial, Dept. of Psychology, Dacca University.

The papers are available for examination.

The titles indicate that there is a significant possibility of interdisciplinary research at Dacca.

17 April 1979

Dear Arnie,

We had an excellent nutrition seminar in Dacca 22-24 March. Kamaluddin Ahmad's Institute of Nutrition and Food Science, University of Dacca, is developing very nicely.

I am enclosing some papers from the seminar which relate to nutrition and function.

Sincerely,

L.J. Teply
Senior Nutritionist

Dr. A.E. Schaefer
Swanson Center for Nutrition, Inc.
8401 West Dodge Road, Suite 101
Omaha, Nebraska 68114

cc. Dr. Doris Calloway

BARBADOS - Site visit report by Dr. Doris H. Calloway, University of California at Berkeley, 4/17/79.

This proved to have been an unfortunate time to visit Barbados. Monday was a national holiday so the day was wasted. I was also unable to interview USAID personnel as key staff were involved in relief operations at St. Vincent following the volcanic eruption.

At the Barbados Nutrition Centre the following people were contacted:

Dr. Frank Ramsey

Mrs. Elaine Yarde - Nutrition Officer

Dr. Mary Rose Ferdinand - Medical Officer/Registrar (Mrs. Henry St. John)

Ms. Marjorie Bowen - Senior Health Sister

Dr. Robert Stifler - Project Hope Medical Officer

Mrs. Barbara Cave - Executive Officer

I had not been notified that the time of my appointment had been changed so my early arrival was unexpected but Mrs. Cave courteously rounded up a discussion group in Dr. Ramsey's absence. I met with him privately in the afternoon.

The Centre is housed in a small, one-story building located in the Queen Elizabeth Hospital compound in Bridgetown. The building contains mainly offices, but also houses a small reference collection, a nursey-school room (for providing "environmental stimulation" to about 30 recovering malnourished children), and an outpatient MCH service. The reference collection covers about the last 4 years of a few journals and a few basic texts. The Centre is involved in extensive community and outreach programs (A copy of 1979-81 plans is available).

I had a very frank and useful discussion with Dr. Ferdinand, the medical officer who was in charge of the research project carried out collaboratively last year with Drs. Galler, Solimano and John. Conduct of that study apparently was a severe drain on local staff time. The data have been coded and key punched locally, but sent to New York for analysis. The outcome is not known but there do not appear to be plans for continuation.

The staff had copies of the "Précis" and some had read the document. (I was queried why no one from the Carribean area had participated in the Workshops and they were relieved to learn that someone had been invited to prepare a background paper, but failed to attend at the last minute.) However, there had been no previous discussion among the staff as to the probable nature and scope of a potential research project. Most of our discussion centered on the nature of Title XII research in general and on the institution - building component of the program. They were interested in learning about possible project designs, but we could not advance this topic in Dr. Ramsey's absence. The staff seemed to feel that they would simply carry out whatever plan was approved by Dr. Ramsey.

The research study just completed had involved about 130 malnourished children and an equal number of controls. We discussed the possibility of using these families for the intake - function research and Dr. Ferdinand thought that might be possible as the same households included less severely malnourished siblings. She believes that the island population of 250,000 could in any case provide an adequate sample for the study. Ninety-eight percent of all births now occur in hospitals in Barbados so it would be easy to obtain good records for young children; records of older children and adults are less complete. Field staff would have to be recruited and trained for this project (there is no

residual from the previous study) and transport would be required. Barbados has a large number of underand unemployed nurses and these would be likely choices for field work. (Annual salary for staff nurses is about 5000 Barbados dollars or $2500 U.S.)

Dr. Ramsey has had only very general discussions with Dr. Norge Jerome. He expressed concern about two things - project management and consistency of the project with Barbadan Centre and governmental goals. In the first instance, Dr. Ramsey has been seconded to the Ministry of Health for one year to develop the National Health Plan for Barbados and would be able to give only superficial attention to the project until that task is completed. (He has requested an Assistant Director for the Centre, but the position is not yet firm.) Dr. Ferdinand has applied for a fellowship and if it is granted she will go to Harvard next fall to undertake study for the M.P.H. degree. Dr. Stifler is scheduled for reassignment next year. Thus there is no obvious candidate for local project management. Nurse Bowen is evidently a strong, able field administrator, but she's nearing retirement (1981).

On the second point, it was Dr. Ramsey's view that the project would be undertaken only if it was seen clearly to contribute to solution of local problems. We discussed potential benefits of the program including improved understanding of the nature of the nutrition problem, development of better nutrition indicators and nutrition training of medical staff whose services will be needed in the envisioned National Health Service. It was my impression that at the end of our discussion Dr. Ramsey was more favorably disposed toward the project and would be prepared to advance it locally.

It is my impression that the Barbados population would be a good one for study because of its uniformity and heavy dependence on a single type of seasonal agricultural employment (sugar cane). There is a 1969 survey on which to build, as well as the neurological/cognitive study just completed. However, the U.S. institutions would have to undertake direct local management on a continuing basis.

REPORT ON SITE VISITS TO BRAZIL, PERU, AND COLOMBIA

This on-site evaluation was conducted over a two-week period (March 10 - March 25, 1979) by Drs. R. Gareth Hanson and Janina R. Galler.

BRAZIL: (March 10 - 14, 1979)

Three institutions were visited:

(a) Instituto da Criana (Children's Hospital), Universidad da Sao Paulo, Brazil - Prof. Eduardo Marcondes, Director.

This institute has three primary functions, including clinical services (as part of the Hospital das Clinicas), under-graduate and post-graduate teaching responsibilities (as part of the School of Medicine), and research investigations in the area of growth and development.

Dr. Marcondes and his staff expressed a substantial commitment to research in the areas suggested, and a strong interest in participating in the development of a research proposal.

On-going studies at this institution include:

(a) studies of physical growth and development in children ages 0-12 years;

(b) metabolic studies in the area of nutrient balance (conducted primarily by Dr. Esperata, who has consulted with Dr. Nichols, USDA, Houston).

Future studies, for which funding has been requested from the Brazilian government, include growth and development of adolescents (12-19 years) and factors affecting intrauterine growth. To date there have been no collaborative studies with U.S. institutions. This institution employs a large number of physicians and para-medical professionals, trained in a number of fields which we view as pertinent to the proposed research objectives, including mental health, pediatrics, clinical nutrition and gastroenterology in children and adolescents.

Supportive physical facilities, including a three year old community health facility, are available, but in need of equipment and development. This health facility was constructed to provide health services to a lower income urban population of 270,000 persons, and as a training center for residents and medical students. Some baseline data on growth and development of children in this population have been gathered and published, and part of this population is the target group for the future proposed studies listed above.

The significance of studying a low income urban population is that urbanization is a major sociologic change currently affecting developing countries and human development. Mild-moderate malnutrition has already been documented in approximately 40 percent of this particular population, and is one of many public health problems inherent in this community. We feel that functional aspects of this type of population are extremely important to evaluate, even though the lack of genetic homogeneity and the high rate of migration present special problems to the construction of well-controlled research designs.

(b) Department of Nutrition, School of Public Health, University of Sao Paulo, Brazil - Prof. Yaro Gandra, Director.

The primary functions of this department are post-graduate teaching of medical and public health professionals, development and evaluation of community nutrition programs, and research programs.

There are currently several areas of research. First, the department is completing the evaluation of a 5-year lunch and recreation program for pre-school children (CEAPE) in rural communities, supported by the World Bank. The outcome variables which have been studied included nutritional status, food intake, and behavioral development, as measured by a modification of the Caldwell scale. Children included in the CEAPE program were compared with children from the same rural communities who had not participated in the program. Other on-going research relevant to a proposed research program include studies of food consumption. This is based on measures of nutrient intake, and computerized information of composition. Prior investigations have included studies of vitamin A deficiency and work capacity in children from one rural village, including measures of oxygen consumption and cardiac function. There have been prior collaborations with Professor John Stanbury (MIT) but no current collaborative arrangements.

This group has a special interest in the pre-school child, because this group is least likely at the present time to receive public assistance, with the large emphasis in developing countries on nutritional risk during pregnancy, infancy, and school-age children. Our impression was that this Department has a wide variety of research skills and access to laboratory and computer facilities. There are twelve full-time staff in the Department, trained in nutrition, pediatrics, and public health, and ancillary staff hired specifically to fulfill research commitments, including psychologists.

This Department clearly has access to rural communities throughout Brazil, as demonstrated by the on-going CEAPE studies.

This group is also committed to future studies of a collaborative nature, exploring the consequences of mild-moderate malnutrition.

(c) Department of Obstetrics - Gynecology, University of Campinas, Campinas, Brazil - Dr. Anibal Faunder, Chairman.

This is a small department with a limited research staff, currently involved in teaching programs to encourage breast-feeding in low income mothers. Although there has been no prior experience with nutritional factors, this group has an on-going interest in risk factors during pregnancy, such as adolescent pregnancies. Dr. Faunder's interest in collaborative research has been long-standing, and he is a member of the world population council. For additional research to be undertaken, considerable support would be needed.

This on-site evaluation was conducted over a two-week period (March 10 - March 25, 1979) by Drs. R. Gaurth Hansen and Janina R. Galler.

PERU: (March 15-19, 1979)

We found no major research programs in Peru at this time which could be considered directly related to the goals of the proposed research program.

Studies related to the effects of severe malnutrition had been conducted at the British-American Hospital in collaboration with G. Graham of Johns Hopkins University. We did not evaluate the current status of this program, but are aware of a recent foundation funding for data analysis. We are also aware of a proposal to AID, which was not funded, prepared collaboratively by Drs. Pretell (Universidade de Cayetano Heredia) and Trowbridge (Johns Hopkins University) to measure growth and development. Dr. Pretell is an endocrinologist with a special interest interest in iodine deficiency. His institution has a long-standing teaching and research tradition, with involvement both in the local community and in a jungle community.

The National Institute of Nutrition (NIN) directed by Dr. Victor Hernandez Perez, has a strong interest in the consequences of both mild-moderate and severe malnutrition, which affects 60 percent and 40 percent, respectively, of the geographically diverse population of Peru. Among its many objectives, this Institute surveys communities at risk for nutritional deficiency (also including vitamin A, iodine, and Fe deficiencies). A systematic evaluation of an ongoing dietary intervention program in Peru, supported in part by AID, is expected to begin September, 1979. The NIN is currently developing methodology for the proposed evaluation.

While this is a potentially significant program, the research component still is in a developmental stage, and would require the addition of considerable human and material resources to carry out a coordinated research program.

Finally, we met with local representatives of USAID, who arranged all our local meetings and provided information about local activities. They expect the arrival of a new Nutrition Officer, Bob Stickney, in April, to reorganize programs in the area.

This on-site evaluation was conducted over a two-week period (March 10-25, 1979) Drs. R. Gaurth Hansen and Janina R. Galler.

CALI, COLOMBIA: (March 20-24, 1979)

The University of Del Valle, Cali, Colombia, has had a strong research tradition since 1963, and is well-recognized for studies in a number of areas directly related to the objectives of the overall research program. Many of the staff have received post-graduate training in the U.S. and, consequently, have extensive working relationships with U.S. institutions. Research programs emanating from this group have and continue to receive major support from both federal and private foundations in the U.S. and, consequently, have a well-developed program of research.

The University has already organized research teams to address each of the five areas of concern of the AID program, and are currently working with Dr. James Carter, Tulane University, to prepare a final document to the Steering Committee. The proposed program will include urban poor, with some baseline information obtained on a population (70,000 - 80,000 persons living in a 1-2 km area) by the nutrition and the behavioral groups.

To measure food intake, the nutrition group with Dr. Fajardo has evolved a computerized analysis using as the two primary inputs FAO standards of nutrient intake and Columbian tables of food composition. From efforts to estimate purchase

of basic food commodities and frequency of consumption of certain foods, estimates of intake of individual members of the family somehow emerge. From the data available the suggestions are that intakes of vitamin A and E are particularly low, calcium and riboflavin intakes tend to be low, and iron intake is suprisingly high. Of specific interest to the proposed research plan, the populations under study have been classified into seven groups, with nutrient intakes ranging from 50 to 80 percent of the standard.

Work Capacity

Dr. Mario Barac, Professor of Physiology, and his group have a grant from NIH, in collaboration with the Medical College of Wisconsin, to study the relationship between nutritional status and physical fitness in children. His unit has a complete in-hospital facility to measure work capacity, including measures of VO_2 max and cardiac output. The recent award from NIH will provide a mobile unit for use in field experiments. This group is also capable of studying adults, as may be pertinent to a research program relating nutritional status to functional outcome.

Behavioral Measures

Drs. McKay and Sinisterra have had long experience with behavioral measures in underprivileged children as part of an 11-year longitudinal study of children subjected to a multifaceted intervention program during the preschool years. Furthermore, this group has had a long-term concern with ecologic factors, of which poor nutrition is one, which may alter cognitive and social competence. In the current program, Drs. McKay and Sinisterra will study cognitive functioning in the preschool children of the sample population, and also propose the study of other factors (including level of education and IQ) as contributors to cognitive ability in children. Their long-standing relationship with the proposed study

population should be advantageous, not only to their proposed involvement, but also to that of the other teams, as well.

Resistance to Disease

Dr. Mario Reyes has collaborated for five years with Dr. Ronald Watson, now at Purdue University and, more recently, with Texas A and M University. The results of this collaborative work aimed at correlating disease resistance with nutrition status will be described in detail in manuscripts now in preparation. Although Dr. Watson at Purdue earlier had stated his intentions to participate in generating a proposal with this group, Dr. James Carter, of Tulane, now is requesting collaboration of Dr. Reyes. Dr. Ducnas, Head of Microbiology, is involved with research in viral disease, especially of the rotovirus type.

Reproduction

Past experience of this group has not specifically involved nutritional measures. This group works with neurohypophysical function, lactation, and clinical hematology. Ongoing studies of small-for-dates infants, in association with the pediatrics groups, have provided some publications regarding relationship of intrauterine growth retardation and metabolic factors.

Organization

This group displayed the most sophisticated organization, with extensive support from the United States, and elsewhere. A non-profit organization (F. E. S.) processes the funding, as discussed in our meeting with Alex Cobo of FES.

This on-site evaluation was conducted over a two-week period (March 10 - March 25, 1979) by Drs. R. Gaurth Hansen and Janina R. Galler.

BOGOTA: (March 20 - 24, 1979)

For years the Javeniana University has conducted studies in the area of malnutrition and cognitive development under Dr. Mora in collaboration with Dr. Herrera (Harvard University). This work is not continuing at a field level, but analysis of collected data is being conducted in Boston. Consequently, we were unable to meet key personnel directly involved in the study and could not adequately evaluate its potential for our program.

Others who were visited were Drs. Eduardo Aldana and Jaime Varela at Instituto SER (research institute), a private collective of social scientists and engineers involved in systems analysis of educational, health, and nutritional programs in Colombia. They have just been funded by IBM for a sophisticated computer which could be used to analyze data emerging from the Cali project.

Finally, USAID representatives met with us in Bogota and discussed in detail their views on local programs and on programs supported by USAID in Colombia.

EGYPT: Site visit conducted in Cairo, February 14-18, 1979 by Christina Wood, Ph.D., University of California, and Samir S. Basta, Ph.D., Nutrition Division of the World Bank (participant in workshop on Malnutrition and Work Output/Physical Activity)

Persons interviewed:

Ministry of Health

Dr. M. Gabr, Minister of Health

Nutrition Institute

Dr. Hekmat El Sayed Aly, Director

Dr. Mohammed Amr Hussein, Head, Department of Nutritional Requirements and Growth

Dr. Ahmad M. Fakhoury, Head, Department of Nutritional Biochemistry and Metabolism

Dr. Khamir Zaki Awadalla, Head, Department of Food Science

Dr. Amin Kone Said, Head, Department of Clinical Nutrition

Cairo University

Dr. Abdul Kader, Chairman, Biochemistry Department

Social Research Center

Dr. Saad Gadalla, Director

Catholic Relief Service

Mr. Steve Allan, nutritionist/chemist

EGYPT

Egypt has a population of about 37 million people of which almost half are living in urban areas. Malnutrition and high population density are major concerns. There is a nutrition Institute in Cairo that has been in operation for more than 30 years.

NUTRITION INSTITUTE

Dr. Hekmat el Sayed Aly is the Director of the Institute. She attended the January 15th New Orleans workshop which focused on viewpoints from researchers from/in developing countries. The Institute has a staff of about 130 with 15 holding Ph.D. degrees, 25 holding masters degrees, and 40 holding diplomas. Part of the staff teaches nutrition in other institutions. There are five departments: Surveys and surveillances (Dr. Hekmat), Food Science and Food Technology (Dr. Nomir), Biochemistry and Metabolism (Dr. Dakroury), Growth and Requirements (Dr. Hussein), and Clinical Nutrition (Dr. Said).

Most of the research is applied. The Institute is involved in nutrition education in the MCH centers (about 20 sessions for nurses, dieticians, and doctors; there are more than 200 MCH centers and more than 2000 rural health centers with MCH activity). Endemic goiter is a major problem and studies are being done on the effects of goiterogens, vitamin A deficiency, excessive consumption of onions, and animal protein deficiency on goiter. Studies have been done on iron absorption with local food patterns (effects of tea). The development of local food composition tables is in progress. The Institute works with a nutritional rehabilitation program in a Cairo clinic and with a nutrition education program (recipes, prices, nutrient value).

There is a surveillance station in Behara (near Alexandria) which depends on the cooperation of the health unit staff. The Catholic Relief Service has now stopped supplying food aids, so there is less incentive for mothers to bring in their children. Some work has been done by the institute on protein requirements (1970).

The Institute collaborated with investigators from the Center for Disease Control to produce the 1978 Nutrition Status Survey covering most of the populated area along the Nile. Measurements included anthropometry, hemoglobin levels, clinical signs, demographic and socio-economic considerations, breast-feeding practices, and morbidity.

The Institute has a library and laboratory facilities which are in need of new equipment. They have access to a computer in the Ministry of Research.

SOCIAL RESEARCH CENTER - AUC

Dr. Saad Gadalla is the director of the Center which is staffed completely by Egyptians. A list of senior researchers is appended to this report. It includes eight researchers holding Ph.Ds (all obtained in the U.S.) and four holding masters degrees. The Center undertakes large-scale, nationwide surveys. It is equipped with vehicles, local interviewers, and a staff of 40 research assistants. It obtains research grants from USAID, UNESCO, HEW, etc. Dr. Gaualla seemed interested in this research program; he would have the necessary staff and he would make the time to participate. He regularly collaborates with the Ministry of Health and the Population Board. The Center has a computer facility.

The following quote from the Center's brochure describes its recent research activities:

"The Social Research Center was established in 1953 as a Unit of The American University in Cairo to conduct and encourage social science research in the Middle East, especially in the Arab Republic of Egypt, to train students and workers in research methods and techniques, and to guide and give assistance to scholars and organizations engaged in social research in the area.

The Research Program The basic issues which characterize the contemporary Middle East are those associated with rapid social and cultural change. The Social Research Center concentrates on conducting studies of significant phenomena and processes which accompany social and economic development such as: industrialization, urbanization, rural rehabilitation, land resettlement, population problems, family planning, etc.

Among the research projects of recent years have been studies of the society and culture of the Nubian communities before and after their relocations as a result of the construction of the High Dam; land reclamation and resettlement in Lower and Upper Egypt and in the Western Desert, urbanization trends in Egypt; the historical development and present ecological patterning of Cairo, labor problems associated with major industrial projects, population and family planning, and social security programs.

Current SCR Research Projects Include:

A. Basic research to acquire reliable data on various social, psychological, cultural, economic and demographic factors affecting population growth and fertility behavior in Egypt; (AID, Ford Foundation)

B. Action research for promoting acceptance and use of contraceptive methods in urban and rural areas; (AID)

C. Action research for developing delivery systems for integrated health-social welfare-family planning services in Menufia Government; (AID)

D. Family Planning Communication Research aiming at compiling and interpreting relevant research findings and literature, and designing and implementing communication strategies for family planning programs in the Arab countries; (UNESCO)

E. Research on the role of cultural values in the formation and implementation of population policies and family planning programs in Egypt; (UNFPA)

F. Studies on menstrual perceptions among women in different cultural settings; (cross national - 10 countries coordinated by Jack Marshall - WHO, Geneva)

G. Research on the Role of Social and Economic Security in Family and Community Life with emphasis on the impact of different social security

patterns on conceptions and functions of various family types, kinship groups, and local communities; (NEW)

H. Research on supporting system involving widows in the city of Cairo (NEW).

The Center conducts these research projects in close collaboration with Ministries and agencies of the Egyptian Government including the Ministries of Health, Social Affairs, Agriculture, and Land Reclamation, the Population and Family Planning Board, and the Egyptian Family Planning Association. A list of publications and reports resulting from research undertaken or partially financed by the Social Research Center is available."

INSTITUTES AND PERSONS NOT VISITED:

1) University of Al-Azhar, International Islamic Centre for Population Studies and Research. Professor Razhid Barakat is a consultant, he was formerly a professor of community medicine with a strong emphasis on nutrition.

2) Institute of Planning does social research, health-related. It is independently financed and run by Rafig Kasuna, M.D.

3) National Institute of Sociology and Criminology headed by Dr. Khalifa and including Dr. Abdel Azer. Research is done on health, poverty, and social welfare.

4) Dr. Shafika Kasser, Nutrition, School of Public Health, Cairo University.

SUMMARY AND OPINIONS

The Minister of Health, Dr. Gabr, was kind enough to see us even though we had no appointment. He is very interested and knowledgeable in nutrition and he was enthusiastic about this program. His active backing would doubtless be invaluable. The Nutrition Institute was also enthusiastic. This Institute seems to have an impressive senior staff that are thwarted by lack of equipment and funds. It seems that the Institute will shortly be undergoing some reorgnization.

Dr. Abul Kaier represented a link between the Ministry, the Institute, and Cairo University.

The Social Research Center was notable in its organization, equipment, training, and accomplishments. Dr. Gadalla expressed a willingness to cooperate with such a program as this. A collaborative link between his center and the Nutrition Institute might prove very effective and complementary in both the areas of design and implementation.

Unfortunately, there were many more people and institutes that should have been contacted, but the visit was too short. The investigator potential is therefore greater than has been described here.

USAID RESPONSE: Friendly interest from Mr. Shutt. We did not have time to see him again after our meetings. Communication in Cairo (by telephone or vehicle) is difficult.

Christina Wood

SENIOR RESEARCHERS (1977-78)

Gadalla, Saad
Research Professor and Director
Ph.D. Rural Sociology-Demography
University of Missouri

El-Hamamsy, Laila Shukry
Research Professor
Ph.D. Anthropology
Cornell University

Fahim, Hussein
Senior Research Associate
Ph.D. Anthropology
University of California

Tadros, Helmi Raphat
Senior Research Associate
Ph.D. Sociology-Anthropology
University of Missouri

Khattab, Find Abou Saoud
Research Associate
Ph.D. Population Anthropology
University of North Carolina
Chapel Hill

Badin El Messiri, Bawal
Research Associate
Ph.D. Urban Anthropology
Indiana University

Badin, Assad
Research Associate
Ph.D. Folklore-Traditional Folk Culture
Indiana University

Boseir, Nazek
Research Associate
Ph.D. Sociology-Demography
Princeton University

Assad, Marie Boseili
Senior Research Assistant
M.A. Sociology-Anthropology,
The American University in Cairo

El-Kateha, Samiha
Senior Research Assistant
M.A. Sociology-Anthropology
The American University in Cairo

Lotayef, Aziaz Rashad
Senior Research Assistant
M.A. Economics
Occidental College,
Los Angeles

Mehanna, Soheir Rashad
Senior Research Assistant
Hold Fletcher School of Law
and Diplomacy
Tufts University

El-Tayeb, Bahaya
Senior Research Assistant
M.A. Sociology-Anthropology
The American University in Cairo

In addition to its senior researchers, the Center has highly trained junior researchers and qualified supporting staff.

HAITI: Site visit conducted August 23-24, 1978, in Port-au-Prince by Christina Wood, Ph.D., University of California, Berkeley

Persons interviewed:

BUREAU OF NUTRITION

Dr. William Fougère, Director

Dr. Michaèle Amédée

Indira de Beausset

Maud Nonez

USAID

Ms. Linda Morris

HAITI

Haiti is a country with severe malnutrition problems, particularly protein-energy malnutrition. There is very little animal protein available; milk and meat are very expensive. Goiter is prevalent among teenage girls in the eastern mountainous region. Vitamin A deficiency is also manifest, infant diarrhea is common. In the late 1950's, investigators from Virginia Polytechnic Institute in collaboration with the Bureau of Nutrition developed a food composed of locally available products, inexpensive, high quality protein, and easy to prepare. The result was "Acamil", a mixture of 2 parts corn (or rice) and one part beans. The mixture is fed to children in the Mothercraft Centers and mothers are taught what to buy and how to prepare it.

Food composition tables for Haiti exist (Bureau de Nutrition, Table de composition d'aliments pour Haiti, Port-au-Prince, Haiti, 1965; Promuderu, Table de composition des aliments pour Haiti par portion usuellement consommée, Port-au-Prince, Haiti, 1976).

BUREAU OF NUTRITION

The Bureau of Nutrition falls under the jurisdiction of the Division of Public Hygiene. Both this Division and the Division of Family Hygiene fall under the Department of Public Health and Population. Dr. William Fougère, Director of the Bureau of Nutrition, has a staff of about twenty eight, including seven M.D.s (with various nutrition/MCH specialties), two agronomists, one lawyer, dietitian-nutritionists, nurses, secretaries, receptionist, etc. At least five staff members were trained at INCAP. Dr. Michèle Amédée is in charge of research evaluation and statistics; she worked with Mme. de Beausset on the 1978 National Nutrition Survey.

The Bureau of Nutrition is primarily involved in the following activities:

1. The National Nutrition Survey, which was started in June, 1978, and the field work completed in September. The field work was carried out by eight teams of three interviewers with three overall supervisors. The interviewers were young Haitians with their baccalaureate degrees. Three auxiliary nurses were involved in the laboratory study. The department system was used to select the study population: Haiti was divided into one urban and five rural departments with 30 localities per department, giving a total of 180 localities used. They examined 30 children per locality. Each family was given a number and the children (3-60 months) were chosen with a random number table. Three questionnaires were used covering health, socio-cultural, weaning, and dietary information. (The questionnaires are in the Creole language; there is apparently a 95% illiteracy rate.) Blood samples were taken from each fifth child and mother (hemoglobin).

2. Operation of the Mothercraft Centers, sixty of which are spread throughout the country (thirty are supported by USAID). When a MC center is started, the thirty most malnourished children are requested to come to the center everyday for four months; the mothers come twice a week. Two meals of acamil are given to each child per day. Immunizations are given as well as information about nutrition, family planning, sanitation, etc. I visited one MC center in Vialet, a one-hour drive west of Port-au-Prince The "responsable" (a male nurse) was in charge. It was weighing day--each of the children are weighed once a week. He had a large set of posters (in French!) to teach nutrition education. Mothers had to memorize the foods in each of the three food groups: structure (symbolized by a house) for protein foods; protection (lock and key) for vitamin-rich foods; and energy (fire) for oil, acamil, grain. This was primarily an education program.

3. Large vitamin A distribution program. Fortification of sugar was under study (USAID). It seems 2.5/1000 children had ocular lesions due to vitamin A deficiency (Dr. Toureau).

The Bureau of Nutrition has access to laboratory facilities, but the lab was not in use when I was there. They use the library at the Faculty of Medicine which contains nutrition journals as well as WHO and PAHO publications. Computer work is sent to VPI or INCAP. The National Nutrition Survey data will be processed by CDC in Atlanta.

The Faculty of Medicine and Pharmacology does some research on parasites--the prevalence of malaria is high and ascaris, hookworm, and tapeworm infestations are common.

USAID RESPONSE:

Linda Morris seemed interested in the research project, which could not be well-described as of August, 1978. She discussed the nutrition research situation in Haiti and she mentioned several private medical laboratories operating in Port-au-Prince whose facilities might be used (Jean Ferreira, Rene Charles, Gladys Lauture, Gamma Medical Labs., Dr. Madsen). There is also the National Research Laboratory in the Department of Public Health. The director is Dr. Lacombe. They have technicians but little funds or equipment.

She also mentioned the Division of Family Hygiene whose director is Dr. Ary Bordes, M.D., MPH, whose main activities include health, MCH, family planning, education, radio programs. The Office of Planning and Evaluation in the Ministry of Health does epidemiological research under the direction of Dr. Evariste Midy, M.D., MPH (Univ. of Venezuela) and Dr. Adrian Hilaire (former deputy director of Deschapelles Hospital; has worked with Berggrens). The Institut Pedagogie Nationale does educational research on the Creole language. There is a National Food

and Nutrition Planning Office in the National Council for Economic Development Planning with a U.N. technical advisor and four technicians.

Other people she mentioned who might be interested in the CRSP:

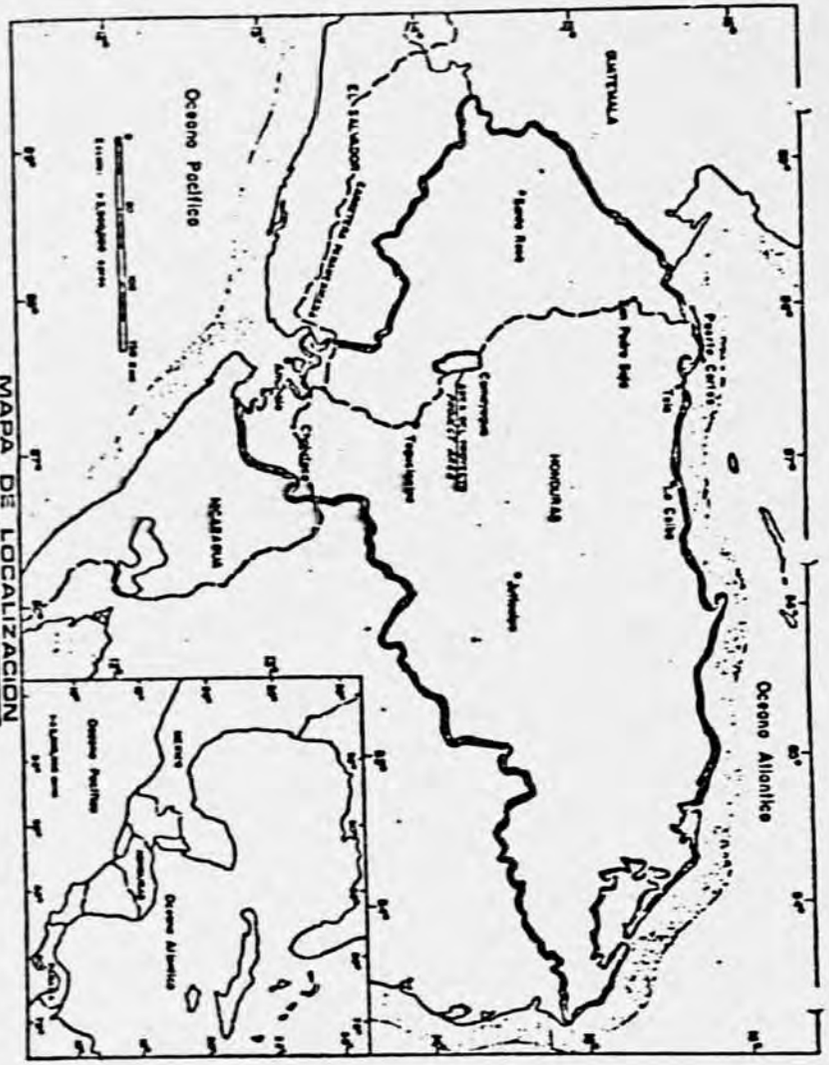
1. Leslie Delatour, economist
2. B. Etheard, sociologist-anthropologist
3. Calixte Clarisme, Haitian-trained anthropologist
4. Pierre Paisible, demographer (Petit Goâve)
5. Leslie Duchatellier, German-trained in rural/community development.

Christine Wood

HONDURAS

Dr. Doris Calloway was scheduled to make a site visit to Honduras, however, it was cancelled at the last minute due to unavailability of Honduran personnel on the proposed dates.

The following report is comprised of excerpts taken verbatim from the Briefing Document on Comayagua, Honduras, for the International Study Symposium on Policy Making and Planning to Reduce Malnutrition, held in April, 1977, at the University of California at Berkeley (under a grant from USAID). The information comes primarily from publications of the Honduran Government.



MAPA DE LOCALIZACION
LOCATION MAP

The 1971 population of Honduras was estimated at 2.6 million inhabitants. The growth rate is high at 3.4% per annum and the overall density is moderate at 21 persons per square kilometer. The most densely populated departments are Valle, Cortes and Islas de la Bahia. More than 40% of all Hondurans are under 15 years of age. Education is free and compulsory from 7 to 15 years of age, but less than 25% of the school-aged children actually attend school.

The Hounduran economy is highly dependent on agriculture. Seventy-three percent of the population is classified as rural with agricultural output accounting for 35% of the value of Gross Domestic Product and 65% of the total value of exports. Processed and semi-processed goods originating from the agricultural sectors constitute the single most important subsector of industry.

Ninety percent of the population is mixed Indian and white (mestizo), 7% is pure Indian, 2% is of African descent and 1% is European, primarily of Spanish ancestry. The last group, while being the smallest, is the most powerful politically. The blacks, found primarily on the Caribbean coast, were brought from Jamaica to work the banana regions. The Indians are Lencas except for a small community of Mayan origin at Copan. At one time, Honduras was the homeland of the Mayan civilization until their retreat into the Yucatan.

A large portion of the labor force (40%) are not year round full-time wage earners. The majority are self-employed for part of the year and hire out for wages the rest of the time. Females in the work force do not exceed 13%.

The problem of unemployment is serious sometimes affecting up to 59% of the economically active population, allegedly because the structure of land tenure is such that very few jobs are created.

The deficient transportation system is an important drawback to agricultural and hence to nutritional development in Honduras. The roads are not adequately developed although there is a small stretch of the Pan American

Highway that crosses the south of the country. The majority of the roads consist of a few feeder lines going to San Pedro Sula from points in the interior and dirt roads between the capital and Dulce Nombre de Culmi. The poor conditions of the roads seriously hinder the agricultural traffic as foods often deteriorate during the long travel. Railroads are limited to a banana line. Large amounts of exportable cargo are now carried by air.

The indigenous food resources of Honduras come from 4,236,000 hectares of cropland and pastures which represent about 38% of the country's total area. Both the costal and inland water resources contribute insignificantly to the diets of the people. The indigenous food resources are not adequate to feed the population. The basic components of the Honduran diet are corn, beans and rice, with some contribution from sorghum and wheat flour, which are produced in quantities that are insufficient to satisfy the local demand. Foods of animal origin are in short supply and the trend is towards even greater inadequacy. The reasons for this state of affairs are considered to be low income, unsatisfactory land distribution, poor marketing facilities, etc. The development of new land is progressing slowly and, as elsewhere, the benefits of technology apply almost solely to cash crops. A minority of the small farms diversify their production beyond corn and beans. When they do, plantains, rice, manioc and sorghum are grown, but no more than 2% of the farmers diversify further. There are three major types of agricultural production in Honduras: 1) the plantation type practiced by the fruit companies on the Carribbean Coast and the large cotton growers on the Pacific side with the benefit of modern technology, machinery, fertilizers, and insecticides; 2) the ranch type centered in the fertile valleys where substantial landowners graze their animals over extensive pastures; and 3) the smallholder type

prevailing in the folds of the mountains where a variety of crops (corn, beans and rice for domestic consumption and coffee, bananas and sugarcane for export) are raised, using primitive methods. Corn is cultivated everywhere possible and in years when there are no wars or hurricanes it is available in sufficient amounts to permit small exports. It is found mainly in the central plateau west of the Humuya River in the Department of Comayagua, in northern and southern Francisco Morazan Department and in adjoining Olancho Department. It also covers large areas of Choluteca Department.

Our knowledge of Honduran diets is derived primarily from a nutrition survey carried out in 1966 by the Institute of Nutrition of Central America and Panama (INCAP). The survey was conducted among 600 families distributed in 30 communities representing approximately 10.25 percent of the total population. Data on urban diets came from 100 households selected in the city of San Pedro Sula which was considered to be representative of Honduras' urban areas.

The average caloric intake in the region, which includes Comayagua amounts to 1649 calories. There can be no doubt that a substantial percentage of the total families surveyed eat less than 50 percent of the requirements, 26 percent eat less than 70 percent of the recommended allowances, and 40 percent less than half of what they should eat. While the national average of 58 grams of protein daily intake is nearly adequate, as well as the 32 percent animal protein, it is reported that 13 percent of the families examined consumed less than 70 percent of this adequate amount. There is also a generalised deficiency in Vitamin A and riboflavin intake. Anemia is prevalent at less than 800 meters elevation. The rate of prevalence is lessened above 800 meters. In the city of San Pedro Sula the percentage of people with a low hemoglobin level was not as great as in rural sectors at the same altitude. Males between 12 and 17 are the most commonly affected in non-urban communities. Pregnant women in their second

and third quarters show the highest incidence of anemia, as do lactating women. The difference between rural and urban populations in this respect is that male adolescents are more affected in the rural areas while children of less than 3 years of age seem to be the most vulnerable group in the cities.

Perhaps the most obvious major nutritional deficiency in Honduras is that leading to endemic goiter. The prevalence of goiter equals that in other Central American countries, however lower levels occurred in Comayagua (6 percent). The age group 12 to 22 seems most severely affected.

Between 1970 and 1972 investigations on the Comayagua Valley were undertaken on behalf of the Government of Hounduras by a team commissioned by the Overseas Development Administration of the United Kingdom. The objective of the study was "to assess the available resources and determine how best to develop their use in terms of the basic needs of the people and to effect some improvement in the quality of their lieves." The Comayagua Valley was thus studied with a view to designing a development project.

SITE VISIT, INDONESIA
July 10-14, 1978
D.H. Calloway

I. Indonesian Nutrition Research and Development Center - Bogor, Indonesia

A. Organization and Administration

The Center is administratively located in the Ministry of Health. The Director is an Indonesia-trained M.D., Ph.D., Darwin Karyadi; his English competency is quite good, spoken, with a Dutch-Indonesian accent. There is no assistant director.

The professional staff numbers about 16 (at least one is presently on study leave, working toward a graduate degree) although the nominal complement is 25. Three, including the Director, hold the Ph.D. degree. There are several technicians, trained to the B.S. level.

The Center is organized in four divisions, each with four sub-divisions as follows:

A. Community Nutrition (Miss S. Martoatmodjo, M.P.H.)
   1. Epidemiology and Surveillance
   2. Clinical Nutrition
   3. Communication
   4. Growth and Development
B. Nutritional Biochemistry (Mr. Muhilal, Ph.D., U.S.-trained biochemist)
   1. Nutritional Requirements
   2. Hematology
   3. Metabolic Studies
   4. Animal Experimentation
C. Food Science (Mr. Hermana, doctoral student in U.S.)
   1. Food Chemistry
   2. Food Microbiology
   3. Food Toxicology
   4. Food Preparation and Testing
D. Socioeconomics and Statistics (Mr. Diumadias Abunain, M.S., Nutrition)
   1. Program Analysis
   2. Consumption Studies and Agroeconomics
   3. Social, Cultural and Economic Studies
   4. Data Processing and Statistics

I was unable to identify any staff members fully qualified to carry out research on nutrient requirements or metabolic studies and I gather no such work has been done, although it is planned.

B. Facilities and Resources

The Center consists of two main buildings: a one-story structure containing offices, library, food preparation and testing room, and statistical laboratory; and a two-story structure where the chemistry and microbiology laboratories are located. Some of the instrument rooms are individually air-conditioned. The Director lives in an adjacent residence.

New buildings are to be completed in the period 1979-1981. The new construction is to include a metabolic unit.

The biochemistry laboratories are now equipped to carry out analyses of biological materials for amino acids, vitamin A, carotene and retinol-binding protein. There is no atomic absorption spectrometer or other equipment that would permit trace element assays. The food science laboratories appear to be equipped for only routine chemical and bacteriological studies, although research on mycotoxins is said to be in progress. The food preparation laboratory is poorly equipped and would not meet U.S. sanitation codes. There is no computer facility in the Center or elsewhere in Bogor; data are processed in Jakarta.

The library is in woeful condition. The holdings are minimal and even the abstracting journals are several years out of date.

IBRD has included this center in the Indonesian project and will provide U.S. $5.9 million over a four-year period for construction, training and support. (See IBRD Report No. 1318-IND.)

C. Assessment

Dr. Karyadi appears to spend nearly full time in his role as administrator and is not directly involved in research except at the program-planning level. His Ph.D. research dealt with some aspects of anemia/work productivity/physical capacity and was carried out in conjunction with the doctoral project of Samir Basta (now IBRD).

The biochemistry operations are clearly the most advanced of Center activities. Dr. Muhilal is well-trained, understands methods and equipment. None of his instruments was "down" and technicians were working even though the senior staff were away, attending a conference.

The present staff could not conduct the research projected for our program, nor would they be able to carry out sophisticated

metabolic studies or extensive surveys. They lack everything but enthusiasm. Dr. Karyadi inquired about training opportunities at Berkeley and I encouraged him to send candidates for advanced training for his projected human research activities. I indicated that the Graduate Division would consider applications for M.S./Ph.D. programs or, alternatively, that we would provide non-degree training on a Limited Status admission basis.

I hope that some of the senior staff will visit functioning metabolic research units in the U.S. before they complete plans for construction and equipment, and I have encouraged them to do so.

II. LIPI Workshop on Food and Nutrition in Indonesia

The Indonesian Academy of Sciences (LIPI) convened a national workshop to consider current food and nutrition problems, as a follow-on from a similar meeting held in 1968. The U.S.-N.A.S. sent a small delegation of scientists to serve as resource people during the workshop.

In his opening address, Professor Vernon Ruttan (University of Minnesota, leader of the U.S. delegation) reviewed changes in the agricultural economic situation from 1968 to 1978. He cited as gains increased productivity and growth of the industrial sector; increased rice production as a result of new technologies and of price policies; and slowed population growth rate. Negative factors were increased imports of wheat and rice; increased numbers of families living in poverty; increased numbers of landless laborers and fewer days of employment available to laborers in agriculture; and increased differential in income distribution, worsened because of increased cost of rice relative to income of the poor. Problems identified by Dr. Ruttan as requiring solution were a) resources to be tapped for continued increase in food production (needed are capacity to provide energy efficiently and for rural people to utilize innovations, a scientific establishment, institutions to transmit knowledge, etc.); b) dependency on rice; c) institutional capacity; and d) limitations of conventional economic planning and analysis.

Attendance at this meeting provided an opportunity to meet most of the senior nutritionists presently active in Indonesia. (Participants are listed in Appendix A.) Of the approximately 175 participants, about 50 indicated a primary interest in nutrition; many of these were in related disciplines and not trained in nutrition. The preponderance of nutritionists are in the health/medical sector.

An exception is Professor Sajogys of the Institute of Rural Sociological Research, Bogor Agricultural University, who has been involved in nutrition, household and community research. It was my impression on speaking to him, and Dr. Benjamin White (ADC, Bogor) confirms, that Dr. Sajogys's work is of good, interdisciplinary quality. He would be a key resource for our work. Dr. White also identified two members of the Faculty of Nutrition, Diponegoro University, Semarang, Central Java--Drs. Satoto and Fatimah--as being good nutritionists in the agricultural sector. Dr. White suggested our contacting Dr. Gillian Hart, ex-Cornell, now Boston University, for additional information. (Dr. Vernon Ruttan has vetted Dr. White himself.)

Ongoing nutrition research in Indonesia is focussed on surveys/surveillance and some aspects of protein-calorie malnutrition, Vitamin A deficiency and anemia. Iodine-deficiency is the other recognized micronutrient problem. Consideration is being given to fortification schemes and MCH measures as direct nutrition interventions.

Integration of nutrition objectives with planning activities seems not to have been effected, even though it is discussed. There is the usual problem of nutrition activities falling within the Ministry of Health and planning efforts focussing on agricultural development without nutrition input. If the recommendation of the Workshop--that nutritional status of the people should be used as the yardstick of success of development programs--is accepted by the government, some coordinating mechanism must be found or there will be internecine conflict (à la USDA, HEW). The mechanism proposed, a ministerial coordinating committee, is unlikely to be effective for the obvious reasons.

III. Potential for Collaborative Work

Indonesia has a full range of nutrition problems and willing investigators. If the health/agricultural interface problems could be overcome, and if the project could avoid accidental perturbation that potentially would come from the smorgasbord of international and bilateral activities in progress/proposed, and if a strong U.S.-institutional linkage could be forged (top U.S. talent willing to spend time in the country and adequate training provided for Indonesian nationals), Indonesia would be a good site. Food patterns include various proportions of the staples--rice, maize corn, cassava--in different populations; there is a variety of climate/soils/agronomic patterns; and terrible deprivation.

Relevant readings from PRISMA, February 1978: Rohde, J.E., et al "Who dies of what and why" (pp 26-38); and Collier, W.L. "Food problems, unemployment and the green revolution in Java" (pp 38-52). Also see working paper U/1/1B from the LIPI workshop, which deals with energy and protein requirements estimates for Indonesia.

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BOGOR 10 - 14 JULI 1978
SEKRETARIAT: Lembaga Ilmu Pengetahuan Indonesia, Jl. Teuku Chik Ditiro No. 43 Jakarta

APPENDIX A

SIDANG KELOMPOK SUB-TEMA 1,

MASALAH KECUKUPAN PANGAN DAN GIZI

NUTRITION SUB-GROUP

DAFTAR PESERTA

Ketua : Julie Sulianti Saroso(♀, M.P.H., M.A.T.) PROF.

Sekretaris : Ir. Tarwotjo[a,b]

Pengarah : 1. Darwin Karyadi(M.D.)[a,b]
2. Sajogyo, Prof.
3. Soeharso

Resource Person : 1. Doris Calloway
2. James Dinning
3. Sunwang
4. Rochmat Qureshi (F.A.O., Asia region)

Peserta : 1. Djumadias Abunain[a,b]
2. Muh. Arief
3. Subiyakto Atmosiswojo
4. M. Amin Aziz
5. John A. Dixon(Econ)
6. Wiratno Haryoko
7. Seyati Hasibuan
8. Lukas Hendrata
9. Husaini
10. Melati P. Joenoes
11. Kamarsjah
12. Sri Kardjati(♀ M.D.)[c]
13. Muhamad Khomsedi
14. Urodjat Prawiranegara
15. Soemilah Sastroamidjojo(♀)[d]
16. Lasam Soeroso
17. Lie Goan Hong
18. S. Melasan(M.D.)
19. I.B. Mantra
20. Sukertijah Martoatmodjo
21. Muhilal (Biochem, Ph.D.)[a,b]
22. Sandillah Hursjid
23. Burhan Napitupulu
24. Sumpendi Metoliharjo
25. Soehorto Prawirokusumo
26. Utoo Muchtar Rafei
27. Broto Romah
28. Samaudin
29. A. Djaeni Sediaoetama
30. Bambang Setiadi
31. Hananto Sigit
32. M.B. Sirait
33. H.H. Sitompul
34. Poorwo Soedarmo
35. Soegito
*36. Soekirman (Ph.D.)[b]
37. Soepardan Soerjohudojo
38. Suhardjo
39. Suharto
40. Sam Suharto
41. Suhartono
42. Haryono Suyono
43. Arifin Tasrif
44. H.A.R. Talaar
45. Bambang Wikantadi
46. Kartomo Wirosuhardjo

*Director of Nutrition, Ministry of Health

*Nutrition Planning, Bureau of Social Welfare, Housing and Health.

a) Authors of nutritional allowances working paper
b) Authors of nutritional status/survey working paper
c) Authors of nutritional survey. E. Java working paper (with Husin)
d) Authors of famine/relief working paper

SIDANG KELOMPOK SUB-TEMA 2,
PEMBAGIAN TANAH, AIR, IKLIM DAN TEKNOLOGI
PRODUKSI DALAM PENGUNAAN TANAH

SOIL, WATER, ETC.

DAFTAR PESERTA

Ketua : Setikno Sumintowharta

Sekretaris : Darjatna Effendi S.

Pembantu : 1. Gunomo Suparti
2. Nasli Hakim

"Resource persons" : 1. Colin McClung
2. Donald C. Taylor

Peserta : 1. Boesono Boedidarsa
2. Zainuddin Marahup
3. Sri Setyati Karjadi
4. Parmesih Isbagio
5. Surahmat Kusumo
6. Amris Makmur
7. Marimurti Martojo
8. Soetodjo Noeljadihardjo
9. Hansani Pekerti
10. M. Gazmini
11. Djamsoeded Sadjat
12. Sumardi Sastrahusumah
13. A.M. Satari
14. D.T.H. Sihombing
15. Soroso Sindoesarojo
16. Soendi Sindoeredja
17. M. Soepraptohardjo
18. Soeyono Soeripati
19. Subijanto
20. I.G.N. Tantra
21. Aldo Purnomo Tirtoredjo
22. Gombang Tjitrosoepeno
23. Triharso
24. Andreas Warkidi
25. Suhardi Wiranatadja
26. Sunino Wirjosuharjo

*Head, Nutrition Unit, Min Agriculture

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SIDANG KELOMPOK SUB-TEMA 3,
PENELITIAN BIOLOGI UNTUK MENUNJANG TEKNOLOGI PEMANFAATAN SUMBER DAYA PERTANIAN (TANAMAN, HEWAN, IKAN)

BIOLOGICAL RES.

DAFTAR PESERTA

Ketua : Setijati Sastrapradja

Sekretaris : Soemartono Adisoemarto

Pembantu : 1. Didin S. Sastrapradja
2. O. Koswara
3. Johan Silas

"Resource persons" : 1. James Moomaw (AVRDC, Taiwan)
2. Hugh Popenoe

Peserta : 1. Wanda S. Atmadja
2. Didi Atmadilaga
3. L.A. Gunawan
4. Go Ban Hong
5. Kamaruddin Ma'sum
6. Sayuti Murad
7. Jetty Murniati
8. Oey Kai Nio
9. P.M. Pajow
10. Soetjipto Partohardjono
11. Roestamsjah
12. Susono Saono
13. Muchtar Effendi Siregar
14. B.H. Siri
15. Justina Sri Adiningsih Soejitno
16. Aprilani Soegiarto
17. Roberto Soemarjo
18. Martono Soeroengoro
19. Hendro Sunarjono
20. Surya
21. Sri Suwasti Suranto
22. Mohamad Hasrol Thajib
23. Mozes Toelihere

SIDANG KELOMPOK SUB-THEMA 4

KEBIJAKSANAAN PERTANIAN
PERANGSANG INTENSIFIKASI

DAFTAR PESERTA

Ketua : Sjarifuddin Baharsjah

Sekretaris: B. Sinaga

Pemasaran : 1. I. Gusti Bagus Teken
2. Affendi Anwar

Resource Persons : 1. M.L. Barnett (Cornell)
2. Richard Goldman (Econ - New York)
3. Iltaf H. Hussain ?
4. V. Rattan (Econ - Minn.)

Peserta : 1. Nadir Abdulkadir
2. Anwar Abidin
3. E. Rukaseh Atirotma
4. Saleh Afiff
5. Sri Suwito Idris Atmodjo
6. A.T. Birowo
7. William L. Collier
8. Soehartojo Hardjopranyoto
9. Harmojo
10. Erfansjah Hasan
12. Ibrahim Hasen
13. D. Hedley
14. Moh. Mahfoedi
15. Montgomery
16. Mubyarto
17. B.S. Haljono
18. Hidayat Natastmadja
19. Andung A. Nitimihardja
20. Nyberg
21. Dibyo Prabowo
22. A.M. Saefuddin
23. M. Arifin Siregar
24. Sayuan
25. Kabul Santoso
26. Soekartawi
27. Rusman Sudjana
28. Wahjudi Sugijanto
29. Saskoro Winarno.

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SIDANG KELOMPOK SUB-THEMA 5

TEKNOLOGI LEPAS-PANEN, PENGOLAHAN,
PEMASARAN DAN PENANGANAN PANGAN

DAFTAR PESERTA

Ketua : Pornadi

Sekretaris : Hermono

Pemasaran : 1. Soewarno T. Soekarto
2. Muhamadi Siswo Soedarmo

Resource Persons : 1. B.L. Bala (Food Tech., Ibadan)
2. Michael Dow (Biochem. NAS staff)
3. E.B. Fariser (Food Tech. MIT)

Peserta : 1. Purwo Artiasto
2. Bardinan
3. Suhadi Hardjo
4. Samruddin Iljas
5. Sofyan Ilyas
6. Siti Janijah S.P.
7. S.B. Joedono
8. Kusarjoni
9. Musrifinah Mahlan
10. Suharto Hartosudirdjo
11. Dich Maulida
12. Sidik Moeljono
13. Sjahdian Muhyi
14. Muslimin Nasution
15. M. Anwar Nur
16. Nuryadi
17. Radjawati
18. Atjang Inchlis Syarief
19. Soedito
20. Sjafar B. Simanbela
21. Hardjo Soeratmadja
22. Ig. Suharto
23. Ismu Sukanto Sunelo
24. Susursono Wijandi
25. F.G. Winarno (H.O. Wisconsin)*
26. Winoto.

* Vice-chair of the Conference

Drafted February 15, 1979

Report on a Site Visit to Kenya in connection with

Title XII - Nutrition - Michael C. Latham

Introduction

Dr. Christine Wood (HCB) visited Kenya from February 19-24. Dr. Latham was already in Kenya conducting research on the "Kenya: Health, Nutrition and Worker Productivity Studies" supported by the World Bank and British Overseas Development Ministry. At the time of Dr. Wood's visit field research was being conducted by the team in Kwale District south of Mombasa.

Dr. Wood therefore flew directly to Mombasa on February 19 and was met by Dr. Latham. On February 20 Dr. Wood was able to view the field study, and met the team members. Dr. Wood and Dr. Latham left by train for Nairobi on February 19. Both had meetings in Nairobi on February 22 and 23. Dr. Latham left for Kwale on the evening of February 23 and Dr. Wood had further meetings in Nairobi on February 24.

Persons with whom discussions were held

U.S.A.I.D. (Nairobi)

Robert Muscat (Deputy Chief of Mission)

Mr. Slattery (I/C Nutrition Programs)

Mr. D'Antonio (Title XII Officer)

John Aldon

Dick Archy (Programs and Contracts)

Institute for Development Studies (University of Nairobi)

Dr. Senga - Director

Dr. P. Hopcraft - Senior Fellow (formerly acting director)

Population Studies and Research Institute (University of Nairobi)

Prof. S. H. Ominde - Director

Prof. R. A. Henin

Prof. H. W. Mosley - Visiting Professor (for 2 years)

Ministry of Health

Dr. Kinoti - Nutrition Section

Department of Community Health (University of Nairobi Faculty of Medicine)

Prof. J. Kaggia - Department Chairman

Dr. Mallone - Lecturer

Medical Research Centre

Dr. A. A. J. Jansen - Director, Nutrition Section

World Bank-ODM Project - Kwale

Dr. L. Stephenson - Post Doc. Res. Associate (Cornell)

Terry Elliott - Res. Asst. (Cornell)

June Wolgemuth - Res. Asst. (Cornell)

Andrew Hall - Res. Asst.-Parasitologist (Cambridge University)

Bahari Omari - Field Assistant

Stephen Mgenja - Rural Access Roads Overseer Road 17

Ramin Mdudu - Rural Access Roads Overseer Road 19

General

Kenya became independent, thus achieving nationhood only in December 1963. Her government has been extremely stable. From 1963 until his death in 1978 President Jomo Kenyatta headed the government. After his death there was a smooth and impressive constitutional transfer of power to President Daniel Arap Moi who had been Vice President. Mr. Kwai Kibaki, the Minister of Finance became Vice President while maintaining his portfolio in charge of Finance.

The new government has, in its first months in office, indicated some new policies, all of which seem to be generally popular. Two of these are

KENYA

related to nutrition. In December 1978 a Presidential decree was issued which indicated the intention of the government to provide all primary school children with milk at school. In February 1979 the Vice President announced that the government was to set up a National Nutrition Council "to cater for all aspects of nutrition" because the Government "was concerned about malnutrition in Kenya, and especially in children below the age of five."

Kenya is a mainly agricultural country, but with an impressive new industrial base. However most foreign exchange comes from agriculture, and by far the majority of people live in the rural areas. Kenya has been pro-western since independence but maintains good relations with countries from all "blocs". Kenya has a good civil rights record. In December 1978 President Moi released all political detainees.

Kenya, like most formerly colonial countries in Africa, is a young and very poor nation. She has one of the highest rates of population increase in the world. Her only University (the University of Nairobi) is less than 15 years old, yet is of a very high standard. Kenya's significant contact with "western civilization" is less than 100 years duration.

Although Kenyans now are fully in control of the government, and occupy nearly all the most senior positions in institutions such as the university, it must be recognised (and is so by the government) that non-Kenyans will for many years be essential to occupy many professional positions in the government, the university and in research institutes etc. The problems of malnutrition may be similar in Kenya to those in say India, the Philippines or Colombia. But those countries all have many universities and sometimes a surfeit of university graduates. Kenya has relatively few of her own doctors, scientists and other professionals. Assistance to strengthen institutions and to train individuals is therefore particularly

welcome in countries such as Kenya. On the other hand the role played by local professionals in the early stages of a program might be smaller than in countries which have more university graduates.

Kenya has a population of about 13 million people. A nationwide census will be undertaken in 1979. The people consist of many different tribes, each with cultural similarities and differences. The country has huge ecological differences from the tropical moist coastal region, to the arid semi-desert of the northern half of the country, to temperate fertile highland areas. Diets vary by tribe and with ecology. The range here is also wide--for example the Masai and other cattle keeping people having a high protein diet with much milk, meat and blood, and other peoples consuming mainly cassava or plantains having a diet relatively deficient in protein. The commonest staple is maize, but important items in the diet of many Kenyans are legumes, cassava, millet, wheat, rice, and green leafy vegetables.

Nutrition problems and nutrition research

A short site visit does not allow an adequate review of past nutrition research.

A series of WHO nutrition surveys were completed in the 1960's and early 1970's. The Dutch Medical Research Centre has done extensive and detailed research into various nutrition and related health problems in Machakos District between 1969 and the present. In 1977 the Central Bureau of Statistics assisted by other institutions conducted an extensive Rural Nutrition Survey as part of a larger Integrated Rural Survey. Various hospital studies of malnutrition in Kenya have been undertaken by members of the Department of Pediatrics of the University of Nairobi and the pediatricians of the Ministry of Health. For many years detailed studies on nutritional anaemias in Kenya have been conducted by the Welcome Foundation

Laboratories in Nairobi. In 1974 an extensive survey of the problem of xerophthalmia in Kenya was undertaken and published. At present a U.S.A.I.D. funded project is underway which is investigating eye diseases including xerophthalmia in Kenya. A number of studies of endemic goitre have been undertaken, and an evaluation of salt iodization is continuing. In collaboration with the Medical Research Centre and Dr. Oduori (Chief of Pediatrics, Kenya Ministry of Health) a longitudinal study is underway evaluating the relationship of Ascaris infection to nutritional status of children. This study being undertaken by Cornell University will also generate useful longitudinal growth data on some 800 children over a period of 5 years. The same group are investigating the role of nutrition and health in worker productivity, and assessing the role of hookworm, schistosomiasis and malaria in anemia of adults in Nyeri and Kwale. Dr. Charlotte Neumann of UCLA has been conducting an investigation of the relationship between nutrition and infection in infants in Kenya.

The conclusion from these and other studies is that protein-energy malnutrition of young children is a major problem in Kenya. Cases of nutritional marasmus and kwashiorkor are frequently seen in Kenyatta National Hospital and in other hospitals throughout the country. But much commoner are mild and moderate cases of PEM. The recent Rural Kenyan Nutrition Survey (1977) included examinations of 1383 children from 6 provinces. This showed that 33 percent of children had a weight for age below 80% of the standard; 29 percent had a height for age below 90% of the standard; and 29 percent had a weight for height below 90% of the standard. This survey indicated a situation commonly found in many developing countries where severe PEM was not very prevalent in a cross-sectional survey but mild and moderate PEM was very prevalent. The survey report

summarises the findings from some dozen other studies in Kenya between 1969 and 1978 most of which came up with quite similar results.

There is evidence that nutritional anemias are common (often associated with parasitic infections), xerophthalmia occurs, and goitre is endemic in certain parts of the country.

Marginal malnutrition and seasonal undernutrition seem to be extremely common. There are areas where droughts and famines occur frequently. The Rural Kenyan Nutrition Survey suggests (rather surprisingly) that Eastern, Central and Rift Valley Provinces have the most PEM and that the Coast and Nyanza Provinces have the least. But in all provinces there is a significant problem of PEM.

U.S.A.I.D. - Nairobi Office

The Mission is a very large one occupying several floors of a substantial modern office building. The Deputy Director of the Mission is Robert Muscat who for many years (before joining A.I.D.) had a real interest in nutritional problems of poor countries and in nutrition policy. He stated very firmly that he was keen to see the A.I.D. Mission in Kenya much more involved than at present in nutrition activities. This is a real plus.

Other members of the Mission expressed the belief that Kenya was now ready for more nutrition activities. They seemed concerned that a Title XII nutrition project might add unreasonably to their work load.

Institute for Development Studies

The Director, Dr. Senga, was quite straightforward in saying that IDS would now take a lead role in a Title XII Nutrition Project. They had recently reviewed their "mission" and had decided to focus attention on (a) rural and agricultural development, (b) industrialization, (c) resource management and environmental studies, and (d) human resources and development. Although nutrition might fit into several of these areas he believed that other institutions were better placed to take a lead in nutrition research. He felt that staff members of IDS might be able to assist other institutions in nutrition activities.

Dr. Peter Hopcraft, a white Kenyan who is a Senior Fellow at IDS, indicated a personal interest in the Title XII nutrition project. He has for many years been interested in economic questions related to nutrition, health and population. Until mid 1979 he is heavily committed but after that he would be interested in some involvement. He is a well qualified economist, with a good knowledge of and deep commitment to Kenya. He currently serves as a Consultant to the Cornell nutrition project in Kenya.

Population Studies and Research Institute

Professor Omnde, the Institute's Director, seemed very interested in the Title XII Nutrition Project. Discussions were held with him and two of his associates (Prof. Henin and Prof. Mosley). The Institute is involved in a variety of research and training activities. At present they are mainly using existing data. However a major study of the determinants of fertility in Kenya is planned. They are also assisting with the Kenya part of the World Fertility Survey. Prof. Mosley is a demographer who has a special interest in the relationship of nutrition to fertility. In 1975 he ran an international workshop on this topic in Washington, D.C. for the U.S. National Academy of Sciences. He will be in Kenya at the University of Nairobi until June 1981.

The Population Institute can help with demographic data analyses in Kenya; it has modest funds to assist other researchers in Kenya (for example Dr. Kaggia from the Department of Community Health); and it has access to interviewers and data collectors.

This Institute might be a good location for research into questions of nutrition and fertility.

Department of Community Health (University of Nairobi)

Professor James Kaggia, head of the Department, and Dr. Mallone, Lecturer in the Department, met with us for some 2 hours. The department at full strength has some 13 faculty members, and may be expanded to 15. Three are out of the country getting advanced degrees but will be back by the end of the year. The majority are physicians with M.P.H.

The department is a part of the Faculty of Medicine of the University. Their main function is in training medical students, in conducting research and in providing service. They also do post-graduate training in nutrition (both Masters degrees and Ph.D.s) and in public health.

Research underway is quite varied. Professor Kaggia has a special interest in nutrition. He has undertaken an extensive study on growth and development of Kenyan children and the social and environmental factors that influence this. Dr. Miriam Were (Senior Lecturer) has a large project evaluating primary health care in Western Kenya. Each year the department undertakes nutrition and health field research with groups of medical students in part to provide training but also to gather data.

Professor Kaggia seemed very responsive and interested in the Title XII Nutrition Project. He and his staff are heavily committed over the next few months but he believes that they could give time to a project and would be interested to do so in 1980 and beyond. Approval for any project would have to come from the Dean of the Medical School. He believes it would be good to work with the Department of Pediatrics as well as his department.

Ministry of Health

The Ministry of Health is responsible for the health aspects of

nutrition in the country. Dr. Kanani is the Deputy Director of Medical Services and in charge of nutrition. He serves immediately below the Minister for Health (Hon. James Osogo M.P. - a politician) and the Permanent Secretary and DMS (Dr. P. Mngola - a physician). Under Dr. Kanani are Dr. A. Oyoo (Assistant Director of Medical Services for nutrition); Dr. Kinoti (a pediatrician working full time on nutrition); Mrs. Susan Ngui (Nutritionist); and all provincial and district nutritionists. Also under the Ministry of Health is Karen College where nutrition training is done.

Plans have been drawn up for the formation of a Food and Nutrition Research Center, as one of the units within the newly established Kenya Institute of Medical Research whose Director is Dr. Gekonyo.

A meeting scheduled to take place with Dr. Kanani, Dr. Kinoti and Dr. Gekonyo at the Kenyatta Conference Center never took place because a message did not reach us. Dr. Latham has in the past met with Dr. Kanani and will do so again in March 1979. Dr. Wood and Dr. Latham did hold discussions with Dr. Kinoti who is taking the leading role in the plans for establishing the Food and Nutrition Research Center, and who also helps coordinate the nutrition activities of the Ministry of Health. Dr. Kinoti is a pediatrician who has a special interest in nutrition, and who the day prior to our visit presented a paper on breast feeding at the International Congress of Pediatrics being held in Nairobi. Dr. Kinoti is planning to do a one year Masters degree in nutrition at Cornell University beginning in September 1979.

The Ministry of Health or the new Kenya Food and Nutrition Research Center are likely in the next year or two to take over the facilities (including the nutrition laboratory) and activities of the Dutch Medical

Research Center. This will include the study area and the longitudinal investigation going on in Machakos District.

Dr. Kinoti expressed great interest in the Title XII Nutrition Project. He believes that the Ministry of Health would welcome involvement in it, and that the new Food and Nutrition Research Center would benefit greatly by cooperating, and that the Center could play a key role in research of the type proposed. Although not explicitly stated, it is clear that Dr. Kinoti himself expects to play a key role in the new Center when he returns from the U.S. in May 1980.

The Medical Research Center (MRC)

This is a branch of the Royal Tropical Institute of Amsterdam, and is fully supported by funds from the Netherlands. However it is gradually being taken over by the Ministry of Health, and by 1981 is likely to be a Kenyan institution. The Director is Dr. Theo Hengreaf. There are Departments of Nutrition, of Virology, of Parasitology and of Epidemiology. The virology department has recently been taken over by the Ministry of Health but remains in the MRC building.

The Department of Nutrition is directed by Dr. A. Jansen, an M.D. with extensive international experience (Fiji, INCAP, WHO in Brazzaville etc.). Except for a senior laboratory technician (Ms. van Bens from the Netherlands) all other employees are Kenyan. The MRC has been involved in nutrition research in Kenya for about 10 years. A variety of activities have been undertaken. At the present time the main activities are based in the Joint Project Machakos (JPM) area in Machakos. This is a large longitudinal collaborative study involving epidemiology, parasitology, virology, MCH as well as nutrition. A detailed study of some 30 villages has been undertaken. There is regular data collection on health, nutrition, social variables, agriculture etc. Good birth, and death records are

maintained, and morbidity data are collected. A variety of nutrition and health substudies have been done or are under way in the area.

The MRC has well equipped and efficient nutrition laboratories where most ordinary determinations can be done. It also has excellent parasitological and virological laboratories. Kenyan field workers and interviewers have been trained and are utilized for a variety of research activities. Reports on the JPM project are available--the major publications appearing in Tropical and Geographic Medicine.

Dr. Jansen and his staff seem interested in the Title XII project, and would be willing to cooperate. They believe that their facilities could be used, and if desired a part of the project could be done in the JPM area. Dr. Jansen for the last 3 years has been collaborating with Cornell University in a nutrition study in Machakos District.

Department of Pediatrics, University of Nairobi

Professor Bwibo who is chairman of this department was heavily involved in the International Congress of Pediatrics during the period of our visit. We were not able to see him. Dr. Latham knows Professor Bwibo and his department, and will visit with him later.

Besides himself there is a faculty of about 10 pediatricians. They are involved in medical school teaching, in research on various problems of child health, and in service activities. They also do post-graduate training in pediatrics. A number of research activities and recent papers from the department are related to nutrition.

This department which is well run and has staff of a high caliber would be an obvious place for cooperation as part of a Title XII nutrition project.

Working closely with Professor Bwibo's Department is Dr. Martin Oluori, Chief Pediatrician for the Ministry of Health. He is responsible for

pediatric beds in Kenyatta National Hospital but also for child health and pediatric services throughout Kenya. Dr. Oduori has been a partner of the Cornell University group in some of their research on nutrition and Anemia. He has expressed a willingness to continue to collaborate in future research related to nutrition and child health.

Other institutions and individuals not visited

Kenyatta University College near Nairobi is where undergraduate training is done in home economics nutrition. Ms. Rodrigues and other faculty do nutrition training. Ms. Rodrigues has been involved with the Department of Community Health in nutrition research.

The Department of Food Science at the University of Nairobi is situated on the campus at Kabete. Faculty there teach nutrition to students of food science. They have well equipped laboratories for food science and technology. Considerable funds from overseas come to this department.

The African Medical and Research Foundation is best known for the flying doctor services. But it is involved in training, research and other activities related to nutrition. Dr. Roy Shaffer who has collaborated with Dr. George Mann of Vanderbilt University has recently joined their staff. He has done extensive work with the Masai in Kenya.

Egerton College, some 100 miles from Nairobi, is responsible for advanced training in agriculture. Women extension officers being trained there receive training in nutrition. Some nutrition research has been done by staff at Egerton College.

This listing of institutions doing work related to nutrition is not complete.

Conclusions

There are things in favor and others against Kenya as a suitable venue for a Title XII Nutrition Project.

Kenya has a stable government, a large AID mission, no serious human rights problems, an adequate prevalence of marginal malnutrition, and considerable ecological diversity all of which factors may be desirable for a project. A number of Kenyan institutions may be suitable bases for collaborative research and several individuals expressed interest in being involved in a research project. Certainly Kenya would benefit from a program conducted there.

The major disadvantage of Kenya is that there is no National Institute of Nutrition or its equivalent, and so there is no clear choice of an indigenous institution which would take a leading role. However the Medical Research Centre which is gradually being taken over by the Ministry of Health, the newly planned Food and Nutrition Research Centre within the Ministry of Health, and two departments (Community Health and Pediatrics) and one Institute (Population) in the University of Nairobi might together form a Kenyan consortium which could adequately handle a collaborative program in Kenya.

The advantages of Kenya far outweigh the disadvantages. I strongly recommend Kenya for consideration.

Note: An organizational chart for the Kenyan Ministry of Health; the University of Nairobi; and the Medical Research Centre were left with Dr. Christina Wood.

March 6, 1979

Post Script

On March 5, 1979, well after Dr. Christina Wood had left Nairobi, I had two separate meetings as follows: (1) with Dr. J. M. Gekonyo, Senior Deputy Director of Medical Services and Director Kenya Institute for Medical

Research; Dr. Kanani, Deputy Director of Medical Services; and Dr. Kinoti, Assistant Director of Medical Services (Nutrition). At this meeting I was informed of the method of operation of the Kenya Institute for Medical Research, and of the belief that a Food and Nutrition Research Centre will soon be established as one of its units. Drs. Gekonyo, Kanani and Kinoti had all read the Title XII precis, and all expressed very great interest in the involvement of the Ministry of Health and of the Medical School of the University of Nairobi. (2) with Professor Bwibo (Chairman of the Department of Pediatrics, University of Nairobi) and Professor Kaggia (Chairman of the Department of Community Health, University of Nairobi). They believed that their departments together with the Department of Obstetrics and Gynecology (headed by Professor Mati) would be interested in exploring with a U.S. institution the possibility of collaborative research of the kind outlined in the precis that they had read. They outlined the formalities that would need to be gone through before final agreement could be reached. Professor Bwibo's department as well as training medical students is also responsible for post-graduate training in pediatrics. Each year about 6 pediatricians (equivalent of U.S. Board Certified pediatricians) complete their training. For the first time in Kenya's history all Provincial Hospitals now have a Specialist Pediatrician. There will therefore be pediatricians available in the future to go into other specialisations, to be involved in special projects, and to devote more time to research.

spectrophotometer and Varian chromatograph; none of these was in use. The food development laboratory is equipped to do very small-scale processing and was currently processing some maize products.

The Division now has three or four rural nutrition centers in operation. The one he would provisionally use for the CRSP project is located about 100 miles distant in the State of Puebla. This unit has been in operation for eleven years and is a model in terms of its simplicity and evident rapport with the community. Dr. Chavez evidently keeps close touch with the Center and was known by name to many of the village people. The woman in charge of the Center, Sra. Cecilia Martinez, has been there since its inception (and had previous experience in other rural centers operated by Dr. Chavez through INN). She is treated with respect and affection by the village people. Sra. Martinez is of rural Indian origin, has completed the pre-medical curriculum and holds a Master's degree in Public Health Nutrition. Dr. Chavez's intervention study of pregnant and lactating women and their children has been conducted in this location. His original population of 40 supplemented children now consists of 34 cases of school age. This work continues.

Most of the villagers have 3 hectares of land in a common location. They grow maize, beans and tomatoes for home use and peanuts as the major cash crop. It is a very poor community but some improvements have been made over the 11-year study period: electricity, water piped into the yard, a modest community center, and a semi-improved road. It's a hot, dry, dusty place with the usual complement of chickens, pigs, burros and scabrous underfed dogs.

Dr. Chavez is giving some thought to an alternative community site, a village of about 3000 people located about 10 miles away. The characteristics

of the two communities are quite similar but they are served by different markets and so are not in communication. Factors in favor of the new location are its somewhat larger population and avoidance of contamination of the long-term study that now could be nearing completion.

The strengths of this potential collaborator are his experience and skills in establishing and maintaining field units with good morale and community goodwill, and his great enthusiasm for the work. Weaknesses are his preference for an intervention model and natural wish to continue with the project in which he has such a large investment, as an add-on to the other projected research. His Division is subject to political whim but he has proved tenacious in maintaining a core staff and program. The collaborating US institution would have to provide special social/behavioral sciences skills and good statistical/data analysis support. A US researcher would have to stay with the project in the field in view of the added complexity of the research to be undertaken.

Site Visit Report/D. H. Calloway
4/9/79 Instituto Nacional de la Nutricion (I.N.N.), Mexico (Av. San Fernando y Viaducto Tlalpan, Mexico 22, D.F.)

INN is a well-established organization, located about 10 miles from the city center. It is one of a cluster of health institutes that include both clinical and research facilities. The group of institutes falls in the purview of the Ministry of Health but INN is managed by a seven-member Board of Governors that includes representatives of: Ministries of Health and Agriculture; Office (Bureau?) of Scientific Research (Science and Technology?); CONASUPO; state/local government; and industry. About 40% of its budget is from the Ministry of Health, 40% from the Office of Scientific Research, and 20% other (including current projects with the World Food Program and the World Bank). The Director-General of INN is an 80-year-old physician whose tenure has been extended on a year-to-year basis due to his prestigious associations. There are several hundred professionals in INN but most of these are medical/paramedical staff associated with clinical work (diabetes, metabolic diseases, anemia, goiter, etc.). About 80% of the budget goes to this activity.

The Division of Nutrition is under the direction of Dr. Adolpho Chavez. The Division has two subdivisions: Applied, or Public Health, Nutrition and Food Science-Nutritional Physiology. The first group are engaged in nutrition surveys and nutrition education activities. The second, supervised by Dr. Hector Bourges, carries out nutrition requirements studies in man and a program of experimental studies in animals; they also develop nutritionally-based food products. The total staff includes 35 professionals, 7 of whom are senior investigators (including Drs. Chavez and Bourges) and 7 junior-level investigators. Four years ago there were over 20

researchers; loss of one-third of the principal staff coincided with a change in the federal political administration. Dr. Chavez referred a number of times to the "budgetary crisis" but is optimistic that that phase is ending. (Apparently the present administration was less willing to operate on an informal ad hoc basis than its predecessor. Nutrition programs/projects did not fare well in the Planning Ministry, when judged according to conventional cost-benefit analysis as would be expected. There is now increased pressure to insure food security and the government is reviewing the nutrition issue.) Dr. Chavez is again serving as advisor to the federal establishment and Mrs. Chavez is employed as a professional nutritionist with CONASUPO.

The Division occupies two floors in one wing of INN and has animal facilities and metabolic beds located elsewhere in INN. (I did not visit these. No projects were currently in progress, but recent human research was said to be directed toward determining protein requirement from maize-beans diet using levels of 0.4-0.8 g protein/kg body weight of adult males.) There is a 2 π whole-body counting facility, previously used for studies of children with PCM, located in the near-by Division of Nuclear Medicine. The Division has a computing facility in an adjacent wing. The man in charge of the computer hardware and software was introduced as a mathematician with additional training in computer science. The system uses basic language with disc storage. Dr. Chavez indicated that other INN units are beginning to use this facility but that it is not overloaded. Should the need arise he believes that he could have access to more extensive facilities in the Ministries of Health and Planning. Chemistry laboratories are small but adequate. Instruments include an amino acid analyzer,

THE PHILIPPINES - Site visit report by Dr. Doris H. Calloway, University of California at Berkeley, July 17 - 18, 1978

I made three principal contacts arranged through the USAID mission in Manila. Dr. R. Engel was away and in his absence, I was guided by Dr. Jo Anne Barton on leave to USAID from the Virginia Polytechnic Institute.

1. National Nutrition Council (NNC). This council is located in a relatively new, well-appointed center and is under the general direction of Dr. Florentino Solon. It is the base through which the federal nutrition projects are organized and administered, and serves as a training center as well. (During the time of my visit, an international short course on educational television was in progress under the direction of Mrs. Florentino Solon.) I was treated to a very polished presentation of the national nutrition program complete with graphics, by Ms. Delfino B. Aguillon.

The NNC was created by Presidential order in 1974 to provide for administrative oversight of all national nutrition programs and for formulation of national nutrition policies and plans. The governing council is made up of Ministries of Agriculture (Chairman), Health (Vice-chairman), Education and Culture, Science and Development, Social Welfare, and Local Government and Community Development and from the private sector representatives of the Nutrition Center, The Nutrition Foundation and the Philippine Medical Association.

A copy of the 1978-1982 Philippine Nutrition Program (PNP) is available for review on request. The elements of the PNP are food assistance (primarily severely malnourished preschool children and

school feeding), nutritional information and education (all levels), health protection (surveillance and MCH programs), and food production (National agricultural policy input and school and home gardens). Some 24 government and private agencies and organizations are involved in in these programs.

For applied nutrition programs, the basic unit is at the very local (barangay) level. Organized units exist in 76 provinces and 1500 municipalities; 87% are covered by NNC programs and follow NNC guidelines. A major feature of these barangay programs is regular weighing of infants and preschool children. About 4 million have been weighed and 30% are judged to be moderately to severely malnourished (Gomez 2 and 3). The nutrition activities are generally carried out by local volunteers who receive very little compensation. Many are young (16-18 years) and have received training under USAID/UNICEF support, consisting of 10 days of didactic and 20 days of practical experience. With assistance of FAO, a functional classification of the malnourished is being developed as a guide to policy formulation.

The most common form of malnutrition among infants and children is energy and protein deficit. Nearly half of all children (0-14 years) score Gomez[1] and another 30% are below that level. Most severely affected areas are Northeastern Luzon, Central Luzon, Bicol, Western Visayas and Eastern Visayas. Anemia is prevalent (about 78% of all pregnant women have unsatisfactory hemoglobin levels) and vitamin A dificiency is widespread. About 3/4 of persons surveyed were found to harbor intestinal parasites.

The Philippines would be a good location for research in the sense

TRIP REPORT: Mexico City, Mexico September 17-18, 1979 D.H. Calloway

I met with Mr. Robert Wilcox, Counsel/Science and Technology and Mr. Thomas Donnally, USAID representative at the U.S. Embassy. We discussed the goals of the CRSP on Intake and Function and the proposed University of Connecticut - INN project in some detail. Excellent questions were raised by Mr. Donnally about plans for disseminating and implementing the findings from individual projects and the program in total. This is a subject of mutual concern and we had a useful discussion as to how this might be accomplished. The format proposed by Berkeley in our project submission seemed generally acceptable and I indicated that this would be suggested as part of the management scheme. Mr. Wilcox informed me that the Embassy was not prepared to assist the project, should it be implemented, i.e. American participants would have to arrange visas, customs etc. through INN, not the Embassy.

Mr. Wilcox and I then went to the National Institute of Nutrition (INN) where we met for about two hours with Dr. Adolfo Chavez. We had a friendly, clarifying discussion about the position of INN in the Mexican governmental system. It was agreed that Dr. Chavez will obtain formal written approval of his participation in the project and that he will send this notification to me with a copy to Mr. Wilcox. We stressed the need for acting with dispatch. Mr. Wilcox later indicated that there was unlikely to be any bar to the project at the Embassy level.

Dr. Chavez does not foresee any difficulties regarding visas for US personnel and is accustomed to handling these matters. Mr. Wilcox suggested that some linkage through NSF that brought the project under the umbrella of the US - Mexico scientific agreement might be facilitating as regards importation of equipment and the like. Dr. Chavez indicated that INN is in a good position to use this linkage if it proves necessary.

Mr. Wilcox was uniformly helpful and should be kept informed as the project develops.

cc: S. Kahn
Allen/Palto

SENEGAL: Site visit conducted February 2-9, 1979 by Christina Wood, Ph.D., University of California at Berkeley, and Samir Basta, Ph.D., World Bank.

Persons interviewed:

ORGANISME DE RESCHERCHES SUR L'ALIMENTATION ET LA NUTRITION AFRICAINES (ORANA)

Dr. Amadou Makhtar N'Diaye, Director

Dr. Simon Chevassus-Agnes, ORSTOM

BUREAU D'ALIMENTATION ET NUTRITION APPLIQUE SENEGALAIS (BANAS)

Dr. Thianar N'Doye, Director

INSTITUT DE TECHNOLOGIE ALIMENTAIRE (ITA)

Mme. M.T. Basse, Director

HOPITAL DANTEC, DAKAR

Dr. A. Sanakho, Professor of Social Pediatrics

MINISTRY OF WOMEN'S CONDITION

Mme. Ndao, Sociologist

UNIVERSITY OF DAKAR

Dr. M. Perier-Scheer, Department of Preventive Medicine

Dr. Sambo Diallo, Department of Parasitology

ENVIRONMENTS ET DEVELOPMENTS EN AFRIQUE (ENDA)

Salam Kane, Sociologist

USAID

Mme. Mary Diop

Persons unavailable:

INSTITUT FONDAMENTAL D'AFRIQUE NOIRE: PSYCHOLOGIE SOCIALE

Mme. Fatou Sow, Sociologist

Mme. Solange Kamara, Sociologist

that suitable populations are available for study and there is a cadre of well-trained nationals. I have the feeling, however, that most senior professionals are already burdened with on-going programs and that preference is given to Manila-based management rather than to the conduct of work in the field and in more remote locations. Dr. Engel should be consulted on these issues if projects are proposed for this country, as he knows the local situation well.

2. Food and Nutrition Research Institute. These research laboratories are directed by Dr. Carmen Intengan. Activities include food consumption surveys, food analysis, nutrient analysis and experimental nutrition. The laboratories occupy an old but functional three-story building. An adjacent building is scheduled for renovation to provide more adequate human metabolic facilities. The food science and chemistry laboratories are reasonably well-equipped, some are air-conditioned and all were in running operation. The food consumption survey group is large and has a major statistical component.

A USAID-supported research project is in progress, involving assessment of special foods for infants. Four previously malnourished infants are housed in cribs in one room of the laboratory building under the supervision of an attendant. An attempt is being made to toilet-train these children so as to carry out balance studies and one infant was seated on the commode the entire time we visited the unit. Body weight records are posted. Two of the infants had gained no weight during the previous month. Dr. Intengan indicated that the full scale project would be initiated when the new metabolic facilities are available. The pro-

ject officer responsible for this research must verify that living conditions and growth rates are improved, or defer the project until such assurance is made.

3. University of The Philippines, Los Banos. I went to Los Banos to meet the staff involved in the new international Netherlands/FAO sponsored training program in Food and Nutrition Planning, and to present a seminar. Students in this first class come from several Asian countries and have mixed academic backgrounds. Dutch staff members involved are Professors Peter Dijkhuizen and J. G. A. J. Jeutwest; the latter was away at the time of my visit. Key Philippine staff are Dr. N. Deonapo and J. Eusebio. The program is ambitious and there are evident leveling problems in the student body, but motivation and morale are high and the directors have matters well in hand.

SENEGAL

Senegal is a small country in West Africa covering 200,000 square kilometers. It has two seasons, the dry season from November to June and the rainy reason from July to October. There are five major geographical zones: 1) the northern Senegal River valley with irrigation projects for rice, millet, sorghum, maize, cotton, sugar and tomatoes; livestock; 2) the Atlantic coast, including the port of Dakar; 3) the west central Savanna; 4) the northeastern Ferlo region which is a semi-desert area inhabited by the nomadic Peul and 5) the Casamance which is a tropical rain forest region south of the Gambia where rice, millet, sorghum, peanuts, manioc, palm oil, and fruits are grown. Peanut oil is the main product of the rural population and a principal export of Senegal.

There are five million people in Senegal with more than 42% under the age of 15. Seventy percent of the population live in rural areas and rural-urban migration is a pressing problem for the cities. The Wolof ethnic group (Wolof language) represents 36% of the population and inhabits primarily the northwestern region and the cities. Eighty-six percent of the population is Muslim; 5% Christian. Polygamy is extensive.

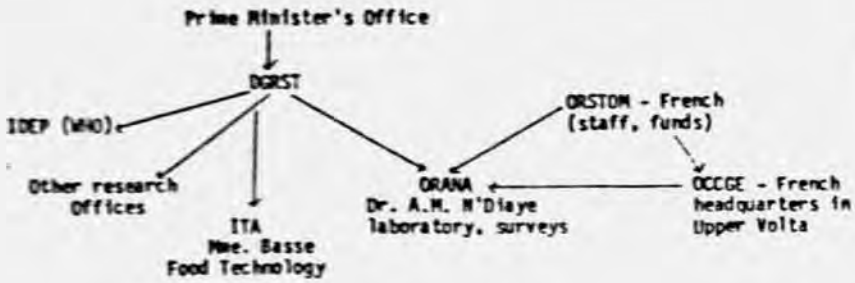
Rice is the staple diet in Senegal and "Tiebou Diene" is the national dish of rice, fish pieces, oil, onions, and vegetables. The rice used for this dish is imported (better texture than local rice) and the liberal amount of oil used in it is thought to contribute to high incidences of obesity and atherosclerosis. I was shown a chart (by Dr. T.N'Doye, BANAS) prepared from surveys of many countries showing that fat consumption increases with increasing per capita income. The average per capita income for Senegal was about $300, but the Senegalese have the fat consumption of $1500 per capita income.

Diarrhea, malaria, and malnutrition are common problems.

FAO has done nutritional studies in Senegal including food consumption in Louga, food consumption and goiter in Kedougou, and food consumption in Dakar. Both the Chinese and the World Bank have rice production projects around Sedhiou in the Casamance. USAID has a rural health project with UNICEF in the Kaolack area (clinics, health mini-posts, ambulances), rural development projects in Thies and Diourbel, and an integrated rural development project (agriculture, parasitism) with UNICEF in Basse Casamance. The Bambey Agricultural Research Center in Diourbel is supported by the Canadians and studies are done there on food conservation and the development of new varieties of millet and maize. The Catholic Relief Service supports some PPMS (MCH) centers and they evaluate their progress.

There are three main bastions of nutrition research in Senegal: ORANA, BANAS, and ITA. In general, they do not collaborate with each other. The following diagram illustrates the relationships between various research organizations.

Nutrition Research in Senegal:



ORGANISME DE RESCHERCHES SUR L'ALIMENTATION ET LA NUTRITION AFRICAINES (ORANA)

ORANA was created in 1956 and in 1961 it was attached to l'Organization de Coordination et de Cooperation pour la lutte contre les Grandes Endemies (OCCGE), a French organization based in Upper Volta with members from Benin, Ivory Coast, Upper Volta, Mali, Mauritania, Niger, Senegal, and Togo. There is another French organization, ORSTOM, which was formerly in charge of overseas research in anthropology, geography, nutrition, and health. ORSTOM now provides most of the staff for ORANA and OCCGE as well as 60% of the OCCGE budget.

Dr. A.M. N'Diaye is the Senegalese director of ORANA. He has a staff of 15 researchers, 10 of whom are French. They include the following:

2 chemists (Cooperation)

1 engineer ENSBMBA (ORSTOM)

1 masters in physiology (ORSTOM)

1 masters in biochemistry (ORSTOM)

1 masters in physiology-psychology (ORSTOM)

1 masters in biology (ORSTOM)

1 M.D. immunology-epidemiology (ORSTOM)

1 M.D. nutritionist

1 MSN (M.D. or pharmacology)

4 laboratory technicians

4 aides

secretaries, drivers, janitors, etc.

ORANA is involved in the following research programs:

1) Epidemiological surveys in West African countries for the OCCGE and WHO covering food consumption, biological, and medical information of children. In 1973-74 they surveyed areas suffering from the Sahelian drought; in 1977 they studied Senegal.

2) Methodological studies for infant malnutrition -- prealbumin measurements (A.M. N'Diaye, A. Rougereau, J. Gore, Le depistage de la malnutrition proteino-calorique interet du dosage de la prealbumine serique, Méd. et Nut. XIII, No. 6, p. 423, 1977, available).

3) Protein content of cereals in conjunction with development of weaning food (A.M. N'Diaye, L'aliment de sevrage Senegalais 'le Ferelin,' mimeo, available).

4) Malnutrition and infection, particularly vitamin A status and onchocerciasis; also measles and malaria.

5) Iron deficiency anemia (with WHO group).

6) Goiter; iodine fortification methods (goiter is prevalent in the central Orientale and the Casamance).

7) Development of local intelligence tests (WHO).

8) A study of the quantity, quality, duration, frequency of mother's milk and breast feeding is in the planning stages (epidemiological study to cover most of West Africa).

The laboratory facilities appeared excellent. They are set up for biochemistry, hematology, parasitology, microbiology, immunology, food composition and amino acid analysis. There are animal rooms to house small animals as well as monkeys. There is a 600-volume library with 20 nutrition journals. ORANA has vehicles suitable for commuting to the rural areas.

ORANA collaborates with the Faculties of Medicine and Pharmacology at the University of Dakar, the Pasteur Institute, the agricultural research center at Bambey, and various international agencies (FAO, UNICEF, WHO, PAG). Dr. N'Diaye also said he could work with the people at the Institut Fondamental D'Afrique Noire (IFAN; social-psychology).

BUREAU D'ALIMENTATION ET NUTRITION APPLIQUÉ SENEGALAIS (BANAS)

Dr. Thianar N'Doye, the Director, is a distinguished senior investigator in his seventies with many ideas and few funds. Since 1965 he has concentrated strictly on applied research including the following activities:

1) Administrating the PPMS (MCH) centers (which suffer from lack of funds and personnel). There are some 350 PPMS centers, but only about one-fourth are really functional. Dr. N'Doye has a training school for the field workers (nutritionists, nurses, dieticians). WFP, CARE, and USAID provide the food distributed at the centers.

2) School feeding programs.

3) Nutrition education.

4) Weaning foods.

Dr. N'Doye works with both UNICEF and USAID. He has strong convictions about the national diet. He is of the opinion that the nutrition problems of Senegal

stem from colonization -- the French introduced the Tiebou Diene with its high oil/fat content and its economically inefficient dependence on imported rice. Before the French, the Senegalese used to drink alot of milk -- no more. He believes the people should return to their traditional diet based on the locally-grown products of millet, sorghum, and cereals.

BANAS has no laboratory facilities or vehicles.

INSTITUT DE TECHNOLOGIE ALIMENTAIRE (ITA)

ITA has been in operation for 16 years. Mme. Marie-Thérèse Basse (6 years with FAO) is the Director. ITA is primarily a food technology unit; its projects include applied research, food quality control, and training. Specifically:

1) A new variety of bread made from 75% millet flour and 25% soya flour (soya beans purchased from Nabisco). This bread is provided to children with kwashiorkor at Hôpital Dantec and seems to be well accepted (blood protein picture improves; edema decreases). ITA staff is teaching bakers in Diourbel how to make the bread (it is delicious!). A soya-millet soup is also in the works. The aim is for a cheap, available, and acceptable protein source.

2) Introduction of new products into families. There is a special school in Thies for training women in home economics who then disperse the information in their own villages.

3) Quality control of foods; aflatoxin; pesticides.

ITA has a staff of 91 with 57 research technicians, 5 doctorates, 13 masters level, 19 baccalaureates, and about 15 technicians with two years university training. Mlle. Gaye obtained a masters in nutrition at Cornell and Mlle. Faye the same at Harvard.

ITA could possibly work with BANAS and IFAN.

Mme. Basse mentioned the Cellule analyse de nutrition et d'alimentation de Senegal (CANAS) directed by M. Sow. It is a group with representatives of ITA, ORANA, BANAS, IFAN, and the ministries of human promotion and education. The purpose of CANAS is to coordinate these organizations and the group meets periodically to discuss potential research projects. Any CRSP would have to be approved by CANAS. The coordination represented by CANAS is more apparent than real.

HÔPITAL DANTEC, DAKAR

Dr. Abdu Sanakho is a professor of social pediatrics at Dantec Hospital. He has a small laboratory. He works with ITA and uses the labs at ORANA when possible. He is associated with a training center at Khombol (between Bambey and Diourbel). The center trains about 100 medical students and nurses per year. Each student spends 6 weeks with the center at Khombol and 7 weeks at Pikin, near Dakar. Khombol is surrounded by 9 villages and the students visit one village each week taking weight, height, nutritional state, physical exam, and morbidity information from all children less than 14 years old. Dr. Sanakho has done a longitudinal study there on malnutrition and infant mortality. He found the mortality to be decreasing until 1973 and then it increased due to the drought. He presented his results at the regional pediatrics conference in Nairobi in February, 1979. He is also studying migration in connection with accidents and parasitism. He has investigated catch-up growth and subsequent reproductive ability. He has a longitudinal study in progress on mental development, stimuli, and food supplementation. He noted that there have been difficulties

with these studies in that people tend to try to hide intake deficiencies; food sharing within the extended family makes measurement difficult; sociologists prefer not to stay in the field for long time periods; and food beliefs cause malnutrition problems (some Senegalese believe egg consumption causes decreased intelligence.)

MINISTRY OF WOMEN'S CONDITION

Mme. N'Dao is a sociologist (worked for 10 years with Dr. Colomb, French psychiatrist). He suggested that we see two other sociologists concerned with nutrition at the Institut Fondamental d'Afrique Noire (IFAN) at the University of Dakar. IFAN has a staff of 122 with departments of marine biology, botany, geology, zoology, cultural anthropology, physical anthropology, civilization and indo-african languages, civilization and black African literature, geography, history, islam, linguistics, prehistory, and social sciences (sociology, social psychology, and social anthropology). Annual Report 1976-77 available.

In the department of social psychology, Mme. Fatou Sow studies urban development, migration, and food patterns. Mme. Solange Kamara studies food habits, Dakar youth, and psycho-social factors and nutrition education. She has published a book on social factors and nutrition in Senegal. Unfortunately both were out of town during the site visit.

UNIVERSITY OF DAKAR

Dr. M. Perier-Scheer is in the Department of Preventive Medicine and she gives the lectures on nutrition. She has worked with Carol Adelman and spent 5 years on a research program in Zaire. Her main research topic was the high

incidence of diabetes in Dakar and she reiterated the concern for excessive lipid consumption. She works at a diabetes counseling center and she did a study on the feasibility of increasing the fish consumption of diabetics.

Dr. Sambo Diallo is in the Department of Parasitology. He studies schistosomiasis and malaria primarily in Basse Casamance. He collaborates with ORANA and USAID.

ENVIRONMENTS ET DEVELOPPEMENTS EN AFRIQUE (ENDA)

I talked with Salam Kane, a sociologist with ENDA. He collaborates with ORANA and specializes in the areas of economics, planning, epidemiology of disease, and environment.

USAID RESPONSE

Marc Vincent, the Head of the health division, was away from Dakar so his assistant Mme. Mary Diop discussed the CRSP with me. She was interested and encouraging and most helpful in arranging appointments. Since Mr. Vincent was absent, it is difficult to know whether is office would be kindly disposed to research of this sort.

SUMMARY AND OPINIONS

There are three nutrition groups in Dakar that might possibly collaborate (independently of each other) in a CRSP: ORANA, BANAS, and ITA. Although Dr. N'Diaye of ORANA was receptive to this sort of research, a primary collaboration with ORANA would mean working with a highly competent French staff. ORANA does have survey facilities (2 land rovers, two cars, local interviewers).

Dr. N'Diaye indicated a strong interest in and awareness of marginal malnutrition (as opposed to severe). Dr. N'Doye of BARAS has a strictly applied nutrition orientation and his staff is engaged fulltime in the operation of the PPNS(MCH) centers and nutrition education. I had the impression he would be wary of working with Western foreigners. Mme. Basse of ITA would be a good partner: well-trained staff, well-stocked laboratories, but she would have to be willing to broaden her orientation from food technology to food consumption surveys and nutritional status (not an impossible idea). A U.S. team would have to provide expertise in medical, biological, and nutritional areas. Dr. Sankho would be a valuable part of the local team. Inclusion of the sociologists at IFAN might contribute an effective local social-anthropological component.

The members of a U.S. team should definitely be fluent in French (none of my appointments were conducted in English).

Christina Wood

SRI LANKA: Site visit conducted April 6-12 in Colombo and Peradeniya by Christina Wood, Ph.D., University of California at Berkeley; and Leonard Schuman, M.D., University of Minnesota.

Persons interviewed:

Medical Research Institute, Colombo:
W.D.A. (Davy) Perera, M.D., Head of Nutrition Department

Faculty of Medicine, Peradeniya Campus:
Malcolm Fernando, M.D., Chairman of Community Medicine
S. Balasuriya, M.D. (Nutrition degree from London School of Tropical Medicine and Hygiene), Department of Community Medicine
Ranjith Nugegoda, M.D., Department of Community Medicine; demography
Sextus Correa, M.D., Department of Community Medicine, Environmental Sanitation Obstetrician-gynecologist

Ministry of Plan Implementation:
W.A.L. Wijayapala, Director of Food and Nutrition Policy Planning Unit
Ms. Malsiri Dias, Secretary for International Year of the Child; Sociolo

Ministry of Health:
Herbert Jesudasan, M.D., Director of Health Services
Tudor de Silva, M.D., Nutrition specialist (Ph.D., University of Toronto)

U.S. Embassy:
Ambassador W. Howard Riggins
Clark Billings, USAID

Persons unavailable:

Dr. Wickrema Weerasuriya, Secretary to Minister of Plan Implementation
Priani Soriasa, M.D., Department of Pediatrics, Faculty of Medicine, University of Sri Lanka, Colombo

SRI LANKA

Sri Lanka (formerly Ceylon) is an island country off the southeast coast of India with some 12.5-14 million people. The majority of the people are Sinhalese, but there is a considerable minority of Tamils. There are two groups of Tamils--the majority of Tamils came over from India centuries ago and they mostly inhabit the northern part of the island around Jaffna. They have a separatist movement to create their own sovereign state of "Eelam". The other group of Tamils was brought over more recently to work on the tea estates in the central hill country. The Tamils have their own language. We were told that since the Tamils have felt themselves to be an oppressed minority, they tend to work hard to get ahead (for instance we were told that 50% of Sri Lankan physicians are Tamil). Tamils are predominantly Hindu while the Sinhalese are mostly Buddhists--there is a small percentage of Moslems and Christians. The literacy rate for the country is over 86% and 10% speak English.

About 75% of the people live in rural areas. There are on the average about 200 households per village (with a range of 80-600 households). There is a village headman appointed by the government; there are elected village leaders; and, of course, the religious leaders are powerful. Unemployment is high in the villages. The educational level is relatively good, but there are no jobs available to utilize this educational level. Consequently migration is a problem and the government would like to stimulate employment in the villages. The people do not seem willing to start farms. There is a high reliance on cash crops--eggs and fruits produced in the villages are sold. There is a program to give 50 rupees (Rs) per month (15.35 Rs=$1) to families with no employment, but we were told that many families do not apply for the 50 Rs because they would have to accept work on the Mahaweli Irrigation Project (to

divert the Mahaweli Ganga to the northcentral area) which is located in an endemic malaria area. The project suffers from labor shortage despite the provision of malaria prophylaxis.

According to the Ministry of Plan Implementation, the average paddy farmer has about two acres and can produce around 150 bushels of unpolished paddy per season. Some areas have two seasons per year. The government price for paddy is 40 Rs per bushel, so the farmer makes about 6000 Rs per season of which 2500 Rs are profit.

To continue with wage levels, an interviewer administering a simple 40-minute questionnaire might finish 8-10 interviews per day and receive 15-20 Rs/day. A nurse working half time makes about 2000 Rs/month and a computer programmer could command 50 Rs/hour. Women tea leaf pickers on the estates make about 9 Rs/day for 15 pounds of leaves with 20¢/extra pound (100 cents=1 Rupee). Many women can pick 30-40 pounds per day.

Sri Lanka has about 5000 physicians located throughout the country. There is about an equal number of herbal doctors who are well accepted. There are health centers in every district but there is still a problem of accessibility. Only about 30% of the people use the MCH services. Malaria is prevalent in the north central and southern provinces. Hookworm, roundworm, and allergic bronchitis are common; infant diarrhea is a problem mostly for urban slum areas. The incidence of vitamin A deficiency is low except on the tea estates and in Kegalle and Matara. Goiter is found in the southwest and in the northwest to central provinces (high rainfall causes erosion of iodine). Iodination programs have not been undertaken. Limited studies have indicated that iron deficiency anemia is a problem among preschool children and mild-moderate protein deficiency is seen in pregnant women. The prevalence of chronic undernutrition was

found to be about 34% (height/age) among children in the 1975 national survey (CDC). Experts estimate that this figure has probably not changed in recent years. It was much higher (49% in Kandy and Badulla) in the tea estate area, but the situation has improved slightly there since the change in government.

Breast feeding is common in Sri Lanka. In the Colombo area it seems that breast feeding is discontinued after about 6 months--the mothers "run dry" and attribute this to renewed use of oral contraceptives. In the rural areas breast feeding is sometimes the only source of nutrients for the first one to two years. Villages have no access to commercial weaning foods, so mothers prepare a rice gruel.

There are various food beliefs, i.e. cow's milk is impure and should not be used as a weaning food (powdered milk is acceptable); a lactating mother should eat jack fruit and coconuts; a girl at puberty should not eat meat or fried foods; and consumption of oil leads to stomach aches.

The staple diet is rice with many varieties grown in Sri Lanka. The land has potential for improved yield, but water supply is a major problem. Sweet potatoes and cassava are also grown. The consumption of millet is low. The monsoons fall between April and August in the southwest (Yala) and between October and February in the northwest (Maha). Apparently Sri Lanka imports around 50% of its foodstuffs. A food subsidy program existed until recently.

While there is no nutrition research institute as such in Sri Lanka, there is a Food and Nutrition Policy Planning Division (FNPP) in the Ministry of Plan Implementation and there are three groups concerned with nutrition research and programs: Medical Research Institute (MRI), Colombo; University of Sri Lanka, Faculty of Medicine (Pediatrics),

Colombo; and University of Sri Lanka, Faculty of Medicine (Community Medicine), Peradeniya. In 1975-76 a nationwide study of nutritional status of preschool children was completed (CDC, USAID, MRI). In 1977 a nutrition surveillance program was established under the auspices of WHO, UNICEF, and CDC to cover the entire population twice a year. This program was temporarily halted by the recent cyclone in the east; it is continuing now but only in a limited selection of areas.

MINISTRY OF PLAN IMPLEMENTATION:

Dr. Wickrema Weerasuriya, Secretary to the Minister of Plan Implementation (actually the President is also the Minister of P.I.) was unavailable during our stay, but he referred us to the Director of the Food and Nutrition Policy Planning Unit (FNPP), W.A.L. Wijayapala. Mr. Wijayapala met with us twice--we discussed the nutrition situation in Sri Lanka and he described two applied nutrition programs funded by UNICEF. One concerns the establishment of school farms in 30 schools, one school in each of 30 regions (based on the CDC survey). The other is an integrated community nutrition program which will cover 100 villages over 5 years. It operates in conjunction with the CARE program. Mr. Wijayapala was interested in the CRSP and any interested U.S. institution should send details to himself or Dr. Weerasuriya for discussion with the nutrition planning council. It seems that Dr. Weerasuriya considers nutrition to be of prime importance. The Medical Research Institute (MRI) team comes under the jurisdiction of the Ministries. The University System links with the ministries only regarding funds.

We also met with Mrs. Malsiri Dias, Secretary for the International Year of the Child under the Ministry of Plan Implementation, and a sociologist by training. She has worked with Dr. Lionel of WHO on the

use of traditional medicine, with the Ford Foundation on maternity leave and fertility, on rural development, and with the U. S. League of Women Voters on child care needs of low income families (with Dr. Priani Surissa). She was very knowledgeable about social and nutritional conditions in Sri Lanka and expressed encouragement for and a willingness to participate in the CRSP.

MINISTRY OF HEALTH:

Dr. Herbert Jesudasan, Director of Health Services, and Dr. Tudor de Silva (Univ. of Toronto), Head of Nutrition Section, were interested in the CRSP. Dr. de Silva felt there was a need to improve and expand the data on nutritional parameters. The Division of Health Services is increasing its participation in the Nutrition Surveillance Program.

MEDICAL RESEARCH INSTITUTE, COLOMBO:

MRI has been in operation for 40 years. The Institute recruits medical graduates and sends them out for postgraduate training. Dr. W.D.A. (Davy) Perera, has recently become the Head of the Nutrition Department. Other departments in the Institute include Bacteriology-Immunology, Virology, Pathology, Pharmacology, Parasitology, Entomology, Vaccine Production, Mycology, and Natural Products. Eighteen members of the staff have MD-PH.D.'s, and four have nonmedical Ph.D.'s. The Institute is funded by the Department of Health Services and specializes in basic research, central reference, and quality control. The Nutrition Department has the following staff members:

Dr. W.D.A. Perera, Head of Department
Dr. Mrs. B. V. DeMel, Medical Officer of Nutrition
Ms. Padma M. Jayasekera, Research Assistant (getting a Masters degree in nutrition in collaboration with Dr. Malcolm Fernando, Peradeniya campus)
Nutrition Assistant-public health inspector
six public health inspectors + field staff
medical laboratory technologist

There is a laboratory and the technologist performs food analyses (nitrogen, fat, calories, calcium, phosphrous, iron). The Department of Biochemistry has the laboratory facilities for vitamin B_{12}, blood folate, triglycerides, cholesterol, glucose, etc., analyses. A spectrophotometer is on order. There is a shortage of medical field staff. The Department could be strengthened in the areas of data analysis, epidemiology, and top-level nutrition experts. The Department has access to an IBM 360 computer (in much demand) in the Department of Censuses and Statistics. There is a library at the Institute (minimal nutrition journals) and they have interlibrary loan privileges with the excellent University Medical School library.

The research orientation of the Nutrition Department is toward public health measures and the collection of food consumption data which can form a base of information for intervention. Dr. Perera has compiled local food composition tables (WHO) but they have not yet been officially released. Some work on growth standards has been done in the country, but generally the Harvard standards are used.

The Department participated in the 1975-76 Preschool Nutrition Status Survey (CDC) and in the first two years of the National Nutrition Surveillance Survey. The latter continues now in selected areas only and MRI trains the Health Service personnel who will be carrying on the survey.

MRI is doing a diet and nutritional status survey in 11 hamlets of the Kitulgala area which is being developed with Norwegian aid. Also, the FNPP unit is considering an integrated rural development program (World Bank) in four districts: Matara, Matale, Kurunegala, and Hambantota. In February-March, 1979, Dr. Perera's group (5 teams) did a nutritional

status survey of preschool children in villages in Habantata to serve as baseline data for the development program. They are planning to do the same for the other three areas.

FACULTY OF MEDICINE, PERADENIYA CAMPUS:

We talked with Dr. Malcolm Fernando, Head of the Department of Community Medicine, and Dr. S. Balasuriya in the same department. We also met the department's medical demographer, obstetrician-gynecologist, and medical-environmentalist. The Department has operated the Hindagala Community Health Project for the last fifteen years in cooperation with the Department of Health Services. The project has served as a field training opportunity for students; it has provided health services in rural areas; and it has provided a testing ground for new methods of health service delivery. The test area covers fifteen square miles adjacent to the Peradeniya campus. The Department has an UNFPA grant to extend the project for three-five more years and to expand the area to include the Gampola area. Major surveys were conducted in 1965 and 1971 (baseline medical, demographic, socio-economic, and health practice data) covering about 1500 households (10,000 people). The survey population included all religions and the tea estates.

Drs. Fernando and Balasuriya have also been working on a five-year study of the effects of roundworm on growth of 2-10 year olds. They take anthroponetric measurements every 4 months. (Fernando, M. A., and Balasuriya, S. "Control of Ascariasis by Mass Treatment with Piperazine Citrate", Ceylon Medical Journal, Sept. 1977, available). They are also involved in a nationwide cross-sectional study (of 15,000) to determine height and weight standards.

If the investigators in the Department of Community Medicine were to be the prime collaborators in a CRSP, they would want the population in the Hindagala study area to be used. They have transport facilities and access to interviewers. For such an indepth study as a CRSP would entail, the population may need more incentive than medical care. They provide occasional movies, books, etc. The Department has very limited laboratory facilities (stool analysis, two technicians) but the Department of Biochemistry has a nutrition component and does hemoglobin, serum protein, amino acid analysis, albumin, etc., but it is not well-equipped for micro-analysis. An IBM 11 (small, no magnetic tape, only discs) is available in the Engineering Faculty, but there is a shortage of programmers.

USAID RESPONSE

Mr. Clark Billings of USAID was enthusiastic about this program. AID has a supplemental nutrition school feeding program (7000 schools, 1.25 million recipients) and an MCH program. He said nutrition research is needed in Sri Lanka.

We also met Dr. W. Howard Riggins, U. S. Ambassador to Sri Lanka. He was also interested in the program and he gave us several insights into working in Sri Lanka, such as necessary adaptation to a slow pace of life, the favorability of low key personalities, etc.

Christina Wood

Visit to Colombo Sri Lanka - Nutrient Intake and Function Research
April 6 - 12, 1979, Leonard Schuman, M.D., University of Minnesota

Our visit to this island nation, 25,000 square miles in size and with 14 million inhabitants, was divided into two segments: one, to the nutrition research program of Dr. W. C. David Pereira at the University of Colombo Medical School and second, to Dr. Malcolm Fernando, Director of the Department of Community Medicine at Peradeniya University (suburb of Kandy).

Dr. Pereira, the only government nutritionist in the Institute who had trained with Drs. Gopalan and Scrimshaw, greeted us in physically sad surroundings but with a good measure of reserved enthusiasm and warm hospitality. The involvement of the Center for Disease Control of the U.S. Public Health Service in Atlanta, Georgia, in nutrition surveillance in Sri Lanka was described by Dr. Pereira as a one-shot survey performed in 1975 - 76 through 15 superintendents of health services in 22 districts of the country. In each health service area, 30 villages had been selected and from each village 30 children were randomly selected for the nutritional survey. The findings serve as the basis of a report shown to us by Dr. Pereira, copies of which were not available anywhere in the country. It would appear that access to the volume may have to be through the Center of Disease Control in Atlanta, Georgia, which, incidentally, is promoting a nutrition surveillance program rather than repeated surveys. Such surveillance would, of course, be dependent upon the recognition of malnutrition among the inhabitants of the villages in the several districts of Sri Lanka. To what extent mild and moderate malnutrition would be ascertained in this way is conjectural.

Inquiry regarding the disease status of the population in Sri Lanka revealed that malaria is hyperendemic in the northcentral and southern regions of the country, that diarrhea was particularly prevalent in the slum sections of the cities and respiratory diseases in the form of allergic bronchitis, though prevalent, was not of high magnitude. Tuberculosis has been controlled and there is no whooping cough, diphtheria, or polio to speak of. A few cases of typhoid fever are occasionally reported but worm infestations are particularly prevalent in the rural areas.

Of the several contacts we made in Sri Lanka, including members of the faculty at the University of Peradeniya, the Director of Health and the Nutrition Director of the Ministry of Health and the Director of the Applied Nutrition Project in the Office of Plans and Implementation, Dr. Pereira seemed to be the most enthusiastic. However, this enthusiasm was reserved as was true for all of our contacts. Dr. Pereira, however, did express a willingness to participate in a collaborative research project with an American Institution in the event Sri Lanka was selected as the locale of such research. He felt that the populations of a number of villages would be readily accessible to such a research team and that they could provide interviewers from among a large number of unemployed graduates of the University as well as drivers for the fields teamwork. He expressed the need for epidemiologists (at least on a consultant basis), programmers, biostatisticians, and nutritionists. In the last instance Dr. Pereira emphasized such need despite the fact that every health officer of the district had had three months of nutrition training at the University.

Dr. Pereira indicated the need for us to see Dr. Herbert Jesudasan Director of Health in the Ministry and Dr. Wickrama Weerasuriya, secretary to the Ministry of Plans and Implementation who was close to the president and to family planning groups in the country. We parted with the hope of seeing Dr. Pereira upon our return from Kandy but his commitments on Wednesday of that week were such as to make this impossible. However, we had the impression that Dr. Pereira would be very happy to cooperate not only with the American team but with any other nutrition research unit in the country (Peradeniya).

A visit on Monday, April 9, to Mr. Wijayapala in the Office of Plans and Implementation and Director of the Applied Nutrition Project was highly enlightening. Mr. Wijayapala proved to be an economist with gratifying insights into the problems of food and nutrition and much was learned from him as to the culture and customs of the country in regard to food and agriculture. The applied nutrition project is a UNICEF funded program for five years. The program is designed to educate and implement the education of schools and village populations to their ecosystem, use of nutrients, and so forth. These community programs are being instituted overlapingly in 100 villages with

starts being made in 20 villages in each of the five years. Mr. Wijayapala who, we were told, could speak for Dr. Wickrema Weerasuriya, secretary to the Ministry of Plan and Implementation, listened attentively to the proposals of the contemplated research and was provided a copy of the précis for reaction at our next visit on Wednesday, April 11. It was on that visit on Wednesday afternoon that Mr. Wijayapala, having provided us with insights into the crop seasons and protein yields of foods in Sri Lanka, documented their interest in participation in the nutrient intake project albeit with characteristic reserve.

On Monday afternoon, April 10, a trip to Peradeniya (suburb of Kandy) was for the purpose of making contact with Dr. Malcolm Fernando, Director of the Department of Community Medicine at that University's Medical School. Dr. Fernando also greeted us with reserve but with hospitality and proceeded to outline his involvement in nutrition projects in the field. The Hindagala Community Health Project is under the control of his Department of Community Medicine of the Medical School. They provide dispensaries (family clinics) for preventive medicine purposes only. These dispensaries do not treat illnesses which are done in proper health centers and hospitals of the districts. The dispensaries provide maternal and child health services, immunizations, and family planning with dispensing of contraceptive devices. The dispensaries are manned by assistant physicians and have midwives and public health nurses attached to it. Sri Lanka is planning the training of 500 "barefoot doctors" at the village level. Presently they have 30 such individuals. Education of the population in health practices is by midwives, nurses, and physician assistants. Nutrition education is a prominent feature of their activity.

The area of Dr. Fernando's medical activity will be expanded into another nearby province south of the present area of Hindagala. The area, predominantly rural, quite hilly and with many tea plantations and rice paddies, is typical of the agricultural scene of Sri Lanka. The population here is beset with many worm infestations, principally ascariasis and hookworm. Diarrhea are a second infectious disease problem and is deemed to be due primarily to Shigella species but in 50% of the cases the etiologic agent is unknown. There is no polio to speak of here, no whooping cough or diphtheria and only a few cases of typhoid and tuberculosis are reported.

Early next morning, a visit to a clinic in the southern valley of Hindagala was quite informative. They were experiencing a very light day because of the preparations for the Buddhist and Hindu New Year celebrations and at that 65 families appeared at the clinic and were waiting on our arrival. Many infants and children were in evidence and the usual weight and height measurements were obtained and physicians from the Department of Community Medicine who accompanied us provided the screening services including nutritional status. An OBGYN specialist also provided personal advice on family planning and actually performed examinations for the application of I.U.D.'s. Education was both person-to-person and in groups. Immunizations were also being given by public health nurses. An atmosphere of appreciation and cooperation pervaded the clinic and the clientele seemed to enjoy our visit and our photography of their activities.

In subsequent conversations with Dr. Fernando and his nutrition director, we gained the impression that they would definitely be interested in collaborative research with teams from American Institutions and also would cooperate with the Colombo Unit as well. A prerequisite for the conduct of such research in the field would, of course, be the provision of health services to the participants.

We did not examine the laboratory facilities for the conduct of such research. All of the testing in their programs of community nutrition and research is performed in the biochemistry laboratory of the medical school. We were assured that their technical help was adequate but that arrangements for contemplated research would have to be on an overload basis.

Visit to U.S. AID Mission and U.S. Ambassador W. Howard Riggins, April 9, 1979

Mr. Clark Billings, Nutrition Officer of U.S. AID, described the activities of his unit in the area of nutrition. They are involved in a nutrient supplementation program for one and a half million children as well as in an MCH Program in Family Planning and related activities. These programs are effectuated through C.A.R.E. Mr. Billings provided us with insights into the characteristics of Sri Lanka cooperation and indicated that Ambassador Riggins would like to see us. We spent a pleasant half-hour with our Ambassador to Sri Lanka who seems to have been a wise choice for the area for he was a Ford Foundation Scholar and Director of Southeast Asian Studies Program at Columbia University prior to this appointment. He was extremely interested in the projected research activities and revealed profound insights into the character and politics of the Sri Lanka population. He was very sympathetic to the work and would obviously provide his blessing therefore but did indeed provide us with a note of caution inthat he suggested that we keep the number of people from the United States as few as possible and that the individuals should be as of low key as is possible but commensurate with research promotion and execution.

The Ministry of Health - April 11, 1979

Contact was made with Dr. V.D. Tudor de Silva, Director of Nutrition in the Ministry of Health. He is a physician who has taken his Master of Public Health Degree at the University of Toronto, School of Public Health. He too, gave us his full attention to the explanation of the projected research in nutrient intake and function. He provided the opportunity for us to meet Dr. Jesudasan, Director of Health in the Ministry. He too, showed interest with a characteristic reserve that we noted throughout Sri Lanka but did indeed intimate that the interest could lead to cooperation with proper exposition of the details and plans.

CRITIQUE

This reviewer gained the impression that there was definite interest in a collaborative research project in Sri Lanka both at the University of Colombo and at the University of Peradenya as well as in high government circles in the Ministry of Health and the Offices of Plans and Implementation. It is this reviewer's futher impression that the reserve and caution with which the proposals were greeted may very well express their objectivity. As such, there may be greater effort in delivery of cooperative activity once there decision is made than with an overabundance of enthusiasm and a failure to "deliver the goods". Furthermore, in contrast to Thailand, there is no good reason to doubt that the two University Medical Centers would cooperate with each other in a consolidated project in nutrient intake. There may well be a greater need here, however, for certain scientific personnel than there would be in Thailand. I am thinking of Dr. Pereira's dissertation of needs in the event that such collaborative research would be initiated there.

[illegible] - [illegible], [illegible] & [illegible]

Name: Professor Valoris Aubrey Fernando

Address: 1123/3, Peradeniya Road, Peradeniya, Sri Lanka

Professional Official Address: Prof. Department of Community Medicine
Faculty of Medicine,
Peradeniya Campus,
Sri Lanka.

Citizenship: Ceylonese

Date of Birth: 27th October, 1927

Education: St. Joseph's College, Colombo - Secondary Education 1937 - 1947

University of Ceylon - M.B.B.S. 1947 - 1953

Postgraduate Qualifications:

Diploma in Child Health, University of Bristol, England. 1955
Diploma in Public Health, Royal Institute of Public Health,
England - 1956
Doctorate in Public Health, Harvard School of Public Health,
Boston, U.S.A. 1961

Previous Appointments:

Dunsillary T.B Services (Medical Officer) 1953 - 1954
Lecturer in Public Health, Faculty of Medicine, Colombo 1956 - 1964
Lecturer in Charge, Department of Public Health, Faculty of Medicine,
Peradeniya 1965 - 1967
Acting Head, Department of Preventive & Social Medicine,
Faculty of Medicine, Peradeniya 1967 - 1971

Research:

i) Study to determine factors responsible for the higher female than male mortality in Ceylon. This study was undertaken in 1950 under the auspices of the National Committee on Vital and Health statistics. A medico-social survey of a stratified random sample of 22,557 families, representative of Ceylon was conducted. Several papers were read and published.

ii) A prospective study of 300 medical entrants of October 1961 (of both Peradeniya and Colombo Medical Schools) through their internship to determine socio-economic characteristics interactions between staff, students and patients, adequacy of curriculum training, etc., was completed.
In 1976 a similar study was conducted on a cross sectional basis. This will make it a comparative study, between 2 periods during which time considerable political, social and economic changes were effected. Teacher opinions was also obtained.

iii) A study of the prevalence and control of Ascariasis. The hypothesis investigated being that a programme of systematic treatment of Ascaris infestation over a given period of time will reduce the worm load to such a level that parasitism is arrested. It is also proposed to investigate the hypothesis that as treatment continues, the re-infestation interval will become longer. A third subject for study is the effect of ascariasis on the growth and development of young children. This prospective study commenced in 1967 and data is being processed. 2 papers have already been published. The third is ready for publication. Several more will be published.

v) Study of 'Heights and Weights of school children in Sri Lanka' is in progress.

(vi) Evaluation of the Family Planning Programmes in the two field practice areas was conducted and data is being computer processed.

(vii) A study to evaluate the delivery of Maternal Health Care Services including Family Planning, at the Family Clinics of the Hiriyala Community Health Project has been completed. A paper is in preparation.

Publications:

i) 'Behaviour Disorders in Childhood - Its aetiology and prevention'. (Dissertation for F.R.C.P. 1956)

ii) 'The Value of Home Visiting in the Education of the Medical Student'. Int. J. Child. Hlth. Vol. Dec. 1957. pp. [illegible]

iii) 'Morbidity Patterns in Infancy and Childhood'. [illegible] 13 WHO Regional Office for South East Asia, New Delhi 1958.

iv) 'Morbidity and Medical Care - Sex differences among children for under different environments'. (Thesis for Doctorate in Public Health. Harvard. 1961).

v) 'Patterns of Mortality among Pre-school children in Ceylon' J.Cey.Pub.Hlth.Ass. 3-4 (New Series) 1963-1964, 15.

vi) 'Recommendations for the Improvements of the health of the pre-school child in Ceylon'. Sub - Committee report to the Hon. Minister of Health. J.Cey.Pub.Hlth.Ass. (new series) 1962-1963, 86.

vii) 'Breast Feeding in Ceylon'. Cey.J.Paed.Ass. 1:1963, 9.

viii) 'Morbidity and Medical Care in Ceylon: A Study of 22,500 Families. Cey.Med.J.9:1, 1964,26.

ix) 'Environmental Sanitation and Health'. Cey.Pub.Hlth.Dep.Rel.XXII, June 1966.

x) 'Tuberculosis and Virus'. (Jointly with Prof. K.E.N.Manayrakkam) Cey.Pub.Hlth.Dep.

xi) [illegible]

xii) 'Patterns of Mortality and Morbidity among Ceylonese Children' Cey.J.Child.Hlth. 1967 - 68. pp 7 - 25.

xiii) 'Inoculations against Bacterial Diseases'. Formulary Notes, Vol. 4, No. 1, January, 1969

xiv) 'The Doctor and his Patient'. Peradeniya Medical School Gazette.1970

xv) 'Trends in Medical Education in several countries and in Sri Lanka'. Cey.Med.J. 19 No. 2 1974, 56 - 69

xvi) 'A report of the Hindagala Community Health Project for the years 1965 and 1966'. (Mimeograph. August, 1967).

xvii) Report of the Hindagala Community Health Project for the years 1967-1973. (Mimeograph, October, 1975)

xviii) Prevalence of soil transmitted helminths in the Hindagala Community Health Project - Cey. Med. J. 1,75. 22. 177

xviii) Control of ancylostomiasis by mass-treatment with Tiperazine citrate- Cey.Med.J. 1977, 27. 125

Papers read, Talks, and Newspaper Articles:

i) 'The Problem of a Higher Female Mortality in Ceylon'. Paper read at the Research Seminar, Harvard School of Public Health, U.S.A., 1960

ii) 'Health and Diseases of the Pre-School Child'. Paper read to social workers at the Institute of Social Work, Ceylon. 27.5.63.

iii) 'How Healthy is the Pre-school child? Article published in the the 'Peoples Week' Supplement of the Ceylon Daily News 13.6.63.

iv) 'Some Problems of the Pre-School Child'. Radio Talk (15 mts.) in connection with the People's Week. 14.6.63.

v) 'Sex Differences in Mortality in Ceylon'. Paper read at the 75th Anniversary Festival of the Ceylon Medical Association. August. 1963.

vi) 'Changing Emphasis in Public Health in Ceylon'. Paper read at the Health Promotion Refresher Programme at the School of Cooperation, Polgolla. August, 1963

vii) 'Patterns of Mortality and Morbidity among Ceylonese children'. Paper read at the 3rd Paediatric Congress of the Ceylon Paediatric Association. 1965.

viii) Morbidity and Medical Care in Ceylon - A study of No. 22,500 families'. Paper read at the 77th Anniversary Meeting of the Ceylon Medical Association. 1968

ix) 'Some Implications of changing patterns in Public Health in Ceylon'. Lecture delivered at the Institute of Social Work, Ceylon 26.3.66.

x) 'The Demographic Setting'. Lecture delivered to the Health Educators at the Family Planning Training Centre, Ambalangoda. 24.5.66.

xi) 'Good Hygiene Practices in Ceylon'. Working paper presented at the Inter-regional Seminar on Food Borne Diseases, New Delhi, India October, 1967.

xii) 'Changing Patterns in Public Health'. A series of three lectures delivered at the Seminar for Medical Officers of Health on Programme Planning for Effective Community Health. September, 1967.

xiii) 'The Health of the Nation'. Article published in the 'Health Week' supplement of the 'Lindima'. 18.6.68.

xiv) 'The Genesis of a Physician'. Paper read at the 83rd Anniversary Sessions of the Ceylon Medical Association. 20.3.70.

xv) 'Priorities in the Medical Curriculum for Ceylon'. (Together with Dr. M.J. Jayasena). Paper read at the 1st Seminar on Problems of Health Care and Medical Education in the Tropics, Colombo. September, 1971

xvi) 'The Hindagala Community Health Project'. Talk delivered at the Tuesday talks sessions of the Kandy Society of Medicine. December, 1972

xvii) 'Trends in Medical Education and what of Ours? Talk delivered at the 'Tuesday Talks' sessions of the Kandy Society of Medicine. 15.5.73.

xviii) 'Maternal & Child Health Services in the Hinagala Community Health Project'. Paper read at the Annual Paediatric Conference. June '75.

xix) 'Health of the Nation'. Rasle Jewel Foundation. 23.8.75.

xx) 'What is Family Health'. Lecture delivered at the 1 th Anniversary celebrations of the Paediatric Association of Sri Lanka Dec. 15-17th 1976.

xxi) 'Role of the Volunteer in Community Health' Paper read at the Family Health Foundation Seminar for F.H.N's 29th March-1st April 1977 at School of Nursing, Kandy.

xxii) 'Health needs in Rural areas' paper read at the seminar on 'Extending Health manpower to Health care needs in Sri Lanka', 28-29th April 1977 - Sri Lanka Foundation Institute, Colombo.

Membership of Professional Societies:

1. Sri Lanka Medical Association
2. Sri Lanka Association for the Advancement of Science and was Honorary Secretary of Section A, during 1963 - 1964
3. Public Health Association of Sri Lanka and was a Committee Member for several years and also the Editor for one year.
4. Sri Lanka Paediatric Association and was a Committee Member.
5. Kandy Medical Society
6. Peradeniya Faculty of Medicine Teachers Association - was the first President.
7. Community Medicine Association of Sri Lanka. Member of the Inaugural Committee.
8. Medical Students Association. Past Senior Treasurer.
9. Medical Officer in Charge and Chairman of the Hinagala Community Health Project and the Badugannawa Peripheral Unit, University Project.
10. Member of the National Committee on Community Health
11. Member of the Advisory Committee of the United Nations Fund for Population Activities.
12. Committee Member of the [illegible] Training and Evaluation Committees.
13. United Nations Economic Commission for Asia and the Far East (ECAFE) Population Correspondent for Sri Lanka.
14. Member of the Panel for the Assessment of Publications, Papers etc., submitted for appointments, scholarships, training abroad, etc., by Medical Officers in the Department of Health, Sri Lanka.
15. Member of the National Committee on National Health Manpower Study WHO Sri Lanka Project 0102.
16. President - Sri Lanka Association for Voluntary Sterilization.

Fellowships, Seminars and Consultancies:

1. The first Asian Paediatric Congress at Singapore, May, 1958.
2. The Regional Seminar on the Certification and the Classification of Mortality and Morbidity at New Delhi, India-October, 1958
3. The Advanced Course in Maternal & Child Health at Uppsala, Sweden. March - May 1965
4. The Inter-Regional Seminar on Food Borne Diseases, New Delhi, India. October, 1967.
5. WHO Seminar on Applied Epidemiology in relation to the Malaria eradication Programme in the South East Asia Region, Colombo-November, 1968.
6. WHO Tuberculosis Control Seminar, Colombo - February 1970
7. Workshop on the Teaching of Maternal & Child Health in field practice areas of Medical Schools at Bangkok, Thailand-April, 1970
8. Seminar on Problems of Health Care and Medical Education in the Tropics, Colombo - August, 1970
9. Study tour of Medical Education of medical schools and Institutions in several countries of the world. August, 1971 to August, 1972 (Sabbatical leave)
10. Conference on the Medical Assistant at Bethesda, Maryland, U.S.A. June, 1973
11. Temporary Adviser to WHO/Sri Lanka for the Seminar on Health Education in Family Health for Superintendents of Health Services and Medical Superintendents of Sri Lanka. September, 1973
12. International Conference on "Population and Population Change" Stockholm, Sweden - 4 - 6th September, 1974
13. WHO Seminar on "School Health Services". Karasoon, Burma - October, 1974
14. Temporary Adviser to WHO Workshop on "Community Medicine Aspects of Medical Education". Peradeniya, Sri Lanka. December 9-14, 1974
15. WHO Consultant on Training in Community Medicine. September,- December 1975 - Several Countries of S.E. Asia.
16. Third International Conference in Voluntary Sterilization - February, 1976 -Tunis, Tunisia.
17. Training Course in the teaching of Women Reproduction and Population Dynamics in medical schools at New Delhi - Nov. 29 - 10th Dec., '76
18. International Conference on Fertility - Turkey & WHO -India 1st Asian Conference, February. 1977
19. Temporary Adviser at the Family Health Education Seminar for MOH's - 29th March - 1st April, 1977 at School of Nursing, Kandy.

20. WHO Fellowship on "Teaching of Postgraduate Community Medicine" October 1 - December Xxx 31st, 1977
21. WHO Fellowship on "Teaching of Postgraduate Community Medicine" S.E. Asia - October - December, 1977
22. 1st National Conference on Surgical Contraception - 17th - 19th June, 1978, Kandy.
23. Workshop - "Training and Management of the Health Team in the delivery of Health Care at the Periphery" - 25th June - 7th July, Kalutara.

Description of Work:

Administer the Department of Community Medicine. Teaching and Research

Administer and provide medical care services to 16,000 persons in the Ibadan Community Health Project area and 25,000 persons in the Ladugbemowo Peripheral Unit University Project Area. Organization of maternal and child health services, ~~MCH~~ including school health services in the project areas. Evaluation of these services.

TANZANIA: Site visit conducted in Dar es Salaam, February 26 - March 2, 1979 by Christina Wood, Ph.D., University of California

Persons Interviewed:

Tanzania Food and Nutrition Centre, Dar es Salaam

Dr. Maletzkamo, Managing Director

Dr. Urban Jonsson, Director of Planning (Swedish national)

Mr. F. Kabumna, Director Manpower Development

Mrs. F.E. Gogmuka, Editor

Jipemoyo Project (Ministry of National Culture and Youth with Research Council for the Humanities, Academy of Finland)

Ms. Eila Vuorela, anthropologist

Bureau of Resource and Land Use Planning (BRALUP), University of Dar es Salaam

Ms. Deborah Bryson, geographer

USAID

Mr. Jack Hershberger

Dr. Al Hum

Persons unavailable:

Dr. Alex Nusha, Director of Food Science and Technology, TFNC

Mrs. Olivia Mgaza, Nutrition Planner, TFNC (presently on leave at Cornell University; she attended sixth workshop in New Orleans)

Ms. Faith Kahurananga, Assistant sociologist-anthropologist, TFNC

Dr. V.P. Elinati, Faculty of Medicine, University of Dar es Salaam

Dr. Anwar Ng, Faculty of Agriculture, Morogoro

Dr. Mascarenhas, Director of BRALUP

Marjorie Mbilinyi, Professor of Education, University of Dar es Salaam (women's position, sexual division of labor, food production)

TANZANIA

Tanzania is a country of 16 million people of which more than 13 million live in the 8000 rural ujamaa villages. Only 10% of the population lives more than ten miles from a dispensary or rural health center. Agriculture comprises 40% of the GDP, but cash cropping continues at the expense of food crops. The British are expanding Tanzania's sugar industry. The national policy is self-sufficiency in food production, but cash cropping and unpredictable weather have thwarted this aim. Tanzania has loans from the World Bank to improve the trucking industry and trunk roads and from Britain for an all-weather road (from Songea to Makambako) linking the major regions in the south (Mtwara, Lindi, Ruvuma) with the rest of the country. Considerable malnutrition exists in Tanzania. The Tanzanian Food and Nutrition Centre in Dar es Salaam is dedicated to determining the best ways of applying existing nutrition knowledge. The Centre demonstrates the national principle of self-reliance in that the investigators return to study locations (many times if necessary) and explain the results of their surveys to the populations and discuss with the people how they themselves can best solve their own nutrition problems. Maize is the main food staple all over the country, but cassava staple is also found along the coast, in Dar es Salaam, Mtwara, Tabora, Ruhwa, Shinyanga, Mara, Tanga, and Karagwe.

TANZANIA FOOD AND NUTRITION CENTRE

The Centre began operations in 1974/75 and currently has a staff of about seventy-eight people. It collaborates primarily with SIDA (SIDA is gradually relinquishing funding support to the Tanzanian government). The ongoing programs include the following:

1) Collection and analysis of available data on the food and nutrition

anemia (expensive iron-containing mixes are not effective), and endemic goitre (there is iodinization of salt).

The laboratory facilities at the Centre have been developing over the last two years. Routine food analyses, parasitological exams, blood analyses (hemoglobin, iron, vitamin A), and urine analyses are done. No animal work is done. There are three laboratory technicians and six in training. Equipment such as an atomic absorption spectrometer has been ordered and should be received within half a year. Library facilities are bare minimum. A computer is available at the electrical suppy company TANESCO, and a programmer is in training (Bureau of Statistics).

Research at the Centre is problem-oriented and prevention-oriented. Local food composition tables exist (Tanzania Food Tables, A.L.D. Marealle, Ministry of Health, East African Literature Bureau, 1974). The Harvard growth standards are used and are considered acceptable for Tanzania. Both local and staff interviewers are available for conducting surveys. Transportation does not present a formidable problem. The Centre staff collaborates with the Uyole Agriculture Center, The Faculty of Agriculture at Morogoro, and BRALUP.

UNIVERSITY OF DAR ES SALAAM

Faculty of Medicine: Dr. V.P. Kimati (Pediatrics) was unavailable for interview during the site visit. He collaborates with the Food and Nutrition Centre and has published quite a few articles on malnutrition and morbidity patterns in children under five in East Africa.

Bureau of Resource and Land Use Planning (BRALUP): The director, Dr. Mascarenhas, was unavailable at the time. He has published on the

situation in Tanzania ("Data Report on the Food and Nutrition Situation in Tanzania 1972/73 - 1976/77, Vols. 1,2, March 1978 available)

2) Development of a nutrition planning approach including discussions in seventeen regions on the food and nutrition situation, nutrition policy, and surveillance

3) Survey and workshops on food storage problems

4) Weaning food studies: development of a weaning food (65% maize, 20% full fat soya flour, 5% dry skim milk, 2% vitamin mix (extrusion cooker required); food processing techniques (viscosity and bulk of weaning foods, preservation, fortification)

5) Evaluation of development and nutrition projects

6) Food industry standards

7) Extension staff training

8) Plans to disseminate weaning and other food information (local manuals); nutrition education of parents

9) Plans for a national food and nutrition surveillance system and development of a maize harvest forecast model

10) Development of rapid assessment of nutritional status of a village (Kibaha, Kisarawe, Tarime, Iringa, Rufiji) (used by Uyole Agriculture Centre and BRALUP); socio-economic nutritional survey in Mvumi village, Kilosa and in Shinyanga

11) Applied nutrition projects where villagers participate in identifying and analyzing the problems

12) Data collection from nutrition rehabilitation units

13) Plans for study of vitamin A deficiency (a serious problem), nutritional

environment and special problems of food supply and nutrition in Tanzania. The following BRALUP reports were obtained:

1) M.L. Swantz, U.S. Henricson, M. Zalla, "Socio-economic causes of malnutrition in Moshi District," Research Paper No. 28, May, 1975.
2) M. Jakobsen, "Economic and geographical factors influencing child malnutrition: a study from the southern highlands, Tanzania," Research Paper No. 32, March, 1978.
3) S.S.L. Sambajee, "An analysis of rural-urban differentials in fertility and child mortality in Tanzania," Research Paper No. 28, April, 1974.

Ms. Deborah Bryson, a geographer with BRALUP, did a study on food production in West Kagunye (about 200 kilometers north of Dar es Salaam)from the historical and economic perspectives. She is planning to do dietary surveys of quantualists vs. agriculturalists, for which she has obtained the cooperation of WHO.

THE JOYSENIUS PROJECT:

This was a joint project of the Ministry of Culture and the Academy of Finland which started in 1975 and was just ending. The staff included two Tanzanian and two Finnish researchers. They studied small industry, music, pastoralist programs, and the role of women in food production. The latter study now exists as a proposal to the Academy by Ulla Vuorela, an anthropologist; she will begin this June.

SUMMARY AND OPINIONS

Dr. Maletzlema, the Director of the Tanzania Food and Nutrition Centre, had thoroughly analyzed the guidelines set down in the Précis and in general, he was in agreement with the basic aim of the project, but he would prefer a different approach. He would like to start with conditions affecting intake (why, what determines how much of what is eaten) which he felt might change some of the assumptions implicit in the Précis and the hypotheses to be tested. He felt research on malnutrition and disease and work output to be important to national goals, but he would have a difficult time justifying expenditure of research time on cognitive development, social competence, and reproductive capacity (work has been done on pregnancy). He also doubts that the methodology exists for many of the analyses required by the guidelines. He expressed concern about how the final data would be handled with respect to publishing and about the significance of the results for Tanzanian nutrition policy. In spite of his doubts and critical appraisal of the Précis, he seemed interested in the program and would probably participate, under certain conditions that would have to be negotiated with an interested U.S. institution. The national commitment to improvement of nutritional status and the policies of prevention, application of existing knowledge, and self-reliance strengthen the possibility that the results of such a program as this would actually be used to the benefit of the population on a nation-wide basis.

USAID RESPONSE: Both Mr. Harshberger and Dr. Henn seemed interested in the program; neither raised any major objections to it. Dr. Henn was working on plans for primary health care facilities for the Masai.

Christina Wood

THAILAND: Site visit conducted April 2-5, 1979 in Bangkok and Chiang Mai by Christina Wood, Ph.D., University of California at Berkeley, and Leonard Schuman, M.D., University of Minnesota.

Persons Interviewed:

INSTITUTE OF NUTRITION, MAHIDOL UNIVERSITY, BANGKOK

Dr. Sakorn Dhanamitta, Professor (University of Pennsylvania)

Dr. Kraisid Tontisirin (M.I.T.)

Dr. Sonjai Sirivech (Florida State University)

Dr. Phienvit Tantibhedhyangkul, Pediatrician (Columbia University)

DEPARTMENT OF PSYCHOLOGY, CHULALONGKORN UNIVERSITY, BANGKOK

Dr. Saisuree Chutikul (National Education Commission)

MINISTRY OF PUBLIC HEALTH

Dr. Somboon Vachalotai, Director General of Ministry of Health

Dr. Puangtong Tantiwongsie, Division of Nutrition

ANEMIA AND MALNUTRITION RESEARCH CENTER, CHIANG MAI

Dr. Dusa Thanangkul, Director

USAID

Mr. Vernon Scott

Mr. Edward Munlak

Persons unavailable:

Dr. Aree Valyasevi, Director of Institute of Nutrition

Dr. Amorn Nondasuta, Deputy Minister of Public Health

Dr. Vilai Benchakarn, Obstetrics-gynecology, Ramathibodi Hospital, Bangkok

Institute for Child Study, Bangkok

THAILAND

Thailand is a country of 45 million people with about 80-85% living in rural areas. According to a national nutrition survey carried out in 1973 about 65% of the country's preschool children were classified as having protein-energy malnutrition (Gomez classification).

There are three seasons in Thailand: the dry season February-May; the rainy season June-September, when more vegetables are available; and the cold, dry winter season November-January. Rice is always available and is exported. Canned foods are imported. Vegetables that are grown are often sold, resulting in areas of riboflavin deficiency. Fishing is done in the south. Distribution of food is not good within the country. The population is composed of ethnic groups: Thais, Chinese, and Muslims, each with their own food beliefs. For instance, Muslims eat beef but not pork for religious reasons; the Chinese prefer pork and shun beef for health reasons; and the Thais rarely eat chicken for financial reasons. (Report prepared by Dr. Sakorn Bhanomitta for the Sixth ASEAN Workshop on Food Habits and In-Field Implementation of Nutrition Problems, 1978, available). The northeast relies mostly on subsistence

farming -- no extra to sell. In the south, north, and northeast the land belongs primarily to small farmers -- this land is not very fertile. The central more fertile areas are owned by large land owners.

The staple diet for the country is rice (ordinary or glutinous) from which the bulk of calories and protein is derived. There is very little fat in the diet (in the northeast, 4-6% of calories are from fat) and there are programs to encourage the use of coconut oil and other vegetable oils to bring up the calorie intake.

The most prevalent childhood diseases in the northeast Ubol area are diarrhea, dysentery, and URI. While the adults suffer from liver flukes and liver disease (attributed to high consumption of fermented fish). In the northern Chiang Mai area diarrhea and URI are prevalent in children while adults are afflicted with tapeworm. Hookworm is prevalent in the south.

The country has seven medical schools. Two are associated with Mahidol University: Ramathibodi and Siriraj. The latter has very limited nutrition activities while the former houses the Institute of Nutrition. The Anemia and Malnutrition Research Center (MALAM) is located with the Faculty of Medicine, Chiang Mai University. Both the Institute of Nutrition and MALAM have excellent laboratory facilities and they both carry out basic nutrition research studies in addition to ongoing field programs. The primary field research area of the Institute of Nutrition is the northeastern Ubol area while that of MALAM is the northern Chiang Mai area. There is in actuality no effective collaboration between the two.

INSTITUTE OF NUTRITION, MAHIDOL UNIVERSITY, BANGKOK

Dr. Aree Valyasevi is the Director of the Institute of Nutrition in addition to being the chairman of the Pediatrics Department at Ramathibodi Hospital. New facilities for the Institute are under construction at the Salaya campus. Dr. Aree was out of the country during our site visit, however, he was a participant in the sixth workshop composed primarily of nutrition investigators from developing countries. Dr. Sakorn Dhanamitta explained the programs of the Institute and discussed the feasibility of the CRSP with us.

The Institute of Nutrition, under Mahidol University, is composed of the following departments:

1) Administrative office
2) Food and Nutrition Chemistry
3) Food and Nutrition Toxicology
4) Clinical Nutrition
5) Community Nutrition and Surveillance
6) Education and Training
7) Community Publications and Data Processing.

The Faculty and their research interests are as follows:

1) Dr. Aree Valyasevi, Professor (M.D., D.Sc.)
   - -Nutritional problems, their relation to health and community development
   - -Dietary factors and prevention of urinary bladder stone disease
   - -National nutrition planning

2) Dr. Sakorn Dhanamitta, Professor, (M.D., D.Sc.)
   - -Nutrition problems in Thailand
   - -Urinary bladder stone disease
   - -Field research operation in food and nutrition
3) Dr. Vichai Tanphaichitr, (M.D., Ph.D.)
   - -Vitamin metabolism
   - -Lipid metabolism
   - -Dietotherapy, tube feedings, and total parenteral nutrition
4) Dr. Phienvit Tantibhedhyangkul (M.D.)
   - -Lipids
5) Dr. Kraisid Tontisirin, (M.D., Ph.D.)
   - -Protein requirements of man in various physiological and pathological conditions
   - -Nutritional evaluation of food
   - -Plasma amino acid levels in health and diseases
   - -Infant nutrition
6) Dr. Songsak Srianujata, (M.S., Ph.D.)
   - -Effect of nutritional status on biopharmaceutics of drugs
   - -Bioavailability of nutrients and drugs
   - -Food analysis and toxicology
   - -Analytical chemistry
7) Dr. Somjai Sirivech, (M.S., Ph.D.)
   - -Iron metabolism
   - -Vitaminology

-Uric acid metabolism

Laboratory facilities include clinical nutrition, food chemistry, nutritional biochemistry, fluid electrolyte, metabolism, and radioisotope laboratories. The metabolic ward with 12 beds is being operated with complete facilities for metabolic studies. Scientific instruments include two amino acid autoanalyzers (Beckman model 121M and Technicon), Pye Unicam ultraviolet spectrophotometer (1800), Beckman Du-2 spectrophotometer, Coulter counter, Technicon-2-channel autoanalyzer system, atomic absorption spectrophotometer (Varian AA-6 with M-63 carbon rod atomizer), gas liquid chromatograph (Packard Model 7300), Coleman nitrogen analyzer, complete set of instruments for food analysis and food toxicology laboratories, liquid scintillation spectrometer (Beckman 1, Nuclear Chicago 2), and many other small instruments. The Division of Nutrition also possesses nutrition field stations at Ubol Rajathani province and Bangpain. There is a small nutrition library for the Masters students; the large library is located at the Salaya campus. Computer processing can be done at the Institute; there is a computer at the Institute of Statistics. The Institute uses Masters students as well as local people as interviewers. There are no apparent transportation problems for the field studies -- there is a train to Ubol; the field station includes two houses, six field offices, two small Datsun trucks, and a Jeep.

The Institute is funded by the Thai government with additional private grants. The Institute's field programs consist of the following:

1) Urinary bladder stone study -- done on 12000 children in the Ubol area. This disease affects some 50% of preschool patients in a stone belt covering the north and northeast. There is an apparent phosphate

deficiency in this area. After seven days of life, infants are given supplementary sticky rice (prechewed by mother). The water intake is low (urine volume low; specific gravity high) with evidence of dehydration. The water contains very little calcium. The program supplies phosphate pills. (It would cost a great deal to increase the water supply.)

2) Vitamin A deficiency prevention -- 17% of rural preschool children have low serum vitamin A.

3) Nutritional anemia - pregnancy study in the Ubol -- there is a 40% incidence of thalassemia. Different methods of providing iron are being tested. Volume and composition of breast milk is being studied.

4) Rural nutrition education

5) Nutrition health and manpower

6) A program in cooperation with the Agriculture Extension Department in the Ministry to study village food production, processing, and distribution, local meaning food, as well as integrated agriculture and nutrition planning and policy analysis for Thailand.

Both basic and applied research orientations are accepted at the Institute, but they say they feel a stronger commitment to applied research. The Institute has some collaborative efforts with the population control program (AID,WHO), with the proposed Ministry of Health program concerning PEM and infants, pregnant and lactating women, with other departments in the Faculty of Medicine, and with some social scientists (for instance, Dr. Saisuree Chatikul). They are also involved with the Community and Rural Development Project in Ayuthaya in which food supplements are given in the MCH centers. Dr. Sakorn also described some recent work (Feb.-March 1979) on protein and energy intake with fixed

protein levels and varying energy intakes. This study took place in Ubol using the young men who distributed the phosphate pills.

The food analysis laboratory works on local food composition tables as does the Ministry of Health. Local growth standards exist, but the Gomez classifications are used. Age is difficult to obtain.

DEPARTMENT OF PSYCHOLOGY, CHULALONGKORN UNIVERSITY, BANGKOK

Dr. Saisuree Chatikul, also of the National Education Commission, has collaborated with the Institute of Nutrition and she was most interested in this potential CRSP. She was well informed of the nutrition situation in Thailand and she discussed with us the Commission's school lunch program (which apparently has no evaluation and also targets 3-6 year olds when the 0-2 year olds may be in greater need). She would undoubtedly be a valuable addition to any team involved in the CRSP.

ANEMIA AND MALNUTRITION RESEARCH CENTER (MALAN), CHIANG MAI

Dr. Ousa Thanangkul directs the MALAN. The Center was founded in 1967 and has received funds from NIH, Rockefeller Foundation, the government of the Federal Republic of Germany, USAID, WHO, and the Thai government. The following studies have been completed at MALAN:

1) The pathology and treatment of PEM, 1967-77 (NIH), covering methods of treatment of PEM, anemia, and its interactions in pregnancy, infection, endocrinology, rehabilitation from PEM, growth patterns in urban and rural northern Thai children.
2) Prevention of blindness with single massive doses of vitamin A, 1972-74 (USAID).

3) Effects of Medroxy Progesterone Acetate Injections, 1974-77 (WHO), a popular contraceptive method in Thailand.
4) Interactions of hormonal contraceptives with nutrition and health, 1974-77 (WHO), on 400 rural women who were malnourished.
5) Interactions between health and fertility, 1977-78 (NIH, in cooperation with East-West Center, Hawaii)
6) Iron supplementation, 1977-78 (WHO).

The current work at MALAN focuses on anemia both in the laboratory (erythropoeitin, infection and immunologic responses, growth hormone, insulin, cortisol) and in the field (etiology of anemia, iron supplementation, in one village in the area). MALAN works with infant care centers in three nearby villages (nutrition education, promotion of weaving etc.). The other focus of research seems to me to be indepth studies in the laboratory and the field on interaction of malnutrition and contraception. With regard to PEM, the orientation appears to be curative, with no training available in prevention. Dr. Ousa says that with a long enough hospital stay (3 months) almost no relapses occur from PEM. She follows up 60% of her cases; they return one month after release and she visits them once a year thereafter. Dr. Ousa says she spends 50% of her time in laboratory research and 50% in field work.

The facilities at MALAN are modern and complete. There is a metabolic ward that accomodates 6 adults and 18 children (there were eight children present at the time of our visit). There are biochemistry, hematology, immunology, and microbiology laboratories, animal colonies, maintenance facilities, and a limited library which contains the standard nutrition journals. MALAN has its own computer programmer who uses the National Statistics Organization computer in

Bangkok. Interviewers and Land Rovers are also available.

MALAN collaborates with the Faculties of Agriculture, Engineering and Social Sciences at Chiang Mai University, particularly in regard to the infant care centers. Dr. Busa mentioned one sociologist and two political scientists (one in rural and one in urban development) but she could not recall their names.

Growth curves have been constructed after an anthropometric survey of 850 rural and 827 urban children (up to 15 years old) in the Chiang Mai area. The results are apparently not published. Food composition tables for Chiang Mai do not exist, the FAO Food Composition in East Asia, 1972, tables are used. Dietary surveys are not done in the area by MALAN and there is no nutrition surveillance system there.

The villages in Chiang Mai vary from 100 to 600 households with about 5 to 6 people per household. The birth rate is low. The diet is composed primarily of rice, vegetables, and fish. Babies are normally breast-fed for 12-18 months with the introduction of rice and banana at one week and other foods after 12 months.

MINISTRY OF PUBLIC HEALTH

We had a brief visit with Dr. Somboon Vachalotal, Director General of the Ministry of Health. He listened to our description of the CRSP, and he seemed favorably impressed. He was particularly interested in the role USAID would play.

Dr. Puangtong Tautiwongsie from the Division of Nutrition was also present.

USAID RESPONSE:

Mr. Vernon Scott and Mr. Edward Muniak were not pleased about the fact that they were informed of our arrival only a day in advance, nevertheless they were helpful with our arrangements. Mr. Scott seemed to think that many of the potential results of our CRSP were sufficiently well-known that programs could go ahead. Mr. Muniak was ethusiastic about the MALAN in Chiang Mai, and encouraged our proposed visit there.

SUMMARY AND OPINIONS

There are three main groups involved in nutrition research in Thailand, in descending order of strength: The Institute of Nutrition (Mahidol University - Ramathibodi Hospital, Bangkok); the Anemia and Malnutrition Research Center (Chiang Mai University, Chiang Mai); and the Ministry of Public Health Division of Nutrition (mainly chemical analyses). Other related institutions include Kasetsart University just outside of Bangkok involved in the development of supplementary foods; the Faculty of Public Health, Mahidol University, fieldwork; the Faculty of Tropical Medicine, Mahidol University; agriculture-related work in Korat Province; Community Based Family Planning Services, Dr. Mechai; the Department of Technical and Economic Cooperation; and the Institute for Child Study, Bangkok.

We visited the first two institutions named above and found the laboratory facilities to be excellent at both. Dr. Aree and Dr. Sakorn of the Institute of Nutrition have both expressed their interest in and enthusiasm for this collaborative research. They have also given thought to putting together a multidisciplinary team composed of people from the disciplines of nutrition, reproductive-biology, ob-gyn, social science, and psychology. They could use

support in the areas of techolcal assistance in methodology and design of fieldwork and in social analysis. It is my opinion that their group represents at least enough if not more than enough infrastructure to effectively collaborate in a research project of such a broad nature.

Dr. Ousa at MALAM also expressed an interest in this program. She expressed concern over the broad nature of the research and the potential burden to the community. She has expertise in the areas of disease and reproduction, but would need strong support in work, cognitive, and social development.

Cooperation with either of the above research centers could probably be worked out; however, one should not expect collaboration between them.

Christine Wood

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Visit to Bangkok and Chiang Mai, Thailand - Nutrient Intake and Function Research - April 2 - 5, 1979, by Dr. Leonard Schuman

Our visit to Thailand for the purpose of ascertaining both willingness and capability of participation in nutrient intake and function research was marked by considerable hospitality both on the part of the U.S. AID Mission and members of the staff of the Nutrition Program in the Research Center of Ramathibodi Hospital, Mahidol University, particularly in the person of Dr. Sakorn, Dr. Aree's expeditor.

Our first contact in Bangkok was with Mr. Vernon Scott, Nutrition Program Representative for the U.S. Agency for International Development. Although greeted quite cordially and with hospitality, we sensed some lack of appreciation for the necessity of the type of research proposed. As in many instances, there seemed to be emphasis on uncontrolled and relatively unevaluated nutritional supplementation programs - the sacred cows of health program applications. Although hospitable and with reminiscences of his school of public health days, Mr. Scott tended to be disparaging of fulfillment of promises by the nutrition group at Ramathibodi Hospital and of Dr. Ousa at Chiang Mai. Offers of assistance were nevertheless forthcoming should Thailand be selected as a site for the contemplated research. It was necessary to emphasize the lack of information in this area despite common belief and the tendency to throw millions of dollars into nutritional assistance without measurement of the real effects on disease prevention and functional efficiency.

The enthusiasm with which we were greeted by Dr. Sakorn and her staff, in the absence of Dr. Aree was in marked contrast to the atmosphere at U.S. AID. Dr. Sakorn made an admirable presentation of the structure and function of the components of Mahidol University and particularly the research center with its nutrition program. Her data on protein energy malnutrition for the population of Thailand as well as the other components

of their field and laboratory studies were admirably presented. This reviewer was impressed with her lucidity and gained personally from her information.

Seven medical schools service the country of Thailand. In northern Thailand, Chiang Mai, admits eighty students per year in their six year program. In the northeast, Khonkaen admits forty students with an increase pending to sixty. In the south, Songkra Medical School admits sixty students a year and in Bangkok there are actually 4 medical schools: Chulalongkorn (120 students), a new military medical school - Mumthue (44 students), and the two medical schools under Mahidol University - one in Ramathibodi Hospital (80 students) and at Siriraj (700 students). The nutrition program in research is housed in the Research Center of Ramathibodi Hospital On the Salaya Campus of Mahidol University. A new building for the Institute of Nutrition is undergoing construction. Dr. Aree, Professor and Chairman of Pediatrics, is also the director of the nutrition programs at both Ramathibodi Hospital and the Institute of Nutrition.

Dr. Sakorn, who was a student of Dr. Paul Gyorgy and a graduate of Women's Medical College of Philadelphia, proceeded to a discussion of nutrition problems in Thailand. A random sample survey of protein energy malnutrition was executed in 1973 among pre-schoolers in Bangkok slums, constituting 5% of the urban population and in rural areas in central, northeast, and south Thailand utilizing a modified Gomez classification. 75% of the pre-school children in Bangkok slums, 55% in the rural area of central Thailand, 63% in northeast Thailand, and 70% in the south, revealed mild and moderate (combined) protein energy malnutrition. For the survey as a whole, 3% of the pre-school population surveyed showed severe malnutrition. Thus, over 4 million pre-schoolers could be considered to be suffering from protein energy malnutrition in some degree of severity.

A whole country survey has not been done. Approximately 120 cases of protein energy malnutrition in young children are seen at the three teaching hospitals every three months. In the north of Thailand, surveys performed in 1969-70 and again in 1978, revealed an increase in mild-moderate malnutrition from 67% to 84% but with a decline in severe malnutrition from 6.8% to 1%. The overall increase irrespective of severity was 11%. In northeast Thailand, a re survey of the rural area was executed in 1977-78 when a shift from moderate to mild

malnutrition was observed and a lessening of severe forms but with very little overall change in total protein energy malnutrition. In fifty other villages in 1978 protein energy malnutrition of similar magnitude was observed. Although fishing is a heavy industry in the south of Thailand, maldistribution of food supplies fails to provide this commodity to other parts of the country.

Nutritional anemia is another problem in Thailand and it is of the combined iron - folic acid type among adults and pregnant women and simple iron deficiency among children. The magnitude of the problem ranges from 22% in central Thailand to 50% in the northeast. Another serious problem related to nutritional deficiency among children is that of the high incidence of urinary bladder stone. Dr. Sakorn is of the opinion that this is probably due to the use of sticky rice as early as 6 days after birth. The mother chews the sticky rice and gives it to the child with a little water. It is felt to be a phosphate deficiency aggravated by low water intake. This represents an important piece of research at this nutrition research center.

Other field research programs include prevention of vitamin A deficiency, nutritional anemia, nutrition education for rural women, surveys of nutrition, health and manpower, village food production processing and distribution, integrated agricultural and nutritional planning and policy analyses, fat supplementation (coconut oil), prevention of energy malnutrition in infants and pre-school children in the northeast, nutrition surveillance and factors influencing quality and quantity of breast milk. This last is a very energetic program emphasising the utilization of breast milk by mothers the large scale educational campaign in all areas of the country.

Metabolic studies being conducted by this research group include the metabolic evaluation of weaning foods and local food mixtures, protein requirements in Thai subjects, chronic infection and protein needs in Thais, relationship of energy and protein needs, clinical evaluation of soybean milk in the treatment of diarrhea in infants, evaluation of partial and total parenteral nutrition to feeding, and phosphorus status in health and disease. A study on anthropometric nutritional classification in Thai infants and pre-school children has been completed by Dr. Pemari and has been published in the Journal of the Medical Association of Thailand (Volume 60, supplement 1, August 1977).

A review of the parasitic diseases reveal the following information: In the northeast, the principle parasitic disease is liver fluke from fermented fish; in the north, tapeworm from raw meat; in the south, hookworm; in the central areas, ascaris and other roundworm infestations; on the eastern border along the Mekong River, some schistosomiasis. Thailand is currently in the midst of a four year plan emphasizing nutrition. This four year plan from 1977-1982 represents the first time that a national development plan which had previously gone thru three periods, emphasized nutrition and recognized that nutrition programs encompassed more disciplines than the health sector alone. A national food and nutrition committee is now in existence with subcommittees on service for mother and pre-school child, on training and research, on mass-communication, on food production and administration and constitutes principally the Institute of Nutrition, the Institute of Food Research and Product Development and the Office of the Secretariat which in turn comprises representatives of the Ministries of Health, Agriculture, Education, Interior, and the two institutes named above. Provincial food and nutrition committees are also set up in this plan and the provincial committees also comprise representatives from health, agriculture, rural development, education, welfare, and the local administration in which latter the flow of policy and activity is effectuated. The ultimate implementation is through the health care network at the village level.

The target population is three million pregnant and lactating women in the total Thai population and six million infants and children from birth to six years of age. The goal is to reach 30% of the pregnant and lactating women and 30% of infants and pre-school children. Six thousand feeding stations are being developed and significant supplemental food production primarily for children 6 to 24 months of age is being processed. The recognition of the inter-disciplinary approach to nutrition problems is a first to Thailand and was finally recognized as the basic need for the peculiar problems of the country. In central Thailand much land was lost by individual farmers to middleman financiers because of unpaid loans. Parliament is attempting this process by providing loans to farmers and taxing the exploitation at higher rates pressuring him to return the land by legislation. In the northeast and north the land is not very fertile and so agricultural development is a principle activity in this nutrition policy. As director of the Institute of Nutrition, Dr.

Aree will undoubtedly exert a powerful influence on the policies of this program since the Institute is a major component of the policy committee.

Insufficient time was available for a visit to the villages in which the nutrition research group of Ramathibodi Hospital functions. However, Dr. Sakorn presented a slide demonstration of their work in the health centers of these villages to the east of Bangkok. The field activities have been mentioned above.

A tour of the nutrition laboratories was quite impressive and during our visit much activity was in evidence. Dr. Kraisid conducted us on this tour and demonstrated a high competence in laboratory methodology. The extent and diversity of the facilities were quite a surprise to this reviewer, fortunately spare parts and instrument company services were readily available in Bangkok.

Dr. Sakorn, our hostess, is actually responsible for the research component of the Ramathibodi Nutrition Program under the overall direction of Professor Aree. Dr. Vichai and Dr. Songsak are responsible for the central research lab and Dr. Kraisid is responsible for the metabolic ward in turn. Dr. Sakorn's direct responsibility is in field research and she is responsible not only for the field research laboratory at Ramathibodi but also for the community nutrition research at the Thol Nutrition Research Station and in the Maeklong integrated rural development project.

Dr. Sakorn assured us that field populations of the type we desired would be readily availabe for study. The Health Services Organization of the country is such that at the peripheral level there exists 550 small district hospitals, each covering 50,000 to 150,000 population and manned by a physician, nurses, and a sanitarian. Below this level there are 6,000 subdistrict health centers servicing 3,000 to 5,000 people and manned by a midwife and junior sanitarian, and at the village level with populations ranging from 500 to 1,000 people, volunteer health workers are employed and communicators are selected for direct contact with the population in promotion and encouragement to participate. These latter number 1 to each 50 to 80 of the population. It is through these communicators that the assembly and education of a cohort for the research would take place.

CRITIQ

The enthusiasm of Dr. Sakorn and her group and their willingness to cooperate in collaborative research was highly apparent. Although cognizant of the warning from the U.S. AID Office that this professional group may promise more than it can deliver, this reviewer would be inclined to temper this warning significantly. I believe that the enthusiasm can be exploited and the personalities of the Thai collaborators would dictate a very happy collaboration.

L. Dr. Schumacher MD
4/23/79

A Visit to Chiang-Mai, Thailand, April 4, 1979

On this visit to the Medical School of Chiang-Mai, Thailand, we were met at the airport after an hour's flight from Bangkok by our hostess, Dr. Ouss, a very gracious, active, and charming lady, who is, by training, a pediatrician and administratively heads up the Nutrition Research Program at the Research Institute for Health Sciences. In this role, she works with the five faculties of Medicine, Pharmacy, Nursing, Dentistry, and Medical Technology. She has ties with the social scientists at the University of Chiang-Mai and with the latter has collaborative research arrangements at the Infant Care Centers in three villages of Chiang-Mai and Lampoon provinces. In these a Nutrition Surveillance Program is also in operation. The Research Institute in Chiang-Mai is involved in field follow-up after therapy at the hospital in six provinces, including Chiang-Mai and surrounding it. Currently, a study of the interaction of contraceptive use and malnutrition is in progress.

Dr. Ouss was most cooperative and had no hesitancy in providing us with responses to all of the various questions that could be raised in the brief period of our visit. Because of time constraints, it was not possible to visit any of the facilities in the field or make observations on the populations that could be utilized for our relevant research. She expressed a great willingness to collaborate and made the interesting comment that the Thai people are far better collaborators with other countries' scientists than they are among themselves. This may have some portentous meaning in terms of any collaboration with other nutrition researchers in the country, such as that at Mahidol University. Dr. Ouss's unit spends about 50% of its time in in-house research in under-nutrition and is concerned with immunocompetence, hormonal aspects and absorption characteristics in the subjects of their research. Metabolic evaluation is primarily among adults although there are facilities not only for six adults but eighteen children in the Metabolic Ward. At the time of our visit, the adults' beds were not occupied, but about eight children were noted in the children's beds of the

Metabolic Ward. This latter count was in contradiction to the expectations by Mr. Vernon Scott that we would probably find fewer than four children in the Metabolic Ward beds.

50% of the time of the unit is also spent in field research and this is principally in the area of iron supplementation among pre-school and school children and among non-pregnant adult women. Apropos of questions in regard to the utilization of human subjects in nutrition research, Dr. Chana noted that participation among the population requires a promise of medical care, that response is dependent upon the relative invasiveness of the study and upon the weight of the burden of activity on the village. A quick tour of the hospital's facilities also revealed relatively modern laboratories with suitable equipment, but at the time of our visit, there was relatively little activity discernable therein.

Critique

Chiang-Mai area, in my opinion, would also provide a suitable base for collaborative research in nutrient intake and function. I do believe that Dr. Chana would present a very acceptable level of cooperation and the facilities would be suitable for such research. In the event that populations both in the Bangkok area and in the north would be required for this type of research (as I do believe that a combination of both areas would be highly desirable), then my concern would be the mechanics of welding together the two nutrition research units at Bangkok (Mahidol) and at Chiang-Mai where there were apparent jealousies between the two units somewhat submerged beneath the surface. However, the position of Dr. Aree's, on the National Food and Nutrition Committee, might provide the ultimate resolution of such problems of inter-university collaboration. In any event, should this not be possible, then an alternative would be two separate but integrated collaborations with each university.

Visit with Director General of the Department of Health, Dr. Somboon-
April 5, 1979

Visit with the Director General of Health on this date provided us the opportunity of explaining our mission to Thailand and an explanation of the details of the collaborative research that was being planned with developing countries under Title II of the Foreign Assistance Act. Dr. Somboon, although quite busy and interrupted many times during our visit, was a willing listener and did seem to provide his blessing and interest in such a study.

Leonard R. Schumacher, M.D.
4/23/79

Site visit conducted February 12-15, 1979 by Christine Wood, Ph.D., University of California, and Anne Perez-Gassi, M.D., National Institute of Nutrition, Rome.

Persons Interviewed:

INSTITUT NATIONAL DE NUTRITION ET DE TECHNOLOGIE ALIMENTAIRE (INNTA)

Dr. Soufaiz Hallal, Director

Mr. Bechir Zarna, Nutritionist

MINISTRY OF HEALTH

Dr. M. Redheb, M.D., Pediatrician, Health Coordinator

USAID

Mr. Charles Sadler

Persons unavailable:

A. Zimmon, Expert-conseil, Division des Politiques alimentaires et de la Nutrition

TUNISIA

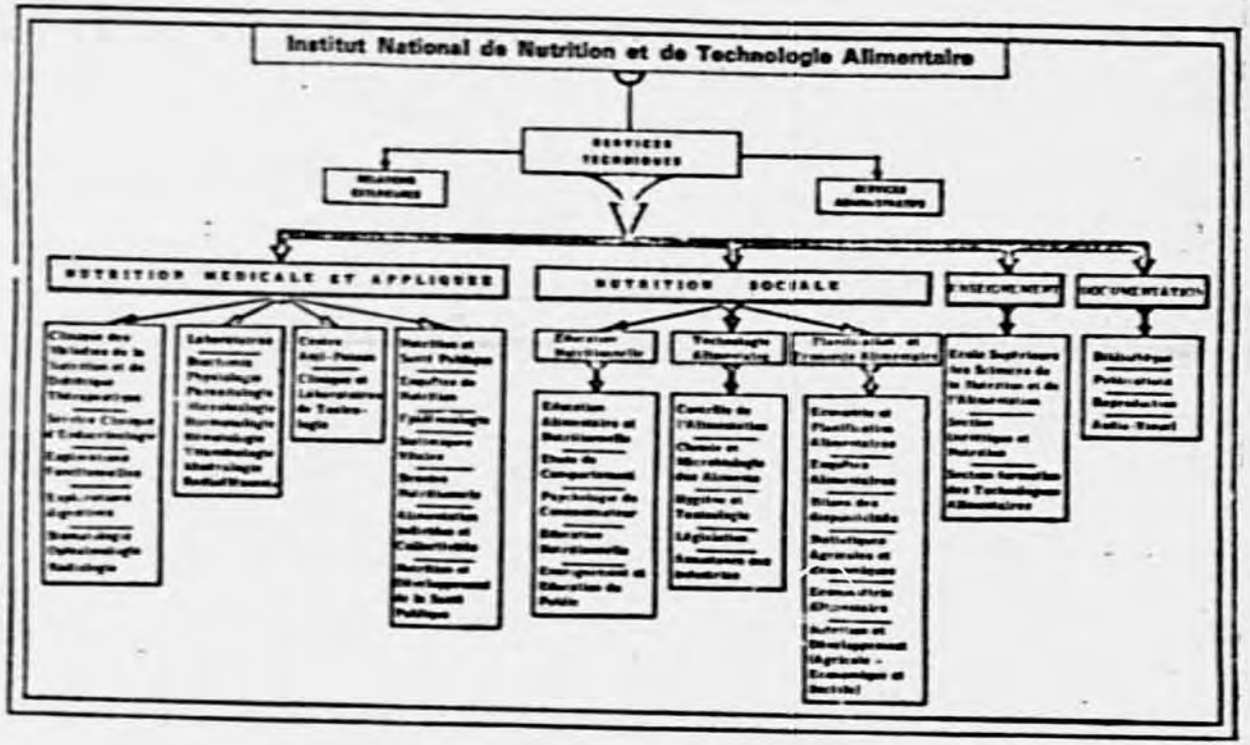
Regions used for the National Nutrition Survey

Tunisia is located on the north African coast between Algeria and Libya. It has a population of about 5.6 million, the majority of whom are Muslim. The president, Habib Bourguiba, has tried to modernize some social and religious practices by discouraging the veil, polygamy, arranged marriages, and fasting during Ramadan. The country has few natural resources; oil and phosphates are the major ones. Agricultural production is thwarted by inadequate water supply, strict land tenure, lack of technology, and rural to urban migration. Unemployment is severe.

Marasmus appears to be a much greater problem than kwashiorkor throughout Tunisia. There is an Institute of Nutrition in Tunis which is responsible for most of the nutrition activities in Tunisia.

INSTITUT NATIONAL DE NUTRITION ET DE TECHNOLOGIE ALIMENTAIRE (INNTA)

Dr. Zouhair Kallel is the Director of INNTA. He has a fairly new building with well-equipped laboratories and a large staff, several members of which have nutrition degrees from the US or Europe. The next page shows the arrangement of the departments within INNTA. The clinical and applied nutrition department includes a 40-bed clinic, laboratories (biochemistry, parasitology, hematology, toxicology, etc.), and a public health epidemiology/research section. The social nutrition department includes nutrition education, food technology, and nutrition planning. There is a teaching section also.



The following staff direct the laboratories and other departments:

1) Dr. Khebis (Syrian, trained in biochemistry in Switzerland) Chairman of the Epidemiology Laboratory
2) Mr. Alguoui (Masters from John's Hopkins) Radiobiology
3) Mr. Farhad (BA in engineering from Belgium) Food Technology and Food Chemistry
4) Mr. Negi (BA in engineering from Yugoslavia) Microbiology
5) Mme. Tounsti (trained in pharmacology in France) Hematology
6) Mlle. Rita (BA from Tunis) Mineral Analysis
7) Mr. B. Lacen (Masters in nutrition from Harvard School of Public Health; Masters in chemistry and nutrition from Tunis) Applied Human Nutrition
8) Mr. M. Mahjoub (Masters in biology from University of Tunis; MPH from Tulane) Nutrition Education
9) Mme. Mashoud (trained in agricultural engineering in France) Nutrition Planning

There are no facilities for animal experimentation. The clinic is filled primarily with obesity cases. INNTA has access to computers at the Faculty of Sciences and at the Institute of Statistics. The Institute has three cars available for transport to rural areas; the road system is apparently one of the better systems in Africa.

INNTA conducted in 1969-75 a two-stage National Nutrition Survey (USAID, WHO). The purpose was to identify at-risk groups by clinical, anthropometric, and biochemical measurements. Limitations of the survey are the following:

1) Lack of socio-economic data; no attempt to identify cause of malnutrition

2) Analysis of data only on a regional basis, obscuring differences within regions

3) The primary survey did not take account of seasonal variation.

The survey found prevalences of goiter, anemia, rickets, dental caries and fluorosis, growth retardation, hepatomegaly, high serum cholesterol, and deficiencies of vitamins C and B complex. (INNTA, Nutrition in Tunisia: Plans and Programs, First Annual Report 1978, available.) The highest risk for development of anemia was found in the Tunis region (V); goiter in region II; riboflavin deficiency in region I; thiamine deficiency in regions I and IV; niacin deficiency in regions V and II; vitamin C deficiency in regions I and II; dental caries and fluorosis in regions I, II, and V; rickets in region V; and protein-calorie deficiency in regions I,III, and V.

In 1974-75 INNTA participated in the National Household Food Consumption Survey covering 5000 households throughout the country. Tunis, region V, had lower intakes of most nutrients (except vitamins A and C and riboflavin). The percentages of the population meeting minimum requirements for calories and protein are as follows:

Region	Calories	Protein
I	68%	78%
II	83	84
III	76	85
IV	74	76
V	66	84

These figures present an optimistic view of the situation due to errors inherent in the study. However, it seems clear that the urban population is worse off nutritionally than the rural population.

INNTA attempts to control and integrate all programs and projects related to nutrition in Tunisia. Nutrition training and education have first priority. The activities of INNTA include the following:

1) The School of Nutrition. There is a three-year course of study after the baccalaureate covering human nutrition (clinical and diet therapy), applied nutrition (epidemiology, planning), and food technology. There are about 135 students in the program with 35 graduates each year. The school also has a section on food education, mass media activity, primary and secondary school programs, and programs for pregnant women.

2) Research. The three research areas are nutritional diseases (diabetes, goiter, anemia); applied nutrition (zinc and growth, anemia in pregnancy, psychological problems of preschool children); and food technology (microtoxin, flavors, iron fortification, vitamins A and C).

3) National activities in conjunction with the ministries of Social Affairs, Agriculture, etc.

4) Food and drug administration, regulation and control.

5) Institutional feeding including restaurant hygiene, factories, school lunch, jail, etc.

6) Nutritional ecology; food patterns and practices; overcoming food taboos; politics of food.

In addition, Dr. Kallal has many international connections and obligations (for example in Morocco and Zaire).

INNTA has developed a weaning food called "SAWA" made of wheat, chick peas, lentils, and milk to be mixed with oil and water. It is well-accepted and is given out free in the PMI (MCH) centers and sold in stores. They also have a fluoration project to treat the teeth of primary school children in Tunis.

There are social scientists on the staff of INNTA, among them, Dr. A. Rahia from the École de Piaget in Geneva who is now with the Institut Psychologie de Tunis and studies food habits, mental development, and school nutrition programs; Dr. Horan of the Kearny Institute is a sociologist from Northwestern; and Mme. Amami, a Tunisian psychologist.

There are no growth standards specific for Tunisians. The FAO food composition tables are used.

MINISTRY OF HEALTH

Dr. Rezheb (pediatrics) said that the main objective of the international organizations involved in nutritional improvement in Tunisia was to provide better distribution of services by means of rural health and development projects. A CRSP would have to be integrated into (and would hopefully strengthen) such projects. He felt that the major nutrition problems in rural Tunisia were marginal calorie deficiency and marasmus. Protein deficiency is seen in villages after weaning. He thought that the pattern of consumption has been changing in the last decade, that city dwellers were eating more milk, meat, and fish and that the poor were trying to follow this trend.

The official policy stresses prevention practices, but the work done is almost completely curative. Some data is collected from the MCH centers, but it is not satisfactory. Their goal is to build an efficient system of data collection for computer processing.

USAID RESPONSE

Charles Sadler was pleasant and most helpful. He explained that USAID has a two-year nutrition planning project in Tunisia with Kearny Management Consultants, Inc. They are now one and a half years into the

project. There are three Kearny experts currently working with INNTA to build a network for national policy and planning. The purpose is to establish an inter-ministerial mechanism to coordinate nutrition policy and to encourage the ministry representatives to conceptualize a planning system. There are three commissions: human nutrition, food production, and food consumption. The ministries do not work well together and this process is moving very slowly.

It was Mr. Sadler's opinion with regard to a CRSP that Tunisia would not favor any more basic research; they want interventions. Also, obesity is becoming the strongest nutritional concern (high olive oil and sugar consumption).

SUMMARY AND OPINIONS

There is a calorie malnutrition problem in Tunisia, but it seems to be most prevalent in urban slum conditions. The National Nutrition Institute manages all nutrition programs and Dr. Kallal's primary objective is the nutrition education of the people. His concern is not so much for undernutrition (he admits there is some undernutrition in Tunisia) but for the obesity, diabetes, etc. that is found in the urban areas. He feels the future of nutrition research lies in immunological techniques to study and combat such problems of overnutrition. Dr. Kallal personally oversees and controls his many and diverse projects; in my opinion it is doubtful that he would have the time to take on a CRSP and I did not have the feeling that he delegates authority easily. He has, however, sent a follow-up letter expressing his interest in participating in a CRSP.

Christina Wood

Report on site visit to Tunisia, February 12-15, 1979, by Anna Ferro-Luzzi, M.D.

The following are my personal opinions formed during my two-day visit to the nutritional installations in Tunisia.

1) Adequacy of present installations available for nutritonal research.

The impression was reached that most, but not all, nutritional research and activities take place at the National Institute of Nutrition, Director Dr. Kallal. The NIN appears to be adequately equipped to carry out some basic research, as it possess refrigerated ultra-centrifuges, precision balances, good microscopes, gas (?) chromatographic equipment, gas analyzers, etc. The major emphasis of NIN activity appears to be oriented towards routine analyses of clinical nutrition (blood analyses, hormones and vitamins) required by its 40-bed clinic (mostly obesity cases).

National tables of food composition are not available, and this may be an important factor in case this country is chosen for a CRSP. Computer facilities are said to be available at cost from the University. N.B. The statistical treatment of the data relative to the most recent (1975) national survey of nutritional status has been performed at WHO Headquarters in Geneva.

Animal experimentation and in general basic research in nutrition seems not to be carried out nor to be in favor at present, and there is no animal house in the NIN.

2) Personnel. There is a three-year course in nutrition, with three different orientations: a) planning, b) human nutrition, and c)

clinical nutrition and dietetics. Each year some 40-50 persons obtain their nutritional qualification. Most of the personnel of the NIN are Tunisian and educated in Tunisia. There are however some Tunisian researchers who have had some training either in the US or in Europe, as well as a few foreign scientists with temporary or permanent assignments and various qualifications.

The Director of the Institute, who studied in Paris with Prof. J. Tremolieres, is a very active and energetic manager whose main interest at the moment seems to be directed towards nutrition education at all levels. His personality is very assertive and may not leave much space for a fruitful prospective collaboration.

3) Nature of the nutritional problems in Tunisia. Conflicting views have been offered by various local sources. My personal opinion, which however may lack supportive evidence, is that the rural community is exposed to moderately frequent sub-optimal protein-energy malnutrition, and that in this respect is not different from most north African countries. Kwashiorkor is reported to have disappeared, while marasmus and probably a range of pre-marasmic conditions are said to be commonly encountered both in rural areas and in poor urban belts.

No major epidemics of tropical or non-tropical infectious diseases effect the population, interfering with the general nutritional status, while the reported problems concerning minerals (iodine deficiency, goiter) seem to be fairly restriced to certain areas.

ZAIRE: Site visit conducted in Kinshasa, March 3-5, 1979; Brussels March 6-7, 1979 by Christina Wood, Ph.D., University of California

Persons met and interviewed:

Kabamba Nkamany, M.D., Director of Zaire National Nutrition Planning Center, B.P. 1743, Kinshasa, Tel. 26828

Robert R. Franklin, M.D., Tulane University

Nakwala na Navambu ye Beda, Ph.D., Sociology

Jesus Rico-Velasco, Ph.D., Systems Analyst, Tulane University

Jean Carlisle, Tulane University

Mr. Chinko, Administrator

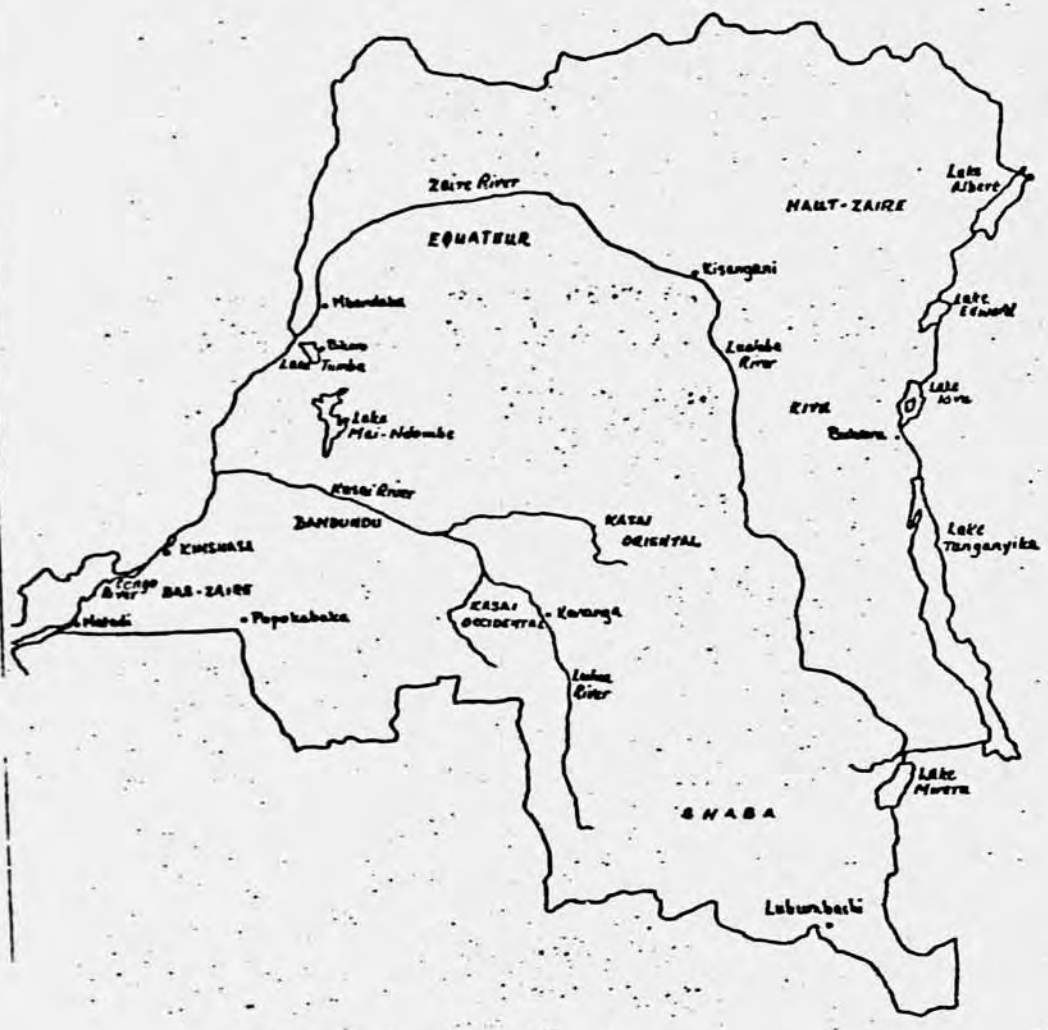
Ms. Monique, Health Educator, Coordinator

Dr. Raba, WHO, Food Consumption Surveys, University of Zaire

Robert Robertson, U.S.A.I.D., Kinshasa

Dr. Henri Vis, Department of Pediatrics, Hôpital St. Pierre, Brussels, Belgium; Director of Centre Scientifique et Médical de l'Université Libre de Bruxelles pour ses activités de Cooperation, Kivu, Zaire.

ZAIRE



The purpose of including a site visit to Zaire was to investigate the purported existence of a population with adequate protein intake but deficient calorie intake. The inclusion of such a population in the collaborative research support program, even on a limited scale, might give valuable information as to the effects of calorie deficiency without the usual accompanying protein deficiency. It was found that such a population does not exist at this time in the Kivu region in the east as originally supposed, but there is a Bantu population in the northwestern Lake Tumba area which does fit this description and has been minimally studied.

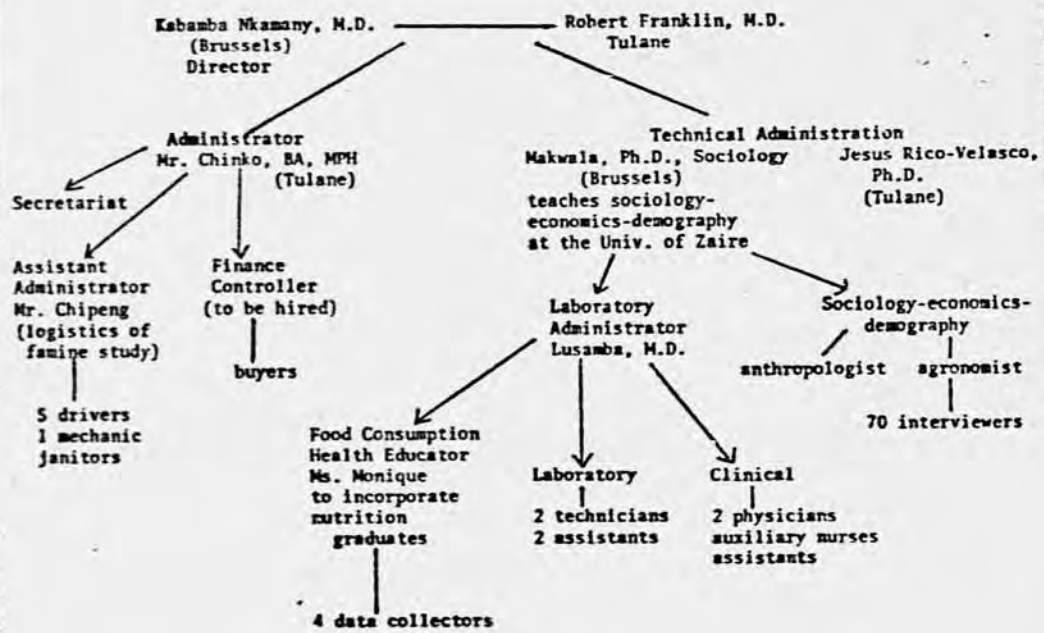
Nutritional studies are being conducted in Zaire primarily by the Zaire National Human Nutrition Planning Center (under the Department of Health) based in Kinshasa and the Centre Scientifique et Médicale de l'Université Libre de Bruxelles pour ses Activités de Cooperation (CEMUBAC) in Kivu region, Zaire. The latter is a Belgian operation.

ZAIRE NATIONAL HUMAN NUTRITION PLANNING CENTER, KINSHASA

The Nutrition Planning Center was formed in early 1978 under a contract between USAID and Tulane University to provide technical services and cooperation with Dr. Kabamba Nkamany, Director of the Center. The basic objectives of the Center are to create a multidisciplinary program for planning food and nutrition programs (including training, baseline studies, etc.), to implement intervention programs to reduce malnutrition in certain areas of the country, and to establish methods to reproduce similar interventions in other areas.

Staff: The Center now has about 100 employees. The following diagram gives the structure of the Center.

ZAIRE NATIONAL HUMAN
STAFF ORGANIZATION: NUTRITION PLANNING CENTER, KINSHASA



Facilities: Laboratory facilities at the Center are limited to one room containing a Coleman Linear Absorbance Spectrophotometer, a refractometer (total serum protein), a Coulter Counter with hemoglobinometer and diluter, two microscopes, hematocrit centrifuge, table top centrifuge, and other equipment to perform red cell morphology, stool parasite exams (plain and flotation), urine analysis (dipsticks), and sickletrol. Serum will be sent to Tulane for vitamin analysis. ("Fiche de Laboratoire Medical" available.)

Replacement parts/maintenance for the equipment is a problem, as is acquisition of chemicals. Humidity and irregular voltage supply cause difficulties. The Center has several trucks/land rover, but the roads even in the outer zones of Kinshasa proper are in such bad condition as to make transportation a major problem. The Center is building an addition to secure its own supply of gasoline. Three good computers are available and underutilized at the Department of Finance, the University of Zaire, and IBM. Statistical packages are available and the Center has a computer programmer. There is no library at the Center. No animal studies are done there.

Studies Performed: Baseline studies have been designed and some completed to elucidate the type, severity, and causes of malnutrition in Kinshasa (using three of the twenty-five zones) and the rural area around Popokabaka (twelve hour drive southeast of Kinshasa). Studies done at the household level include the following:

1) A population census covering 100% of the study population of three zones (30,000 households; 300,000 people)
2) A socio-economic study concerning effects of family socio-economic conditions, environment, health care service, feeding/weaning practices, birth history, contraception, and morbidity on nutritional status of children. This study uses 100% of the children under five years in three zones of Kinshasa (60,000 children) and 5-6000 women (20% of households with children under five).
3) The nutritional status of children under five, same sample as described above, using anthropometric measurements.
4) An in-depth biochemical study on a 5-10% sample of the above population.
5) A clinical study to complement the biochemical and anthropometric measurements on a 5-10% sample.
6) A food intake study on the children under five; a 2.5% matched sample. This study has had problems since the concept of food models is not understood by the mothers and 24 hour recall has proved impossible.
7) An ecological study in Kinshasa is planned.

Studies done within the health system include:

1) A study of dispensary records to classify morbidity.
2) A study of health center/maternal and child health center records for morbidity and mortality.
3) A study of hospital records.

At the national level, a monitoring system will be developed based on the health centers. There are five good MCH centers in Kinshasa -- three are mission-run, two state-run. (Inception Report, April 15, 1978, contains details of baseline studies).

The Center did a study in 1978 of the famine conditions in Bas-Zaire which included 1277 children in 39 villages throughout the area. The study

was organized in one week, the data collected in three weeks, and the data analyzed in five weeks. It included anthropometric, agricultural, clinical, food consumption, and record review information. (Report No. VIII, Investigation of Nutritional Consequences of the Drought in Bas-Zaire, 1978 available.) This study is an example of the Center's ability to rapidly organize a study and overcome severe technical and logistical problems. The report forms the basis for food aid to the area.

There are no recent local food composition tables available (there are tables done for the former Belgian Congo). There are no local growth standards established.

The Center collaborates with two pediatric nutritionists, one at the University and one at the hospital (Drs. Ouanga and Kabeya), an anthropologist, and several psychologists. The University of Zaire has three campuses (Kinshasa - three year nutrition degree; Kisangani; and Lubumbashi - social sciences). They also worked with the Department of Rural and Agricultural Development on the Bas-Zaire study.

The Center is now concentrating on strengthening the capabilities of the staff and adding facilities to this very young institution. Once the results of the baseline studies have been analyzed, they will be in a position to develop further research plans and to design, implement, and evaluate appropriate interventions.

Any potential CRSP would most likely collaborate in some way with the Center. The proposal would have to be approved by (and funds channelled through) the Ministry of Foreign Affairs and the Ministry of Health to the Center. (Funds would have to be changed at the official rate of 1.5 Zaires/$1; the real value of the dollar is four - five times this amount.)

OTHER NUTRITION-RELATED ACTION

The Kinshasa campus of the University of Zaire has a three-year nutrition program taught by Dr. Raba (of WHO) and Dr. Paka. The program is necessarily limited by lack of supplies (paper, etc.) and of transport for field training. Dr. Raba feels the nutrition problem in Zaire cannot be solved by teaching nutrition since there is simply not enough food and what is there is very expensive. The agricultural potential is decreasing. The first graduates of this program will finish this spring -- some may be absorbed into the Nutrition Planning Center. There is essentially no basic nutrition research of any sort taking place at the university.

Appendix B of the Inception Report contains a list of selected groups doing nutrition-related work (missionaries, hospitals, Peace Corps, USAID, etc.) in Zaire. The CREIAC in Lubumbashi is doing some work with food industry. The IRES and IRS are carrying out social and economic studies.

The Belgian CEMUBAC has been doing nutrition research in the Kivu region for the last fifteen to twenty years under the deirection of Dr. Henri L. Vis (see publications). This research provides a thorough data base as well as a long standing infrastructure for field work (staff, hospitals, etc.) and rapport with the population. They work with the Ministry of Health and the IRS. CEMUBAC offers postgraduate work to Zairois physicians in public health (including nutrition), pediatrics (nutrition), surgery-obstetrics, and laboratory science. Their research is mostly applied and not dissociated from medical care. Dr. Vis is of the opinion that the chronic malnutrition in the Kivu area is worse than the conditions created by the Sahel and Bas-Zaire droughts. He is studying the interaction between infection (measles) and parasitism and nutrition; the long post-partum amenhorrea; physiological effects of protein

malnutrition; breast feeding practices; and reproduction in rural and urban areas. He has local food composition tables (they differ from FAO tables primarily in water and minerals). He concludes that the malnutrition in Kivu is due to the subsistence economy with strong seasonal variation and a demographic spurt. Intervention should be at the level of maternal malnutrition and family planning but the situation is deteriorating so quickly that it is probably too late for such programs to have an effect. The only solution is to transplant some of the population to less dense areas in conjunction with subsistence agricultural projects to also supply Kivu. Kivu is a good area for cash crops and if the revenue could be kept in the area it could support the transport and cash crop system. Kivu has the potential for improvement but the political constraints make this impossible.

POSSIBLE STUDY POPULATIONS

Kinshasa: The choice of a study population in the peri-urban zones around Kinshasa or a "nearby" rural area such as Popokabaka would have the following advantages:

1) The baseline information soon to be completed by the Nutrition Planning Center
2) Relative ease of transport and accessibility to laboratory facilities

It would be difficult for Center personnel to relocate to a region in some other part of Zaire, so collaboration may depend on choice of population near to Kinshasa. The local language is Lingali.

The diet of this population is based on manioc. Only the powdered form of milk is available. There is considerable banana-beer drinking. Members

of households eat out of a common plate and 24 hour recall records have proved impossible. One zone was particularly hostile and people threw stones at the interviewers when they interpreted use of the measuring boards for infants to be measurements for coffin size and they thought the interviewers would come back and kill the children!

Kivu Region: Despite the extensive data base that has been amassed on the population in Kivu, primary collaboration with the Belgian-run CEMUBAC would probably not be appropriate for a CRSP. (However, some Government of Zaire buildings exist in the area, are not in use at this time, and might be suitable for storage, etc.) The population as a whole gets 50-60% of calories from beans and sweet potatoes; neither protein nor calorie requirements are being met. There has been a decrease in breast-feeding among the Shi and Havu tribes of Kivu, even though no commercial formula is available.

Lake Tumba Region: A population of Bantus has been studied in the equatorial rain forest around Lake Tumba by Helen Pagezy (France) under the direction of Dr. Vis (unpublished thesis: Adaptation physique et organisation des activités quotidiennes des femmes pygmoïdes Twa et nonpygmoïdes Oto de la foret equatoriale, 1973). The two year study included investigation of the physical ability and daily activity of women. A dietary survey and food composition analysis were done. The Bantu population (Oto) is situated in Bikoro; access to this area is difficult. The diet contains a large proportion of protein from animal sources: meat, fish, caterpillars, and termites. Cassava, cassava leaves, yams and sweet potatoes are also consumed. About 20% of the calorie intake comes from palm oil. The diet fulfills 133-180% of the protein requirement (FAO, 1973) and 70-90% of the calorie requirement. Total serum protein levels are 8-9 gm/100 ml, but serum albumin levels are

low. Malaria and hookworm infestation contribute to low hemoglobin levels and anemia.

SUMMARY AND OPINIONS

The Zaire National Human Nutrition Planning Center has made considerable accomplishments in just over one year of operation: six baseline studies to determine extent and type of malnutrition in three zones in Kinshasa and in Popokabaka, and an assessment of the drought/famine situation in Bas-Zaire. Dr. Kabamba works closely with long-and short-term consultants from Tulane University. He made the following comments on the Précis:

1) The program may be too complicated and sophisticated in its entirety for Zaire. Perhaps a simpler version could be worked out.
2) The physiological measurements described would involve the use of complicated equipment which might frighten the people. Sometimes clinical examination is not sufficient compensation for participation and the study may have to pay the subjects (which could bias the results).
3) The overall concept seems feasible.
4) A CRSP should collaborate with the Center; the University would probably not be a suitable partner.
5) Each U.S. investigator in a CRSP should have a Zairois counterpart.

Any research project in Zaire would have formidable, but not insurmountable, logistics problems. Collaboration with the Center might necessitate choice

of a population near Kinshasa. A Bantu population does exist in the northwest with more than adequate protein intakes and calorie deficiency, but it is relatively inaccessible and there are no existing laboratory or support facilities in the area.

USAID REACTION: Mr. Robertson seemed interested.

Christina Wood

APPENDIX III-3

Research Grant Applications Received:

Institutions and Investigators

Research Grant Applications Received:

Institutions and Investigators

1. Primary U.S. Institution: University of Arizona
   Affiliated Institutions
   U.S.: University of Kansas
   Advanced Research Resource Organization (ARRO)
   Midwest Research Institute (MRI)
   Texas Tech University
   Foreign: National Nutrition Centre of Barbados, Bridgetown, Barbados (proposed)
   Ministry of Health and Housing of Grenada (confirmed)
   PD/PI: Gail Harrison, Ph.D. (Arizona)
   CoPI's: Norge W. Jerome, Ph.D. (Kansas)
   Frank Ramsey, M.D. (Barbados)
   Desmond Noel, M.D. (Grenada)
   Other investigators: Edwin Fleishman, Ph.D. (ARRO)
   Joyce C. Hogan, Ph.D. (ARRO)
   S.S. Fotopolaus, Ph.D. (MRI)
   Mary R. Cook, Ph.D. (MRI)
   Ruth Hassenein, M.S.P.H. (Kansas)
   Leon Hopkins, Ph.D. (Texas Tech)
   Jane Geders, Ph.D. (Texas Tech)
   Katherine P. Riddle, Ph.D. (Arizona)
   Charles Weber, Ph.D. (Arizona)
   Milos Chvapil, M.D. (Arizona)
   Burris Duncan, M.D. (Arizona)
   William A. Shini, Ph.D. (Arizona)
   Consultants: W. Carter, D.D.S. (Kansas)
   O. Sieber, M.D. (Arizona)
   George Clarke, Ph.D. (Grenada)
   Cole Thies (no bio.)
   Administrator: W.G. Matlock, Ph.D. (Arizona)
   Project Manager, Arizona: C. Rittenbaugh, Ph.D.
   Project Manager, Kansas: To be named.

2. Primary U.S. Institution: University of California, Berkeley
   Affiliated Institutions
   U.S.: Washington University, St. Louis, MO
   University of California, San Francisco and Santa Cruz
   Foreign: Tanzania (proposed)
   Colombo, Sri Lanka (alternate proposal)
   Consultants. See below.*
   PD/PI: Doris H. Calloway, Ph.D. (Berkeley)
   CoPI's: Helen M. Wallace, M.D. (Berkeley)
   Rosemarie Ostwald, Ph.D. (Berkeley)
   C. West Churchman, Ph.D. (Berkeley)
   Irma Adelman, Ph.D. (Berkeley)
   Elliot Turiel, Ph.D. (Santa Cruz)
   David K. Leonard, Ph.D. (Berkeley)
   Alex M. Sarris, Ph.D. (Berkeley)
   G.E. Montgomery, Ph.D. (Washington U.)

Other investigators: Dorothy J. Cattle, Ph.D. (Berkeley)
Allen E. Black, Ph.D. (Berkeley)
Christina Wood, Ph.D. (Berkeley)
Nancy Butte, Ph.D. cand. (Berkeley)
Robin D. Beall, Ph.D. cand. (Berkeley)
J. Michael Halderman, Ph.D. cand. (Berkeley)
Christine S. Wilson, Ph.D. (San Francisco)
J.B. Brow, Ph.D. (Washington Univ.)

Consultants: Anna Ferro-Luzzi, M.D. (Institute of Nutrition, Rome)*
Ralph S. Paffenbarger, M.D. (Berkeley)
J. Leonard Joy, M.A. (Berkeley)
Jonas Langer, Ph.D. (Berkeley)
H. Goldstein, Ph.D. (Berkeley)
J.V.G.A. Gurnin, Ph.D. (Univ. of Glasgow, Scotland)*

3. Primary U.S. Institution: University of California, Los Angeles
Affiliated Institutions
U.S.: None
Foreign: Ministry of Health, Nairobi, Kenya (agreed)
PD/PI: Charolotte Neumann, M.D. (UCLA)
CoPI's: David D. Nicholas, M.D. (UCLA)
Ann Fleuret, Ph.D. (UCLA)
Other investigators: Richard E. Stiehm, M.D. (UCLA)
Jonas B. Cherry, M.D. (UCLA)
Gerald W. Gardner, Ph.D. (UCLA)
Clare B. Kopp, Ph.D. (UCLA)
Marian E. Swenseid, Ph.D. (UCLA)
Isabelle Hunt, Dr.PH (UCLA)
Alfred J. Zerfas, M.D.
Derrick B. Jelliffe, M.D. (UCLA)
E.F. Patrice Jelliffe, M.P.H. (UCLA)
Yvonne B. Ferguson, M.D. (UCLA)
Consultant: Roger Detels, M.D.

4. Primary U.S. Institution: Columbia University
Affiliated Institutions
U.S.: Harvard University
Boston University/MIT
N.Y. State Dept. Mental Hygiene
Foreign: Universidade de Sao Paulo, Sao Paulo, Brazil (confirmed)
PD/PI: Pedro Rosso, M.D. (Columbia)
CoPI's: Rose Frisch, Ph.D. (Harvard)
Janina Galler, M.D. (Boston Univ./MIT)
Jennie K. Kline, Ph.D. (N.Y. Dept. Mental Hyg.)
Giorgio Solimano, M.D. (Columbia)
Zena A. Stein, M.D. (Columbia)
Yaro Gandra, M.D. (Sao Paulo)
Ruy Laurenti, M.D. (Sao Paulo)

Dulce Machado, M.D. (Sao Paulo)
Eduardo Marcondes, M.D. (Sao Paulo)
Carlos Montiero, M.D. (Sao Paulo)
Jaoa Yunes, M.D. (Sao Paulo)
Consultants: Mervyn Susser, M.D. (Columbia)
Myron Winick, M.D. (Columbia)

5. Primary U.S. Institution: University of Connecticut
Affiliated Institutions
U.S.: University of Massachusetts
University of Miami
Florida International University
Yale University
Consultant. See below.*
Foreign: Instituto Nacional de Nutricion, Mexico (confirmed)
Consultant. See below.**
PD/PI: Gretel H. Pelto, Ph.D. (Connecticut)
CoPI's: Lindsay H. Allen, Ph.D. (Connecticut)
Adolpho Chavez, M.D. (Mexico)
Other investigators: R. Brooke Thomas, Ph.D. (Massachusetts)
Benjamin Ricci, Ph.D. (Massachusetts)
Ellen Messer, Ph.D. (Yale)
Gordon E. Finley, Ph.D. (Florida Int)
Tiffany Field, Ph.D. (Miami)
Pertti J. Pelto, Ph.D. (Connecticut)
Consultants: James E.C. Walker, M.D. (Connecticut)
Ben Butler Morgan, Ph.D. (Old Dominion Univ., Virginia)*
R.K. Chandra, M.D. (Memorial Univ. of Newfoundland, Canada)**
Advisors: Kirvin L. Knox, Ph.D. (Connecticut)
Robert G. Jensen, Ph.D. (Connecticut)

6. Primary U.S. Institution: Harvard University
Affiliated Institutions
U.S.: Cornell University
Foreign: Bureau of Nutrition, Haiti (proposed)
Universidad Javeriana, Bogota, Colombia (proposed)
PD/PI: Manuel G. Herrera, M.D. (Harvard)
CoPI's: Warren L. Berggren, M.D. DrPH (Harvard)
Gretchen G. Berggren, M.D. (Harvard)
Robert B. Reed, Ph.D. (Harvard)
Jose O. Mora, M.D. (Harvard)
Mohamed S. el Lozy, M.D., Ph.D. (Harvard)
Rose E. Frisch, Ph.D. (Harvard)
Maarten D.C. Immink, Ph.D. (Cornell)
Virginia Utermohlen, M.D. (Cornell)
Jean-Pierre Habicht, M.D., Ph.D. (Cornell)
Henry N. Ricuitti, Ph.D. (Cornell)
Jere D. Haas, Ph.D. (Cornell)
Other investigators: L. Guillermo Mora, M.E. cand. (Colombia)
B. Gerry (no bio.)

7. Primary U.S. Institution: University of Hawaii (Manoa)
Affiliated Institutions
U.S.: Consultant only. See below.*
Foreign: Research Center, Ramathibodi Hospital, Bangkok, Thailand (agreed)
Institute of Nutrition, Mahidol University, Bangkok (proposed)
Research Institute for Health Sci, Chiang Mai (confirmed)
Kasetsart University, Bangkok (proposed)
Consultant. See below.**
PD/PI: Robert Van Reen, Ph.D. (Hawaii)
CoPI's: Aree Valyasevi, M.D. D.Sc. (Mahidol)
Scott B. Halstead, M.D. (Hawaii)
Dexter S.Y. Seto, M.D. (Hawaii)
Marian E. Melish, M.D. (Hawaii)
Bluebell R. Standal, Ph.D. (Hawaii)
Ronald C. Johnson, Ph.D. (Hawaii)
Joseph P. O'Reilly, Ph.D. (Hawaii)
Other investigators: Raul Rudoy, M.D. (Hawaii)
Robert E. Cole, Ph.D. (Hawaii)
Jean M. Fargo, Ph.D. (Hawaii)
John W. Engel, Ph.D. (Hawaii)
Harold J. McArthur, Jr., Ph.D. (Hawaii)
Peter Kunstadter, Ph.D. (Hawaii)
Consultants: Robert A. Tracy, Ph.D. (Hawaii)
Maarten D.C. Immink, Ph.D. (Cornell)*
Sakorn Dhanamitta, Ph.D. (Mahidol)
Ousa Thanangkul, M.D. (Chiang Mai)
Suwat Pratoomraj, M.D. (Chulalongkorn Univ., Bangkok)**

8. Primary U.S. Institution: Iowa State University
Affiliated Institutions
U.S.: Consultants. See below.*
Foreign: Institute for Nutrition of Central America and Panama, Guat. (confirmed)
Honduras (proposed)
PD/PI: Jacqueline Dupont, Ph.D. (Iowa)
CoPI: Fernando Viteri, M.D. (INCAP)
Other investigators:
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Irma Galeys, Ph.D.
Sedhalia Crase, Ph.D.
Samuel Clark, Ph.D.
Mary Heltsley, Ph.D.
Donald Hotchkiss, Ph.D.
Michael Whiteford, Ph.D.
Thomas Bubalz, Ph.D.
INCAP: Benjamin Torun, M.D.
Oscar Pineda, Ph.D.
Luis Mejia, Ph.D.
Juan Urrutia, M.D.
Charles Tiller, Ph.D.

INCAP: Rafael Flores, Lic.
Alfonso Mata, Ph.D.
Edmundo Alvarez, M.D.
Jose Belizan, M.D.
Marc Erwin, Ph.D.
Lionel Gallardo, Ph.D.
Jose Ramiro Cruz, Ph.D.
Thomas Schofield, Ph.D.

Consultants. Gerald Keusch, M.D. (Tufts Univ.)*
K. McAdam, Ph.D. (Tufts Univ.)
Ernesto Pollitt, M.D. (Univ. of Texas)
K.M. Hambidge, M.D. (Univ. of Colorado

Iowa State: Gerald Klonglan, Ph.D.
E. Elliott, Ph.D.
R. Deacon, Ph.D.
G. Biven, Ph.D.
L. Wolins, Ph.D.
W. Brewer, Ph.D.
W. Rungan, Ph.D.
J. Hatchcock, Ph.D.
C. Roderuck, Ph.D.
R. Hughes, Ph.D.

INCAP: Robert Klein, Ph.D.
Jose Aranda-Pastor, Ph.D.
N.W. Solomons, M.D. (also MIT)*
Aaron Lechtig, M.D.

9. Primary U.S. Institution: University of Nebraska-Lincoln
Affiliated Institutions
U.S.: None
Foreign: Institute of Nutrition and Food Science, University of Dacca, Bangladesh (confirmed)

PD/PI: Khem M. Shanhani, Ph.D. (Nebraska)
CoPI's: Hazel Fox, Ph.D. (Nebraska)
Arnold E. Schaefer, Ph.D. (Nebraska)
Other investigators: Roy G. Arnold, Ph.D. (Nebraska)
Violet Kalyan-Masih, Ph.D. (Nebraska)
Constance Kies, Ph.D. (Nebraska)
Thomas W. Sullivan, Ph.D. (Nebraska)

10. Primary U.S. Institution: North Carolina State University, Raleigh
Affiliated Institutions
U.S.: University of North Carolina, Greensboro
Research Triangle Institute, North Carolina (RTI)
Foreign: Instituto de Nutricion, INS, Lima, Peru (confirmed)
Universidad Nacional Agraria, La Molina, Peru (confirmed
Alternate: Senegal
PD/PI: Ronald A. Schrimper, Ph.D. (North Carolina State)

Other investigators: Grant M. Scobie, Ph.D. (N.C. State)
Daniel A. Sumner, Ph.D. (N.C. State)
James M. Wallace, Ph.D. (N.C. State)
Loren A. Ihnen, Ph.D. (N.C. State)
Thomas Johnson, Ph.D. (N.C. State)
_____ Troost (no bio) (N.C. State)
Terry L. Bazzarre, Ph.D. (UNC)
Larry Wilder, Ph.D.
Elizabeth L. Schiller, Ph.D. (UNC)
Thomas W. Draper, Ph.D. (UNC)
Lynne S. Koester, Ph.D. (UNC)
Lee D. Dahringer, D.B.A. (UNC)
Thomas K. Fitzgerald, Ph.D. (UNC)
John Scanzoni, Ph.D. (UNC)
_____ Roberts (no bio.) (UNC)
Raymond B. Isely, M.D. (RTI)
David L. Franklin, Ph.D. (RTI)
Paul F. Mulligan, Ph.D. (RTI)
Laurie Zivetz, M.P.H. (RTI)

Consultants: E. Schaffer (no bio.)
M. Edgerton (no bio.)
C. Ramey (no bio.)

11. Primary U.S. Institution: Purdue University Research Foundation
Affiliated Institutions

U.S.: Indiana University
University of Michigan
St. Louis University
Texas A & M
University of Illinois
University of North Dakota
U.S. Navy Medical Research Unit #3, Cairo (proposed)

Foreign: Cairo University, Cario, Egypt (confirmed)
Ein Shams University, Cairo (confirmed)
American University, Cairo (proposed)
Alexandria University, Alexandria (proposed)
National Research Center, Cairo (proposed)

PD/PI: Ronald R. Watson, Ph.D. (Purdue)

CoPI's: Avanelle Kirksey, Ph.D. (Purdue)
Theodore Wacks, Ph.D. (Purdue)
A.H. Ismail, H.S.D. (Purdue)
Victoria Lui, Ph.D. (Purdue)

Other investigators:
Abdel H. Kafraury, MD.S. (Indiana U.)
Joseph Fitzgerald, M.D. (Indiana U.)
Robert C. Karn, Ph.D. (Indiana U.)
A. Roberto Frisancho, Ph.D. (U. of Michigan)
Tim R. Kramer, Ph.D. (St. Louis)
David N. McMurray, Ph.D. (Texas A&M)
Adria Rothman Sherman, Ph.D. (U. of Illinois)
Don M. Tucker, Ph.D. (U. of No. Dakota)

Purdue: Virgil L. Anderson, Ph.D.
George McCabe, Ph.D.
Lloyd Weaver, M.B.A.
D.R. Smith (no bio.)
Philip Loverde, Ph.D.
S.M. Gaafar, Ph.D., D.V.M.
David Woodruff, Ph.D.
H.S.Ragheb (no bio.)
James Knight, Jr., Ph.D.
Gavriel Salvendy, Ph.D.
Dorothy Morre, Ph.D.
Robert Maker, Ph.D.
Richard Abernathy, Ph.D.
Jon Story, Ph.D.
Donald Ottinger, Ph.D.
A. Fogel (no bio.)
Macalyne Fristoe, M.D.
Lyle Lloyd, Ph.D.
Charles Whittemore, Ph.D.
B. Cooper (no bio.)
Jack Waddell, Ph.D.
K.N. Haffer, Ph.D. cand.
Tim Petro, Ph.D. cand.
Azza Sallam M., Ph.D. cand.
William A. Cooper, Ph.D.
Martha Lopez-Asuna, student

Egypt: M. El Sadr, M.D., Ph.D. (Cairo U., Ein Shams)
E.M. Ekladious, M.D. (Cairo U.)
D.H. Fleita, Ph.D. (American U.)
Moustafa Mansour, Ph.D. (NAMRU#3)
Aly Abd El-Hadi Massoud, M.B., Ph.D. (Ein Shams)
Sabry Ziad Marcos, Ph.D. (Natl. Research Center)
Issis Nawar, Ph.D. (Alexandria U.)
Mohamed Aly Rifaat, M.B., Ph.D. (Ein Shams)

12. Primary U.S. Institution: Tufts University
Affiliated Institutions
U.S.: Boston University
Foreign: Division of Nutrition, Department of Health, Bangkok, Thailand (proposed)
PD/PI: Stanley N. Gershoff, Ph.D. (Tufts)
Other investigators: Robert B. McGandy, M.D. (Tufts)
Gerald T. Keusch, M.D. (Tufts)
Beverly A. Bullen, Sc.D. (Boston U.)
David Elkind, Ph.D. (Tufts)
Amorn Nondasuta, M.D. (Bangkok)
Puangtong Tantwongse, M.D. (Bangkok)
Vina Viravaidhya (Bangkok)
Prasert Suwannus, M.D. (Bangkok)

13. Primary U.S. Institution: Tulane University

U.S.: Lincoln University, Missouri
Medical College of Wisconsin
University of Michigan
University of Wisconsin, Milwaukee
Consultants. See below.*

Foreign: University del Valle, Cali, Colombia (UV) (confirmed)
Human Ecology Research Foundation, Cali (HERF) (confirmed)
Fundacion paras la Educacion Superior, Cali (FES) (confirmed)

PD/PI: James P. Carter, M.D., Dr.P.H. (Tulane)

CoPI's: Giovanni Acciarri, Ph.D. (UV)
Jaime Arocha, Ph.D. (FES)
Edgar Cobo, M.D. (UV)
Alvaro Duenas, M.D. (UV)
Luis F. Fajardo, M.D. (UV)
Harrison McKay, Ph.D. (HERF)
Reynaldo Miranda, M.D. (UV)
Julio C. Reina R., M.D. (UV) (Alternate: L.M. Borrero [no bio.])
Humberto Rey, M.D. (UV)
Jose E. San Martin, M.D. (UV)
G. Hurtado, M.D. (no bio.)
G. Sansome Bazzano, Ph.D. (Tulane)
William E. Bertrand, Ph.D. (Tulane)
Ramiro Delgado, M.D. (Tulane)
Michael G. Maksud, Ph.D. (U. of Wisconsin)
I. Gabriella Malnar, Ph.D. (Lincoln U.)
James Koopman, M.D. (U. of Michigan)
Gerald B Spurr, Ph.D. (Med. College of Wisconsin)
Stephen Avala (no bio.)

Other investigators:
Maria Caravajal de Guerrero (UV)
Ira M. Longini (UV)
Arlene McKay (no bio.)
O. Bolanos (no bio.)

Consultants:
Cyril A.O. Akpom, M.D. (Michigan State U.)*
Richard J. Campeau, Jr., M.D. (Tulane)
David N. McMurray, Ph.D. (Texas A&M)*
Jack Metcoff, M.D.
Martin L. Pernoll, M.D. (Tulane)
Irwin H. Rosenburg, M.D. (U of Chicago)*
Dr._____ Brown (no bio.)
Dr. Betty Oseld (no bio.)

Project Director, Colombia: A. Cobo, M.D. (FES)
Project Director, Lincolon U.: M. Neufrille, Ph.D.
Senior Associates: Hans Walter Dahners, Ph.D. (Med. Coll. of Wisconsin)
Jean R. Carlisle, M.S. M.P.H., R.D. (Tulane)
Martha Arboleda (no bio.)
Alberto Levy (no bio.)
Augusto Bermudez (no bio.)
Rodrigo Afuentes (no bio.)
Carmez de Escobar (no bio.)
Carlos Quintero (no bio.)

APPENDIX III-4

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APPENDIX III-5

Peer Reviewers Form

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APPENDIX III-5

Peer Reviewer's Form

REVIEWER: _____

_____

_____

_____

_____

APPLICATION IDENTIFICATION:

TITLE: _____

P.I.: _____

INSTITUTION: _____

_____
Signature of Reviewer

_____
Date

This sheet will not be made available to the applicant institution. All pages that follow will be, if requested.

Overall evaluation should stress criteria stipulated by NSF and as appropriate to this special program of research:

Criteria relating to competent performance of research - the technical adequacy of the performer and of his or her institutional base:

1. The scientist's training, past performance record, and estimated potential for future accomplishment.
2. The scientist's demonstrated awareness of previous and alternative methodologies applicable to the problem.
3. Probable adequacy of available or obtainable instrumentation and technical support.

Criteria relating to the internal structure of science itself:

4. Probability that the research will lead to valid, significant conceptual generalizations within its programmatic sphere.
5. Probability that the research will lead to significant improvements or innovations of investigative method - with possible extension to other fields of science.

Criteria relating to utility or relevance:

6. Probable contribution of the research to policy and program formulation and assessment - i.e., to estimating and predicting the direct and indirect, intended and unintended effects of existing or proposed policies and programs affecting nutrition.
7. Identification of an immediate programmatic context and user of the anticipated research results.

Criteria relating to future and long-term scientific potential of the United States and the host country:

8. Probable influence of the research upon the capabilities, interests, and careers of participating graduate students, postdoctoral associates, or other junior researchers.

9. Probability that the project will lead to significant strengthening of overseas institutional capacity to conduct high quality research and oversee its timely application.

10. Probability that the research will lead to radiation and diffusion not only of technical results but also of standards of workmanship and a tradition of excellence in the field.

PEER REVIEW FORM

CRSP: Intake and Function

Check list of features stipulated in guidelines:

(Unless otherwise specified, give score on a scale of 1-5, with 1(one) being the best.)

General

1) Which areas of function are covered in the proposal?
(xx for major focus; x for minor component)

_____Disease

_____Reproduction

_____Activity

_____Cognitive function and social competence

Other (specify):_____

_____

2) Proposal covers overall mandate in that there would be quantification of relation between food/energy intake and function: _____

3) Research approach is (x): _____naturalistic, observational

_____interventional, experimental

_____

4) Level of collaboration with LDC counterparts: _____obtained so far

_____planned for in proposal

5) Level of proposed strengthening of LDC institutional/personnel capabilities: _____

6) Level at which the research strategy contains broad sets of cross-disciplinary variables to be systematically investigated in relation to food energy: _____

7) Variables to be measured were chosen selectively, based on theory: _____(level of selectivity)

8) Level at which criteria are set forth for conceptualization and measurement of all variables: _____

9) Items identified for CRSP standardization: _____

10) Level of plans for data analysis: _____

Specific:

1) Food intake measures:	take adequate account of nutrient composition	Yes	No
	bioavailability	Yes	No
	intraindividual variation of daily intake	Yes	No
	seasonal/cyclical variation	Yes	No
	age-specific changes	Yes	No
	time interval between food intake and function	Yes	No
	specific nutrient deficiencies	Yes	No

Level of proposed food intake measure analysis: _____
(tests of validity, etc.)

2) Nutritional status: overall adequacy of measurements _____

takes account of energy balance Yes No

3) Community selection and sampling frame: adequacy of households _____
(record system - vital statistics, range intake, demography, etc.)

consideration of specific nutrient deficiencies _____

consideration of other severely confounding conditions _____

method of sampling _____

population coverage _____

adequacy of numbers _____

overall_____

4) Disease: appropriate selection of specific entities _____

general health evaluated Yes No

considered in context of family behavior patterns _____

morbidity patterns and vital stats measured Yes No

overall _____

5) Reproduction: Takes account of which periods (x):

_____gestation/pregnancy

_____infancy

_____lactation

_____weaning

_____late effects on mother

5) (contd)

level of account for maternal malnutrition before, during, after pregnancy _____

level of account for interactions (including behavioral) between household members _____

6) Activity: level to which proposal will answer: do incremental changes in energy intake have observable effects on activity and performance: _____

what consequences for

individual _____ family _____ community _____

development of behavioral

profile _____

overall _____

7) Cognitive functioning and social competence:

level to which behavior competencies addressed _____

level to which cognitive competencies addressed _____

recognition of distinction between sensory-motor and mental health impairment and cognitive and social competencies Yes No

overall _____

8) Level to which proposal describes and resolves ethical issues _____

Description of informed consent procedure included Yes No

Level of risk to subjects: (5 = high risk; 1= no risk) _____

9) If approach is "experimental" (interventional)

power of research design _____

reasonability of cost of perturbation _____

ethics of proposed perturbation
(5 = unethical, 1 = ethical): _____

suitability of control group _____

overall _____

10) Previous field experience of U.S. team _____

Documentation of productivity of field work in the form of published papers/reports _____

11) Foreign language competency required: Yes No

Competency represented in team: Yes No

12) Suitability of budget _____

Comments:

Overall Evaluation:

1. Narrative comment.

2. In case of budget constraint, could some of the research proposed be deleted without damaging the quality of the remaining components? If so, specify:

3. Is there a small component(s) that should be funded independently? If so, specify:

4. Merit Rating 1 = Outstanding 5 = Poor

Total proposal as is: _____

After deletions specified in 2 above _____

Identified small component _____

PLEASE DO NOT SIGN THIS FORM!

APPENDIX IV-1

Minutes of the CRSP Planning Meeting, December 1979

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Appendix 1

Part IV

Minutes: CRSP Planning Meeting
December 13-17, 1979
Berkeley, California

Attending: Lindsay Allen (University of Connecticut), Robin Beall (University of California, Berkeley), George Beaton (University of Toronto), Doris Calloway (University of California, Berkeley), Adolfo Chavez (Instituto Nacional de la Nutricion, Mexico), Hekmat El-Sayed Aly (Nutrition Institute, Egypt), Patrick François (FAO), Gail Harrison (University of Arizona), Irwin Hornstein (USAID), James Kagia (University of Nairobi, Kenya), Elmer Kiehl (BIFAD/USAID), Charlotte Neumann (University of California, Los Angeles), Gretel Pelto (University of Connecticut), Johnnie Prothro (BIFAD), Aree Valyasevi (Institute of Nutrition, Thailand), Leonard Schuman (University of Minnesota), Ronald Watson (Purdue), Christina Wood (University of California, Berkeley).

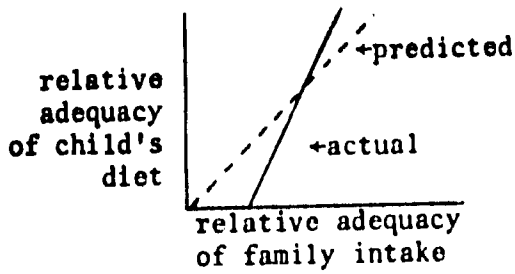
Due to ambiguous communication between USAID/Washington and USAID/Thailand, the University of Hawaii/Thailand project was on indefinite suspension and the planning contractor was advised by USAID to disinvite representatives from this project. Dr. Aree Valyasevi attended in an advisory capacity.

December 13

The purpose of this meeting was to bring together the US and LDC principal investigators from each of the projects included in the CRSP to discuss development of a core research design. The emphasis of the meeting was on minimum common measurements of intake and nutritional status. Representatives of BIFAD and USAID gave a brief status report on the planning phase: they stated that the meeting should proceed as if funds would be forthcoming; they were optimistic on this point.

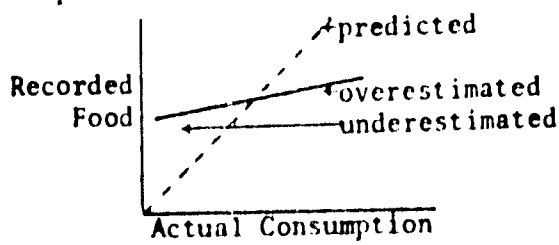
There was a general discussion of items in the CRSP requiring standardization. For food intake these included quality determination, timing of measurements (food cycles, season, life events), approach to intraindividual variation, indicator foods, food composition tables, micronutrient measurement, and moisture content. For nutritional status, standardized items would include anthropometry, scaling, country-specific standards, handling of longitudinal data, biochemical measurements, puberty measures, effects of goiter, hair analysis, long-term effects of treatment and nutritional histories.

Patrick François spoke on the topic "current developments in methodology for food consumption surveys". He mentioned inventory surveys, the weighing method, determination of per capita intake from household measurements, and recalls of food expenditure. For the FAO Brazil study, he described a rotating sample where each family was surveyed for seven continuous days once per year. Each interviewer surveyed two families per week; 1500 interviewers were trained; three or four pilot surveys were done. In Rio, subjects did not accept the inventory method due to illegal hoarding, etc. François finds high fluctuations with the recall method and prefers weighing, which is easier to control. George Beaton raised the Flores data:



Gretel Pelto addressed the subject of "anthropologic approaches to food intake measurement". She made the point that investigators should understand the culture of the behavior they are studying; this would help to determine whether sampling points represented the full stream. The eating cycle must be determined before time points for measurement are selected. Each project location may have a different cycle. The question "where do what kinds of people eat what kinds of food" must be asked. A pilot study would show whether or not the fiesta system, for example, is ethnographically interesting but nutritionally insignificant. Investigators observe, question, and infer; and it may be that validity decreases with this progression.

Gail Harrison spoke on the same subject. She emphasized that there is no perfect intake measurement methodology: each project must find the methods best suited to that locale. Both quantitative and qualitative (subjective) information is needed at the level of the individual. We must find out what the barriers are to sufficient consumption. She repeated Montgomery's assumptions that: 1)we must understand people on their terms; 2) we must suspect that what they say may not equal what they do; 3) cultural behavior may not be conscious; it can only be observed and questioned; and 4) variation among families is great. She mentioned indexing and scaling of categorical data (Guttman). How good is a trained observer vs. weighing of food? George Beaton presented:



Respondent burden was discussed.

The group discussed specific methods of intake measurement. They were reminded that the LDC investigators at the New Orleans meeting felt that 24-hour recalls should be used to facilitate comparisons with previous research. The Mexico group said that their subjects would not record their own intakes. Tape recorders were suggested. Chavez suggested a three day weighing and measuring study. He discussed the roles of his community aides and technical aides in participant observation as a check for consistency. The UC group suggested 24-hour individual recalls--six done each quarter of the year on all families, thereby covering all days of the year. This could be aggregated for household data. Second, they also proposed a food inventory: one family member would record all food and water brought in and discarded for one week. Eight comparisons would be available on every family. It was felt weighing intake for each individual in a household would be prohibitive. Other points raised were: 1) what if the diet methods disagree?; 2) frequent feeding data is necessary, particularly for children; 3) one full day of

observation in a household is essential; 4) alcohol consumption is a significant source of calories but difficult to measure; 5) urine osmolarity is a good check on fluid intake; and 6) the staple should be the item most accurately measured.

Lindsay Allen, Gail Harrison, James Kagia, and Patrick François comprised the drafting group for core intake measures.

December 14

The core-intake-measures drafting group discussed their plans. The projects should concentrate on measuring intake of the individual; therefore, there should be some weighing and measuring of individual intakes. The drafting group was enthusiastic about the inventory method. Observation and following should be done on subsamples of "unreliable" family members. They proposed, after ethnographic and food cycle data, to use a 72-hour sampling unit. Workers would do weighing and measuring at the kitchen level on a random unannounced day. They would also record activity, morbidity, and market basket in addition to asking what was prepared the day before. A 24-hour recall would be done on the mother for the whole family and on each individual separately. An additional day of recall would be done. Chavez noted that his use of 24-hour recall and weighing/measuring "worked". Calloway commented that just because the two answers agreed does not mean the result is valid. Weighing may be accurate, but is it representative? Beaton said time schedules would be different for different members of the family (i.e. infant growth vs stable adult). Karen Todd (temporary attendant) noted her recall data was consistently below (about 20%) weighing data for energy. Prothro asked if a large sample size would wash out discrepancies with having two recalls and one weighing. Pelto presented a scheme based on a one-week food cycle:

24-hr recall	weighing	24-hr recall	weighing
Sun.	Mon.	Mon.	Sun.
Tues.	Thu.	Wed.	Fri.
Wed.	$\bar{M}$	Thu.	$\bar{M}$
Fri.		Sat.	
$\bar{M}$		$\bar{M}$	

Beaton asked how to combine them? Maybe they cannot be combined. Neumann suggested before-after people-weighing for small children.

Patrick François gave another talk about "current FAO approaches to nutritional status measurement". The FAO/Brazil Study included 300,000 subjects. Height and weight categories were devised, for example:

1.50 - 1.59m = brachysoma
1.60 - 1.69m = mesosoma
1.70 - 1.79m = hypsosoma

He classified subjects according to geographical location. He could define the heights of parents by looking at growth of the children and this turned out to be a division by income groups. He compared weights of children with food typology groups and found that also related to income. Calloway noticed at high intakes a greater relation between morphology and type of diet than with amount of diet.

Several participants spoke on "nutritional status measurement in relation to growth and reproduction" or in relation to disease. Neumann mentioned birthweight measures, childbearing timing, illness, pregnancy, lactation, taboos, pica and weaning which would be elucidated in the ethnography study.

Other items discussed were parasitism and the effects on infection, medications, and food containing nutrient-destroying components. A nutritional status exam should consist of a physical exam for baseline and surveillance (does not contribute much to detection of mild-moderate malnutrition). Anthropometry is crucial and requires accuracy, training, and standardization (UCLA training manual). Longitudinal measures of children's growth (length, height, weight, head circumference, arm, chest, and four skinfolds with Durnin's equation) should be made. Skinfolds are useful for studying pregnant women and newborns (footsize may be indicative). Dubowitz testing is an index of maternal malnutrition. Frequent measures are needed in the first year of life and at weaning. For younger subjects the international standards are sufficient because the environment has more influence than genetics. With regard to biochemical measures, fasting and timed specimens should be avoided. Hemoglobin, hematocrit, white cell count, differentials, iron stores, ferritin stores (transferrin saturation may be adequate), red cell folic acid, albumin, B vitamins, vitamin A and carotene could be done. Eight ml of blood is enough for the whole battery plus immunoglobulins. Beaton showed serum iron particularly varies with time of day. Watson said IgA level is a potential marker for severe malnutrition. There is no significant difference of secretory IgA with Grade I and II malnutrition. He made the point that we should look at how nutritional deficit affects immune parameters rather than use them as a tool.

Hekmat described the 1971 (CDC) nationwide survey done January-April on 10,000 children below the age of six. Well-to-do Cairo children have comparable height for age to the U.S. National Health Survey. Anemia was found in about 40% of the children (less than 11 gm Hb) and was worse in females. Food consumption was estimated by 24-hour recall done on 400 women at the Maternal Child Health Centers. Seasonal variation in consumption is not drastic (vegetables mostly). Parasitism was not studied; mothers were asked about recent fever or diarrhea episodes.

Aree spoke about the situation in rural northeast Thailand. Average energy consumption is 1900-2000 kcal, protein is low and 70% of it comes from rice. Birthweights average about 2.7kg. Mothers breast-feed 400-600 ml/day (700-1000 ml in the city). Infants are measured every month.

Kagia said that in 1969 in Machakos, 90% of three year olds were already exposed to polio. He made a distinction between infection with disease and infection without overt disease but with possible functional impairment. This situation occurs with viruses in the GI tract and prevents weight gain. He goes by the premise "sick until proven healthy". Ascaris is the most prevalent parasite in Kenya.

Charlotte Neumann, Gretel Pelto, Ronald Watson, and Aree Valyasevi were assigned to the core nutritional status drafting group.

George Beaton led the discussion on statistical problems in research and design management. He said if the change in daily intake is not large (20 to 200 kcal/day) the net weight gain would be 0-1 kg/year or 14-20 kcal/day. From NHLBI studies, there is no handle on the reliability of recall or on the errors in the food composition data base. There were six interviews on non-consecutive days. Three interviewers saw each subject twice. Each subject was seen twice per day (MWF). Investigators looked for sources of variation among the measurements. There were differences in the amount (not type) of food for women but not men. There was a day-of-the-week effect. Confidence limits were, per mean energy by groups,

n=50	get	± 10%
=100		± 7.2%
=200		± 5.1%

For individuals, day-by-day variation in energy intake was about 25%,

Number independent replicate interviews	1 get	± 50%
	5	± 23%
	10	± 16%
	15	± 13%

which represents the reliability of the estimate of the individual's usual intake. One day data biases toward the mean, one should beware the negative conclusion. He suggested doing regression reversing (the dependent and independent variables). One should start by asking what will be done with the data to arrive at what is needed in terms of data gathered.

Patrick François talked about data management problems. He prefers post-coding to pre-coding. He had 10,000 codes for foods, etc. with 3500 food varieties. Problems arose with various names for one food. The coder must have a list of equivalent names.

December 15

Leonard Schuman expounded on design considerations. He began with a review of the Précis emphasizing that the ethnographic studies were critical and reviewing the merits of the naturalistic approach. He discussed random sampling, stratification (middle years must be included), and pilot studies to determine degree of over-sampling. Sample size must be large enough to detect statistically significant differences. The 5% level is not sacred. Differences must be biologically significant.

The group met again in the afternoon to discuss research design. The Mexico group described their design: 600 families screened to 200, of which 150 would participate in three substudies (50 in each). The last stage would involve a longitudinal intervention in their lactation study. The Kenya group proposed an initial 800-1000 households in the overall survey. In the worst case, if 5-10% are adequately nourished, that gives a minimum n=10 well-nourished babies. Forty well-nourished families would be needed: with 20% attrition, one must start with 50 families. 350 families are needed to get 60 babies. Studying any one infant for 6 months gives 2.5 years of studying.

On what should the initial screening be based?

Hekmat described sample selection from Maternal Child Health centers. The Center provides a check to see if the non-responders were different from those willing to participate.

What determines the 2-year stretch of measurements? Two years pick up climatic changes, life history and events. A study of short duration needs a large n; long duration needs a small n.

December 16

The day was reserved for individual project groups to meet together.

December 17

The group was reminded that they must agree on a minimum sample size. Interventions would have low priority because of high cost and would have to be incorporated at a late stage in the project.

Beaton proposed a 3-month cycle with 6 interviews per 3 months.

Different three month measurements may overlap. As long as the data is collected, the analyses can be reconciled. The issue of more interviewers with less relation to the family vs. one long-term interviewer with a close relationship was debated. The limiting factor is the intake measurements. Is it better to have fewer observations and less attrition? Beaton: no clear answer. Six months is too long between measurements.

Classification of subjects would be by food intake. But, to avoid misclassifications, classification could be done by some other measurement (i.e. activity)if the precision is greater. Associative or surrogate variables were discussed. There is no reliable substitute measurement for intake (Intake Committee, Washington, D.C.). A pilot study cannot estimate whether a surrogate variable would be a good replacement. There is more variability in nutrient estimation than in energy estimation.

Hekmat wanted a 4-month cycle instead of 3 months. Chavez said he cannot have a fixed day for measurements, his people have to work by weeks. With staggered measures one loses the ability to compare diet in month 1 with growth in month 3. How important is that? What measures need to be simultaneous? Chavez feels it is better to predetermine groups of individuals, Calloway says grouping must be done according to the data gathered.

Calloway asked if the three groups could agree that Beaton's design was fundamentally acceptable with the knowledge that revisions might have to be made after initial data gathering. All three groups agreed.

Calloway said further meetings should be held on activity, cognitive and social function, disease and statistics; but the reproduction group could use WHO guidelines. Participants should suggest names for the external evaluation and review panel required by USAID.

With regard to management, Hornstein said that AID had discussed the matter and would accept any of the management plans in the document from the management consultation, but preferred design B. There should be a board of institutional administrative representatives.

APPENDIX IV-2

University of Connecticut Proposal in collaboration with the Instituto Nacional de la Nutricion, Mexico

CRSP ON INTAKE AND FUNCTION: A PROPOSAL FOR MEXICO

Lindsay H. Allen
Gretel H. Pelto
University of Connecticutt

Adolfo Chavez, INN

Revised: January, 1980

INTRODUCTION

"Just as in a war, malnutrition casualties should be counted not only by deaths, but also by the 'wounded' people"(1)

The functional consequences of mild to moderate malnutrition may not be as dramatic as the obvious pathology and pathos induced by severe malnutrition. The consequences are nonetheless far reaching, with profound implications not only for individuals but for their societies as well. One cannot remain for long periods of time in a state of energy imbalance. Faced with prolonged or chronic insufficiency of calories and protein, humans must alter their activity level to establish a balance between physiological requirements and the available nutrient supply.

One mode of achieving balance is to increase the food supply through various activities; such as developing more intensive agricultural techniques, expanding into more fertile areas, or migrating to regions where nutrients are more readily available (2,3). However, in many parts of the underdeveloped world today inadequate resources, as well as political and economic constraints, prevent the initiation of successful action by individuals and groups to alter their nutrient supply.

Alternatively, people may cope with the problem of inadequate food by reducing their requirements through a series of physiological and behavioral adjustments. Unfortunately, such adjustments may negatively affect individuals' abilities to function effectively. Thus, energy-sparing adaptations may lead to reduced social interaction, retarded growth, reduced resistance to disease and decreased capacity to work. The potential effects, direct and indirect, of chronic undernutrition and the adaptations this situation requires, are multiple and complexly interrelated. A major purpose of the proposed research is to determine the effects of chronic undernutrition on physiological, social and psychological functioning of individuals and households in a rural region of central Mexico.

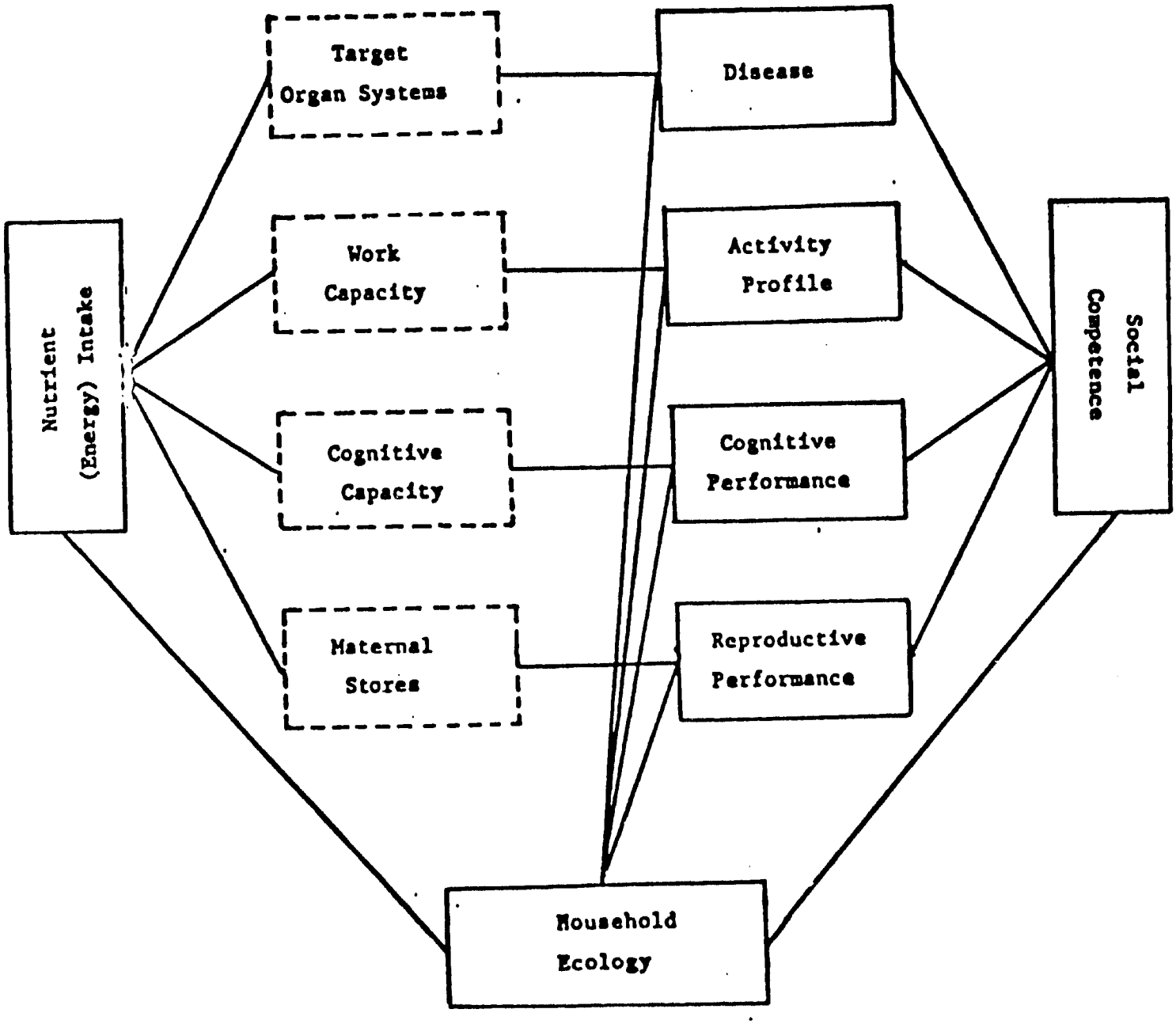
The research has the following general goals:

1. To assess the degree of association between nutrient intake and a series of outcome variables of functioning and behavior--in the domains cognitive performance, social competence, reproductive performance, health status and activity patterns.

2. To verify the role of postulated intervening variables within this network of associations, such as immunocompetence, work capacity and maternal energy stores.

3. To assess the effects of pregnancy and lactation on these relationships.

4. To develop a quantitative description (or systems map) that places nutrient intake in the constellation of related, interacting factors of human biosocial functioning.



The diagram above identifies a number of categories of factors to be measured. Our purpose is to clarify the nature of the relationships among these categories. The categories designated with dotted lines represent postulated intervening variables. Subsumed under the category of "household ecology" are demographic and sociocultural factors that influence both nutrient intake and social, psychological and physiological outcome variables, but do not directly influence the intervening variables.

The first goal of the research program, as stated above, will be achieved by data collection and analysis of the relationship between nutrient intake (the left-hand side of the diagram) and the outcome variables (the right-hand column), controlling for the effects of confounding (household ecology) variables through statistical means.

The second and third goals require the collection of data on the intervening variables, as well as nutrient intake and functional variables. The role of the intervening factors in accounting for associations between the independent and outcome variables can be assessed using statistical methods. The fourth goal requires additional analytic procedures based on causal modeling techniques.

To accomplish these goals we propose to carry out a three-phase research program, with an experimental fourth phase added, as resources permit. The proposal that follows is organized in relation to the phases, presented in sequential order. While the phases follow each other chronologically, they are overlapping in that some features of data gathering and processing of a particular phase will be on-going and repeated after the next phase of work has begun. For each phase the types of data-gathering procedures, their rationale, pertinent background material and logistics will be described. That is followed by a general section on data analysis and a description of the organization of the project. Budget and appendix material completes the proposal.

PHASE I. COMMUNITY DESCRIPTION AND ASSESSMENT

In Mexico today malnutrition is a major public health problem. It is estimated that more than 50% of the population fail to consume sufficient food to meet recommended allowances (4). In rural areas over half the total calories and a large part of the proteins are obtained from corn, which is supplemented with "varying amounts of beans, sugar, some fats, a little meat, bread, alimentary pastes, rice and occasionally vegetables and fruit. Milk, eggs and other dairy foods are rarely consumed." (5)

Types of malnutrition problems vary in different regions of the country in relation to different ecological-environmental conditions and subcultural food and economic systems. In selecting an area within Mexico as a site for the proposed research a number of criteria were applied:

1. Generalizability

2. Heavy reliance on the main staple crop(s) of the country--in this case the corn-beans complex

3. Relative population stability and only moderate out-migration from the study site

4. Nucleated settlement patterns, as contrasted with widely dispersed homesteads

5. Cultural and ethnic homogeneity

6. A community large enough to contain the range of variation in diet and nutrient availability necessary to conduct the study

7. Local political stability

8. Availability of information about the region

9. Reasonable accessibility to Instituto Nacional de la Nutricion (INN) in Mexico City, where much of the laboratory and data analysis will take place, yet distant enough to preserve rural characteristics.

The area selected should be not only representative of regions of mild-moderate malnutrition in Mexico, but also should exhibit some features that are generally characteristic of such regions in other parts of the underdeveloped world. This would suggest the selection of a rural, rather than an urban, site because there is some evidence that chronic undernutrition tends to occur more frequently in rural areas. (5, 6, 7, 8) A related consideration is the selection of an agricultural population engaged in a mixed strategy of production for home consumption, plus some cash-generating activities through cash-cropping, agricultural wage labor, non-agricultural labor or a combination of these. This mixed strategy is highly characteristic of the rural sector of poor, non-industrial countries. To simplify the logistics of data-gathering and ensure the long-term success of the research program, population stability, ethnic homogeneity, nucleated settlement and local political stability are all highly desirable traits.

Based on this set of criteria, and following a fieldtrip to examine potential sites by the three principal investigators and other members of the research team, we have tentatively selected the community of San Juan Epatlan in the state of Puebla as the site for the proposed research. To the best of our current knowledge it meets all of the criteria noted above. However, as described below, we will take steps to assess the correctness of this choice.

The Research Site

San Juan Epatlan, in central Puebla, is located about two and a half hours drive from Mexico City on an all-weather road. It is less than a half hour by car from the small city of Izucar de Matamoros, where medical, social service, and commercial establishments are located. The municipio of Epatlan is quite compact (116 km^2), with a population of 3500-4000 persons in approximately 400-425 households. The community is quite nucleated. However, there are clear micro-environmental differences in access to water and elevation above the valley that are likely to affect household adaptations. Although sugar cane production occurs within an hour's drive of Epatlan, the local economy is dominated by subsistence agriculture, only a small part of which involves irrigation. Rice, jicama and peanuts are grown as cash crops in the irrigated valley lowlands; most of the rest of the cultivated land is devoted to maize, beans and squash. Cattle, pigs, chickens and turkeys are also raised by some families. The population is fully Spanish-speaking. Out-migration to Mexico City and other wage-labor locations occurs, but affects only a small minority of families at this time. Wage labor opportunities in the local region play a modest role in the local economic situation, but are important for families who lack adequate crop lands.

Overall, then, to the external observer, the community of Epatlan gives an impression of relatively homogeneous agricultural poverty. Within this uniformity there is a considerable range of variation, however. Families with lands in the valley bottom benefit from irrigation and receive income from their modest cash crops. Households higher up on the hillside, above the central community are visibly poorer in living conditions, and their agricultural lands are less productive.

The National Institute of Nutrition (INN, Mexico City) carried out a dietary survey in Epatlan in 1968. Table I shows the main items of daily food intake, averaged for the sample:

Table I Average Consumption of Major Food Items in Epatlan

Food Item	Grams per person/day
Maize	406
Beans	70
Bread	63
Milk	53
Vegetables	38 (Onion, tomato, chili, wild greens)
Sugar	31
Fruit	24
Potato	14
Meat	13
Fat	12
Egg	8

The survey demonstrated that a significant portion of the population of Epatlan suffers mild to moderate malnutrition. The picture is clearest in the weight distribution of pre-school children.

Table II Weight of Pre-School Children in Epatlan

% of expected normal weight	Percent of Sample
110 - 90	5.9
89 - 75	70.6
74 - 60	17.6
< 60%	5.9

Clinical signs of malnutrition in preschool children were manifested in the following areas: hair discoloration (10.2%), lips and tongue (11.8%), other 5.9%.

By comparison with other surveys the community would appear to be about "average" in its degree of manifest malnutrition among rural, Mestizo agricultural populations of Mexico. In the ten years since the survey was completed there

have been no major development efforts in this region, nor other changes that would significantly alter the quantity or quality of diet. However, a major feature of Phase I of the program is a new dietary survey, which will also serve as a household census.

The Dietary Census

The initial phase of quantitative data-gathering has three purposes: 1) to establish that a wide range of variation in nutrient intake from adequate to mild to moderate degrees of deficit is present within the community; 2) to enumerate all households in the community as a first step in drawing the sample; and 3) to gather sufficient information about nutritional status and dietary intake of households to provide a basis for sample selection.

The census interview will include age, sex, household composition and occupations of household members. Two types of nutritionally-relevant data will be collected: a) height and weight of pre-school children in the household, and b) a food frequency report. The latter data will be used to construct a Guttman scale of dietary complexity, a measure that is easily constructed and appears to be a sensitive indicator of dietary quality (9). It has also proven to correlate well with socioeconomic and other variables that influence dietary intake in a Mexican peasant community (10).

To facilitate a stratified random sampling procedure, households will first be clustered on the basis of dietary complexity and child growth scores. The resulting groups will be arranged in an array from high to low nutritional adequacy. Households will then be selected randomly from within each group, to a total sample of 220 households, allowing for a 10% drop-out of households during the course of the study.

The data collection will be carried out over a two-three week period, using professional interviewers who have been involved in previous surveys by INN. Precoded interview schedules and the mimimal amount of data to be collected in this phase will help to ensure rapid data processing.

Ethnographic Reconnaissance

The other major component of Phase I, which will be on-going while the materials of the dietary census are being analyzed, is obtaining ethnographic data through direct observation, key informant interviewing and examination of available documentation. The purposes of this research operation are:

1. To facilitate the operationalizing of variables in other phases of the study by identifying relevant local behaviors and conditions, as well as local idioms of expression. The failure to devote sufficient attention to this type of data has been a major shortcoming of much nutrition and health-related research in the past. For example, in a community like Epatlan cash income may be a very poor or inadequate indicator of socioeconomic status, while some composite measure of material possessions may more accurately reflect a household's economic resources (11). The operational measurement of a variable like "material-style-of-life" requires detailed knowledge about the types of material possessions and economic resources in the community, so that appropriate questions can be asked, and appropriate observations made on the households in the sample. A period of ethnographic research is therefore an essential first step to the construction of many of the data-collection instruments.

2. A second purpose of the ethnographic reconnaissance is to describe the political, social and economic organization of the community that provides the context in which individual "functional competence" is played out. That is, to intreprat certain aspects of outcome measures, such as activity levels, we must know a great deal about the forces that constrain or facilitate individual's actions. Furthermore, it should be noted that sensitivity to social and political features of the community is also very important for the successful management of the research program itself.

Among the types of information to be collected during this phase are descriptions of agricultural practices, marketing arrangements, indicators of social differentiation, recreational patterns, literacy, social attendance, and so on. In-depth interviewing will be carried out to obtain information on people's perceptions and definitions of health and illness, treatment strategies, family patterns of social support in times of serious illness, food shortage and other crises. In this stage of work heavy emphasis will be placed on collecting information about food use and features that influence food patterns. Stores will be inventoried; the ethnographer will accompany informants to the market in Izucar and observe food purchasing behavior; detailed interviewing will be done to elicit individual's perceptions about food, including taste preferences, the rationale for food restriction (e.g. pregnancy and lactation food taboos) and conceptions about the appropriateness of different foods for different categories of people (e.g. old people, toddlers, farmers, etc.). Another area to be investigated is the degree to which the traditional "hot-cold classification system" (12) is operative in the community. Food storage and preparation methods will be carefully observed, and food use in relation to ritual and religious occasions will be described. The various ways in which households procure food will be ascertained, including attention to gathering of wild foods and game (13) use of domestic animal products (10), as well as types of items purchased from commercial sources.

The information generated through ethnographic research will be directly applied in several of the subsequent research phases.

PHASE II. HOUSEHOLD DESCRIPTION AND ASSESSMENT

The second phase of the research program consists of three distinct data-gathering operations: the household survey; the dietary assessment plan and the nutrition and health status assessment plan. The household interview is the first contact the sample households will have with the permanent project personnel. This operation precedes the other two components of this phase and will be described first.

The Household Interview

Research in nutrition and public health epidemiology provides ample evidence of the significance of socioeconomic and demographic factors in explaining patterns of disease and nutritional status. Recently attention has been directed to the investigation of other sociocultural factors as it has become evident that many additional factors, including apparently small differences in household resources, family composition, social values and so on can have significant effects on nutrition and health status (8, 14, 15, 16, 17).

Since many aspects of "household ecology" affect nutrient intake and the outcome variables in our study they must be regarded as "confounding variables" whose effects have to be "controlled" in order to assess the impact of nutrient intake. Therefore it is imperative to collect extensive information on as many relevant features of household characteristics as is feasible. The vehicle for achieving this is the household interview, a structured interview schedule that will be constructed and pretested following the period of ethnographic research.

Data to be collected during this initial interview include economic characteristics (e.g. land ownership/access, wage labor activities, material possessions), migration experience, education, religious participation, kinship relationships and other social network relationships, contacts with the health care system (both traditional and modern) and other social and cultural characteristics. The household interview instrument will be similar to schedules used by members of the research team in the Temascalcingo and Sahagun regions of Mexico (18, 19).

The interviews will be conducted by a "technical aide," a well-trained, educated paraprofessional who will be accompanied, in this initial contact with the household, by a local "community aide."
The technical aides, who will be hired as permanent members of the research team, will receive training in interviewing and observational skills prior to the beginning of this phase of data-gathering.

Dietary Assessment Plan

Energy intake, the independent variable throughout the project, must be carefully measured and monitored on a continuous basis. The methodology chosen for those measurements should be tailored to take advantage of unique dietary patterns prevalent within the community. A major constraint is that subjects cannot be expected to measure or record their intakes. Both the diet record and the weighed inventory methods, as generally applied, rely on subjects' ability to record their own intakes obtained by estimation or measurement (20). In contrast, the 24 hour recall, diet history, and weighed record require a skilled recorder (20). The diet history does not yield sufficient precision, and a strict weighed record is clearly impossible given the scope of the project. A hybrid weighed record-weighed inventory approach is feasible and such a method is proposed. (described below)

The 24 hour recall method, when repeated over time with the aid of food models, can provide a good estimate of individual dietary nutrient intakes (21). In view of the preceding, two methods will be used for intake measurements--a hybrid weighed inventory-weighed record in which all records are generated by a skilled observer and the 24 hour recall, with food models.

Twenty Four Hour Recall, With Food Models

Dietary intake data will be collected every two weeks from each household, using the 24 hour recall method. Interviewers who are specifically trained as "dietary intake technicians" will visit households to collect 24 hour recall records, using food models to aid respondents. To the extent possible, the "dietary intake technicians" will interview all members of the household who are able to report responsibly about their food intake. Information on the intakes of infants and children will be obtained from their mother.

The timing of visits to each household will be scheduled by the research coordinator in such a manner that, over the course of 14 weeks, all the days of the week will be represented in a household's record. Scheduling will be arranged in a manner which will make it appear random from the perspective of the household, in order to avoid bias as the result of anticipation of the researcher's visit.

Observed, Weighted and Measured Record

Knowledge about some features of household dietary behavior are best obtained through observation. In particular, understanding intrafamilial food distribution requires first-hand observation. Also, it is vital for the assessment of the validity of the 24 hour recall to have an observational record, especially to judge the degree of "snacking," "picking from the pot," and other behavior that can easily go unreported in a 24 hour recall.

Although a full observational day is expensive, from the perspective of measuring energy intake alone, the costs are justifiable if the observational day is used for other purposes in addition to collecting food intake data. Thus, this aspect of the dietary assessment plan is scheduled to take place 4 times per year (per household) and to be integrated with the collection of other behavioral data.

The observational record will be made by the same technical aide who conducts the initial household interview. This technical aide will be the household's major link with the project.

The technical aide will commence early in the day, before the first preparation of food. At the "kitchen level" all ingredients (including water) will be measured or weighed before they are cooked. This will provide a close estimate of the final composition of a mixed dish. When food is provided to each family members as a "serving", the size of each food item in the serving will be measured or weighed. At the end of each meal measurements will be made of the amount of food left unserved and the amount left on individual plates. The fate of unconsumed food will be recorded.

The weighing of food on a gram scale, or precise measurement of liquid volumes, is a relatively time consuming process. For this reason, weighing and precise measurement will be routinely used only at the kitchen level of food preparation and for plate waste. In order to minimize interference and delay in food consumption, the food placed on individual's plates or bowls (or handed to individuals) will be estimated, after weighing the quantities represented by the cups, spoons or other utensils used to serve the food. With practice the aides should become skilled at "measuring by eye," and periodic "quality control checks" will be made of aide's estimates, following the initial training period.

Since the technical aide will be present for the entire day, all "eating episodes" will be observed and recorded. Household members who are absent from the house during the day will be questioned about food consumed outside the household. If the amount is large, or difficult to estimate reasonably, the intake for that day will not be used in data analysis.

Nutrient analysis of selected dietary items will be spot checked by the laboratory at INN. Composition of foods, except for those analyzed by INN , will be estimated by reference to Mexican food composition tables. (22)

Household Activity Observation

Another duty of the technical aide during each all-day visit is to observe and record activity of household members. Beginning in the early morning she will record the duration of all activities by a simple timing procedure, on a standardized form, noting the time of starting and ending of all activities. Durations and frequences of activities and interpersonal contacts will be calculated from the time data on the day following the interview, when the technical aide has a day for "rest and recording." Since the record includes the starting and finishing time of all activities, and the length of interruptions and interactions, this data should show activity patterns and circumstances affecting "efficient" task performance for use in later analysis.

Dietary Assessment as a Long-term Data-gathering Operation

The activities outlined above are intended to be continued throughout the fieldwork period. We will therefore have 12 observational days and 68 24-hour recalls for each household. This long-term cycle of repeated observations will enable us to look at changes in nutrient intake over time, in response to seasonal variation and larger economic or climatic events. It will provide us with much needed information on the degree of stability of intake in a peasant community.

It will also provide us with data to examine the role of ritual events in affecting nutrient intake. The majority of community members participate in approximately 12 community-wide festivals (Saints days, major Christian holidays) and 12 more private celebrations (baptisms, weddings, confirmations) each year. It will be important to assess the nutrient intake of people at these festivals, for these occasions may represent a major mechanism for distributing scarce, high-quality protein (144). To accurately assess the contribution of the food consumed during ritual occasions to total diet requires long-term observations. Furthermore, the fact of a large series of observations will also allow us to look at intra-group differences with respect to this issue. To the extent that ritual occasions do play a significant role, differences in the extensiveness of an individual's social network should affect dietary intake. People with more social contacts (especially when these involve ritual godparenthood) would be included in more social occasions where meat, fruit and other valued foods are consumed. Thus we hypothesize a relationship between sociability measures and nutrient intake that would take repeated measurements to demonstrate.

Nutrition and Health Status Assessment Plan

An array of parameters have been designated for evaluation within the category of "nutrition and health status." These parameters may be classified as clinical, anthropometric and biochemical. Except for information on "illness episodes", these measurements will be made by the clinic physician once every 3 months.

Clinical Measurements

In the context of this research, clinical data includes medical history, physical assessment and illness episode documentation.

The medical history is intended to serve as a starting point for ongoing medical evaluation and must be as complete as possible. This record will include:

hospitalizations, clinic visit frequency and reasons, childhood diseases, other known serious acute illnesses, accidents, chronic diseases, immunizations, age of menarche, thelarche if applicable, use of drugs or remedies including alcohol and tobacco, food intolerance or allergic manifestations, review of systems with special emphasis on hearing and vision, respiratory, GI, and GU systems.

The physical assessment implies a thorough physical examination including vital signs and a careful search for clinical signs considered to be of value in nutritional assessment. (23) Signs will be graded as present or absent. (23) Teeth will be examined for linear hypoplasia of maxillary incisors. (27) Tonsillar size of children will be graded. (28).

At the time of the 24 hour recall the "dietary intake technician" will ask about "illness episodes" during the two weeks preceding the visit, using a standardized protocol. (29). The format will be an abbreviated version of the method developed by Fabrega (29). Focus will be directed to health problems known to be related to nutritional status, including diarrhea (30 - 33), respiratory disease, urinary tract infections (34) and other infectious processes (35). Diagnostic efforts will be minimal in this phase of the research project. The objective is to have an on-going record of morbidity experience, as perceived by respondents.

Anthropometric Measurements

Anthropometric data reflect the effects of a number of factors, including both genetic and environmental influences (23). Anthropometric parameters have been selected that are known to correlate well with other indicators of nutritional status.

Anthropometric data will be analyzed with a program designed to calculate meaningful composite parameters such as body fat, lean body mass, weight for age, weight for height squared, etc. Distributions in the sample will be compared with Mexican National Standards. (26) Table III shows the schedule for anthropometric measurements.

TABLE III. SCHEDULE OF ANTHROPOMETRIC MEASUREMENTS

Age Group	Measurement	Frequency
Newborn	Birthweight Length Head Circumference	Once, within 48 hours
First Year (0 - 12 mos.)	Weight Length Head Circumference	Every Month " " " "
Second Year (13 - 24 mos.)	Weight Length Head Circumference Arm Circumference Skin Folds (7 sites)	Four Times Per Year " " " " " " " "
Ages 3 - adult	Weight Length Arm Circumference Head Circumference Skin Folds (7 sites)	Four Times per Year " " " " " " " "

Pregnancy and Lactation: see Substudy D.

Biochemical Measurements

Biochemical parameters that may be altered by nutritional state are legion, however, only the most pertinent and sensitive have been chosen for inclusion in this phase of the study. They are: hemoglobin, hematocrit, serum transferrin (36-38), albumin (36,38), folate (41,42), urine creatinine and hydroxyproline, stool sample (ova and parasites) and hair roots (44).

Serum transferrin levels are significantly depressed in severe malnutrition (36) and correlate with response to therapy (37). Levels are intermediate with moderate malnutrition and correlate well with cutaneous reactivity to common antigens (38).

Serum albumin may be significantly lower with severe malnutrition, particularly kwashiorkor (36), and falls into the low-normal range with moderate malnutrition (38). Serum transferrin levels are likely to be more sensitive and may be determined rapidly in the field using commercially produced immunoplates (39), however, serum albumin determination will be included as a crosscheck.

Serum folate has been included as a measurement because folate may play a role as a confounding variable during subsequent immunocompetence

studies (40, 41) that have been proposed in Phase III of the study design.

Urinary hydroxyproline and creatinine will be determined in 3-hour fasted samples since hydroxyproline/creatinine and creatinine/height ratios have been shown to be good estimators of lean body mass (42).

Hair roots will be obtained and quantified for percent anagen and telogen phase roots, as well as, mean anagen phase bulb diameter. Mean bulb diameter has been shown to be a more sensitive indicator of protein status than serum albumin (43, 44, 45).

Analyses of the above parameters will be performed, in part, at the clinic-research site which will be situated in San Juan Epatlan, while others will be performed in Mexico City at the INN.

TABLE IV. SCHEDULE OF BIOCHEMICAL ASSESSMENT

Measurement	Frequency
Hemoglobin	2 X year
Hematocrit	2 X year
Albumin	1 X year
Transferrin	1 X year[a]
Folate (on whole RBC)	1 X year[a]
B_{12}, Riboflavin, Pyridoxine Thiamine	1 X year[a]
Iron, Zinc, Copper	1 X year[a]
Urine Creatinine	1 X year
Urine Hydroxyproline	1 X year
Fecal Parasites	2 X year
Hair Roots	1 X year

[a] Will also be measured 4 times in samples drawn for immunocompetence s

PHASE III. SUBSTUDIES OF FUNCTIONAL CATEGORIES

This phase of the research program is intended to generate the type of in-depth data required to examine hypotheses concerning intervening mechanisms. Because of the bulk of data required, as well as considerations of expense, time constraints and most importantly, intrusion on people's lives, this phase will be organized as a series of substudies on smaller samples.

The three substudies on disease, activity and cognition will be carried out on parallel samples of 60 households, selected to contain the full range of variation in energy intake. It should be noted that by the time the substudies begin, we will have careful, quantitative measurements of household members' intakes. The sampling procedure for the reproductive substudy and the procedures for social competence assessment will be described in their respective sections.

A. Substudy of Disease and Intake.

The main thrust of the disease substudy will be to ascertain the presence or absence of threshold effects when parameters known to be abnormal in severe malnutrition are studied in the setting of mild to moderate malnutrition (112). Food measurements will continue uninterrupted through this substudy intake, as previously delineated, without alteration of frequency of measurement or techniques employed.

The physician's assessment component includes a historical inquiry and physical examination repeated every three months. Careful recording of symptom severity, duration and impact on function will yield improved definition of group differences in perception of diseases. This inquiry will be in much greater depth than those that are ongoing from Phase II in other households. Particular emphasis will be placed on careful elicitation of symptoms known to be related to nutritional status, such as diarrhea and dysentery (30,31,32,33), respiratory disease, urinary tract infections (34), and other infections processes (32). Diagnostic efforts will include, when indicated: 1) sputum culture for pathogens; 2) stain for acid-fast bacilli; 3) throat culture; 4) urine culture; 5) stool specimens for ova and parasites; 6) wound infection culture; or, 7) any other procedure deemed warranted. If dysentery is suspected, stools will be obtained and held in gram-negative broth, then transported to INN for enteric pathogen isolation. Shigella is very prevalent in this community, thus sanitation, fecal contamination, and household spread will be scrutinized. Seriously ill individuals will receive appropriate available therapy.

Physical examinations performed every 3 months will include anthropometric measurements as previously described, and a thorough search for clinical signs related to nutritional status (23). Signs will be graded as present or absent. Tonsillar size of children will be graded (28). Hair will be obtained and graded for bulb atrophy and diameter (44). In the households in the substudy, the clinical assessment will be performed by the project physician, rather than the nurse practitioner.

TABLE V. IMMUNOCOMPETENCE TESTS

Test	Sample	Method	Remarks
(C*) Secretory IgA	Saliva (? and Tears)	Radial immunodiffusion (Radioimmunoassay to be developed).	We will also estimate lysozyme on the same sample for our interest.
(C*) Complement assays (Opsonic activity, C3, Factor B)	Plasma/serum (0.3 ml)	Laser nephelometry. Rocket electrophoresis. Phagocytosis of particles.	
(C*) Transferrin	Plasma/serum (0.1 ml)	Laser nephelometry.	
(C*) CRP	Plasma/serum	Laser nephelometry.	May be a good indicator of associated infection.
(M*) Bactericidal capacity of neutrophils	Blood (5 ml)	Number of viable intracellular bacteria estimated by surface colony count on agar.	
(M*) T Lymphocytes	Blood (3 ml)	Rosette formation with sheep red blood cells.	
(C) Leukocyte TdT	Blood ( )	Radioassay. Cells can be separated and kept frozen until estimation.	New test. Is increased in PEM. Probably it is not altered by infection.
(C) RNAses	(?)	Buffy coat cells can be kept frozen until estimation.	This is still experimental. However, preliminary data suggest that it may distinguish wasting from stunting.
(M) Cutaneous-delayed hypersensitivity		Intradermal injection	In field clinic. Requires reading after 48-72 hours.

C = Cambridge M = Mexico City/Field Clinic

(C*) These tests can be done at frequent intervals (3 months) and require only saliva, tears or finger pinch blood.

(M*) These tests require venous blood samples and could be done in older children and adults, perhaps once or twice a year.

Substudies of Functional Categories (cont.)

Disease and Intake (cont.)

Table V indicates the tests of immunocompetence to be used, and the sample sizes required. Saliva and finger prick samples will be taken from all individuals in the 60 families of this substudy once every three months for one year. Venous samples will be drawn only once during the year. Since a deficiency of several nutrients (iron, zinc, vitamin B12, and folate) may affect tests for immunocompetence, analyses for these nutrients in serum will be performed concurrently using microtechniques.

Secretory immunoglobulin sIgA levels in saliva are lower in both infected and noninfected children with severe PCM (53) and response to immunizing doses of virus particles is markedly diminished (47). Secretions will be obtained and assayed by radial immunodiffusion (54) with the hope of detecting a threshold for this phenomenon.

Severe malnutrition is known to be associated with depressed levels of certain components of complement (48) and with dimunution of total hemolytic complement activity (28,48); the deficit worsens with infection (49). By measuring opsonic activity, C3, and factor B, effects of mild to moderate malnutrition on the complement system may be elucidated. Serum opsonic function has been reported to be depressed when serum concentrations in the assay are five percent or less (61). This result was obtained from a pooled group of severely and moderately malnourished individuals. The properdin pathway of complement activation is a feedback amplification and bypass system for the classical pathway. Factor B is a cornerstone of this system (62) and is a logical starting point for unravelling the effects of nutritional adequacy on the properdin system.

C-reactive protein is an acute phase reactant which is known to bind to T-lymphocytes (55) and is commonly elevated in severely malnourished individuals (56,57). Children with severe malnutrition are known to exhibit shifts in lymphocyte subpopulations, specifically a relative paucity of E-rosetting T-lymphocytes and a proportional increase in null cells (60). Leukocyte terminal deoxynucleotidyl transferase is increased in malnutrition, and is probably not altered by the presence of infection.

The competence of the cell-mediated immune response is reflected by skin reactivity to common antigens and to DNCB following sensitization. Reactivity is negligible or subnormal in folate deficiency (41,42), iron deficiency (58), and protein-energy malnutrition (28,38,59). Furthermore, reactivity may be graded and may demonstrate intermediate responsiveness in the case of mild to moderate malnutrition (28,38).

B. Substudy of Cognitive Functioning

Investigators have suggested a link between malnutrition, environment and social-cognitive development (80, 81). In addition to possible direct effects on growth patterns and the central nervous system, malnutrition may undermine the establishment and maintenance of a relationship between the child, his caregivers and his environment. The malnourished child, by virtue of his lesser responsivity may elicit less stimulating behaviors from his caregivers. Although most investigations have focused on the child, attention to the full life-span is suggested because of a) reciprocal child-adult relationships, b) the potential continuation of low-intake related effects into adulthood and c) the limited research on nutrition-cognition interactions as a lifespan problem (82).

The areas selected for this substudy have been shown to be affected by severe malnutrition and growth retardation. These include auditory acuity (83, 84, 85); visual acuity (86, 87); exploratory behavior (80, 88); information-seeking (89, 90); memory (89, 90), language development (91) and family interaction patterns (80, 88).

The criteria for selecting instruments for the cognitive substudy are: 1) to permit the formulation of a life-span picture of intellectual functioning and comparison with other known communities, and 2) to select instruments that are known to be sensitive to nutritional and environment effects. All instruments will be extensively pilot tested for adaptability and replaced, modified or expanded in relation to local conditions. Specific research instruments and techniques are listed here as tentative, subject to careful assessment of the field context.

It should be noted that the observations and measurements on neonates, infants and "toddlers" will be carried out for all of the offspring of the women in the reproductive study, described below, and will therefore, over time, involve a larger sample than the 60 households in the cognitive study. Infants and young children already present in the 60 households in the cognitive substudy sample will also be measured so that we can describe the picture of cognitive functioning for entire households.

Functions	Subjects
1. Auditory Acuity	
Auditory habituation with "pure tones" (83)	infants
Standard audiological exam	children/adults
2. Visual Acuity	
Visual habituation task	infants
Visual acuity task designed with culturally meaningful stimuli	children/adults
3. Attention	
Novel object exploration task (92)	infant
Visual habituation tasks (93)	infant
Auditory habituation tasks (83)	infant
Tasks to test vigilance, attention span and incidental learning (94, 95, 96, 97)	children/adults
4. Memory	
Visual memory paradigm (98)	infants
Digit test, brief story recall, object recall (99, 103)	children/adults
5. Perception	
Reorganization of ambiguous figures (100)	older children/ adults
Visual illusions (101,105)	
6. Cognitive Style	
Field dependence/independence (102,104)	older children/adult
Reflectivity/impulsivity (102)	older children/adul
7. Psychomotor Abilities	
Measures of speed and accuracy (106)	older children/adul
8. Language Development	
Analysis of audiotapes collected in naturalistic and test situations	all ages
9. Development Assessment	
Brazelton Neonatal Scale	48 hours after bir
Gesell	pre-school
Bender-Gestalt and WISC-R (adapted for use with Mexican respondents)	older children
10. Classical Aging Pattern	adults

The literature on intellectual functioning in adulthood and old age has been summarized by Botwinick (107) who noted that the verbal scales of the Wechsler Adult Intelligence Scale (WAIS) and markers of crystallized intelligence tend to remain stable from young adulthood to old age while the performance scales of the WAIS and markers of fluid intelligence tend to decline. The replicability of this pattern, as well as the ages of onset, will be studied with culturally adaptable measures of: a) indices of the WAIS verbal scale

vocabulary and similarities (a measure of abstract thinking) which has been shown to both improve and decline over age in a longitudinal study and thus may be sensitive to nutritional effects (108); (b) two indices of the WAIS performance scale, picture completion and picture arrangement; (c) one index of crystallized intelligence, verbal comprehension (109); and (d) one index of fluid intelligence, induction (109, 110).

From naturalistic observations a number of processes will be examined. For example, observations of mother-infant feeding interactions, floor play, peer interactions, recorded with standardized time sample unit procedures will be used to describe significant aspects of social interaction. These observations and various rating scales such as the Infant Temperament Scales and Behavioral Problem Checklist will be used to assess various dimensions such as activity level, apathy, impulsivity, emotionality, aggressivity, hyperactivity, temperament, coping skills and interaction styles.

Protocols for home assessment of emotional and verbal involvement, restriction and punishment by parents, the organization of the home environment, provision of age-appropriate play materials, and opportunities for variety in daily routine have been modified for Mexican communities by Cravioto (111) and have effectively discriminated homes of malnourished children. A supplement assesses the parents' disciplinary and coping strategies derived from the literature on learned helplessness. These will be used as an additional measure of the degree of stimulation provided and family involvement available in the child's learning environment.

The total formal testing time for infants is estimated to be two hours. The total formal testing time for school-age children is estimated to be four hours. The total formal testing time for adults is estimated to be three to four hours. To avoid fatigue effects, formal testing sessions would be divided into shorter sessions. The estimated time in naturalistic observations per subject is five to ten hours depending upon the observation situation and age of the subject.

C. Work Capacity and Performance Substudy

This substudy is an intensive investigation of human physical actions and their relationship to nutritional status and nutrient intake. Parameters to be studied include: 1) activity (what people do) 2) performance (what people accomplish by their activity) 3) physiologic and physical function (energy and psychologic costs of activity and prediction of performance levels) and 4) gross morphology (as related to efficiency of activity and performance.) Clearly, nutritional status may be considered both an antecedent and a consequence of these parameters. Of critical concern is how the capacity of individuals to perform activities influences a household's ability to gain access to nutritional resources.

Nutritional status and dietary intake assessment will continue for individuals of this substudy as described in Phase II. Anthropometric measurements reflect long-term nutritional experience, whereas dietary intakes provide information about present dietary adequacy. This distinction is necessary for the analysis planned in this substudy.

During Phase II, the technical aide records an activity profile on each household member every ~~four~~ three months. These records will continue for all households throughout the project, however in Phase III a stratified subsample will be chosen and studied more intensively. Fifty families (hereinafter noted the "exercise subsample") will be selected and data will be collected on 1) resting metabolic rate 2) respiratory quotient 3) work capacity 4) fitness 5) work performance 6) physical activity and 7) total daily energy expenditure. Certain restrictions will be adhered to, namely: children under 5 years old will not perform treadmill tests, and pregnant or sick individuals will not be exercised to maximum oxygen uptake.

The exercise subsample will be studied in two locations. The measurements of metabolic rate, respiratory quotient, work capacity, fitness and measurements of work performance will be performed in an "exercise laboratory," namely a room in the field clinic which contains a treadmill, O_2 and CO_2 analyzer etc. and in which temperature can be somewhat controlled. The physician will be on hand at all times during these tests. In contrast, the caloric cost of performing set tasks, and the estimates of total daily energy expenditure, will be made outside of the laboratory. Each measurement to be performed is discussed briefly below.

Resting Metabolic Rate (RMR) This measurement will be obtained after allowing each subject to rest in a horizontal position, in a thermoneutral room, for 30 minutes. This will be standard procedure before any treadmill exercise is undertaken. This measurement will be nearly BMR, but we anticipate that true BMR cannot be obtained using a mouth-piece respiratory valve, and that the environment may vary from thermoneutral.

Respiratory Quotient (Respiratory exchange ratio, R) will be assessed from the CO_2/O_2 ratio during RMR measurements. The ratio of CO_2 to O_2 (R) at rest, and at each exercise intensity on the treadmill, will be used to calculate the correct value for converting O_2 consumption to kcal energy expenditure. This factor needs to be thoroughly evaluated in malnourished individuals since R may be altered in those adjusted to low energy intakes.

In a subsample of individuals representing a range of caloric intakes, the change in R in response to a standard, typical meal will be determined. This information will be used, i) to examine the long-term effect of nutritional status on response to a metabolic load, and ii) to determine the point at which R returns to baseline values after a meal. VO_2 max measurements can therefore be avoided during the response period.

Work Capacity is a measurement of the individuals physiological ability to perform work. It is dependent on lean body mass, muscle mass and oxygen transport capacity. Lean body and muscle mass will be assessed by anthropometric measurements, and urinary creatinine excretion. Work capacity is usually defined as maximal oxygen consumption (VO_2 max), which is determined as the maximum rate of oxygen uptake (l. min. kg^{-1}) that can be induced by exercise. This will be determined by measuring oxygen consumption during 3 minute intervals at increasing exercise intensities on a treadmill (113). The details of this method and precautions to be taken, have been described by Astrand (114). A treadmill will be used in preference to a bicycle ergometer since it is easier to reach (VO_2 max) on this apparatus. Body weight affects working capacity on both the treadmill, and bicycle ergometer (115). Data will be expressed on a body weight basis.

Expired air samples will be collected and the O_2 and CO_2 content will be measured rapidly and simultaneously by an O_2/CO_2 analyzer, using reference standard gas mixtures.

During the treadmill tests, the heartrate, skin temperature, and pulmonary excursion will be monitored using a Medilog.

Blood lactate concentration (finger prick) also plateaus near VO_2 max, is a good indirect, confirmatory measure that VO_2 max has been reached (116). It would also be of interest to observe lactate accumulation during work relative to the degree of caloric undernutrition. The subject's rating of perceived exertion at the end of each exercise stage will also be determined (114).

Physical Fitness This will be estimated from the regression of oxygen uptake (VO_2) on heart rate. (VO_2 at F_H 150 beats/min and F_H at VO_2 1.5 l/mm for each subject will be predicted).

Work Performance A battery of tests will be used to assess work performance. They represent varying degrees of cognitive versus psychomotor performance, they provide measures of speed as well as accuracy, and both self-paced and experimenter paced tasks are represented.

For example strength endurance and recovery may be measured using a hand grip dynamometer. This task has been found to be sensitive to effects of occupational exposure to lead and may also be sensitive to marginal nutritional adequacy. Data from this test will be expressed in terms of muscle mass cross sectional area as well as body weight (117).

In addition, we propose to measure 1) tremor as assessed by counting contacts of a 1/8 inch stylus with the edges of a 1/4 inch "contact hole" in which the subject has inserted the stylus. 2) Eye-hand coordination as measured by the subjects ability to insert a stylus sequentially into a maze of receptor holes. 3) Serial reaction time as measured by the subjects ability to maintain concentrated attention. 4) Digit-span test administered in the standard format and 5) Dual-task performance test wherein subjects are required to perform tasks number three and four above concurrently. It is hoped that this battery will be sensitive to work performance alterations resulting from marginal nutritional adequacy.

Physical Activity is defined as the type and amount of work (energy expenditure) performed during defined periods of time. We will measure physical activity by an observation method and by use of an actometer.

Observation Method This will provide information on the type of activities pursued (obligatory and discretionary) and the time spent in each activity. As previously described, each member of all households in the sample will be observed throughout the waking hours by the technical aide assigned to that household. These observations will be made on different days of the week, every 4 months for 3 years. Tasks will have been classified previously into major categories based on the Ethnographic Reconnaissance (Phase I). Data on the amount of time spent in social interactions will also be obtained during these observations.

Use of Actometer This instrument is an automatically winding wrist watch from which the escape mechanism has been removed. It records movement and also the intensity of the movement. The advantages of this instrument are minimal interference with the life and activity of the subject, and inexpensiveness. Each actometer will be calibrated using a treadmill (118). In an experiment where an actometer was attached to the ankle, an excellent correlation was found between treadmill speed (1-15 km $hour^{-1}$) and actometer readings. This method of recording activity will be especially useful for children, where it is less important to know which activities are being performed, than to record total daily activity. It has been shown that the activity of kindergarten pupils assessed by observation at 2 minute intervals was not significantly different from that assessed by an ankle actometer (119). We propose to validate actometer activity data by correlation with direct observations.

Estimation of Total Daily Energy Expenditure This can be estimated for all individuals in the sample from the amount of time spent in various activity categories during a day, multiplied by the energy cost of each activity. The energy cost of each activity will be derived from the average VO_2 for tasks performed by the subsample subjects. The method of obtaining activity records has been described. The energy cost of each activity will be obtained by asking subjects to perform these tasks in the field, using methods described by Viteri et al (120). Tasks will be standardized as much as possible and the subjects will perform them for 15-20 minutes. Samples of expired air will be collected in a Kofranyi-Michaelis respirometer through a respiratory mask during the last 10 minutes of the task. Expired air will be transferred rapidly to oiled syringes or tonometers for transportation to the field laboratory, where O_2 and CO_2 will be analyzed within 4 hours. For those activities where energetic cost is not measured, this will be estimated from the difficulty of that task relative to a tested activity.

For the individuals in the subsample of households selected for the work capacity measurements, total daily energy expenditure will be obtained more accurately by using a SAMI heart rate monitor (121). As previously mentioned, those subjects in whom VO_2 max was determined were also attached to a heart rate monitor during this procedure. Therefore, the regression of VO_2 against heart rate has already been obtained for each individual. Individual calibration of the monitors in this way considerably improves the reliability of estimating energy expenditure from heart rate. While we realize that the individual regression lines are not linear at high levels of activity we anticipate that these activity intensities will occur infrequently in our sample. When they do occur, estimates will be based on minutes of observed participation in the activity multiplied by energy cost of the activity.

D. Substudy of Reproductive Competence

The reproductive competence of women in San Juan Epatlan is not documented. However, Tezonteopan is a neighboring village (30 KM) that is characterized by a similar ecology and has been the subject of extensive reproductive research

for the past 10 years by one of the principal investigators(124). We expect that the reproductive characteristics of these two villages will be similar so we are summarizing the findings of the Tezonteopan study as an indication of what we may expect to find in Epatlan.

The women of Tezonteopan have an average age at menarche of 15.5 years and at menopause of 40.4 years; age at first pregnancy is 15-16 years; total weight gain in pregnancy averages 4.8 kg. and birth weights are 2.79 kg. In the recent past the average number of pregnancies was 8.8 and deliveries 7.9, but only 4.8 children reached adulthood. Milk volume was 423 ml at 2 weeks, 577 ml at 8 weeks, 540 ml at 16 weeks, 444 ml at 56 weeks and 350 ml at 78 weeks of lactation. Total milk volumes were lower in those women with greatest weight deficit, highest parity, more dead offspring, and whose infants showed the lowest weight gains. The diets of the infant would therefore appear to be most deficient from 3 to 4 months onward, until the age of 2 years. Supplementary feeding of infants is introduced around 8 months, and consists of very small amounts of tortilla and bean broth, which is given only on demand. During lactation the women consume 1950 kcal and 50.1 gm protein/day, all of vegetable origin. Severe malnutrition was not found in these women, who continue to perform their heavy domestic duties and help with agricultural tasks throughout pregnancy and lactation. Lactation usually continues for 18 to 24 months until a new pregnancy becomes noticeable.

From the foregoing information it is clear that the diet of many women in Epatlan is likely to be insufficient to support optimal performance during pregnancy and the extensive period of lactation.

The important research gaps relating to pregnancy and lactation have been clearly described in the Workshop on Nutrient Intake and Reproductive Competence (125). In this project we want to place heavy emphasis in data gathering on the role of maternal body composition (prepregnancy, during pregnancy and lactation) on pregnancy outcome, and the quality, quantity, pattern and duration of lactation. An issue of critical concern is the extent to which a marginally malnourished woman can adequately breast feed her infant and with what further drain on her nutrient reserves. Careful examination will be made of the factors that affect body composition, namely dietary intake, maternal activity and metabolic rate, and milk volume and composition. An important emphasis is also placed on the role of mother-infant interaction in relationship to milk production.

Research Protocol for Pregnancy Study

In contrast to the method of sample selection in the three substudies described above (in which stratified random sampling is used to produce a small sample that represents the range of variation of nutrient intake in the community with adequate numbers at the upper and lower ends of the range), the sample for this study will be constituted as follows:

All women in the 600 household sample who become pregnant will be selected as members of the reproductive subsample. We have estimated on the basis of reproductive patterns in Tezonteopan, that approximately 60 women will be identified

over a one-year period. These women will then be followed through pregnancy and lactation. A description of data to be collected is as follows.

a) Preprepregnancy: Since all the subjects in this subsample will be chosen from the 200 household sample the following information will have been collected in Phase II. Age at menarche, current age, weight, height, dietary data, anthropometrics, health and obstetrical history, and sociocultural data.

b) Pregnancy:

(1) Changes in eating behavior: Appetite, food preferences, pica, beliefs about appropriate diet and weight gain, nausea, expectations and advice of spouse and other significant persons about weight gain 24 hr. recall.

(2) Anthropometric Measurements: Will include those found to change most during pregnancy such as: weight, limb circumference, skinfold thickness at triceps, biceps, suprailiac crest, mid thigh, subscapula, costal. A subsample of women will be transported to Mexico City for ^{40}K measurements (whole body crystal counter) at INN.

(3) Biochemical Measurements: Will be chosen to reflect current nutritional status and physiological changes; for example, 24 hr. urine samples will be analyzed for creatinine, urea, and nitrogen. Blood samples will be analyzed for hemoglobin, hematocrit, folic acid, etc.

(4) Hair Root Measurements: Hair root samples will be examined for anagen atrophy since we have found mean bulb diameter to be a good predictor of birth weight outcome in Guatemalan women (126).

(5) Medical Examination: Prenatal care exam, morbidity, medical diagnosis (pre-eclampsia, abruptio placentae, etc.).

(6) Activity Measurements: Activity will be observed for 1-day period by trained observers; 2-day actometer and SAMI measurements, basal metabolic rate, resting metabolic rate, energy expenditure for selected activites (KM respirometer) will be done on this population in order to standardize heart rate monitor (SAMI) measurements.

Measurement for (1)-(6), except one and two-day "field" observations, will be obtained during visits to the clinic-research facility, scheduled at two-month intervals starting at approximately the sixth to eighth week of pregnancy.

c) At Parturition: Infants are delivered at home by midwives. After delivery the nurse practitioner will record: pregnancy complications, apgar scores, birth weight and length and, if possible given cultural expectations, the placenta will be weighed and frozen prior to analysis for protein, DNA and gross histology (127). Cord blood will be obtained and analyzed for IgA and IgM (128). Since maternal IgA and IgM cannot pass the placenta (unlike IgG) their presence in fetal blood are indications of fetal synthesis and therefore can be used as a sign of in utero infection.

Research Protocol for Lactation Study

All women who became part of the "pregnancy study" will continue to be studied at 2 month intervals throughout the period of lactation (approximately 18-24 months). The data collection protocols i.e., measurements and instruments) will be the same as those that were employed throughout the "pregnancy study." The following additions will be added in the "lactation study."

a) 48 Hours Postpartum At this time the Brazelton and Dubowitz (gestational age) examinations (129) will be performed by a certified Brazelton examiner. In addition, the following data will be collected: 24 hr. recall, maternal weight, anthropometric measurements, and physical examination (by nurse practitioner); infant anthropometric measurements, including length, weight, biacromial diameter, circumference at thorax, head, arm and thigh, size of the inferior segment, and if possible skinfold measurements at biceps, triceps, subscapula, and suprailiac. Skinfold calipers will be left on the infant for 60 sec. to minimize the effects of edema (130). A colostrum sample will also be obtained at this time.

b) 7 Days Postpartum Infant and maternal physical examinations including anthropometrics (nurse practitioner), repeat Brazelton exam (certified Brazelton examiner), 24 hr. recall.

In addition to modifications (a) and (b) data will also be collected throughout the study about the amounts and types of supplemental foods consumed by the infants as reported by the mother. The validity of this data will be cross-checked by the "activity field worker" during her 1-day activity observations (see Pregnancy (6)). A further cross-check will be available for a subsample (N=15) of these infants who will participate in the "milk volume" substudy.

Research Protocol for the Milk Volume and Composition Study

Milk analyses will be performed to assess the importance of current maternal nutrient intake, and maternal body composition, on milk volume and quality. Malnutrition has been reported to cause a significant decrease in milk volume, no change in total protein or lactose, changes in fatty acid composition (to a

depot fat pattern) and an increase in lactoferrin (131). A few women in this region are beginning to use oral contraceptive agents. These women will not be excluded from study, and the effect of these agents on milk composition and volume will be noted.

This study will quantify the volume and composition of breastmilk produced during lactation. Subjects for this study will be chosen from the lactation sample described above. The selection criteria will be by assignment of every other live birth to this study until fifteen subjects have been obtained.

Milk Volume: The method used to quantify milk volume will be patterned after that employed by Chavez et al (132) in Tezontcopan. The method involves weighing the infant before and after each feeding on a non-oscillating infant scale. Milk volume will be measured in this way over a 48-hr period at 2 weeks, 8 weeks, and each 8 weeks thereafter until the cessation of lactation (18-24 mo).

Milk Composition Samples of colostrum (at 48 hours postpartum) and milk every 2 months during lactation (but not during volume determinations) will be obtained by hand or by a manual breast pump. Attention will be paid to designing appropriate sampling protocols. Milk will be analyzed for total lipid, sterols, cholesterol, fatty acids, osmolarity, dry solids, total and non-protein nitrogen, lactose, lactalbumin (133), transferrin (134), lactoferrin (135), zinc-binding protein (136), secretory IgA (137) and amino acids.

SOCIAL COMPETENCE ASSESSMENT

This aspect of the research program will involve all households in the study population rather than a selected subsample. From a Western cultural perspective a number of "social competence indicators" are already measured in the "independent" and "outcome" variables. That is, it could be argued that getting enough food to satisfy physiologic requirements or maintaining sanitary conditions in the home, with reduced infectious disease in family members, are indicators of social competence.

On the other hand, all groups have locally-defined norms of valued social behavior, which may only partially coincide with such behavioral measures. Therefore, social competence must be defined in locally-meaningful units of behavior and evaluation.

The identification and measurement of culturally-meaningful "social competence" will be carried out through several, related research operations, based on the following principles:

a. Data should include both direct behavioral observations and indirect "clinical" or "panel" assessments.

b. Locally relevant and meaningful units of observation and analysis should be used.

c. Procedures of randomization, inter-rater reliability checks, and other standard safeguards must be employed to preserve data from "observer contamination." (11)

First, a small sample of key informants (ea. 5 women and 5 men) will be selected to represent different social groups within the community. These people will be interviewed with semi-structured schedules to elicit from them the qualities, and characteristics of social competence. The composite "profile" will then be informally checked with other community members.

Following this exercise two types o operations will be performed: 1) direct behavioral observation, to assess the frequency of socially-valued behaviors, and 2) rating of individuals by a panel of "local experts."

For the first operation the household observations by the technical aides will be the first source of data. However, it is anticipated that an additional observation schedule will be necessary.

The second technique, using local people to rate their peers, has proven to be a reliable and useful tool in a number of contexts. For example, DeWalt obtained ratings from key informants concerning social competence categories in a mixed Indian-Mexico community northwest of Mexico City (19). Needless to say, it is important to handle this procedure with care and sensitivity.

PHASE IV. FOOD SUPPLEMENTATION STUDY OF PREGNANT AND LACTATING WOMEN

Rationale for the Study

In this research program we are proposing a range of types of observations from fully "naturalistic" to more structured situations to one in which a key variable is experimentally manipulated to alter its value.

Observations of work, activity schedules, disease episodes, and food intake represent the fully "naturalistic" end of the continuum. These behaviors and conditions of interest are simply observed and recorded as they occur in the "real life" conditions of the community.

For some variables of interest it is impractical to wait for sufficient numbers of behaviors to occur in order to make a measurement or it is too difficult to assess the postulated underlying condition from observation alone. In these situations surrogates for behavior are utilized--the cognitive and perceptual tests represent this middle part of the continuum.

In some situations, however, the original variables are so closely related and their interaction effects are so great that the most efficient way to study the hypothesized processes is by actually intervening and changing the "value" of the variable you are interested in. However, the drawback to this approach is that the process of intervention itself changes the context of the situation within which the proposed relationships had existed; therefore, the elicited change within the system may not necessarily have been entirely due to a change in the experimental variable. But, in the matter of reproduction and malnutrition we feel there is much to be gained by adopting this approach in addition to other research modes.

Differences in behavior that parallel intake differences provide important evidence about the role of nutrition in explaining these behavioral differences. However, we cannot be sure given the context of life in a community like Epatlan that other factors whose effects cannot be simply statistically "partialled out" are not responsible for the observed differences. For example, it is very likely that differences in maternal activity and responsibilities will be altered in households with fully adequate nutrient intakes because of their capacity to hire additional labor at very low cost. The ethnographic context suggests that these changes do not occur in a linear fashion so that statistical manipulation will not allow us to unravel the interaction effects. Furthermore, it is important to point out that in the similar environmental context of Tezonteopan food supplementation not only increased the nutrient intake of women and infants to adequate levels but, also produced behaviors that were new in the community.

We believe that the need to include an experimental component within a research design is necessary not only for studying reproductive functioning, but also for all the other areas of functional research as well (e.g. activity, cognitive, disease, etc.). We recognize that it is beyond the capacity of any single project to explore these relationships. We would hope that those other areas would be addressed inthe other projects within the CRSP mandate

Protocol for Food Supplementation Study

Phase IV of the research program involves supplemental feeding of pregnant and lactating women. Chavez (124) has developed a protocol (used in the Tezonteopan study) in which women who became pregnant were supplemented with 64 g/day powdered half skim milk from the 45th day of pregnancy, and 96 g/day of powdered whole milk during lactation.. Vitamin and iron supplements were also consumed. This supplementation program resulted in an additional gain of 3.4 kg in pregnancy; birth weights were increased by 180 g; a new pregnancy or menstruation occurred in 7.5 months compared to 14.0 months. Infants were also supplemented from the 12th week with milk bottles, baby foods and iron. Supplemented infants showed a greater increase in body size and most anthropometric measurements starting from birth to 4 months, and these increases were substantially greater by 7 months.

It is not clear from the Tezonteopan study whether the observed effects seen on the reestablishment of menstruation and infant growth were due to maternal supplementation or to infant supplementation. In order to establish that relationship we, in contrast, propose to supplement the mothers but not their infants.

The subjects for this study will consist of all women who become pregnant during project year 3 in the 160 household sample. The data collected and schedule of collection will be the same as those described in Phase III under the Reproductive Competence section. The research protocol will differ only in that each women will be provided with a daily food supplement consisting of an enriched, milk-based formula (300 kcal/day).

The problem of intestinal lactase difficiency has been investigated in Mexico and shows that lactase difficiency is not a problem in the majority of individuals if 2 or more glasses of milk are offered at 12 hour intervals (138). The formula would be distributed by the community aides to the women in their homes, and their intake carefully recorded. One of the main concerns in a supplementation program of this type is to be sure that the additional food is, in fact, a "supplement" and does not merely replace a similar proportion of the normal diet. We believe that we are in an excellent position to monitor and quantify this replacement phenomenon should it occur since all of these women's dietary intake will have been monitored for the previous two years via their inclusion as household members in the ongoing Health and Nutrition Study. In addition, many of these women will have been previously pregnant during project year one so that we will have an opportunity to make comparisons between pregnancies with the same individuals.

DATA ANALYSIS

The various phases of this research project require the accumulation of a very extensive and complex data array. In all phases of research there will be combinations of qualitative and quantitative materials, so that the bare bones of statistical analysis can be supported by case examples, descriptive analysis of socio-cultural and nutritional contexts, and other kinds of non-numerical rapport.

At the same time, all phases of research will, of course, involve the production of numerical data. Nutrient intake will eventually be expressed as units per kilogram body weight. Qualitative observations such as behavioral data, illness episode symptomatology, and clinical signs will be converted into ratings, scores, and frequencies. In fact, a key part of this research involves transformation of naturalistic behavior (performance of routine tasks, play, social interaction) into data that can be statistically analysed. All such analysis will be carried out by using rigorous methods that have been successfully utilized in rural, naturalistic surroundings (11, 139). Portions of social competence assessment may require the use of "unobtrusive measures," as outlined by Webb, Campbell, Schwartz, and Sechrest (140). Biomedical and anthropometric data will be quantitative and hence useable without modification.

As described in connection with individual research operations above, randomization of observations will be used whenever possible in order to enhance the representativeness and statistical credibility of numerical data.

Aggregation and Simplification of Data

Some of the data operations will result in large numbers of individual data bits, which will be far too numerous for separate statistical analysis of each item. The aggregation and organization of these data will include the following forms:

1) Development of Scales and Scores Concepts or conceptual clusters such as "material style of life," "household sanitation," and "social support network," will be developed from groups of items whose internal consistency can be assessed by means of item analysis and related techniques. For example, a "material style of life" scale may involve the aggregation of 10-15 separate items (items of property ownership, land, access to resources, etc.). Guttman scalogram techniques may also be useful in developing adequate ordinal measures of this type of variable (11).

2) Factor Analysis and Multidimensional Scaling Data reduction from a large matrix of items has traditionally been carried out by means of factor analysis. Both orthogonal and oblique rotation solutions have proven successful, in given instances, for identifying the statistically coherent dimensions in large composites of data (141). When factor analysis produces a small set of relatively clear-cut factors from a large number of independent items (with adequate eigen values and credible communalities) the factor scores of individual persons may be used as composite variables encompassing a large number of items from an interview or battery of tests.

More recently, however, it has been established that data matrices with considerable numbers of nominal and ordinal variables can be better analyzed and reduced by means of multidimensional scaling (MDS) (142). Multidimensional scaling has been particularly useful for matrices of socio-cultural data from field research in sociology and anthropology, and thus will be especially suitable to some of the data reduction processes envisaged in this project.

Univariate Statistical Analysis

There are a number of critical tests of hypotheses which take the null hypothesis form:

H_0 Energy intakes below recommendations do not lead to reductions in cognitive capacities (or psychomotor skills, or disease resistence, or....)

It will be very important to test this type of hypothesis directly, controlling for extraneous factors such as age, sex , socio-economic status. Pairwise tests of independence and measures of independent-dependent variable correlations will be carried out by means of appropriate parametric or non-parametric statistics.

Certain relationships will undoubtedly turn out to be curvilinear or linear within a limited range once a threshold level is reached. In fact, the stratified household selection process is designed to enhance the detection of such effects. Thus, an important aspect of the data analysis will be the careful search for sigmoidal or other nonlinear functional relationships.

As analysis procedes, one line of inquiry will require the definition of the statistical relationship between levels of a single independent variable (levels of nutritional adequacy) and a number of dependent variables within a functional category, for example nutritional and health status. This will be achieved by categorizing according to nutritional adequacy, measuring a number of parameters postulated to be altered by borderline nutritional adequacy, and analysis of the array by means of multivariate analysis of variance (143). This approach can be used to select, among the constellation of parameters measured, the cluster that yields the strongest relationship. In this manner a useful index of health status can be devised that is most sensitive to changes in nutritional adequacy.

On the other hand, much insight can also be gained by organizing the statistical analysis to examine the separate and cumulative predictive inputs of a series of independent variables in accounting for variance in a dependent variable. Multiple regression analysis will therefore be an important part of

statistical methodology. In a number of cases we expect that theoretical and logical propositions will make possible the use of path analysis, in which some differential sequencing and interactions of independent variables can be postulated and tested.

Use of Statistical Consultants

All of the researchers listed as major participants in this project are familiar with the main lines of statistical and analytic procedures outlined here. Chavez, Allen, Pelto, Pelto, Thomas and Finlay have all participated in large-scale, multidisciplinary research involving complex bodies of quantitative and qualitative data. They are thus capable of identifying and using appropriate statistical procedures.

Specialized statistical advice will nonetheless be of great importance to the project, especially in the early states when size of various subsamples, procedures of sample selection, and plans for scales and indices are worked out in final form. We will rely heavily on the special statistical advice of Professor Joseph Lucas, Biostatician (Agricultural Experiment Station), Professor Charles Monroe in Geography, and epidemiological advice from Dr. James E.C. Walker and the newly appointed professor of epidemiology in the Department of Community Medicine. Dr. Melgar Marcon, M.D., Ph.D.

SUBSIDIARY PROJECTS

The research program outlined above represents our response to the problems outlined during the planning workshops and described in the CRSP precis. The comprehensiveness of the CRSP program provides an opportunity to examine a number of other issues not directly addressed in the materials above. That is, it may be possible, with a small additional effort of data-gathering, to examine other theoretical and practical problems. It would seem wise to seek ways of responding to these questions provided that they do not interfere with the basic mission of the project. The two subsidiary projects briefly outlined below are offered as illustrative examples, whose feasibility and funding will be explored after the program is underway.

Energy Flow Analysis

After the collection of additional data on agricultural production practices and economics, the data on energy production, consumption and expenditure will be analyzed using an energy flow approach. (146) Questions of most interest in relation to energy flow are; 1) how changes in energy availability affect biological traits, and 2) how changes in biological traits affect the capacity to produce energy. For example, if growth rate of a population is decreased due to caloric insufficiency, or if long term debilitating disease (e.g. tuberculosis) is widespread among adults, group work capacity may be adversely affected. This requires an adjustment or change somewhere in the system. The compartmentation approach, measuring rates of energy transfer between compartments, has been widely used in understanding the complexity of natural systems. Appendix I is a simplified diagram illustrating both the energetic and economic interconnections between major research areas in this proposal. Appendix II summarizes the methods and procedures used in measuring and analyzing energy flow. Three key variables

form a basis of the energy-flow study: energy production, consumption and expenditure. Their principal value lies not only in providing estimages of the amount of energy passing through a group, but also in assessing the manner in which it is utilized.

If a group is to maintain itself in an area, energy production or acquisition (food) must exceed the total energy expended by its members. Thus, for each unit of energy expended, greater than one energy unit must be acquired. This ratio of energy production over energy expenditure has been referred to as "energetic efficiency." It serves as a convenient base for: (1) assessing the overall adaptiveness of a group to the energy-flow system(s), and (2) identifying specific responses that contribute to this adapted state.

The concept of "adaptation to the flow system" suggests that hypocaloric stress is effectively counteracted and that energy produced is being utilized in an efficient manner. It is therefore possible to regard adaptation under limiting conditions as a strategy that attempts to minimize long-term energetic efficiency (energy production/energy expenditure). The assessment of specific adjustments to energy flow may be approached in the same way. If alternative responses or strategies are available to a group, those with the highest long-term energetic efficiency may be ragarded as the most adaptive, since higher energetic efficiency generally makes serious hypocaloric stress less likely. Such a definition does not imply causation, simply a functional relationship.

Caloric values can be assigned to most bio-behavioral phenomena and their influence quantitatively assessed. Such quantification permits comparisons on a number of levels: i) comparisons can be made among the energy costs of biological processes such as growth, pregnancy, lactation, energy storage, and alternative locomotive patterns and adjustments to stressors; ii) Intra-group comparisons between adaptive strategy alternatives to deficits in caloric intake can be carried out for a wide range of behavioral and biological responses. Comparisons between the energetic consequences of technological alternatives, activity patterns, division of labor, exchange patterns, family size and composition, and biological characteristics are possible.

When simulation modeling techniques are applied to the analysis of an energy flow system it is possible to evaluate the systemic consequence of alternative courses of action. Thus, the consequences of various degrees of nutritional supplementation can be modelled as can improved health facilities which are expected to reduce morbidity and mortality. Thus, simulation is useful in experimental manipulation which is not feasible in the real system. Above all, it forces investigators to make explicit assumptions about the nature of the system and to formalize how components interact. This is frequently a source of confusion in interdisciplinary studies. When a system is developed in the context of planned intervention, a variety of specialists, managers, community representatives and decision makers responsible for the program can assist in the construction, modification and validation of the model. Hence, the model is primarily useful as an ongoing device for self instruction as to the possible consequences of alternative policies and responses.

Functional Competence of the Elderly

This substudy is an examination of the [illegible] of survivors to determine whether or not they constitute a homogeneous group and to determine whether or not they differ in any systematic way from the younger adult population which, presumably, will be more diverse and heterogeneous. The research strategy is to study intensively the 100 oldest persons from the town by comprehensively examining the ten domains listed below. In the first five areas, data will be collected in an identical manner as for the younger adult population so that we will have a basis for comparison. The second list constitutes five areas of investigation unique to the elderly.

Domains common to the larger study include; 1) demongraphy, 2) medical/disease, 3) nutrition, 4) social competence, and 5) cognitive functioning.

Domains unique to the elderly include; 1) ethnographic data gathered to examine the status and roles of the elderly so that comparisons may be made to the characteristics of the elderly from other non-industrialized towns (146,148,149,150). Opinions regarding the determinants of longevity also will be gathered from both the elderly and younger adults, 2) the genetic correlates of longevity will be examined by gathering data on the life-spans of all blood relatives of the elderly and non-related families (151), 3) data on the causes of death for adults in the society will be determined, as best as is possible, from local records for the past 20 years, 4) biological markers of aging (140,152,153) will be obtained to compare the chronological age at which they are observed in the town with data from industrialized societies, and 5) data on the personality and emotional characteristics of the survivors will be gathered to examine the suggestions of Gutmann (149) and Simmons (150) regarding the role of personality characteristics in survival. The "life-review" technique also will be used to look for signs of positive/negative orientation; stress; and personal integration.

The significance of this substudy stems from: 1) the comprehensive data it will yield on the elderly in a Spanish-speaking population. No data of this nature currently exist (147,148); 2) the opportunity it provides to gather data on an understudied group of surviving elderly -- those who have suffered malnutrition -- and to be able to compare them to younger adults in their society; and 3) the opportunity it provides to focus on the cummulative effects of malnutrition as they interact with the normal aging processes.

ETHICAL ISSUES

This research proposal in this program has been designed to minimize intrusions on individuals, households and the community. The research instruments will be designed to protect the cultural integrity of the community. One criterion in the selection of investigators was their previous experience in Mexico or Central America and ability in the Spanish language. Their familiarity with Mexican cultural history further facilitates sensitivity to the community and its needs. Major ethical considerations are outlined below:

1) Dr. Chavez and his colleagues will convey potential risks and benefits to both individuals and the community. Informed consent will be requested of all participants in the presence of a community witness. Individual privacy will be preserved in the standard manner using randomly chosen identification numbers.

2) All individuals in the community will be allowed access to the clinic and its facilities, regardless of their participation in the study.

3) Individuals will be free to drop from the study at any time and will incur no adverse consequences by doing so. Ability to use clinic resources will be retained by these persons.

4) Care has been taken to plan the study in phases in order to gain the confidence and understanding of the community. For example, Phase I of the study will be brief and relatively non-invasive. In Phase II, community aides will be permanently assigned to households and will be used to introduce the technical aides. In Phase III, the sample population has been divided into subgroups, each of which will be subjected to more intensive study. Additional informed consent will be obtained prior to starting this Phase. By this time, subjects will have become more familiar with the field personnel. The use of subgroups is intended to ensure that the amount of data collected from any one household is not excessive. Supplementation does not begin until later in the study; at this point, supplements will be provided for all women during pregnancy and lactation. No woman will be coerced into taking the supplement. Any individual who requests it will be provided with supplement, however, our experience in Tezonteopan suggests that the number of these requests will be insignificant.

5) Collection of blood samples will be kept to a minimum. No coercion will be used to persuade subjects to provide blood. Acquisition of blood samples is not anticipated to be a problem in this community.

6) Following the pattern established by Dr. Chavez in Tezonteopan and other research sites, some medical services will be available at the clinic/research center. Additionally, referrals to medical facilities will be made, and program staff will facilitate the keeping of these appointments by offering communication and transportation services when necessary.

7) At the end of the study, the research report will be available to the community, together with suggestions for change and the anticipated consequences of those changes. The health clinic and equipment will be donated to the community and INN.

All research protocols must be approved by the Human Use Committees at all sub-contracting instutions (including INN) and the University of Connecticut.

If the conduct of research and ethical procautions are standardized across CRSP projects, those guidelines will be followed.

IGNIFICANCE AND LONG TERM BENEFITS OF THE RESEARCH

While this project has been designed to preserve the natural stability of the community under study, long range benefits will be enjoyed by the community, the Mexican nation, and the academic institutions in both Mexico and the United States. At the community level, the project will bequeath the clinic and its facilities to the people of Epatlan. Professional medical advice will be provided throughout the study. The presence of the clinic facilities will hopefully increase the chances of continuing work and medical care in this community after the project has terminated. Some employment will be provided for individuals in the community during the project. The community aides will acquire valuable skills that may lead to educational advancement. The findings of the research team will be explained to the community, with emphasis placed on the feasible changes which would be most beneficial.

Certain benefits will accrue to INN and associated agencies. Laboratory and field testing devices will be donated and will provide modern equipment beyond the scope of their present budget. Laboratory technicians will receive training in state-of-the-art techniques under expert supervision. Data-gathering tools will be refined in early stages of the project, and will be available for future research projects.

A project of this magnitude will focus national attention on nutritional issues and could lead to substantial large scale committment to meeting nutritional needs. The focus on the effect of marginal malnutrition on performance is anticipated to be of interest to the Mexican government, and to governments on a world-wide basis. The data to be obtained may provide a foundation for nutrition and health planning.

From the viewpoint of the United States personnel, this proposal represents a much-needed opportunity to use a multi-disciplinary approach to examine the complex relationship between nutritional status and function.

Effective multi-disciplinary research is expensive and not easily achieved. Thus, the program outlined above represents a unique opportunity for U.S. researchers to work together, in collaboration with colleagues from Mexico on a project that has far-reaching implications for theoretical developments in nutritional, medical, and social sciences, as well as practical implications for health and nutrition planning.

ADDENDUM ON DATA MANAGEMENT AND DATA ANALYSIS: TITLE XII NUTRITION PROJECT IN MEXICO

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This report is organized in two parts. The first part lays out the major issues concerning data-gathering, mamagement and analysis, outlining the problems that have to be solved. The second part describes our organizational (and operational) solutions to them. This should be regarded as a preliminary statement, subject to discussion and revision.

Part I. Principles and Problems of Data Management.

Three crucial areas must be managed effectively if a complex, multidisciplinary project is to achieve its purposes:

A. Field management of the data-gathering process.

B. Organization of data processing, including cataloging, coding, keypunching and development of computerized data files.

C. Statistical analysis of data in a theoretically sophisticated and responsible manner.

Needless to say, each of these areas is conceptually only partially distinct and there are important interrelationships among them. Thus, the initial design of the data-gathering instruments requires detailed planning concerning data analysis procedures, including the organization of data for computerized analysis. This, in turn, should be planned with foresight concerning the types of statistical analyses that will be carried out. In the following section we will discuss organizational procedures to facilitate the coordination of the three sectors.

A. Field Management of the data-gathering process.

Community-based fieldwork poses serious problems of maintaining amicable and productive relationships in the research community and, at the same time, devising locally-specific strategies for samples, scheduling different research procedures, developing effective means for standardizing behavioral observations, and establishing appropriate laboratory conditions.

The nutrition project in Epatlan will require carefully orchestrated communication between the Mexican researchers and the several different contingents of North American investigators. A major feature of the research design is that the data gathered by different researchers (representing different disciplines) will be

Addendum (cont.)

fitted together in the data analysis. However, to some extent, there are quasi discrete operations of data-gathering. In field management terms this requires a highly competent and skilled field manager (see below). It a so requires communication among the several different components, so that everyone is fully appraised about the scheduling of data-gathering activities and knows, in detail, the specifics of each data-set.

B. Organization of data-processing.

Before considering the details of data-management, a general feature of the project must be reiterated. As expressed above, the coordination of data from different disciplines, gathered by different researchers, is both a major strength and a major problem for the management of the project. Consider, for example, the test of a hypothesis that relates a dietary intake variable to a variable measuring cognitive capacity, with consideration of a health status variable as an intervening variable. No such hypothesis can be tested until:

a) three different research components have organized, coded and keypunched their data

b) the three data packages have been brought together in the hands of a data analyst.

The following principles will be used to guide the organization of data processing:

1. The management of data processing must be the responsibility of a single individual with experience and training in data management, detailed knowledge of the day-to-day operations of data gathering in the field, and academic qualifications in nutrition - the "parent" discipline of the project.

2. The principal investigators must take a major responsibility for insuring rapid preparation and communication of the data.

3. The sharing of data among research teams will require agreements concerning co-ownership of data, co-authorship of publications, and so on.

4. The principal investigators must assume major responsibility for fair and equitable data-sharing practices.

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5. The data management and preparation should be carried out in Mexico, involving training of Mexican research staff and collaboration with Mexican data-management personnel.

6. The preparation and organization of data must be done in such a way that the next phase, statistical analysis, can be carried out at more than one site. That is, data banks have to be transportable and compatible.

C. Statistical analysis.

The analysis of the data from the project will be carried out in a number of different ways. Some procedures can be effectively carried out with only 2 or 3 different data pools; each set of data will also require its own internal analysis. However, many procedures will require the use of large numbers of variables concurrently, thus aggregating several data pools.

The several different kinds of data analysis procedures call for different statistical approaches. To some extent the appropriate statistical procedures for the different operations are affected by the "cultural customs and norms" of different disciplines. For example, analysis of variance techniques are commonly used by psychologists, while some form of multiple regression analysis may be more appropriate from the perspective of the nutrition-anthropology team.

In the "statistical analysis" component of data management and analysis, the following principles will guide our organization:

1. Different sub-teams or disciplinary groups are likely to need the services of statistical advisors and consultants in different ways, and at different times.

2. It will be important to have more than one source of statistical advising.

3. The principal investigators will need statistical advice both in their own data analysis and in participating in decisions about the analyses of the affiliated researchers.

4. One individual in the research team must be responsible for coordinating statistical advisors and statistical operations. This individual must be familiar with the theoretical and philosophical issues in data analysis in the various disciplines and be able to communicate with both statistical advisors and the various members of the research team.

Addendum (cont.)

Part II. Organization of Data Management.

To make the principles outlined above operational we intend to designate one individual as the principal manager for each of the three components. The principal investigators will assume responsibility for the overall management and coordination of these three components as well as taking responsibility for specific data sets. The individuals responsible for the main data management components are already budgeted and specified in the original proposal. The following is intended as am amplification.

Position A. Field manager of the data-gathering operations.

As specified in the proposal, this is budgeted as a full-time position, under the title: Director of Field Clinic. (Position A.L. in the "Detailed Budget for the First Twelve Month Period, Mexico Subcontract"). This individual should be a Mexican National with previous experience in rural communities and a strong interest in research. Since this individual will also be responsible for the research center clinic he/she should have medical training. In the proposal this position is designated for an M.D. However, it could possibly be filled by an experienced nurse practitioner or public health nurse.

The person responsible for on-going data collection in the field must live full time in the research community and be responsible for over-seeing the day-to-day activities of the research staff, including all local assistants. In the initial stages of the research, the principal investigators will work closely with this member of the team to establish good procedures of data-collection management and to develop procedures for training and maintaining research skills of the staff. The Director of the Field Clinic will also work closely with the Mexico-city based data manager-project coordinator, as well as maintaining close ties with Dr. Chavez.

To date the individual to fill this position has not been identified. Dr. Martha Fernandez, a medical consultant to the project, has agreed to help us identify candidates, based on her national network of contacts with physicians in rural health centers. Other possible candidates are personnel from INN who have worked on previous projects.

Position B. Data manager-coordinator.

As outlined above, this individual must meet the following criteria:

1. Experience and training in data management.
2. Academic qualifications in nutrition.
3. Detailed knowledge of the data-gathering in the field.

We have an outstanding candidate for this position, and his resume is attached to this statement. The senior members of the research team at Connecticut have much respect for, and confidence in, the capabilities of Mr. Wood, who will complete his Ph.D. in the Department of Nutritional Sciences by January, 1980. In addition to meeting the above criteria, Mr. Wood is fully conversant with the underlying philosophy and approach that we have taken in this proposal. He is dedicated to the concept of integrated nutrition research and has a strong commitment to the theoretical development of this approach. Moreover, his graduate training and experience has provided him with the tools to facilitate such research. His reading knowledge of Spanish is good, but he will need further work to develop his verbal fluency. He is committed to living and working in Mexico for the duration of the project. In addition to his organizational and data management skills, his steady even temperament and personal style will greatly facilitate the success of the work.

Mr. Wood will work in close collaboration with the Field Director and will make frequent trips (at least two/week) to the field site. His major responsibilities, however, will be at the Institute in Mexico City where he will supervise and coordinate the activities of the data management staff, specifically the data coders, computers operators, and so on. In coordination with Dr. Chavez, he will also coordinate the work of the laboratory assistants.

Position C. Coordinator of statistical analysis.

Once the management of data transformation (from field observations and measurement to computer cards and tapes) is successfully established, the other major data management task is statistical analysis. The management of this task requires high level theoretical capabilities and skill in communicating across disciplines. As noted above, some features of data analysis will be done within a data set (e.g. descriptive analysis of the dietary intake and nutritional status data). However, much of it will involve cross-disciplinary data sets, with data bases of varying si The individual who has responsibility for this difficult coordination task must have

Addendum (cont.)

experience in data analysis of multi-disciplinary nature and a strong foundation in theories of data analysis. We feel that a senior member of our research team (Dr. P.J. Pelto), who has 15 years of experience in directing or participating in large-scale, multidisciplinary projects is in the best position to assume this responsibility. For this reason, he is written in for 10% time (matching) after his initial full-time involvement in the summer of year one. His C.V. was attached to the original proposal; a more detailed description of his experience with inter-disciplinary data management is included at the end of the Addendum.

Professor Pelto will maintain sole surveillance of the data-processing tasks and will seek expert opinion on statistical procedures for the various parts of data analysis. He will establish an informal committee of statistical advisers from the considerable body of expertise available at the University of Connecticut and whatever additional outside consultants may be deemed necessary. From the Connecticut campuses, the following people will be regularly consulted:

1. Professor Kenneth Hadden. Department of Agricultural Economics and Rural Sociology. A demographer by training, Professor Hadden is a specialist in data reduction techniques and in multivariate analysis. He has previously served as a statistical consultant to several health-related projects in Third World countires undertaken by people at the University of Connecticut.

2. Professor Joseph Lucas. As described in the original proposal, Professor Lucas (Agricultural Economics and Rural Sociology) is committed for 20% time (matching). His C.V. is included in the original proposal; he is a biostatistician, with interest and expertise in experimental design and the application of statistics to biological problems.

3. Professor Gary Granden of the Data Processing Center. Professor Granden is a specialist in the use of statistical program packages, and in the past has worked closely with faculty and students from Nutritional Sciences and from Anthropology.

4. Professor Charles Monroe. A medical geographer by training, Professor Monroe is an expert in systems modelling and computer simulation. Like Professor Granden he has been very generous with his time and very helpful to the principal

Addendum (cont.)

investigators (and their students) and has indicated his interest and willingness to provide assistance in this project.

5. Epidemiologist from the Department of Community Medicine

Dr. Holgar Hansen, M.D., Ph.D., epidemiologist in the Department of Community Medicine, has agreed to serve as the epidemiologist-consultant for this project, and the Department Head (James E.C. Walker) supports and approves this collaboration.

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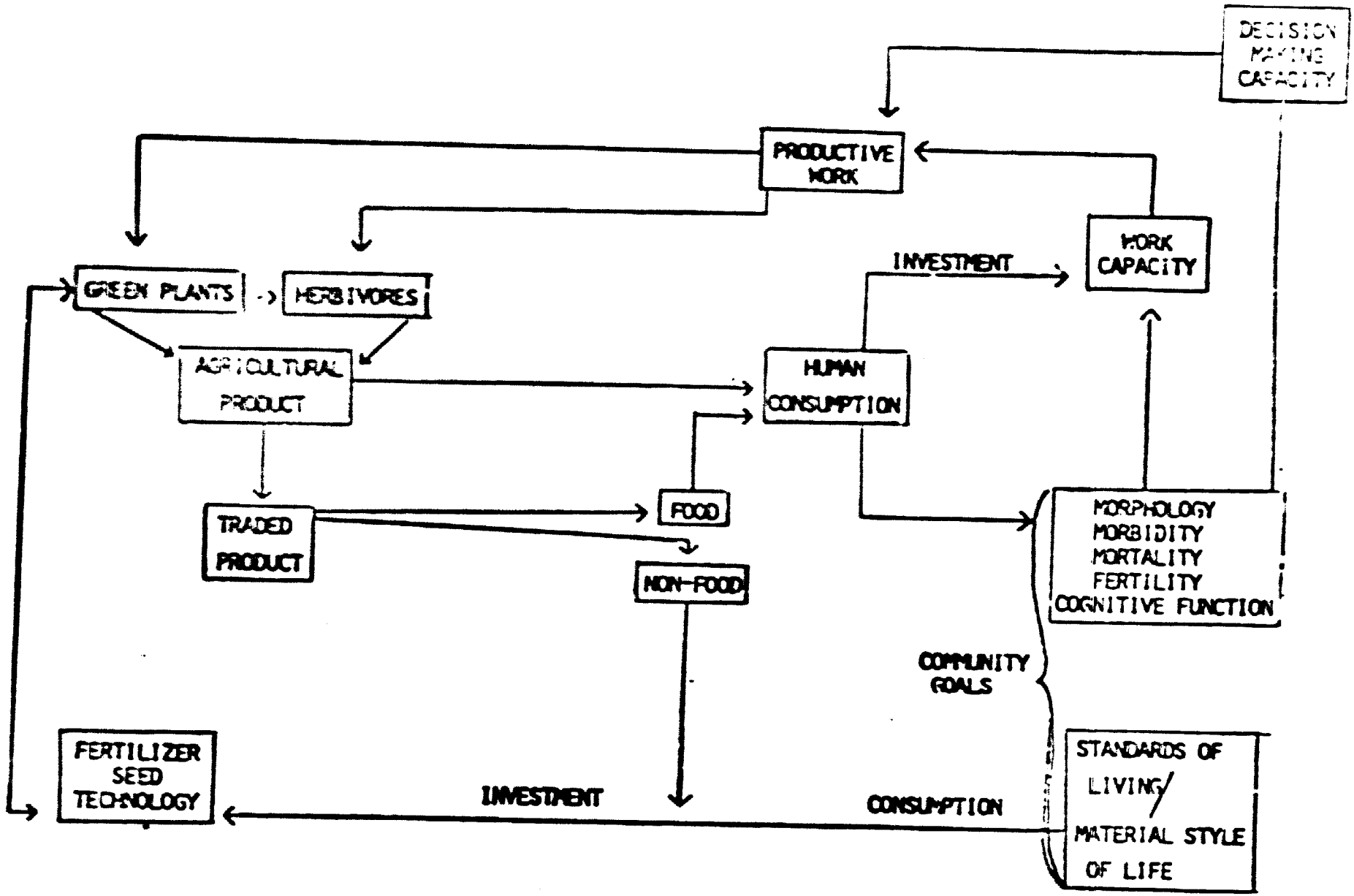
APPENDIX 1

ENERGETIC AND ECONOMIC INTERCONNECTIONS BETWEEN RESEARCH AREAS



Methods and Procedures Used in Measuring and Analyzing Energy Flow

I. Energy production.

A. Collection of data.

1. Regional survey of production.
2. Questionnaires and conversations concerning production techniques.
3. Direct measurement,

a. of production per land unit of animal, per time unit.
b. of food stores.
c. of wastage and loss preceding consumption.

B. Conversion of caloric values.

C. Evaluation of the measurement period.

1. Representativeness of annual production.
2. Annual variability in production.

II. Energy consumption.

A. Collection of data.

1. Weighing of food consumed.
2. Questionnaires concerning food use.
3. Daily recording of food items consumed.

B. Conversion to caloric values.

C. Establishment of consumption by sex-age group.

D. Evaluation of the adequacy of energy consumpti

1. Comparison with international standards.
2. Presence of deficiency-related symptoms.
3. Indicators of caloric balance.

III. Energy expenditure.

A. Survey of daily activity pattern.

B. Determination of key activities.

1. Importance in subsistence pattern.
2. Extent to which activity is relied on.
3. Performance effort necessary.

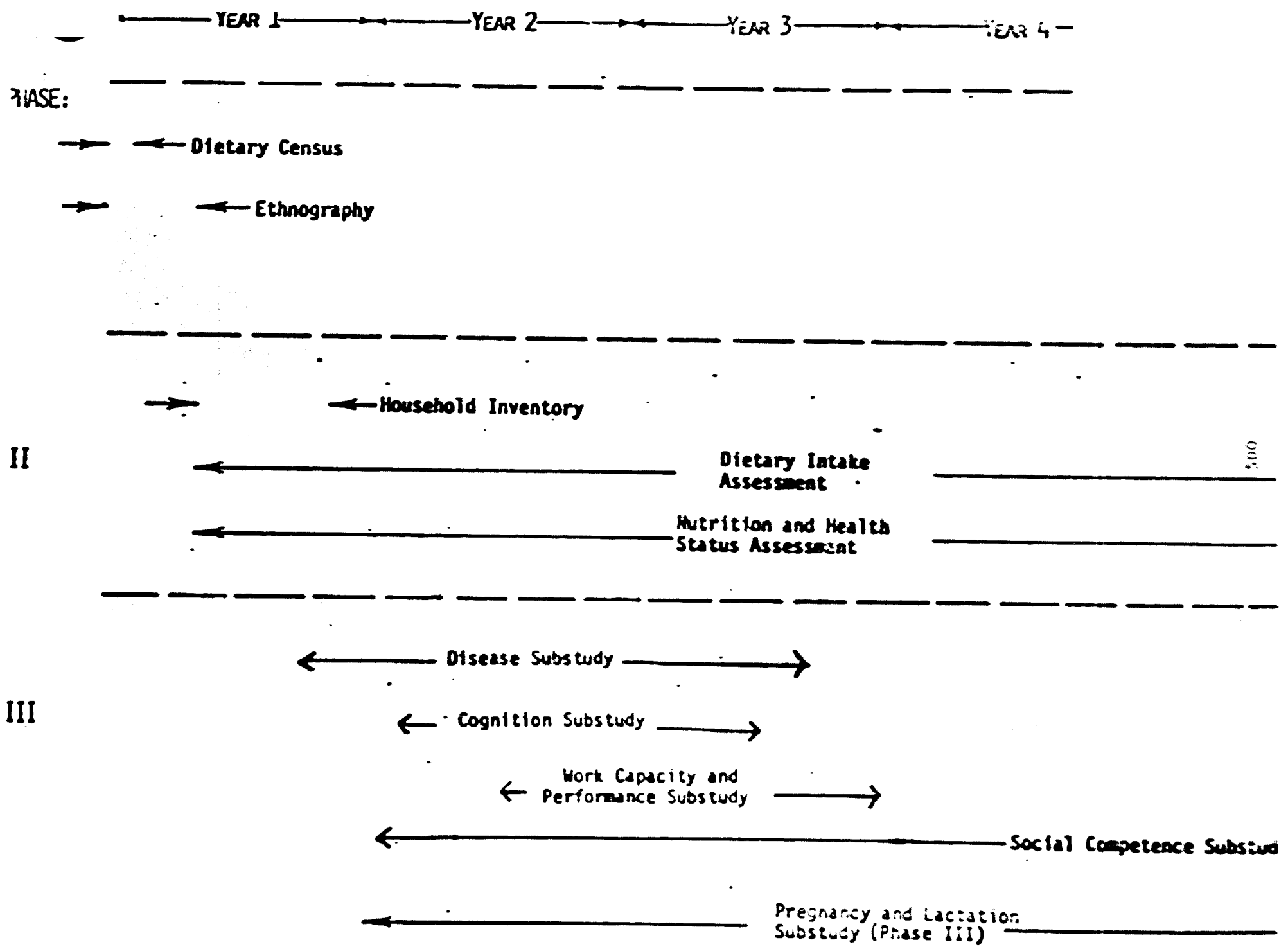
C. Testing procedures based on indirect calorimetry.

1. In field measurements.
2. Under standardized testing conditions.

D. Estimation of the energy cost of activities not examined.

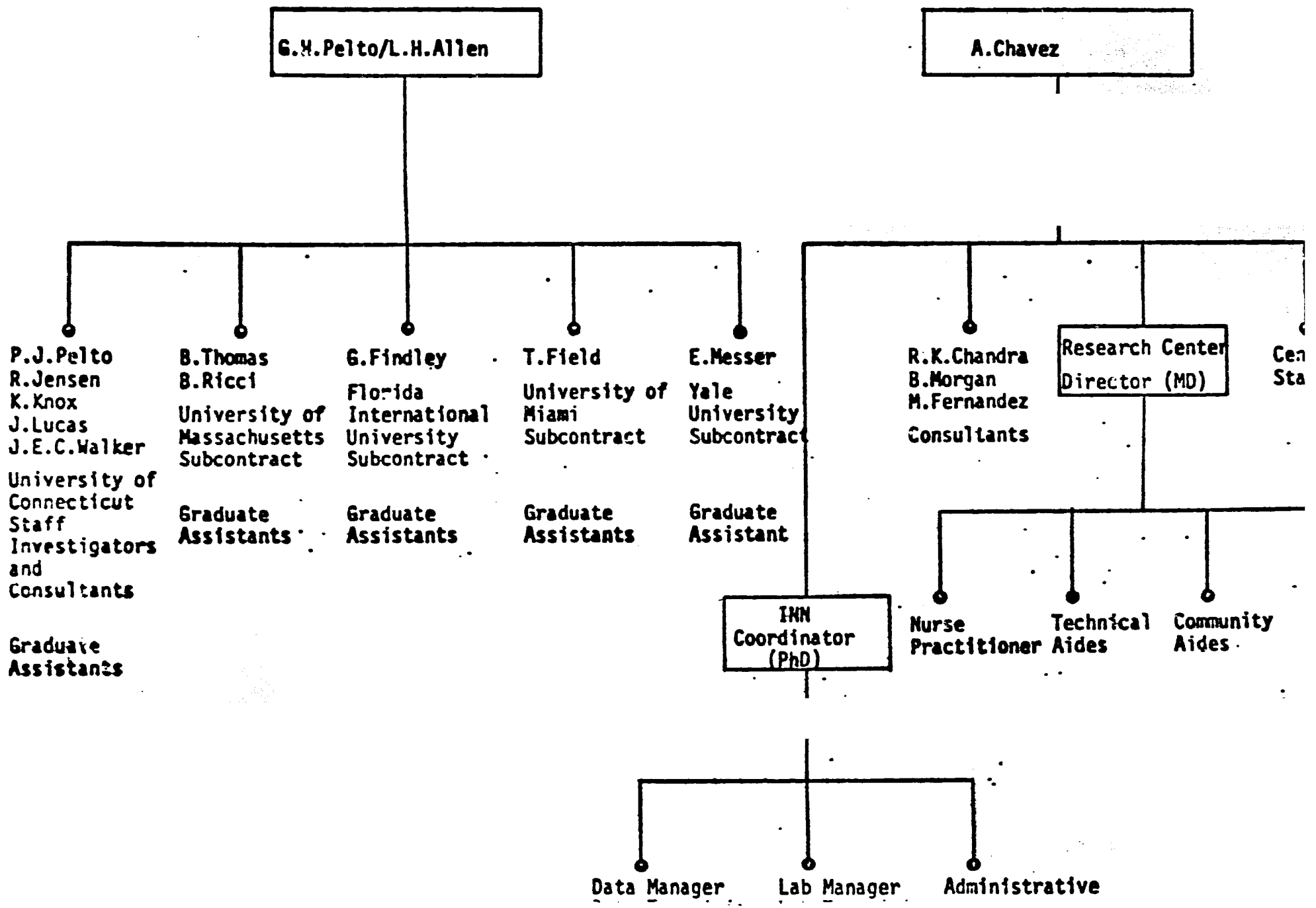
E. Time-motion studies.

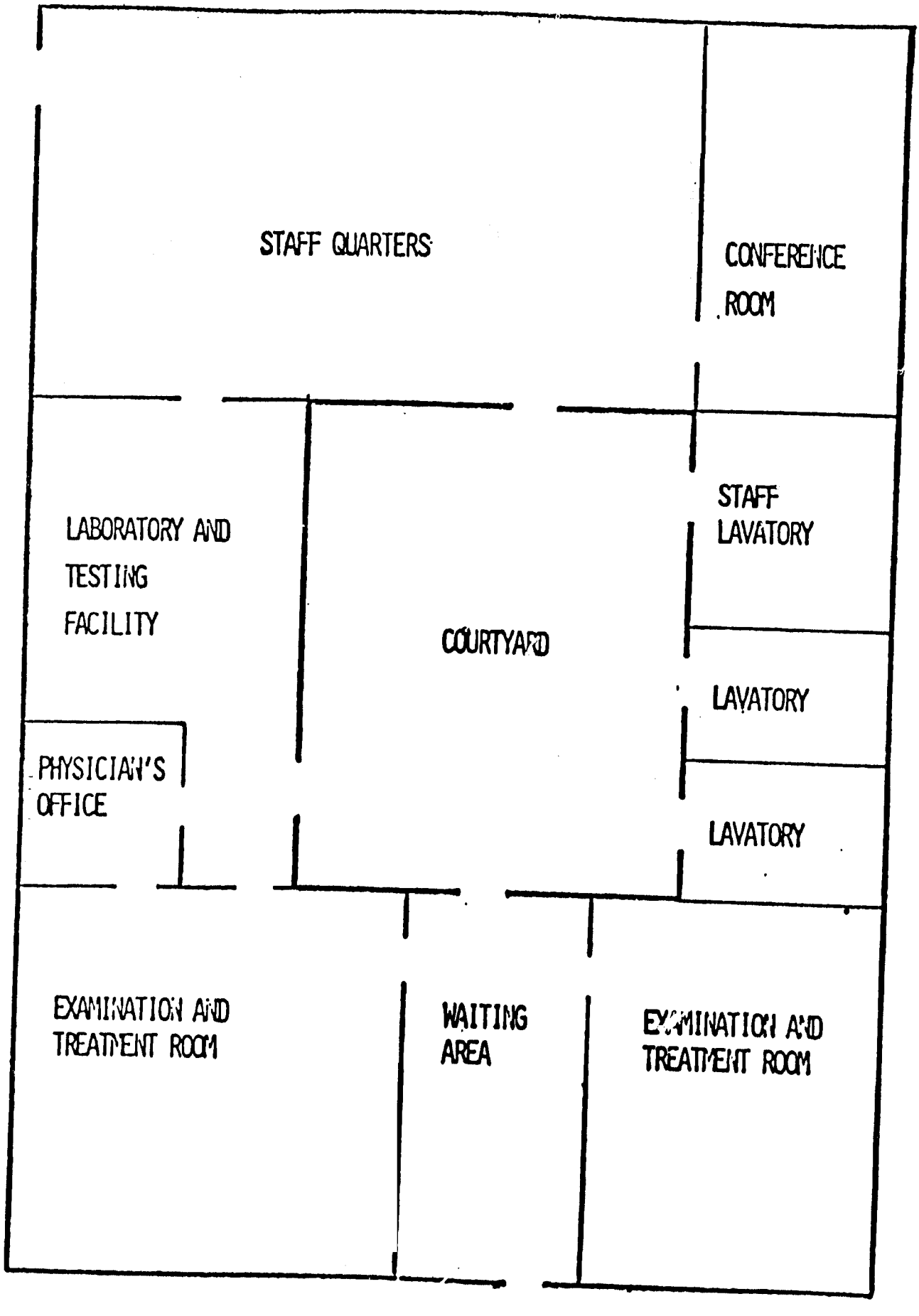
F. Assessment of physiological strain in performing activities.


YEAR 1
YEAR 2
YEAR 3
YEAR 4
PHASE:
Dietary Census
Ethnography
Household Inventory
II
Dietary Intake Assessment
Nutrition and Health Status Assessment
Disease Substudy
III
Cognition Substudy
Work Capacity and Performance Substudy
Social Competence Substud
Pregnancy and Lactation Substudy (Phase III)

APPENDIX IV

ORGANIZATIONAL STRUCTURE




STAFF QUARTERS
CONFERENCE ROOM
LABORATORY AND TESTING FACILITY
COURTYARD
STAFF LAVATORY
LAVATORY
PHYSICIAN'S OFFICE
LAVATORY
EXAMINATION AND TREATMENT ROOM
WAITING AREA
EXAMINATION AND TREATMENT ROOM

RESUME

Richard James Wood

Address: [redacted]

Field of Specialization: Community Nutrition; Nutritional Status Assessment: Nutritional Biochemistry; Protein Metabolism.

Date of Birth: [redacted]

Place of Birth: [redacted]

Education:

Boston University, B.A. in Biology, 1972

University of Connecticut, M.S. in Nutritional Sciences, 1977.

Massachusetts Institute of Technology, International Nutrition Program, 1977.

University of Connecticut, Ph.D. in Nutritional Biochemistry, 1980.

Marital Status: Married
One child, age 6

Language Proficiency: Spanish (read), Hebrew.

Skills

Dietary: 24-hour recalls
food histories
food diaries, weighed food intake

Anthropometry: height, weight, skinfolds, circumferences, hair root analysis

Biochemical: atomic absorption spectrophotometry
GLC
TLC
electrophoresis
radioimmune assay

Skills (cont.)

Biochemical (cont.)

liquid scintillation and gamma counting
autoanalyzer
food composition analysis
kinetic analysis
bomb calorimetry
Kjeldahl analysis
dry and wet ashing
diet formulation
fluorometric analysis
column chromatrography
ultracentrifugation

Interviewing: structured and open-ended questionnaires.

Statistics: analysis of variance, linear and curvilinear regression, multiple regression and correlational analysis, covariant analysis, factor and path analysis, stepwise discriminant analysis.

Computer: coding of socioeconomic, dietary, anthropometric and biochemical data
structured programming
plotting
flow charting
data reduction
Fortran
PL1
SPSS
BMD

Research Projects:

Community/Human Nutrition:

(1) Evaluation of the nutritional status of pregnant women in the Women, Infants, and Childrens Program (WIC).

(2) Changes in body composition of lactating and non-lactinting mothers.

(3) Effects of maternal weight gain and smoking on the neruological development of the newborn.

(4) Studies in protein-induced hypercalciuria.

Research Projects (cont.)

(5) Health and nutrition survey of residents of Northeastern Connecticut

(6) Assessment of the zinc status of preschool children in Northeastern Connecticut.

(7) Nutrition education for migrant children.

Animal Nutrition:

(1) Long-term effects of various dietary protein levels on skeletal development in the hamster.

(2) Role of insulin in protein-induced hypercalciuria.

(3) Evaluation of the relative biological availability of various iron fortification compounds.

Awards and Fellowships:

1979 - Lloyd Matterson Scholarship Award
(most promising graduate student in Nutritional Sciences)

1979 - Doctoral Dissertation Fellowship

1978 - Summer Research Fellowship

1977 - Predoctoral Fellowship

Professional Societies:

Sigma Xi
Gamma Delta Sigma

Publications:

Shippee, R.L., P.E. Stake, K.L. Hermayer and R.J. Wood. Tissue Zinc, Cadmium and Copper Ratios of Hens Fed Graded Levels of Zinc and Cadmium. Fed. Proc. 36(3):1176, (1977).

Resume of Richard J. Wood

Wood, R.J., P.E. Stake, J.H. Eiseman, R.L. Shippee, E.L. Welski, and Uwe Koehn. Effects of Heat and Pressure Processing on the Relative Biological Value of Selected Dietary Supplemental Inorganic Iron Salts as Determined by Chick Hemoglobin Repletion Assay. J. Nutr. 108(9):1477-1484, (1978).

Block, G., R.J. Wood and L.H. Allen. A Comparison of the Effects of Feeding Sulfur Amino Acids and Protein on Urine Calcium in Man. Presented at USDA Symposium on Human Nutrition, Beltsville, MD, (submitted to Am. J. Clin. Nutr., (1979).

Wood, R., R.S. Bartlett, and L.H. Allen. Long-term Effects of Various Dietary Protein Levels on the Skeletal Development of Hamsters. (submitted to Proc. Soc. Exp. Biol. Med.) (197

Shlosser, S., A.E. Edmonds, L.H. Allen, and R. Wood. An Evaluation of the Nutritional Status of Pregnant Women in the WIC Program. (in preparation) Report submitted to Connecticut State Department of Health, 1979 (160 pp.)

Edmonds, A., S. Shlosser, R. Wood and L.H. Allen. Dietary Patterns of Pregnant Women in the Connecticut WIC Program (in preparation).

Picone, T., R. Wood and L.H. Allen. A Neurological Assessment of Newborns of Smoking and Non-smoking Mothers. (in preparation).

Block, G., R. Wood and L.H. Allen. Role of Insulin in Protein-Induced Hypercalciuria (in preparation).

Wood, R., and L.H. Allen. A review of body composition changes in pregnancy and lactation. To be submitted to Am. J. Clin. Nutr.

Pertti J. Pelto

- experience in planning and coordinating of data processing and statistical analysis in complex, multi-disciplinary research projects has included work in:

  Upper Mississippi Research Project, Minnesota (1964 - 1968);

  Ciudad Industrial Project in Central Mexico (1966 - 1970);

  Tema_scalcingo Valley Project in Central Mexico (1970 - 1975);

  Mental Health Project of the Illinois State Psychiatric Institute in Chicago, (1969 - 1975);

  Latino Mental Health Research Project in Hartford, (1977 - 1980);

  Area Health Education Center, Hartford (1978 -).

- major publications concerned with field methodology and data analysis:

  Anthropological Research: the Structure of Inquiry. (2nd Edition with G.H. Pelto. Cambridge Univ. Press, 1978)

  articles in Human Organization, American Ethnologist.

  and chapters in Rethinking Modernization (Poggie and Lynch), Marginal Natives (Freilich), and others.

- teaching of seminars in methodology, including statistical strategies Cornell University, 1961 - 1963; University of Minnesota, 1963 - 1968; Washington University, 1968 - 1969; University of Connecticut, 1969 - 1979.

  Advanced Research Methods Seminar (Department of Community Medicine) 1977, 1978.

CONSEJO NACIONAL DE CIENCIA Y TECNOLOGIA

TELEF. 617-74-521 DIR. TELEG. CONACYT AP. POST. 20-033 INSURGENTES SUR Nº 1677, MEXICO 20, D. F.

DIRECTOR GENERAL

Ref.: 3788

México, D.F., December 6th, 1979.

MISS DORIS HOUSE CALLWAY
Professor of Nutrition
Department of Nutritional Sciences
Berkeley, California
U.S.A.

The Mexican National Council of Science and Technology has received the proposal for a collaboration project between Mexico and the United States institutions on the subject intake and human functioning (ingestión de alimentos y funcionamiento humano).

This proposal presents a great interest and once the evaluation is completed will be included in our program on health sciences with the support of CONACYT.

I will appreciate the collaboration that you could give to Dr. Adolfo Chávez in the development of this project which I think will be of benefit for both sides.

Sincerely,

DR. EDMUNDO FLORES

CONSEJO NACIONAL DE CIENCIA Y TECNOLOGIA

DIRECTOR ADJUNTO DE ASUNTOS INTERNACIONALES

Ref.: DAAI-04/79-5853

México, D.F., December 11th, 1979.

MR. DEAN HUGE CLARCK
Director of the Foundation for
Research Graduate School
University of Connecticut
Storrs, Conn. 06268
U. S. A.

Doctors Federico Chávez Peón and Adolfo Chávez asked me to send you a copy of the letter that the Director General of CONACYT has sent to Miss Doris House Callway, related to the support of this Council for a collaborative project between the University of Connecticut and the National Institute of Nutrition on the subject intake and human functioning.

The enclosed letter mentions that CONACYT, as the government's body for science and technology, will support the project on the Mexican side.

Sincerely,

ALFREDO RAMIREZ ARAIZA

THE GRADUATE SCHOOL
OFFICE OF RESEARCH DEVELOPMENT
JAN 7 1980
THE UNIVERSITY OF CONNECTICUT

Enclosure

The University of Connecticut

STORRS, CONNECTICUT 06268

OFFICE OF THE VICE PRESIDENT FOR
GRADUATE EDUCATION AND RESEARCH
Research Foundation

January 11, 1980

Mr. Alfredo Ramirez Araiza
Director, Adjunto De Asuntos Internacionales
Consejo Nacional De Ciencia Y Technologia
Insurgents Sur No. 1677, Mexico 20, D. F.

Dear Mr. Araiza:

Many thanks for your letter of December 11 and copy of Dr. Flores' letter pledging support of CONACYT for a collaborative research study on nutritional intake and human function.

We are enthusiastic about the plan and hope that funds will be provided for this important project.

With best wishes,

Sincerely yours,

Hugh Clark
Associate Dean

HC/pah

cc: Dr. K. Knox
Dr. L. Allen
✓Dr. G. Pelto

Budget Estimate for All Years for the University of Connecticut
(Including Subcontracts)

Expense Category	Year 1	Year 2	Year 3	Year 4	Year 5	Total for 5 yr period
Personnel	104,129	126,127[a]	165,280[d]	78,675	86,140	560,351
Equipment	--	4,000[b]	--	--	--	4,000
Supplies	9,000	19,000[c]	12,000	5,000	5,000	50,000
Travel	9,350	6,570	9,430[e]	11,040	12,870	49,210
Contractual	13,140	13,700	21,405[f]	23,596	27,520	99,361
Indirect cost	63,177	72,429	96,340	54,869	60,734	347,549
Subcontracts						
Mexico	241,938	278,000[x]	290,170	262,280	247,561	1,320,649
UMass	--	57,019	62,417	68,748	2,000	190,184
FIU	--	29,092	44,080	45,329	47,781	166,282
U. of Miami	--	23,827	25,769	28,846	31,730	110,172
Yale	21,789	--	--	--	--	21,789
Subtotal of Subcontracts	263,777	388,638	422,436	405,203	329,072	1,809,076
Total Proposed Amount	462,423	630,414	726,891	578,383	521,336	2,919,547

[a] Additional personnel: immunocompetence technician is full-time; Knox and Jensen (UConn) for substudies.

[b] Equipment: electrophoresis system; column chromatograph; fraction collector.

[c] Supplies: additional requirements for breast milk analysis, and immunocompetence study.

[d] Additional personnel: full-time research assistants for analyzing substudy data.

[e] Travel: increase due to more personnel and allowances for domestic (scientific meeting) travel.

[f] Contractual: increases in per diem totals due to increased personnel; additional publication and computer costs.

[x] Increase is for personnel, equipment for substudies.

Detailed Budget for First 12-Month Period
University of Connecticut

	% Time	Salary	Proposed Amount
A. Salary & Wages			$ 50,780
1. Senior Personnel			
a. Co-principal investigators			
Lindsay H. Allen	100 (summer)	6,412	
	50 (1/81 - 5/81)	5,771	
	12.5 (AY)	2,886	
Gretel H. Pelto	100 (summer)	4,990	
	25 (AY)	5,429	
b. Faculty Associates			
Pertti J. Pelto	50 (summer)	4,990	
c. Project Coordinator			
Richard J. Wood	100	19,260	
2. Other Personnel			35,834
a. Statistician/Programmer	100	15,000	
b. Research Assistant (immuno-competence)	100 (6 months)	7,500	
c. Research Assistants (2) (Ethnographic and Dietary)	33	6,334	
d. Student Labor (Keypunching, coding)	2,500 hours	7,000	
B. Fringe Benefits (22%, excluding student labor)			17,515
C. Total Salary, Wages and Fringe			104,129
D. Equipment			0
E. Material/Supplies Xeroxing (1,000), Office Supplies (1,000) Laboratory Supplies for establishing immunocompetence study (7,000).			9,000

	% Time	Salary	Proposed Amount
F. Travel			$ 9,350
4 round trips Mexico/US for each P.I. (Allen and Pelto, G.H.)			
2 round trips Mexico/US for Faculty Associate (Pelto, P.J.)			
2 round trips Mexico/US for R.K. Chandra			
3 round trips Mexico/US for Research Coordinator			
2 round trips Mexico/US for Research Assistant			
G. Publication Costs			0
H. Computer Costs			4,000
I. Other Costs			
UConn Organization Meeting (4,140)			4,140
Per diem for Mexico			1,500
Phone ($100/hour U.S. to Mexico x 25 hours)			2,500
Consultant fee for R.K. Chandra (1,000)			1,000
J. Subcontracts (see attached sheets for details)			
Mexico (INN)			241,938
Yale University			21,789
K. Direct Cost			399,346
L. Indirect Cost			63,177
48% of K - (D + H + J) = (0.48)			
M. Total Estimated Project Cost (K + L)			462,523

Summary of Expenses for
Instituto Nacional de Nutrition
(Mexico) Subcontract

Expense Category	Year 1	Year 2	Year 3	Year 4	Year 5
Personnel	117,738	179,380[a]	218,394[b]	209,329	188,990
Equipment	65,250	34,515[c]	--	--	--
Supplies	26,800	35,325	39,000	20,000	18,000
Travel	1,650	1,980	2,376	2,851	3,421
Contractual	30,500	27,500	30,400	30,100	37,150
Indirect Cost	--	--	--	--	--
Total Proposed Amount	241,938	278,700	290,170	262,280	247,561

Total for Entire Proposed Project Period: $ 1,320,649

a Additional personnel: medical student (5,833); graduate students (7,360); laboratory technician for immunocompetence (7,500); 2 lactation aides (1,563); additional salary increase due to some salaries in Year 1 not full 12 months (21,424), addition for inflation of salaries (11,255), performance technician (6,132).

b Additional personnel: 6 lactation aides (28,134); 2 activity aides (7,600); 4 graduate students (13,148); inflation increase (15,000).

c Includes equipment for work performance substudy: 2 K-M respirators (3,500); medilog (2,500); O_2 analyzer for laboratory (4,700); O_2 analyzer for field (1,200); CO_2 analyzer (5,500); treadmill (3,500); 3 Kw generators (900); Spectronic 20 (700); Douglas bags, 250 liter (950); miscellaneous equipment under $500 each (5,065).

Detailed Budget for First 12-Month Period
(Mexico Subcontract)

	% Time	Salary	Proposed Amount
A. Salary and Wages			$ 177,738
1. Senior Personnel			
Director of Field Clinic (M.D.)	100	20,773	
2. Other Personnel			
Bilingual Admin. Secretary	100	9,500	
Data analyst/programmer	100 (3/1-12/30)	6,360	
Key puncher	100 (3/1-12/30)	3,280	
Driver	100	5,750	
Servants (3)	100	1,800	
Technical aides (12)	100 (9 months)	41,400	
Community aides (4)	100 (9 months)	6,440	
Clinic assistant	100 (9 months)	3,115	
Lab technicians (2)(clinic)	100 (9 months)	13,320	
Student labor	100d x $60/day	6,000	
B. Fringe Benefits			0
(INN protocol incorporates frinbe benefits into salary figure)			
C. Total Salary, Wages and Fringe			117,738
D. Equipment			65,250
1. Total for Field Site		50,050	
Construction costs for clinic-research center at San Juan Epatlan (18,000); furniture and appliances (3,650); vehicle (6,500); 2 freezers (1,200); 4 portable scales (600); 6 skin-fold calipers (900); 6 anthropometers (600); 2 non-oscillating infant scales (4,000); 3xamination room equipment (5,000); 4 breast pumps (2,000); spectrophotometer (1,100); audiometer (500); other miscellaneous equipment.			
2. Total for Instituto Nacional de Nutrition (INN)		15,200	
Vehicle for transport to/from field (9,000); computer terminal (3,000); office equipment (includes electric and manual typewriter (1,000); 2 freezers (1,200); incubator (for bacteriology)(1,000).			

Detailed Budget for First 12-Month Period
(Mexico Subcontract)

	% Time	Salary	Proposed Amount
E. Material/Supplies			$ 26,800
Medical supplies (3,000); office supplies (4,000) xeroxing/mimeographing (3,000); urine/feces containers (5,000); syringes, etc. (1,000); lab supplies (Hct, Hb, parasites, bacteriological, etc.) (6,000); glassware (4,800).			
F. Travel			1,650
1 round-trip to Mexico/US for Director of Clinic 2 round-trips to Mexico/US for P.I. (A. Chavez)			
G. Publication Costs			0
H. Computer Costs			4,000
I. Other Costs			26,500
Phone ($10/3 min. Mexico to U.S.) (4,000); maintenance of Clinic-Research Center and vehicles (14,100); per diem for short-term professionals at $15/man-day x 300 (4,500); per diem for student assistants at $6/man-day x 667 (4,000).			
J. Direct Cost			241,938
K. Indirect Cost			0
(INN does not require indirect costs)			
L. Total Estimated Project Cost			$ 241,938

Detailed Budget for First 12-Month Period
(University of Massachusetts Subcontract)

	% Time	Salary	Proposed Amount
A. Salary & Wages			$ 30,833
1. Senior Personnel			
R. Brooke Thomas	25	5,491	
Benjamin Ricci	25	7,902	
2. Other Personnel			
2 Research assistants	100	16,000	
2 Field interviewers	30	1,500	
B. Fringe Benefits			1,800
Health fringe benefit $100/month x 3 months x 6 (1800)			
C. Total Salary, Wages and Fringe			32,693
D. Equipment			0
(included in Mexico subcontract)			
E. Supplies			500
(also included in Mexico subcontract0			
F. Travel			3,300
1 round-trip U.S./Mexico for each person in personnel (6 x $550/trip).			
G. Publication Cost			0
H. Computer Cost			0
I. Other cost (850); per diem in Mexico, 10 days @ $35/day (350); 4 months at 700/month (2,800).			

Detailed Budget for First 12-Month Period
(University of Massachusetts Subcontract)

	% Time	Salary	Proposed Amount
J. Direct Cost			$ 40,493
K. Indirect Costs			16,526
L. Total Proposed Amount			$ 57,019

Summary of Expenses for
University of Miami Subcontract

Expense Category	Year 1	Year 2	Year 3	Year 4	Year 5
Personnel	-	12,997	14,296[b]	15,726	17,298
Equipment	-	400	-	-	-
Supplies	-	2,000	2,200[b]	2,420	2,662
Travel	-	777	855[b]	940	1,034
Contractual	-	1,025	1,127[b]	1,740[a]	1,914[a]
Indirect Cost	-	6,628	7,291	8,020	8,822
Total Proposed Amount	-	23,827	25,769	28,846	31,730
Total for Entire Proposed Project Period:				110,172	

[a] $500 for publication costs added Year 4 & 5.

[b] 10% increase added each project year.

Detailed Budget for First 12-Month Period (University of Miami Subcontract)

	% Time	Salary	Proposed Amount
A. Salary & Wages			$12,150.
1. Senior Personnel:			
Tiffany Field	100 (summer)	5,650	
2. Other Personnel:			
Research Assistant	100	4,000	
Graduate Student	100 (summer)	2,500	
B. Fringe Benefits			847.
15% X 5,650 = 847.			
C. Total Salary & Wages & Fringe			12,997
D. Equipment			
20 activity bracelets @ $20. ea.			400.
E. Material Supplies			2,000.
xeroxing/mimeo (1,000); testing materials (1,000)			
F. Travel			
3 round trip Florida to Mexico			777.
G. Publication Cost			0.
H. Computer Cost			0.
I. Other Cost			1,025.
Communications (500); per diem in Mexico ($35/day X 5 days X 3) (525).			
J. Direct Cost			17,199.
K. Indirect Cost			6,628.
51% X 12,997 = 6,628.			
L. Total Estimated Project Cost			$ 23,827.

Summary of Expenses for
Florida International University Subcontract

Expense Category	Year 1	Year 2	Year 3	Year 4	Year 5
Personnel	-	15,206	24,675[a]	25,143	26,613
Equipment	-	460	-	-	-
Supplies	-	2,500	2,500	2,500	2,500
Travel	-	777	900	900	1,000
Contractual	-	1,025	1,200	1,700[b]	1,700[b]
Indirect Cost	-	9,124	14,805	15,086	15,968
Total Proposed Amount	-	29,092	44,080	45,329	47,781
Total for Entire Proposed Project Period:				166,282	

a Number of Research Assistants increased from one to three.
b $500 for publication costs added Year 4 & 5.

Detailed Budget for First 12-Month Period
(Florida International University Subcontract)

	% Time	Salary	Proposed Amount
A. Salary & Wages			
1. Senior Personnel			$ 14,000.
Gordon R. Finley	25	7,000	
2. Other Personnel			
Research Assistant	100	4,000	
Graduate Student	3 months	3,000	
B. Fringe Benefits			
17.23% X 7,000 = 1,206.			1,206.
C. Total Salary & Wages & Fringe			15,206.
D. Equipment			
Audiometer: Beltone Model D-9			460.
E. Material/Supplies			
xeroxing/mimeo (1,000); testing materials (1500).			2,500.
F. Travel			
3 round-trips Florida to Mexico			777.
G. Publication Cost			
H. Computer Cost			0.
I. Other Cost			0.
Communications (500); per diem @ $35/day X 5 days X 3 (525).			1,025.
J. Direct Cost			19,968.
K. Indirect Cost			
60% X 15,206 = 9,124.			9,124.
L. Total Estimated Project Cost			$ 29,092.

Detailed Budget for First 12-Month Period
(Yale University Subcontract)

		% Time	Salary	Proposed Amount
A.	Salary and Wages			12,407.
	1. Senior Personnel			
	Ellen Messer	100 (1/80-6/80)	8,333	
		100 (7/80-8/80)	4,074	
B.	Fringe Benefits			2,530.
	21.9% X 8,333 = 1,825			
	17.3% X 4.074 - 705			
C.	Total Salary & Wages & Fringe			14,937.
D.	Equipment			300.
	12 Timex watches (300).			
E.	Material/Supplies			362.
	40 rolls of film (362).			
F.	Travel			1,160.
	2 round trips U.S. to Mexico (900); limosine service, New Haven, CT to N.Y.C. (60); transportation Mexico City-Epatlan (200).			
G.	Publication Costs			0.
H.	Computer Costs			0.
I.	Other Costs			490.
	per diem in Mexico for first 2 weeks (14 days X $35/day) (490)			
J.	Direct Cost			17,249.
				4,540
K.	Indirect Cost			~~4,450.~~
	36.6% X 12,407 (SW) = 4,450			
L.	Total Estimated Project Cost			$ 21,789.

APPENDIX VI

Sources of Matching Funds from the University of Connecticut

Univ. of Connecticut Faculty	Department	Area of Consultation	% Time	Salary
Lindsay H. Allen, Ph.D.	Nutritional Sciences	Principal investigator (growth and development)	33[a]	7,754
Gretel H. Pelto, Ph.D.	Nutritional Sciences	Principal investigator (nutritional anthropology, dietary assessment)	15	3,352
Pertti J. Pelto, Ph.D.	Anthropology and Community Medicine	Faculty Associate (community research methodology)	10	3,626
Kirvin L. Knox, Ph.D.	Nutritional Science	Energy expenditure	5	1,845
Robert G. Jensen, Ph.D.	Nutritional Science	Breast milk analyses	10	3,850
Joseph J. Lucas, Ph.D.	Agricultural Exp. Station	Biostatistics/ experimental design	20	7,000
James E.C. Walker, M.D.	Community Medicine	Epidemiology	5	3,295
				$ 30,622

Total Matching Funds (Year 1) = 32%
(30,622/94,432)

Total Estimated Matching Funds for Entire Project (5 years) = 25% (180,586/722,343)

[a] L.H. Allen's 33% calculated as follows: 1/80 - 5/80, 15% time devoted to project. Sabbatical leave 9/80 - 12/80; 100 percent of this period will be devoted to project (50% salary paid by the University of Connecticut).

APPENDIX VI (cont.)

Additional Sources of Matching Funds from the University of Connecticut

Appendix VII contains some explanatory materials concerning the University of Connecticut Center for Latin American Studies. The Center has an annual operating budget of approximately $850,000. We believe that some portion of this budget should be applicable as matching funds. However, since we are uncertain as to the specific CRSP criteria for matching funds eligibility, we only mention the activities of the Center of Latin American Studies as a potential furure source of matching funds should it be necessary to show further University commitment.

APPENDIX IV-3

University of California, Berkeley/Los Angeles, Proposal

in collaboration with

University of Nairobi

Kenya

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I. OBJECTIVES

An increasingly important emphasis in nutritional research is on the interrelations between people and their environment. The environment includes not only the biophysical but also cognitive and sociocultural dimensions. Such an emphasis is encompassed within the specific objectives and research design of this study. The long-term orientation of the proposed research is toward understanding, within the general domain of intake/function foci, the nature of certain processes and their consequences for various individuals and social units, both singly and as a combined, dynamic system.

The specified primary objective of the proposed research is to define the relationships between food intake, functional competency, and overall life experience so as to generate information that can be used effectively in the development of strategies to achieve sustained improvement in the nutrition, health, and welfare of affected populations. To achieve this goal it is necessary: a) to establish relationships in quantitative terms between a range of food energy intakes (above severely underfed but less than adequately fed, by existing criteria) and a range of competencies in the areas of disease, reproduction, activity and work performance, cognition and behavior; b) to elucidate the processes, paths, networks, or institutions through which inadequate food energy intake impairs the function of self and others; and c) to identify key points, levels, or mechanisms for the most effective intervention(s) through the various sectors (health, agricultural, economic, social/governmental).

The various subparts of the research proposal are addressed to more narrowly defined objectives in each of the specified functional areas and these are stated therein. A single objective theme sets the framework for the approach in each of the topical areas, unifying and bringing coherence to what could otherwise be a series of parallel but essentially independent studies carried out in a single population. This objective may be restated simply as an attempt to answer the question of whose intake affects whose function at the moment and through time. To the extent that it is possible to do so in a few years of study, the research will also attempt to determine how these effects are mediated; the research will provide, at least, the basis for development of sound and testable hypotheses concerning the mechanisms involved.

A second specified objective is to enhance the competency of the institutions involved to address more effectively the pervasive problem of food deprivation wherever it exists. The overseas institution involved in this collaborative project will have significant strengths to contribute, most particularly in the biomedical sphere; activities have not generally extended into the social and behavioral sciences in-depth. Research at all institutions involved has generally focused fairly narrowly within a given disciplinary area. Thus the objective for all participant institutions is to promote collaboration and interdisciplinary interaction by the development of complementary research teams and by clearly formulating and providing for a variety of research and collaborative formats, including training and scientific exchange.

Because this project is seen as but one component of a larger research program it incorporates the objective of providing empirical data and conceptual-theoretical formulations which may serve as a basis for cross-societal comparisons.

II. RESEARCH PLAN AND DESIGN

A. Introduction and General Plan

This proposed five-year research project is planned in detail for the first 3-year period; years 4 and 5 are intended for follow-up of longitudinal aspects and specific hypothesis testing. Research during years 1-3 is conceived mainly as a field study paralleling the traditional approach of particular social science studies. While the latter usually focus on a delimited population, they may include a range of variables, which in number and type are not characteristic of most nutritionally-focused research. That is, the field study is generally structured to involve a bounded, sometimes demographically small population but a broader range of variables than is customary in most other types of research on humans. This type of general design of population/variables makes the best use of multidisciplinary expertise and is the most suitable research framework for the specified priorities of the CRSP guidelines.

The 3-4 year research plan for this project has three integrated phases. The 6-12 month initial phase will establish the collaborative research operations including training in specific techniques, selecting the study communities, making field site arrangements, and implementing the informational bases. The investigators also view the initial phase as a field orientation period, in part for adjusting personnel to the field situation and in part for adjusting the socionutritional research procedures to field contingencies. This should enable the research procedures to be most effectively designed, adjusted, and scheduled. During this time a survey of 800 or more households will be made from which the sample population of households will be selected, and the ongoing informational bases will be established. The informational bases are to be used to define, describe, and monitor various data throughout the research program. This aspect of the program will provide continuously gathered and/or updated core data on variables and parameters considered basic to all the disciplines involved in this project and that may be used in common or by any of the participating investigators to pursue other questions which may arise. In addition, these data may serve as a basis for cross-societal comparisons.

The second phase, lasting two years, builds on the continuing informational bases previously established. This mid-phase includes specific individual intake/function foci and their contexts. Relationships between intakes and functions are to be understood on the individual and social levels as part of the human experience. It is thus necessary to embed the intake/function foci within a series of contexts, from the individual through relevant social units, i.e. household, community, and institutions. The unit of primary reference is the household. To understand its functioning, the environments in which the household operates must be investigated. The mid-phase of this project provides for the integration of all dimensions--biophysical, sociocultural and cognitive-- through an array of investigative components. The contextual concern given to CRSP-identified areas is valuable in view of the anticipated concerns with multivariate, multiplex problems and relationships in this phase.

The third phase involves completing major aspects of analyses, and writing-up and disseminating the research information, results of the surveys, and the field study. Conservatively, this activity will span six months, though not all components will adhere to the same timetable. It is expected that the most fruitful uses of project materials will be made if

this phase is based on several formats for interaction. During the third phase, work will also be underway on relevant longitudinal research studies in the cognitive, social and reproductive competency areas. Analysis of the findings from the second phase will be used to develop hypotheses that can be tested in years four and five. This research cannot be formulated at the present, but it is likely to follow an intervention or experimental, rather than a naturalistic, design.

LEVELS OF MEASUREMENT. There are four levels of measurement: the individual; the household; the community; and the institution. The first three serve as primary units of analysis, while the institutional level provides a necessary and important linkage to policy concerns for the other units. These units are viewed both singly and in interaction with each other. Research foci commonly cross-cut several levels of measurement and involve several disciplines. The following features of this research design especially allow all four levels to be effectively accommodated: a) the field study framework; b) the informational bases; c) the contextual concerns; d) the attention given to multidisciplinary collaboration; and e) the ongoing consideration of data management.

DATA NEEDED IN COMMON. Data which are likely to be needed in common by all investigators include both historical and current materials. Food intake data are primary, although various investigators will use them at different levels of resolution. At the individual level, biographies and histories (including medical and health) constitute the main common data set. At the household level, descriptive and quantitative information includes a physical description (for example: house type, cooking facilities), household composition, household resources, and, if possible, a household history. Community data needed in common include: population and vital statistics; a village map showing residential units and various facilities with accompanying descriptive information; and material on climate, weather, and other environmental conditions. These data will necessarily be collected by survey and census methodologies as well as from existing public information sources.

B. Selection of the Study Community(ies)

Selection of the study community will be undertaken in collaboration with colleagues in the field location. However, it is clear that there are a number of considerations to be taken into account and reconciled, during the selection process, based on our knowledge of the proposed study area, previous experience with longitudinal studies in rural Africa, and our proposed budget.

Overall, the population base for which samples are to be drawn needs to be in the order of 4000-5000 persons. Based upon previous work done in Kenya, Ghana and India by members of this research team, this population size should not only be manageable for measurement purposes but should also provide the degree of variability required within most of the variables to permit the mathematical analysis to be carried out. Again, the feasibility study will be important in the final determination of these points and may lead to modifications before the main study begins. As is usual in a field research project, the sample size will be a compromise between the numbers required for acceptable statistical accuracy and the twin constraints

of logistic problems and human and fiscal resources. Prior to definitive selection of the field site we are not prepared to specify a precise sample size.

For the purposes of this research, a well-defined group of rural villages is contemplated. Concentration of the research in a small area will minimize transport costs and sampling bias. As the study results could not produce a valid descriptive picture of all of the country, it is best to concentrate on the establishment of valid relationships, not on extensive geographical coverage.

These villages will need to have reliable access, though they may be a distance from a main highway. They will also need to be conveniently accessible to one another. A cluster of four villages will satisfy, insofar as possible, the intake requirements of the research, i.e. a range of intakes will be observable that includes an adequate level.

Enumerators will be housed for the most part outside the study villages in a readily accessible nearby village in order not to have a large disruptive impact upon the economies of the study villages. Resident villages for the enumerators will be at least within convenient cycling distance to the study villages.

In practice, the collaborating researchers will develop a specific set of guidelines in order to make a final selection of the cluster of villages. For example, it may be desirable to choose villages that span a district or state boundary in order to see the effects of administrative variation on the handling of nutrition related problems. Overseas colleagues will expedite the selection process through their knowledge of and experience with village studies. The choice of the site will be critical for the research and more careful thought will be given to it once the general area in which the research is to be conducted is known.

DESCRIPTION OF POSSIBLE STUDY SITES AND KENYAN DIET.

Machakos District, Eastern Province, Kenya. Machakos District, Eastern Province, Kenya is approximately 80 to 100 km east of Nairobi (see map) and has a total area of 5,790 miles. Machakos District is divided by a high range of hills with a relatively fertile, hilly side to the west where coffee and bananas are grown as important cash crops. A flat, semi-arid side with poor soil lies to the east, bordering on the Athi River where subsistence farming of cowpeas and maize and raising cattle predominate. The altitude ranges from 3000-5000 feet; the mean annual rainfall is 900mm. Abundant information about Machakos' cropping patterns, household size, and consumption of basic food groups about Machakos is available.

The average number of household members is six. As in many parts of Kenya, migration is considerable. About a quarter of all heads of households have a job in one of the larger towns in Kenya - most of them in Nairobi - and come home most weekends or once a month. Due to a shortage of land, some families move away or maintain one farm within and one outside a given area moving back and forth several times a year.

The Medical Research Institute, now part of the government of Kenya (formerly of the Netherlands Tropical Research Insittute) carried out studies in the Machakos area. A number of population-based longitudinal studies have been carried out on pregnancy outcome, nutritional status, and epidemiology of pertussis and respiratory illness. The studies were conducted by local field workers. The Machakos area is very

large and there are many sections that have not been studied or touched in any way by research efforts. The area is close enough to Nairobi to make logistics for special studies and back-up relatively feasible. Also, a great deal of background material is available about the area. There is a cadre of well-trained local Akamba-speaking personnel, and it is anticipated that some of them would be available for further field work.

Taita Hills District. The Taita Hills District in Coastal Province, about 200 km from the coastal city of Mombasa, (see map) has been the subject of anthropologic studies, as well as a few nutritional studies.

The Taita Hills District is a small, geographically isolated, mountainous area rising sharply from a surrounding plain to elevations over 7,200 feet above sea level. The Taita District, which encompasses the Taita Hills proper, has an area of 504 square miles. The Hills are sharply differentiated from the plains not only in elevation but also in terms of rainfall (the hills receive 30 to 50 inches per year), vegetation (grading into hardwood canopy forest at higher elevations), and population. The Hills can be described as an "island" of high population density (125 persons per square mile in 1962 for Taita Division, according to the Kenyan census, with some locations over 200 per square mile), almost totally surrounded by a National Park with a population density of 0.7 persons per square mile in 1962.

A number of studies show that the Taita people are settled agriculturalists, growing crops of maize, beans and sweet potatoes for subsistence, practicing patrilineal descent, with a tradition of lineage-held territories, residence in nucleated settlements, individual ownership of land, property and livestock rights, and (largely) male inheritance.

The Taita Hills have also been the subject of a recent doctoral dissertation in geography (Nazzaro, 1974). This dissertation examines the resource base of the highland areas of Taita District, and documents changes occuring with the introduction of commercial agriculture and contact with foreigners. This research provides useful background data for evaluating the effect of these changes on nutritional status.

Other sites. Other possible sites for the study were discussed with the Kenyan representative.

GENERAL DESCRIPTION OF KENYAN DIET.

The following statements characterize a typical Kenyan diet:

--Corn is the main staple everywhere in Kenya, except in highlands of Eastern Province where sorghum is added. Corn is usually pounded before cooking and is eaten roasted whole, or boiled with beans, potatoes, onion and/or green leaves (uji).

--Manioc is mixed with sorghum and made into a thick paste, ugali.

--Legumes are universally eaten, usually mixed with other foods or made into paste; legumes are an important source of protein.

--Meat, fish and chicken are not eaten regularly in Eastern Province.

--Green leafy vegetables are used in stews but cooked for long periods of time.

--Fruit (mainly bananas) are eaten as snacks.

--Tea and coffee are used if cultivated but beer made from sugar cane or millet is a favorite. Milk is used in tea.

--The main meal is at night with the same dinner for several nights. The mid-day meal, if anything, consists of leftovers, and for breakfast uji and tea are taken.

Overall data indicate the average Kenyan diet consists of 78.5% carbohydrate, 14.0% protein and 10.2% fat. Thirty-six percent of infants are nursed for 12 months, 18.1% for two years and 5.5% for three years. Banana and potato are the first non-milk foods and uji and milk are given. Intake of vitamin A, vitamin C and calories are found to be generally low. Our own food intake data on Nairobi women and children obtained in 1977 concur with this general picture except that iron and calcium were also low and calories were adequate.

The nutritional picture in Eastern Province at the time of food shortage in the late 1960's showed average caloric intakes of 1426 kcal and 45 gm of protein per day. Fifty percent usually did not consume animal protein and in general intakes of calcium, vitamin A and niacin were all below requirements. Protein-calorie malnutrition, anemia and endemic euthyroid goiter were also found. Anemia of pregnancy was largely megalobastic, attributed to folic acid deficiency.

In 1975-1976 extensive, precise quantitative dietary surveys in infants and children were conducted by Von Steenbergen in Machakos District under the Medical Research Institute. These surveys included breast milk composition, seasonal variation, weaning and breastfeeding practices and attitudes and diet of mothers. The survey results should be published soon.

C. Community Survey and Sample Selection.

Because the CRSP specifies household as the unit of investigation and emphasizes the mother-infant dyad, a basic determinant of the sample population is that it must include a sufficient number of fertile couples to provide for the minimum required number of pregnant women. A second determinant is the need for a sufficient number of well-nourished individuals ("controls") so that adequate function can be defined in the cultural/environmental context. The variability of some measures is not known precisely, but it is assumed that an n of 20 well-nourished pregnant women will provide an adequate sampling base. Assurance that adequate numbers of other well-nourished adults and children are included in the sample stems from the expectation that well-nourished women are likely to be found in well-nourished households and that other well-nourished individuals may also be present in households where the pregnant woman is mildly or moderately energy-deficient.

At least 5% of the population is likely to be well-nourished, even in poor rural communities, so a total population of about 800-1000 households (about 4000-5000 individuals) would include 40 that would constitute "controls". The annual birth rate is estimated to be about 40/1000. Thus, there should be 200 live births annually, of which at least 10 would be "controls", and the required n would be accumulated in a 2-year study.

If the total population were included in the study, the number of less-than-adequately nourished persons would be greatly in excess, so a sampling procedure will be devised. Ultimately the data will be analyzed according to the range of food energy intakes observed over the 2-year period, but some stratification of the population is needed before sampling to assure that the desired range of intake is likely to be encountered.

To do this, a preliminary survey of limited scope will be made of the total population, covering the following points: age, sex height, weight, medical history, reproductive history including family planning practices, physical examination (emphasizing signs and symptoms of present and past nutritional deficiency or excess), hematocrit, dietary history (food preferences, frequency of household food use, previous experiences of hunger, famine, drought), living arrangements (type of house, water source, etc.), income and occupation/work, education and training, literacy and language, and religion. All households having members that in medical judgement are severely malnourished (i.e. frank clinical signs of deficiency, weight/height below 60% of international standard) will be excluded from the pool of households from which the sample population is to be drawn and will be referred for appropriate available treatment. The remaining households will be divided into five strata according to: a) weight for height of the male and female heads of the household*; b) approximate energy intake per energy-consumer unit**; c)hematocrit of female head; d) type of house; and e) income per consumer unit. The stratification will be done by discriminant analysis using the SPSS program. If these factors do not discriminate adequately, additional factors will be used: height-for-age and weight-for-height of 6-8-year-old children; occupation of male head, and years of education completed by female head. Sixty households, fifty of which must include a presumptively fertile, conjugal couple, will be selected at random from each stratum. These 300 households constitute the sample population. For subsequent study, the selecting stratum-classification is irrelevant; intake data collected during the major study itself will constitute the independent variable for final subject classification.

Some information to be gathered in the survey is required for other components of the study in that it contributes to a description of the community. Additional information to be collected in the initial phase includes the following:

1. Community data: public records and archives (vital statistics; census materials; land register; licenses; tax payments); population (structure; growth; migration; other demographics); institutions and organization of community and other levels of government (formal and informal); communication (including publications) and transportation; financial institutions and banking facilities; health and medical facilities; health-care givers; industries; sanitation facilities; education facilities; introduction of new traits, facilities, programs; village map showing residential units, neighborhoods, various facilities; and inheritance.

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*The designation male and female "heads of household" as used in this document refers to the couple (or the man and woman individually) residing in and dominantly involved in management and provision of subsistence to the household.

**Energy consumer unit is derived by converting all individuals to mature male energy equivalents, for example:

Reference Person	Weight (kg)	Energy kcal/day	Units
Male Adult	65	3000	1.0
Female Adult	55	2200	0.73
Male, 10-12 yrs	36.9	2600	0.87
			etc.

2. Environmental data: weather records; agricultural reports; aerial photos; major environmental events or conditions; land (biophysical description, ownership,utilization); water (sources, quality, quantity); geography (map, biophysical resources); fuel sources.

To verify the continued validity of the sample population, the total population will be resurveyed at the end of the first and second years of the principal study. Examination of the larger population should alert the team to major trends/changes in demographic characteristics, income, food use, and the like, and will provide reference data on birth and death rates of children, and migration patterns.

3. Preparatory work for initial community survey and sample selection: It has been our research experience in Africa that careful and intensive preparation can eliminate most of the major problems that could arise. Our preparatory work would involve approximately three stages:

1) While final funding arrangements are being made, about a three-month period, the investigators will prepare survey and testing instruments and the computer programs that will be used in analyzing the data.
2) During the first three-month period after funding, work will proceed in Kenya to establish a central office and field base, modify survey instruments (based on further collaboration with senior Kenyan colleagues), and to recruit and train local staff.
3) The third stage will be a six-month period that will include initial surveys and sample selection.

4. Preliminary steps in establishing field study area: The first step is obtaining official government of Kenya permission from the Office of the President; it is anticipated that this will proceed expeditiously once funding is assured.

The second step is the establishment of close links with the chiefs, sub-chiefs and other local leaders of the area. Subsequently, the chiefs could organize meetings with the people in the study area.

Informed consent for the survey will be obtained in each community, in consultation with its chief elected or appointed administrative officer. The purpose, plan, and procedures will be explained verbally in the local language(s) and all will be encouraged to ask clarifying questions. Any household may refuse to participate without penalty, and no incentive will be offered to induce participation (other than the medical examination that is an essential part of the study). The project staff will emphasize that a considerable amount of cooperation is requested, including a willingness to accept frequent home visits by the field staff who would question members of the household about a variety of items for several years. Meetings would continue to take place on a regular basis to keep the population informed about past accomplishments and activities planned for the coming year, and to enlist their help with logistics.

At least one senior investigator from one of the collaborating institutions and a disinterested observer will witness the consent procedure. Community leaders will be invited to witness oral consent. Informed consent for participation in the full study will be obtained in the same manner.

TABLE 1 Foods comprising the usual diet of pregnant Kenyan women (n=59)
UCLA Kenya Study 1977

FOOD GROUP	Percent of women who reported eating the foods regularly					
	7-10%	11-20%	21-30%	31-50%	51-70%	71-100%
GRAINS			Maize	White bread Chappati White corn	Rice	Ugali (cornbread)
FRUITS & VEGETABLES	Peas Sweet potatoes Mango Pears	Carrots Pineapple	Spinach Red beans White beans	Cabbage	Potatoes Banana	Onions Tomatoes Oranges
MEAT, FISH, POULTRY & EGGS	Chicken	Fish, fresh			Eggs Beef	
FATS			Margarine			Vegetable fats
SUGARS			Sugar cane		Brown sugar	White sugar
MIXED DISHES					Sukuma Wiki (onions, collards 7 cornbread)	
MISCELLEANEOUS	Cocoa		Soft drinks Treetop (orange beverage)			
DAIRY PRODUCTS*					Milk in small amounts in tea.	

*yogurt and sour milk were consumed regularly by 1 to 5% of the women

D. Food Intake Measurement

The purpose of measuring food intake is to determine the specified independent variable, the energy intake of individuals and households over time. To do this, it is necessary to know the amount of food eaten in representative sampling periods and the composition and digestibility of the food. Since all of these measures are prone to error, an important objective is to identify and if possible reduce sources of error by using a variety of independent measures. Coincidental to calculation of energy intake, information will be obtained on intakes of protein, iron, calcium and the vitamins.

Determination of food patterns and their effects on competencies requires study of individuals, and the households and communities in which they live. Food is chiefly consumed in familial settings;and social as well as economic factors in a community affect what is available and what may be eaten. Reasons for food patterns will be sought in sociocultural terms. The patterns themselves will be ascertained by observation, by questions,and by specific methods herein outlined. Information on food patterns (what is available, how it is prepared and eaten,and by whom) will be obtained collaboratively by the anthropologists and nutritionists.

24-HOUR INTAKE.

The basic core measurement is 24-hour food intake of individuals. This will be obtained by the retrospective method using experienced local interviewers. During the pilot phase intake will also be recorded by direct observation and weighing/measuring as specified in the core. Whichever of these two methods provides the more reliable consistent information will be used thereafter. If the two methods provide essentially equivalent information, the retrospective method will be used in the main study because of its simplicity.

FOOD INVENTORY.

The first two 24-hour recalls of each quarter will be taken one week apart. On day 1, an inventory record of household food and water use will be started by weighing all food and fluids in store. The female head, if literate, will be asked to record: all food and fluids brought into the home during the week (nmount,source); household members absent from meals and guests present; and food and water in the household not consumed by people and not in store (spoiled, fed to animals). If no one is capable of satisfactorily completing this task, the food preparer will be interviewed on the last day of the week's study to recall gifts, purchases, costs, and subsistence items entering the house in the intervening days. Food and fluids in store will be weighed on day 8, completing the inventory. Food consumed by the household will be derived and compared with the 24-hour recall data. Since there will be 8 comparisons over time, this will be one test of the validity of each method.

Necessary information on food preparation techniques and recipes will be obtained and samples of food will be purchased (at cost) as warranted for analysis of nutrients, digestibility studies, etc. Additional information can be gathered at this time that will be needed for special purposes, e.g. cost of food, fuel used in food preparation, sanitation.

DIETARY HISTORY.

On a subsample of the population, habitual intake, frequency, and amount of specific foods consumed will be determined during the second and third quarters of the study, using the same open-ended questionnaire as in the preliminary community survey. This information will be compared with records obtained in the preliminary survey to determine reliability of the instrument.

If the respondent is a pregnant or lactating woman, questioning will be used to determine diet changes during pregnancy and lactation, as well as changes in appetite and taste. Questions will probe to include information on practices such as pica, use of drugs, intake of caffeine, alcohol, herbs, or other substances that could interfere with or alter metabolism.

NUTRITION HISTORY.

Nutrition history will be taken as specified in the core.

INTAKE BY INFANTS.

Intake by infants will be measured as specified in the core. Intake of breast-fed infants can only be known by weighing them before and after each feed.*

PERSON-FOLLOWING.

As another validating method, the "child- or person-following" observation technique will be used. In this technique all eating activities of the subject are observed with permission and recorded for one complete day, from the time of waking or rising until s/he has retired for the night. Each item taken into the mouth (food, liquid, drug, other) is recorded, including amount. If the individual leaves the dwelling, the investigator accompanies him/her, recording ingestions as they occur. Food and fluid intakes and other ingestions will be determined for a small sample (n=35) of lactating women and preschool children (n=60). Observations on lactating women included in the energy expenditure study will be done every three months on the days on which their infants are weighed. Children 2-5 years of age selected from those being examined in the cognitive study will be followed singly for one day at a time to observe and record everything each puts in his mouth and swallows. The observations will be repeated as time and availability of team personnel allow but should be made on the child during at least two other periods during one year.

ALTERNATIVE METHODS.

Any or all of the following may be used, as time and availability of personnel allow, to validate food availability, intakes and distribution within families: meal watching; "dropping in" at meal time; spot checks of food on hand; and food diaries and/or food purchase records (kinds and costs) kept by literate family member.

INDICATORS.

Table 1 shows the foods that comprised the regular diet of a subsample of 59 low to middle class Nairobi women in our Kenyan study. We will use

*Procedures generally follow the WHO Collaborative Study of Lactation. Protocol: Volume and Composition of Breast Milk(Geneva: WHO, January 10,1978).

these data and the data from the proposed study to determine if the consumption of selected "super" foods such as sukuma wiki and ugali could be used as indicators of total food patterns. This method of assessment of nutrient intake could prove to be a relatively simple, low-cost pragmatic measurement tool.

CALCULATION OF ENERGY AND NUTRIENT INTAKE.

Calculation of energy and nutrient intake will be carried out as specified in the core.

TRAINING DIETARY INTERVIEWERS.

Qualified Kenyan staff will be trained as field supervisors and dietary interviewers. As part of of the training program, behavioral objectives will be formulated, and pragmatic experiences in interviewing and measuring under supervision are anticipated.

E. Indicators of Nutritional Status

Information needs to be gathered on a group of indicators of status as noted in the core. In this study, indicators will serve as an intermediate variable,and statistical techniques will be used to identify factors relevant to the observed states over the 2-year period. Indicators may also have explicative power. An attempt will be made analytically to identify parameters which capture meaningful relationships, have a low variability over time, and are highly sensitive to nutrition inputs. If this goal were accomplished, nutritional status and changes in nutritional status could be monitored effectively.

Meaningful analysis of height data requires that age be known accurately and that there are norms based on adequately nourished people of similar genetic background in a like environment. This project will rely on anthropological techniques to elicit and cross-check ages. Initially international growth norms will be used,but the project ultimately will use height of its own adequately-fed population as the reference for analysis.

Most methods of assessing body composition are far too complicated for field use. Collection of a timed 24-hour urine sample would allow for measurement of creatinine excretion which is a fairly reliable index of total muscle mass. In addition to collection from lactating women as specified in the core, collections will be obtained from a representative subsample of men and women.

Some development features may serve as nutritional markers: age of tooth eruption; age at menarche; age at maturity of pubic hair in boys (Tanner stage 4); age at first pregnancy; age at menopause.

There is some evidence to indicate that the basal metabolic rate (BMR) is lower in underfed people than in the adequately nourished. As this information is needed for other components of the study, BMR will be measured in a sample of adults. Body core temperature is thought also to be lower and the simplicity of this measure warrants an attempt to verify the notion. The BMR will be measured every 3 months in 35% of female heads (1/3 each pregnant, lactating, and other) and 10% of male heads from the same households as the women studied. Body temperature will be recorded when the BMR is measured in adults and at 3 fixed times of day in infants when breast-milk intake is recorded.

F. Unit of Analysis: Individual

1.DISEASE (EXPERIENCE AND RESPONSE).

Disease experience of individuals in the study households needs to be known both as an outcome variable related to energy intake and as a confounding variable in studies of other competency areas. The sample population is far too small to permit meaningful analysis of any but the most prevalent diseases, so this component will concentrate on diarrheal diseases and upper respiratory infections, especially of children. It will be necessary to keep a running account of family health in general, however, as e.g. days lost from work and school may profoundly affect individual and household welfare. Some concept of the demographic effects of disease may be developed from retrospective records. The project will assess the immune status of a subsample, utilizing simple procedures not requiring a sophisticated laboratory in the field, that will indicate a) overall immunocompetence including contributions of B and T cell systems, and b) presence of chronic infection.

EXPERIENCE.

With respect to the primary diseases, duration and recovery will be investigated by means of structured questioning. Emphasis will be placed on issues of appetite, food withholding, and food therapy as well as medications and treatment. Other questions will be concerned with family response in order to identify contacts but more importantly, to learn how nursing and required work are reassigned, what work is regarded as expendable, and so forth.

Respondents will be especially questioned about accidents and injuries because these may reflect other effects of chronic malnutrition. The effect of importance might be defective coordination or balance, or lowered alertness, but it could also be antisocial behavior patterns within and outside the household.

Health-care institutions and physicians will be located,and in the first phase of the study information will also be gathered on informal and/or traditional health-care services and providers. Through these information sources and a continuing census maintained by the field anthropologist(s), data will be collected on births and deaths in the entire (800 household) population. The annual survey of the entire population will include the same medical measures as indicated for the preliminary survey.

On the first visit to each sample household at the beginning of the formal study, additional health data will be gathered. Persons with limited activity due to chronic disease or impairment will be identified, tests of vision, hearing and speech will be administered, and a stool specimen will be obtained for examination for ova and parasites. The sample population will be monitored over the next 2 years by means of a questionnaire to be administered at least every 2 weeks by a local field worker (ideally a public health worker). A pilot study may be necessary to determine if biweekly sampling provides sufficient information from memory. Weekly queries may be required. Items to be included for each household member are:

a) Acute conditions: infective and parasitic diseases; common cold; other acute respiratory conditions; injuries; acute digestive conditions; acute communicable diseases of childhood (ICD Classification); and all other acute conditions.

b) Days of disability: restricted-activity days; bed days; school-loss days (ages 6-16 years); work-loss days (reported for wage- and self-employed persons of all ages); days worked but not fully recovered.

c) Health care: number of visits to health center, hospital, clinic, physician in office, dentist in office, other (specify); principal nursing-care given in the home.

d) Injuries: in moving-vehicle accidents; in work accidents; in home accidents; in all other accidents.

e) Nutritional care of sick/injured: amount of food consumed ("appetite") during acute phase; type of food consumed during acute phase; food withheld for therapeutic purposes; number of days of poor appetite; therapeutic foods administered during acute phase; therapeutic foods administered during recovery.

f) Current family planning practices: oral contraceptive (specify); mechanical contraceptive (specify); other (specify); none.

When the household food inventory is made, the same questionnaire will be administered covering the one week of the inventory. Comparison of this one-week record with the subsequent bi-monthly record will provide a crude validity check.

Several of the questions will not provide unequivocal answers because persons define sickness differently, both for self and others. Definitions of "diarrhea" are not uniform, even among professionals. Both personal and medically defined answers are required for understanding of the disease setting. Because all projects will focus on some diseases in common, definitions should be developed for use throughout the CRSP but information based on the informal/indigenous definitions should also be sought.

RESPONSE.

A sub-sample of approximately 200 children will be drawn from the study households for disease response studies. The intention is to closely interrelate any sub-sample immuno-response investigations with disease experience inquiries. The studies will be co-ordinated with the nutritional/biomedical determinations.

Based on Kenyan data showing impaired cell-mediated immune function (CMI) both in mild and moderately malnourished young children (weight for age 60 - 80% of the Harvard standard ; transferrin , albumin, low normal; and no signs of kwashiorkor) the PHA, lymphocyte stimulation, E rosettes formation and delayed hypersensitivity all showed levels below normal, but not as severe a reduction as in the severely malnourished group. Also, there was some reduction in tonsillar size compared to the well-nourished group, but not as reduced as in the severe malnourished group. C3 levels in the moderately malnourished group of children were between the severely depressed levels of the severely malnourished group and normal group.

In an intermediate group of low birth weight infants between 2500 to 2800 gms., who were small for gestational age, there was depressed E rosette formation compared to the normal weight group with birth weight over 2800 gms. Also, the prevalence of infection in the mild moderately malnourished groups was between that of the severely malnourished group and the normal groups.

Physical examination.(at least once/year, preferably once/season, to provide a picture of the community and the prevalent disease conditions there.)

Tonsillar size will be graded on individuals from 0 to 3+ according to Smythe et al. in which 0 indicated that a trace or no tonsils are seen, 1+ indicates that the tonsils are clearly visible but do not extend beyond the faucial arch; 2+ indicates that the tonsils are enlarged beyond the arch but not beyond the midpoint between the arch and uvula, and 3+ indicates that the tonsils extend beyond the arch-uvula midline. In addition, lymph node, liver and spleen size are recorded.

Humoral immunity and complement fixation. These are assessed by measurement of IgG, IgM, and IgA levels by radial immunodiffusion and IgE by PRIST radioimmunoassay, tetanus and measles titers by hemaglutinin assays already established in our laboratory: C3 by radial immunodiffusion and C3 breakdown products by counter immunoelectrophoresis respectively. C3 breakdown products are useful to determine *in vivo* complement activation, usually a result of concomitant infection.

Cellular immunity will be assessed *in vivo* by cutaneous delayed hypersensitivity to 3 ubiquitous antigens to which nearly all subjects develop a delayed hypersensitivity response. These include Candida albicans, Streptokinase-Streptodornase and tetanus toxoid antigen (1:5 dilution fluid tetanus toxoid). Skin test results are at 48 hours.

For children who have cutaneous anergy, a plasma will be obtained for Bach's thymic hormone assays. He has found this a useful measure of T cell function in cellular immunodeficiency and in aging populations.* Its validity in malnutrition will be assessed. In addition, selected anergic children may have T cell enumeration (by E rosetting) and PHA activation on peripheral leukocytes in the WHO Research Laboratories at Nairobi. IgE levels, being under strong T cell control also indirectly assess T cell competence.

These studies will be particularly meaningful when performed serially to determine dynamic changes with time or when acute infection appears.

Although work focuses primarily on several viral diseases, laboratory conditions permitting in Nairobi, cultures may be taken for bacterial, respiratory and diarrheal infections.

1) Respiratory syncitial virus (RSV) constitutes a large percent of respiratory illness among young children. Diagnosis of RSV infection can be accomplished quickly by fluorescent antibody technique. Field staff encountering acute respiratory infection will take a swab of nasal secretion and spread this out on a glass slide and fix it in acetone. These can be examined either at the field clinic laboratory or in a laboratory in Nairobi, at the Medical School.

2) Diarrheal disease. Rotovirus infections are universally common. High maternal IgG antibody levels are found early in life, which declines between three to five months. Rotovirus antibody then rises at seven to eight months. Stool specimens can be obtained either by rectal swab or actual stool collected from all children encountered with diarrhea. The specimens should be kept cool (4°C) and examined in the field laboratory or sent to Nairobi for further testing. A most appropriate technique,

*Since the test is done on serum it obviates the need of a cellular immunology laboratory and the need to work on fresh specimens and separate lymphocytes.

however, for field study identification of rotovirus is the enzymatic labeled antibody test (ELISA). Elisa is stable, requires no radioactivity hazard, and requires no sophisticated equipment. The test can be read by the naked eye or with a simple colorimeter. A large number of specimens can be examined in a relatively short period of time. The method is efficient and as sensitive as the electromicroscope method and the radio-immuno-assay methods. Stool or rectal swab filterates can be used or a 2% unfiltered specimen can be examined. A field laboratory could be set up to identify rotoviruses in stools. Because the role of breast milk secretory IgA antibody in rotovirus needs to be evaluated, antibody levels can be obtained and measured in breast milk and would not be difficult to do under field circumstances.

2.REPRODUCTION.

A primary purpose of this project is to determine the significance of biological, sociocultural, environmental, and nutritional factors associated with maternal morbidity and mortality, perinatal mortality, low birth-weight, low infant growth rate, and lactational failure. Knowledge gained from other functional areas of the project will permit this.

Because all women in the sample population are to be studied, food intake will be known for some women before, during, and after pregnancy, as will body weight on a month-to-month basis. Similarly, some women will be studied throughout lactation. Knowledge of milk intake of breast-fed infants will permit calculation of the energy cost of lactation. The variety of reproductive histories likely to be encountered should also enable assessment of the cost to the mother of repeated reproductive cycles at different levels of intake. For this reason, the study will include women nearing and beyond the menopause.

Information about disease experience is, of course, critical to interpretation of reproductive events. Activity patterns will be known for all as will BMR and energy cost of activities for a representative sub-sample (see section III-F-3, below). The anthropologists will gather information about what women are expected to do (to be contrasted to what they can and actually do) and will explore the involvement of fathers and other household members in parenting activities. All the social science components will yield information on the potential for and availability and provision of general aid and assistance to pregnant and lactating women from household, community and institutional resources. The cognitive development of children born in these described households will be followed (see section III-F-4 below).

Continuing from the third year, appropriate cases will be followed longitudinally through project years 4 and 5. It is possible that a suitable intervention can be devised to test a specific hypothesis concerning linkages among nutrition, disease, work requirements, etc., so that reproductive outcomes can be compared at different and improved nutritional intake levels. In this connection it should be made clear that qualified members of the investigating team will provide requested advice to individuals who wish to practice family planning, irrespective of considerations of study design.

For project purposes, reproductive competency is seen as encompassing the outcomes specified initially and also the life-long nutritional and health state of women. The contribution of men, other household members, community, and institutions to the post-conceptional phases of reproduction are seen in one sense as confounding variables but also as indicating potential points for subsequent intervention to improve reproductive outcomes.

To accomplish this task, a study will be made of all pregnancies and the outcome (live births and perinatal deaths) of products of conception of mothers in the study population within a 24-month period (see Appendix B). One of the requirements is that staff trained in obstetrics, pediatrics, and community medicine are included among project personnel drawn from the overseas institution.

It is proposed that all known and possible sources of information and contacts in the study community be utilized to keep a register of pregnancies, still births, live births, and early neonatal deaths in the entire population as well as the study sample. Such possible sources include: attendance at clinics (prenatal, child welfare, postnatal, rehydration); delivery in or by health center staff; traditional birth attendants; midwives; doctors (employed and in practice); community leaders; school teachers; agriculture extension workers; staff serving community feeding programs; and usual community enumerators.

All measurements relating to reproduction will be carried out as specified in the core as well as gathering current information on spontaneous and induced abortion; labor and delivery; and presence of congenital malformations. For the 24-month period, the causes and associations of low birth-weight and perinatal mortality will be sought. Information on food intake, body weight, disease, behavior, etc. (as described separately) will be used in this assessment.

Many accounts from different parts of the world suggest that malnourished women often lactate with unexpectedly little clinically obvious deterioration of their nutritional status. However, in recent years there may be increasing evidence of shorter periods of satisfactory lactation than previously, at least in some parts of the world. The effect of maternal malnutrition may be partly hormonal, with decreased secretion of cortisol and possibly prolactin. The cumulative effects of sequential reproductive cycles, including prolonged lactation, can lead to general maternal depletion, as shown by progressive weight loss and a prematurely aged appearance. More specific nutrient deficiencies may occur with repeated reproductive cycles--for example, an increasingly large goiter, anemia, osteomalacia or nutritional edema, all of which will be monitored in our study.

Lactation performance will be evaluated in terms of milk composition and quantity ingested by the infant (as specified in the core) but more importantly by infant growth rate and the need for early supplementation. Test-weighing of infants will provide needed information on infant suckling patterns and maternal-infant interactions. The causes of lactation failure will be studied, including such diverse factors as maternal and/or infant disease, introduction of supplementary foods, method of contraception,

insufficient maternal fluid or food intake and weight gain during pregnancy.

3.ACTIVITY, BEHAVIOR, AND ENERGY EXPENDITURE.

This component of the project is designed with two major dimensions, one which focuses on comprehensive activity and behavior, and a second which is concerned with determining the physiological energy cost of the activities engaged in by study household members. It is important to know how availability of food energy (within ranges currently encountered in the diets of poor people) affects habitual physical activity patterns. If activity is decreased with decreased intake, as is to be expected, it is important to know how choices are made about activities to be foregone and the impact of forced choices at various intakes on individual physical well-being and on the functioning of individuals, households, and community. Energy balances of individuals may well undergo periodic or occasional changes while the energy balance of the household as a whole does not show any change, as a consequence of redistribution of food supplies and shifts of task allocation.

Restriction of food intake in childhood that results in diminished growth (skeleton, musculature) and development (cognitive, sensorimotor, social) has the potential to limit work performance throughout life. It may also set patterns of activity and behavior that have lasting consequences reflected in attitudes toward activity, work, and societal obligations. Currently low intakes must limit activity unless body mass is expended; the mass available for expenditure is a function of immediate past intakes and activity requirements. Decisions as to what to do and not do may well be affected by the individual's perception of his reserves and potential for replenishment; ultimately the sacrifice of tissue is a physical limitation.

ACTIVITY AND ENERGY EXPENDITURE.

The energy expenditure component of the study will focus in detail on activity patterns of a subset of male adults (n=30), women in three reproductive phases (pregnant, lactating, intergestational; n=35 each), and children. This sample will be the same as those adults in whom basal metabolic rate is to be measured, and the children in their households. In the first three months of the study, the men, women and older children (> 10 years) will be asked to keep a diary record, or to recall in a structured interview, all of their activities for a 24-hour period each month. These records will be obtained in conjunction with the 24-hour food intake records. From these records and observations made by field team members, lists of most common activities engaged in by men, women and children will be constructed.

The energy expended during the activities that occur frequently and occupy significant portions of time will be measured by respiration calorimetry. Each activity will be tested on two occasions at appropriate seasonal intervals for all adults noted above and for 10 children per age/sex category (males 15-18 years, females 13-16 years, males 11-14 years, females 10-12 years). Monthly records of activity will continue throughout the study and energy cost of other activities will be measured if there are significant differences over time.

Using these energy cost figures and records of the daily activity patterns (time budgets), total daily energy expenditure will be computed. In lactating women, a correction will be made for the cost of breast-milk as determined from the intakes of their infants (by test-weighing and analysis of milk for energy content). Energy intakes of the sample population will be known and this information, plus data on changes in body weight and estimated fatness (skinfold thickness) and musculature (urinary creatinine) will allow construction of energy balances. Energy expenditure data will also be used to construct tables of energy cost of various occupational and self-selected activities, by persons of different body weight and estimated body composition, that can be applied to the larger study population.

It is not feasible directly to measure energy expenditure of young children in a field study of this scope. However, detailed records of activity will be obtained whenever a child is followed for other study purposes, and children's activities will be randomly sampled as will activities of other household members not included in the energy-expenditure sub-sample. A rough estimate of the energy available for activity of young children will be derived from data on their food intakes, growth and body composition measures. Energy costs of growth and maintenance will be computed as suggested by Waterlow and others. The difference between recorded energy intake and the growth-maintenance estimate is the amount theoretically available for activity and this should compare with observed patterns if both measures are reliable. In the second year of the study, an attempt may be made to obtain a more quantitative assessment of children's activities using miniature heart rate and activity recording equipment, but our experience with these devices indicates that the method has little promise for field application. The tests will be carried out only if the effort is warranted by observations made in the first year.

Men, nonpregnant women, and older children will have administered a simple work test (Harvard step test or equivalent) in a preliminary attempt to determine if activity patterns are related to physical fitness for work. More sophisticated measures of the various components of performance capacity are deemed not feasible under anticipated field conitions. It is very likely that activity patterns will be severely constrained by availability of resources (food, but also employment, land, equipment, etc.). When these constraints have been defined by the present study, it will be possible to design an interventional study from which the residual due to performance capacities can be determined. This should be done in years four and five of the project.

ACTIVITY AND BEHAVIORAL PROFILES.

The broadest aim is to determine which activities/behaviors are suppressed/expressed under varying levels of energy intakes, which tradeoffs are implicated, and what consequences these tradeoffs have for nutritional status and the functions specifically under study in this project. Data will be analyzed with a view to determining the ways and extent to which time, sociocultural preferences, technological items, and other environmental factors are themselves constraints on behavior independent of possible energy constraints.

Intensive open-ended interviews with reliable informants and participant observation will determine how individuals in the community expect activities to be done, what ideals of performance are, how these expectations vary in the local population, and how structured and refined this knowledge is for the various segments of the local repertoire of activities. Local presumptions of the systemic/strategic character of differing behaviors and activities will be determined, i.e.,what the perceived functions and consequences of particular actions are.

The whole population of the community will be surveyed to define locally appropriate descriptive categories of behaviors and activities. Coding procedures for activity analysis will be developed and data recording methods will be pretested and refined. These will be used to collect data on time allocation for 300 households. For verification the time allocation profiles will be checked against the 24-hour activity records collected on the subset of households previously described.

4.COGNITIVE AND SOCIAL DEVELOPMENT

In approaching the problem of assessing cognitive and social competence across a major portion of the life-span, a strategy has been adopted which directly addresses a number of well documented problems associated with cross-cultural research in this area. First, the assessments will involve cognitive functioning that is both relevant to a wide range of cultural contexts and is epistemologically powerful. For example, basic logical, causal, spatial and social concepts will be assessed using a variety of problems and situations. The problems chosen minimize the importance of verbal skills by focusing on object manipulations and predictions for the physical-spatial problems, and on prescriptions and proscriptions in the social problems, rather than abstract conceptions and exact "correct" solutions. Some of these procedures have already been used successfully in other cultures. The specific problems administered to subjects will include objects and situations indigenous to the population studied. In devising these problems, principles designed to assess the structural equivalence of problems will be used. Intensive collaboration with Kenyan counterparts will also be useful here. Second, the same basic concepts will be assessed in infants, classificatory skills in children, and combinatorial operations on classifications in adolescents and adults. Because the approach is developmental (the conceptual advances have been ordered in an ordinal and inclusive sequence), extent of development is an easily interpretable dependent variable.

The relationship between nutrition and growth and development of individuals has of course been studied for some time. However, until recently not as much has been studied about how family interactions, child-rearing styles, and general social competence affect the growth and development of the child; including the parameters of physical, cognitive, and emotional development. Family and cultural factors influence individual health not only in the specifics of dietary practices, the provision of a healthful and sanitary environment, the seeking-out and utilization of appropriate medical care when necessary, but equally in the social inculcation in children of perceptions and attitudes about health and illness, life-styles, etc. Such aspects of family functioning as socio-demographic features, family cohesion, tension management and conflict resolution, emotional

climate, problem-solving skills, support connections, organization and task division, values and cultural orientation, should be considered in conjunction with the various assessments of cognitive processes specified below.

Also, there are indications that caregiver sensitivity to a child, and caregiver structuring of the environment can be linked to the child's ability to be tuned into salient features of the milieu. As we study the ability of malnourished children to select features of the environment to respond to, and to maintain attention appropriately, we will also attempt to document variation in caregiving behaviors. The quality and quantity of these interactions will interact with a host of health and nutrition factors and impact on the course of psychological growth. Analysis of caregiver variability may provide another promising way to study differential outcomes in the developmental course in addition to the set of specific assessments. The study will thus also seek to assess family social functioning and social competence as a variable factor in the nutritional, health and developmental status of children. This assessment is interrelated with and relies on other components of the overall study.

To assess the relationship between nutritional intakes and cognitive development adequately, a two-phase study is proposed. The first phase is cross-sectional and will be completed during the first three-year period of the project. The goals of this phase are: (a) to establish reliable assessments of levels of cognitive development across most of the life-span; (b) to extend these procedures where necessary to include a structurally parallel set of procedures based on objects and activities indigenous to the population studied; and (c) to establish through correlational means the relationship between levels of current nutritonal intake (and retrospective reports of nutritional history) and current levels of cognitive and social development.

The second phase of the study is longitudinal and is proposed for years four and five of this project. All individuals seen during the first phase of the study will be seen two years after the initial assessments. This will allow for a detailed analysis of the relationship beteen nutritional intake and cognitive functioning over a two-year period. For example, individuals assessed at the same level of development at Time 1 may not show equal cognitive advances as a function of nutritional history. In addition, the number of individuals available for establishing adequate norms for cognitive development will be effectively doubled. For those subjects born during the first phase, almost complete life records of nutritional intake will be available for that period which previous studies have indicated is critical for subsequent cognitive development.

Because of the time required to obtain reliable assessments of cognitive and social competence, it will not be possible to assess all individuals who are part of the overall study. A sub-sample that has been screened for sensory capacity will be selected on the basis of age, sex, and nutritional status,as follows:

Age	Assessment Time		
	N	hrs/S	E
6-12 months	30	1.5	45
13-24 months	50	2	100
2-4 years	60	4	240
5-6 years	30	8	240
7-8 years	30	9	270

Age	Assessment Time		
	N	hrs/S	E
9-10 years	30	9	270
11-13 years	30	10	300
14-16 years	30	11	330
17-19 years	30	11	330
20-40 years	30	7	210
	350		2335

Half of the subjects at each age range will be male and half female. With the exception of adults over 20 years of age, half of the sub-sample will consist of individuals that have been judged by the nutritional-medical team to have had an adequate history of nutritional intakes and half will have been judged to have had an inadequate nutritional history. To avoid the possibility of confusing mental retardation with sensory deficits, only individuals that are found on examination to have adequate vision and hearing (and those who are not incapacitated by disease) will be included in the study of cognitive and social competence. In addition, the medical examiners will assess adequacy of sensory and memory functions for the individual cognitive tasks. A problem is not foreseen, however, except for the younger children and infants, for whom the pediatrician's assessments will be critical.

Because of the need for these prior evaluations, this component of the project will begin in the second quarter. During the two-year study phase, the oldest subjects will be seen first. The youngest children will not be seen until the second year of data collection. Hence, for the 6-month-olds, extensive data on the mother's nutritional history during pregnancy will be available. Similarly, extensive nutritional data will be available for the entire life span of the one-year-olds and probably the 18-month-olds.

The sample of subjects over 20 years of age will include only adequately nourished individuals. Long-term nutritional histories are the least likely to be known accurately but every effort will be made to select subjects of the best probable state in order to establish upper ranges of cognitive development attained in the study population under prevailing biophysical and sociocultural conditions.

The procedures for assessing cognitive and social development are divided into two content domains: those concerned with the development of logical-physical concepts and those concerned with the development of social judgements. A broad range of cognitive and social tasks will be used, yielding a comprehensive assessment of the subject's levels of cognitive and social competence. The concepts to be assessed at critical age periods are:

	Concepts		
Ages	Logical Development	Physical Concepts	Social Concepts
6mo - 2yr	Pre-Classification Seriation	Object, Space, Causality	
2yr - 5yr	Same as above	Identity Space Causality	Social Identity Social Regulations Positive Justice
4yr - 12yr	Classification and Seriation	Identity, Space, and Causal Concepts (as above) Conservations of Continuous and Discontinuous Quantity and Length	Social Identity, Social Regulations, and Positive Justice (as above) Social Organization and Conventions
10yr and older	Classification: Class Inclusion and the Duality Principle Combinatorial Permutation	Volume Conservation Causal Inferences Density and Specific Gravity Proportionality	Social Organization and Conventions Social Regulations Moral Judgements

Note that the comparability of assessments across ages is insured because: (i) the same problems are used across a range of ages, and devleopmental advances in the same concepts are assessed across all ages.

Logical-physical development. To insure breadth of cognitive assessments, the research strategy is to assess the development of logical concepts on the one hand, together with the development of related physical, spatial, and experimental concepts on the other. And, in addition to utilizing problems indigenous to the population studied, two further modifications in the conventional assessment procedures will be introduced. First, all individuals assessed will receive the same problems on two separate occasions. The first administration will serve as a familiarization session for the subject and as a diagnostic session for the interviewer. Information obtained will be used to facilitate communication during the second session. Second, beginning with the 6- or 7-year-olds, a training session will be introduced between the other two sessions. At this session the principles underlying each problem will be taught to each subject individually. For these subjects, additional, structurally parallel problems will be introduced at the third session to assess transfer of training. Combined, these modifications will greatly enhance our ability to assess cognitive competence rather than the ability to adapt to unfamiliar problems in unfamiliar settings.

Social development. The assessment of social development has two components, interviews and behavioral observations. All individuals 4 years of age or older who are selected for cognitive assessments will also be assessed on their level of social-cognitive development across a number of content domains. These will include procedures for assessing the development of: (a) social identity; (b) concepts of positive justice in young children; (c) moral judgements in childhood, adolescence and adulthood; (d) concepts of social organization and conventions; and(e) concepts of laws and regulations. Intensive consultations will be made with overseas colleagues in order to insure that the measures of social development are appropriate to the population studied.

A behavioral measure of social development will be obtained by taking narrative records of each subject's activities during critical periods of the day. For the children, a play period in the natural setting will be included. This naturalistic observation will focus on peer interactions. The second observational period will encompass the major meal time. These observations will focus on parent-child and parent-parent interactions. For adults, the meal-time observations will be supplemented by including observations on adult interactions outside of the home. This component of social assessment will be coordinated with the general random time sampling of behaviors described in preceding section.

G. Unit of Analysis: Household

1.FOOD PATTERNS AND RELATIVE DEPRIVATION.

A major interest of this research component is examination of the ability of a household unit to support itself nutritionally in a given

environment. This interest requires investigation of food patterns and their environmental contexts, synchronically and diachronically. Food patterns include: procurement, preparation methods, storage, distribution, and consumption; knowledge, values and attitudes about food; food uses on special occasions (e.g. festivals) and under special circumstances (e.g. ill-health); food and dietary histories. Also to be examined are the relationships of food patterns to the sociocultural and biophysical environments. Assessments of the effects/results of the patterns is part of the broader investigation, with dietary assessment a major emphasis. The latter is multi-purposed and provides part of the core of the informational base of the project. Other assessments include the more biographically-oriented aspects of the proposed research project, as well as the subjective assessment, relative deprivation which is the special concern of this component. Two parts of this component are explicitly diachronic: a) collection of food and dietary histories, especially on the household level, in part to ascertain pervasive nutritional experiences; and b) determination of relative deprivation (see below). The synchronic orientation encompasses: a) ongoing management and manipulation of food patterns to current assessments and biological states (e.g. pregnancy and lactation). Investigation of food patterns and relative deprivation is one of the interfaces between the nutritional/biological and the economic-administrative components. Clearly not separate from these other parts of the research, this area provides opportunities for integrating several research topics and activities.

For purposes of this research, food patterns may be usefully divided into resources and strategies. Three specific objectives of this part of the project are: 1) to examine management of nutritionally relevant resources (e.g., cash, credit, commodities, kinsmen, comestibles) and the environmental context of such manipulation; 2) to describe resulting household food patterns; and 3) to explore the relationship between food patterns and people's sense of well-being in terms of relative deprivation.

Relative deprivation is defined as the gap between preferred and actual levels of food intake, although in the literature this terminology is not consistent or precisely defined. In addition to food itself, the comparison with former (perhaps also 'rightful' or 'expected') status vis à vis food is of concern here. It is expected that preferences and such self-comparisons or evaluations will include aspects of food constituting culturally defined qualities as well as desired food quantities. The concept therefore can be applied more broadly to food patterns rather than being restricted to intake levels.

Since this component of the research project is closely linked with the independent variable food intake, some of the data collection will coincide with sampling procedures and field survey enumeration described for the nutritional and health status component of this research. For example, the household food inventory schedule provides one opportunity to elicit particular information on food procurement, storage, and inter-household distribution, and uses of nutritionally-relevant resources. This information will be obtained through interviewing techniques such as limited structured, serial structured and unstructured interviews. Structured observations in conjunction with the household sampling schedule will also be possible. As is true for the entire proposal, a combination of nutritional/biomedical and social science approaches will be utilized in data-gathering. The general approach of this component is an anthropological field study incorporating the use of respondents and participant observation. Participant observation simply implies that the field researcher

takes part to varying degrees in daily and special activities of the study population. Field data records will include field notes, maps, photographs, unstructured interviews, questionnaires (if needed), structured observations, food intake measures (e.g. quantitative child-intake records obtained by the child-following technique), and such elicited materials as household case histories. Insofar as possible, independent measures of related data on the household level will be sought in order to cross-check information.

Since the research design of this component is a field study and not merely a survey, the cross-check procedures are feasible. It should be noted that some research activities listed below are concurrent, some ongoing, and some recurrent; some of the activities are shared with other components. The tentative outline of major anthropological research activities is as follows: a) initial preliminary census interviews and selection of household sample; b) description of the household units and environmental contexts; c) ascertainment and utilization of public information (public records, maps, etc.); d) implementation of food intake survey (includes the household food inventory); e) implementation of a community census; f) involvement in unstructured interviews on food patterns (includes both quantitative and descriptive data); g) development of a measure of relative deprivation; and h) collection of other elicited material (i.e., nutritionally-important resources). Participant observation will be used in these eight activities as well as particular techniques and methods as needed.

Methodologically, this anthropological component is designed to fulfill the need for detailed, ongoing household information to complement and complete the nutritional/biomedical information and the need for linkages between the household unit level of study and the broader community and institutional levels. Other social science components also provide some of these linkages.

Conceptually, this component will relate to nutritional/biomedical assessments of capacities and capabilities. For example, the research concern with relative deprivation focuses on a subjective judgment of capacity which complements the traditional emphasis on "nutritional status," an objective multi-measurement of capacity. Capability relates to ability and competence. Examination of food patterns is a particular aspect of such capability. The basic conception of a human system with capacities as well as capabilities also is included in other economic-administrative components. This conception is linked back to the focal relationship between intake and function by regarding that relationship as part of a multi-dimensional feedback loop involving both biological and societal concerns.

2. THE INTERDEPENDENCE OF INTAKE AND PRODUCTION.

This component and a second economic investigation (see next section) aim, in part, to explain the role of food intake, and of the need to insure minimal intakes, in governing patterns of household and village economies. Starting with an overall conceptualization of a community of households, each unit may be described in terms of its evolving resource patterns (including its pattern of labor force, its transactions, and its command of further resources, goods (including food), and services). The purpose is to enable simulation of the process of evolution of household arrays

(in which the size and composition of households is related to their access to resources and employment) in order to understand the key determinants of change in the numbers of dependent households (households unable to ensure adequate intakes by their own resources.)

Emphasis is on the consequences of malnutrition, together perhaps with the threat of hunger; for household behavior as this in turn governs subsequent household productivity and earning, intake patterns, behavior, and function generally. An understanding of these relationships might contribute to the design of social action to reduce malnutrition and minimize its repercussions. Next, research will focus on general equilibrium and dynamic properties of communities of interacting households with respect to patterns of intake and function of different categories of households (to be defined by the study) and attempt to identify characteristics of the institutional framework (e.g. inheritance, land use rules, credit institutions) that are significant in producing the observed and postulated patterns of intake/function. Ultimately, a model will be developed to simulate long-term trends in intake and function and in relevant institutional changes in the community. The significance of this research is that it studies the role of social institutions in mediating the relationship between intake and function, i.e. the two-way relationship in which intakes affect and are affected by social institutions.

The central methodology of this component is linear programming used as a technique for exploring alternative household strategies for allocating time and resources and for appraising observed household behaviors as they relate to the provision of food and its destribution over time and between people. The final outcome is seen as a definition of the social/institutional framework in which households interrelate and which mediates the cumulative social impacts of experiences or threats of malnutrition.

H. Unit of Analysis: Community and Institutions

1. ADMINISTRATIVE MECHANISMS OF FEEDBACK AND ERROR CORRECTION.

The ultimate purpose of the research project is to strengthen the capacity of developing nations to deal with the problems associated with malnutrition. Since the project focuses upon the consequences and not the causes of low intake, it will establish how serious the problems are but will not directly indicate how they might be solved. The utility of the entire project to policy-makers will be greatly increased by this social science research component which supplements and draws on the findings produced by the project's life scientists. The purpose of this investigation is to indicate the manner in which the particular systems under study could most appropriately be strengthened in their capacity for dealing with malnutrition. This research is a central component of the study of the relationship between deficient intake and "social competence" in a community, studying, especially, societal competence in response to the threat or existence of malnutrition.

The social, economic and technical conditions of production and existence are changing constantly, and the past and future thus pose an unending series of challenges to the nutritional status of some individuals and communities. It is impossible to anticipate, much less prevent, the nutritionally damaging components of all change. Many of these challenges are met by adjustments in the market and in the behavior of families. Other changes are not met effectively by these relatively micro-level responses, however, and produce pervasive problems of deficient intake. A nation therefore needs an institutional framework for dealing with changes in nutritional status as much

as it needs policies attuned to dealing with current malnutrition. Social competence exists at the levels of family, market, community and national behavior and is both affected by and affects nutritional deficiencies.

A set of community and national feedback and error-correction institutions depends on the effectiveness of three components: (1) problem identification mechanisms, which will detect the existence of a nutritional problem quickly and reliably; (2) decision-making institutions, which will make competent and binding decisions to deal with the problem; and (3) implementation mechanisms which will move forcefully and effectively to execute the decisions made. The effectiveness of a nation or community in feedback and error correction on nutritional matters depends on the interaction and operation of all three components. Frequently one finds situations in which error correction is better dealt with by three imperfect components which work very well together than by a system which has excellent components which are poorly articulated with one another. For example, a problem identification mechanism which is highly proficient and located in a Ministry of Health, with decisions and implementation being undertaken in a Ministry of Agriculture,might work less well than a set of mechanisms that were separately less proficient but were all in one or the other ministry. The "best" is often the enemy of the practical, and a major objective is to discover what will work.

A community's and nation's feedback and error-correction institutions for nutrition will be investigated in the following manner: a sample of present and past challenges to nutritional status will be drawn; and the experience of the community and the state and national administration in identifying and dealing with these problems will be investigated. The sample will be composed of two parts. The first will be the present and past nutritional problems which are identified by the larger research project itself. (This sample, because it focuses on problems that remain pervasive, will tend to highlight the shortcomings of the existing institutional structures. It is important that it be supplemented by another sample in which there is a good chance of finding successful responses, where problems were solved before they became pervasive.) The second sample will be drawn from an investigation of government initiatives for change in agricultural production in the area. Government files will be checked and local respondents interviewed concerning the potential problems which the initiative posed for nutrition.

Having identified situations in which nutritional problems needed to be solved, the research will then focus on the manner in which the feedback and error-correction processes worked, where they were successful and where they were subject to delays, blockages and mistakes. This investigation will be conducted through study of relevant government files and interviews with community and administrative informants. The researchers intend to be open minded and broad about the range of community and administrative institutions which will be explored. The point is to identify the ways in which a community or nation deals best with its nutritional problems, not to evaluate any one particular institution. In principle, effective response mechanisms might be found in any one of the following: informal community social structures (traditional or new), community official councils, religious bodies, the courts, administrative personnel operating at any level from the village to the capital, functional administrative bodies composed of anything from generalists to health or agricultural specialists, private medical practitioners, and so on. Thus this research component attempts to discover whether nutritional problems in practice are best dealt with by institutions which are: private or governmental, centralized or decentralized, generalist or specialized, a particular type of specialty, or

some combination of these types of structures. The prospects are that it will be found that some types of challenges to nutritional status are well dealt with by one set of institutions and another type by a different set.

A brief methodological note is in order here about units of analysis and quantification. The units of measurement for this particular study are challenges to nutritional status. These units will be systematically selected. However, the intent is to be unstructured and diagnostic in collecting data on what institutions responded to these challenges and how. Systematic, quantitative analysis of the relative success of different feedback and error-correction "treatments" to challenges will then be made. This will be supplemented by qualitative analysis of the same material.

The research proposed here seems essential if the results of the larger project are to be translated into effective policy recommendations. At a minimum, it will be conducted at the site assigned to the University of California, Berkeley. Ideally, such research would be carried out at all the sites, however. This broader coverage would facilitate the development of policy recommendations for those sites. In addition, the observations common to the funded projects would indicate generalizations about appropriate institutions that would have a high probability of applicability to a range of other developing countries. The greater the degree of institutional variation between research sites, the greater the richness and reliability of the findings will be. In particular, it would seem desirable to have differences between countries in which this kind of study is being done along the following dimensions: centralization, colonial heritage (as each metropolitan country tended to create a similar set of institutions), orientation of national policy toward the poor, and relative importance of subsistence agriculture.

2.NUTRITION AND ECONOMIC FUNCTION IN COMPARATIVE COMMUNITIES.

Most economic analysis has been developed under the implicit assumption that people are adequately nourished. Ratioanl economic functioning then is interpreted as a choice about consumption and production,based on utility and profit maximization. However, when the level of income is so low that it barely suffices for marginal fulfillment of basic needs, such as food, clothing, and shelter, the functioning of indiviudals, households and communities as economic units and the nature of the economic environment in which they operate are drastically altered. Not only is the individual's transformation between available labor-time and productive labor-time affected, but the processes of wage determination and of the allocation of the use of land and credit are affected as well.

It is hypothesized that a major criterion of the organization of the village economy is to ensure low-income households of adequate, stable food supplies in the face of seasonal and weather-induced fluctuations in their marketable surplus. This is accomplished by institutional arrangements which interlink the provision of access to credit and land to low-income households to the provision of peak-time labor and crop-sharing contracts to the landlord. Departure from standard patterns of food production via, for instance, improved technology are seen as intensely risky, and their adoption depends very much on the initial level of well-being of the individual. The research described in this component will attempt to analyze the economic functioning of local institutions under conditions in which many indiviudals in different communities have very low food intakes.

A comparative study is proposed encompassing economic groups in different sociocultural conditions and varied levels of food intake. It is proposed that the study be carried out using appropriate study communities included in the total CRSP as case studies. By controlling for the few separate factors that have affected the evolution of the communities differently, common patterns of economic behavior are likely to emerge that can be generalized into a theory of economic function under subsistence and uncertain food supply conditions. The evolution, over time, of the affected economic groups will be studied in a model of household behavior and interaction in subsistence communities. The internal as well as external constraints imposed on household functioning at these low-income levels will be identified, and their relationships with the maintenance of poverty will be clarified.

This research component will implement an empirically well-grounded mathematical model of the household decision processes in the survival-oriented institutional framework of the traditional village economy. The dynamic evolution of a population in a number of household categories will be traced as they interact in the quasi-markets for labor, land, credit, and commodities within the risk-minimizing village economic intitutional setting. It is expected that the combined result of the institutional ways of insuring against falling below subsistence food requirements is, in the medium run, to perpetuate poverty and quasi-feudal economic relations within a stagnant agricultural village system. Another expectation is that when the traditional system is replaced by a pure market system, without any extra institutional provisions directly or indirectly to ensure subsistence food supplies, the situation of the poor becomes actually worse: a process of successive marginalization, displacement, greater indenture, and indebtedness increases the numbers falling below subsistence. Simple solutions are not forthcoming because the structure of the economic system under which many undernourished people function does not allow for the efficient conduct of nutrition intervention and other development policies. It is the relation between this structure and the people affected by it that this research will attempt to untangle.

A rigorous formal theory of economic functioning under subsistence conditions has not emerged from previous research. Absent are explanations of the reasons for the structure of land, credit, and commodity markets and the reasons for the structure of the labor markets within which outside employment is sought by the subsistence farmers. Several studies have examined the imperfections in the labor, credit, and other factor markets as explanations of poverty. The research concentrated on how the interlinkage of various factor markets reinforces poverty, on how individual transactions are interlocked and result in maintenance of stagnant subsistence agriculture, and how differential adjustment mechanisms operate in the different markets. Many of the basic assumptions of the models remain untested and the need exists for constructing a rigorous analytical framework to incorporate all meaningful relations.

This research will evolve in three general phases, each lasting approximately one year. First, a preliminary theoretical background for the study will be formulated as a basis for subsequent data collection. The theory will provide the appropriate hypotheses to be tested by the data and formulate the models that will from the basis for later analyses. After visits to field sites and collaborative interdisciplinary discussions a feasible empirical research package will be designed that will yield information necessary for the analysis in the later phases. The second year will involve extensive data collection in the field. The initial design and programming of relevant modeling software for the subsequent empirical

analysis will also be started during this phase. The final phase will involve mainly analysis of the data; refinement of the models developed; and other aspects of write-up and dissemination as stated for the overall research project.

I. Data Management

Data management is an ongoing concern throughout the three major phases of this research project, although certain phases and research components present particular concerns. Major responsibilities of data management include: coordination with work force and equipment needs in the active data collection phases of the project; non-duplication of data collection efforts; facilitation of computer processing; and ensurance of accessibility, distribution, and security of research data and materials. It is anticipated that field data will be directed to a central field location for initial processing. Subsequently, data management centers will be established at both of the main collaborating institutions.

The management of data will be as follows:

1. Each person in the community will be assigned a code number. The code identification will be kept in a separate locked file with controlled access. This file of information will be kept current and available only to senior scientific investigators. This coding will preserve the confidentiality of the individual respondents. Any basic information gained by any investigator will be added to this file.

2. A second file will be kept by household. Each household will also be assigned a code number. The correspondence between household and number will be kept confidential in a separate locked file with controlled access. This identification number will be catalogued with the code numbers of all members of the household. The membership composition of the household will be kept current and avaiable to only senior scientific investigators.

3. A third file will be kept on community data.

4. A fourth file will be kept on environmental data

5. Each investigator has defined a topical area with a data core for which s/he is responsible, as presented in the research components. Each researcher will also identify specific data which are likely to provide complementary interconnections between various components. All data collected by scientific participants will be available to all other such participating researchers upon request.

6. Types of data to collected and methods of analysis as well as any special concerns or considerations will be shared with all investigators before fieldwork begins. Any changes or emerging collection or management problems will also be discussed by all researchers as soon as possible.

Adequate computer facilities exist at participating U.S. institutions. It is anticipated that language and data storage and retrieval systems will be agreed upon by all participants in the CRSP, to which this project will conform.

Statistical methods of multivariate, multifactorial analysis may be another area for CRSP standardization, supplemented by initiatives of individual project statisticians.

Tentative University of California Budget
Summary

Expense catagory	Year One	Cost Sharing	Year Two	Cost Sharing	Year Three	Cost Sharing	Year Four	Cost Sharing	Year Five	Cost Sharing
Personnel	249.5	108.2	333.3	117.8	360.2	122.6	270.5	92.1	135.0	46.0
Travel	46.1		52.6		63.1		75.7		60.0	
Supplies/Expense	34.5		34.5		39.7		43.7		30.0	
Equipment	0.7		0		1.0		1.1		1.2	
Subcontract Washington Univ.	0		48.7	16.0	53.8	17.0	59.1	18.7	60.0	20.0
Overseas										
Personnel	89.1		98.0		107.8		118.6		90.0	
Travel	12.4		13.6		15.0		16.5		18.0	
S/E	39.6		33.0		36.3		39.9		30.0	
Equipment	21.0		31.7		6.3		6.9		5.0	
Totals	492.9	108.2	645.4	133.8	683.2	139.6	632.0	110.8	429.2	66.0

Detailed Budget for First Two Years
University of California

Personnel	Year One			Year Two		
	%time	$	cost sharing	%time	$	cost sharing
Calloway	0	0	20/9420	0	0	20/10407
Ostwald	0	0	25/8140	0	0	25/8954
Adelman	0	0	10/4720	0	0	10/5005
Turiel	16	6551	10/2590	16	6946	10/2745
Wallace	0	0	10/4350	0	0	10/4615
Leonard	0	0	10/2030	8	5440	10/2150
Cattle	100	29396		100	32248	
Black	75	22115		100	32248	
Churchman	0	0	20/8068	0	0	20/8552
Wood	100	27854		0	0	
Research Nutritionist	50	13398		100	28983	
Research Nutritionist	50	13398		100	28983	
Halderman	50	3616		0	0	
Post-grad social scientist	0	0		100	20970	
Research Assistants (6)	150	14302	150/14302	150	15162	150/15162
Secretary (UCB)	100	16539		100	19201	
Neumann	25	10626	37/15939	25	11689	37/17533
Fleuret	25	5951		25	6550	
Kopp	5	4113	5/4113	0	0	
Ferguson	0	0		5	5002	5/5002
Cherry	2.5	2276	5/4552	5	5007	5/5007
Stiehm	2.5	2182	5/4365	5	4801	5/4801
Field pediatrician	50	14373		100	31265	
Latham	0	0		0	0	

Personnel	Year One			Year Two		
	%time	$	cost sharing	%time	$	cost sharing
Secretary (UCLA)	100	16323		100	17906	
Statistician (UCLA)		1000			1000	
DIRECT COSTS		204013	82589		273400	89933
INDIRECT COSTS		45596	25603		59879	27879
Total		249609	108192		333279	117812

Travel	Year One		Year Two	
	airfare[1]	per diem[2]	airfare[1]	per diem[2]
Calloway	1750	30/1650		
Ostwald	1750	30/1650	2100	30/1800
Adelman			2100	30/1800
Turiel	1750		2100	
Wallace	1750	30/1650		
Leonard			2100	
Cattle	1300		2220	
Black	1300			
Wood	1300		2220	
Research Nutritionist	1300		2220	
Research Nutritionist	2575			
Halderman	1300		1500	
Neumann	1750		2100	
Fleuret				
Kopp or Ferguson	1750	15/825	2100	15/900
Cherry or Stiehm	1750	15/825	2100	15/900
Field pediatrician	1300		2220	
Latham	1750	30/1650	2100	30/1800
Training person	1750		2100	45/2700
Ferro-Luzzi	1850		2220	
Domestic travel				
Washington, D.C. (2)	1400		1680	
Los Angeles/San Francisco	800		900	
DIRECT COSTS	38425		43980	
INDIRECT COSTS	7570		8664	
Total	45995		52644	

Travel

[1]Airfares	Year One	Year Two
San Francisco/Nairobi 14-45 days	1750	2100
San Francisco/Nairobi fullfare	2575	3090
Europe/Africa	1850	2220
Los Angeles/San Francisco	80	90
San Francisco/Washington D.C.	700	840
[2]per diem rates, Nairobi	55	60

Supplies and Expense	Year One	Year Two
General s & e	3000	4300
Copying	3000	3300
Phone/telex/etc.	5000	6000
Computer	4000	7000
Personal shipping	2400	800
Research supply shipping	8000	0
Misc. shipping	2000	5500
DIRECT COSTS	27400	26900
INDIRECT COSTS	7093	7600
Total	34493	34500

Equipment	Year One	Year Two
File cabinets (2)	300	
Storage cabinets (2)	400	
Total	700	

Subcontract Washington University

	Year Two			Year Three		
	%time	$	cost sharing	%time	$	cost sharing
Personnel						
Montgomery	17	5675	25/6180	17	6015	25/6550
Research associate	75	17490		75	18540	
Secretary			25/2070			25/2190
Fringe		2470	830		2620	880
Supplies/Expense		6000			7500	
Travel						
Berkeley (3)		2700			3000	
Foreign (3)		6000			7200	
Indirect Costs						
on-campus (84% salary)			6930			7345
off-campus (36.2% salary)		8385			8890	
Total		48720	16010		53765	16965

Overseas Personnel	Year One	Year Two
Physicians (2)	26400	29040
Nurses (2)	6000	6600
Lab Tech	4500	4950
Economist	6000	6600
Statistician	5000	5500
Stat Clerk (2)	4000	4400
Enumerators (13)	28600	31460
Admin. Assistant	3000	3300
Secretary	2000	2200
Clerk	1300	1430
Driver	1300	1430
Housekeeper	1000	1100
Total	89100	98010

Travel	Year One	Year Two
Domestic		
Capital to/from site (24)	2400	2633
Foreign		
Trainees/sr. staff to/from US (5)	10000	11000
Total	12400	13633

Overseas Supplies and Expense	Year One	Year Two
Gasoline (1800 gal.) 45000 mi/yr, 25 mpg	5400	6300
Auto club membership	30	35
Rental van (2 @ $100/mo.)	2400	2640
Mileage on rental vans (10¢/mi.)	4500	5000
Housing in field	3600	3940
Paper, printing, forms	1500	1600
Computer	500	550
Communications	2500	2800
Film and processing	1000	1100
Videotapes	1000	1100
Food/transport for survey team	7200	7900
Lab supplies	10000	0
Total	39630	32965

Overseas Equipment	Year One	Year Two
Printing infant scales (2)	7600	
Audiovisual equipment	6600	
Misc. equipment		3500
Fatfold calipers (2)	360	
Calibrating weights	150	
Infant hanging scales (3)	210	
Infant measuring boards (6)	420	
Infant Detecto scales (2)	170	
Infantmeter for standardization	150	
Adult Detecto scales (3)	510	
Microhematocrit	350	
Bicycle ergometer	1000	
Oxygen meter		5000
Carbon dioxide meter		6000
Pack for energy expenditures (2)		10000
Recorder & analyzer, energy/work		5000
Bicycles (6)	600	
Housing	2000	2200
Typewriter	900	
Total	21020	31700

APPENDIX IV-4

Purdue/Arizona/Kansas Universities Proposal

in collaboration with

Nutrition Institute and Ministry of Health

Egypt

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THE RELATIONSHIP OF NUTRITIONAL INTAKE TO THE MAINTENANCE OF FUNCTIONAL COMPETENCY

A Proposal for Participation in Egypt

in a

Title XII

Collaborative Research Support Program

NOTICE OF RESEARCH PROJECT
SCIENCE INFORMATION EXCHANGE

SMITHSONIAN INSTITUTION
NATIONAL SCIENCE FOUNDATION
PROJECT SUMMARY

PROJECT NO. (FOR USE IN THIS SPACE)
NSF AWARD NO.

1. NAME OF INSTITUTION (INCLUDE BRANCH/CAMPUS & SCHOOL OR DIVISION)

Purdue University

2. MAILING ADDRESS

Purdue University, West Lafayette, IN 47907

3. PRINCIPAL INVESTIGATOR AND FIELD OF SCIENCE/SPECIALTY

Ronald Ross Watson, Ph.D.
Nutrition - Immunology

4. TITLE OF PROJECT

Purdue, less-Developed Country Collaborative Research Project.' Recommend Egypt as site.

5. SUMMARY OF PROPOSED WORK (LIMIT TO 22 PICA OR 18 ELITE TYPEWRITTEN LINES)

Children, pregnant women and the elderly in families will be studied in a rural Egyptian setting. The effects of marginal and moderate caloric deficiency will be assessed. Changes in host defense and incidence of common diseases will be measured and correlated with differences in the work capacity, psychomotor function, and cognitive development. The effects of marginal nutritional stress will be determined in the elderly, emphasizing an area of nutritional research extremely poorly studied in less-developed countries. In the aged, disease incidence will be studied in detail as well as humoral, secretory and cellular immune responses, and work capacity. The immune responses will also be developed for the first time in the aged as a technique for better biochemical assessment of their nutritional state. A major portion of our study will be the measurement of early infant undernutrition and the relationship between nutrition and the outcome of pregnancy and quality of lactation. Infants will be followed after birth for nutritional status, and disease incidence and duration. Particular emphasis will be attachedto diarrheal infections. The interactions of family members with the development of infants and children will be studied in a long-term, prospective manner. The development of the child born to an undernourished mother, or one who becomes undernourished as it matures is a principal objective of the research. It is expected that the project will cause a significant increase in the professional development of the Egyptian nutritionists and clinicians participating. Efforts will be made to encourage their rapid development, intensive involvement and assistance in disseminating the information generated to appropriate governmental agencies and health care professionals in Egypt and elsewhere in the Middle East.

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SECTION	PROPOSAL NO.	F.Y.

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FORM 4 (7-78) 1. Proposal Folder 2. Program Summary 3. Division of Grants & Contracts 4. Science Information Exchange 5. Principal Investigator 6. Off. of Govt. & Pub. Progs 7. Assistant Director

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PROGRAM ANNOUNCEMENT/SOLICITATION NO

CLOSING DATE (IF ANY): 18 April 1979

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Purdue University

ADDRESS OF ORGANIZATION (INCLUDE ZIP CODE)
Purdue University, West Lafayette, IN 47907

TITLE OF PROPOSED PROJECT
Purdue, Less-Developed Country Collaborative Research Project. Recommend Egypt as site.

REQUESTED AMOUNT

PROPOSED DURATION

DESIRED STARTING DATE
January 1980

PI/PD DEPARTMENT
Food and Nutrition

PI/PD ORGANIZATION
Purdue University

PI/PD PHONE NO
(317)493-0886

PI/PD NAME	SOCIAL SECURITY NO.*	DATE OF HIGHEST DEGREE ACHIEVED	MALE*	FEMALE*
Ronald R. Watson	519-44-5632	PhD 1971	X	
ADDITIONAL PI/PD Avanelle Kirksey	191-32-8789	PhD 1960		X
ADDITIONAL PI/PD Theodore Wachs	079-34-2494	PhD 1968	X	
ADDITIONAL PI/PD Gail G. Harrison	556-62-5043	PhD 1976		X
ADDITIONAL PI/PD Norge W. Jerome	072-32-1545	PhD 1967		X

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☐ Endangered Species ☐ Marine Mammal Protection ☐ Research Involving Recombinant DNA Molecules
☐ Historical Sites ☐ Pollution Control ☐ Proprietary and Privileged Information

PRINCIPAL INVESTIGATOR/ PROJECT DIRECTOR	AUTHORIZED ORGANIZATIONAL REP.	OTHER ENDORSEMENT (optional)
NAME Ronald Ross Watson	NAME	NAME
SIGNATURE	SIGNATURE	SIGNATURE
TITLE Associate Professor	TITLE	TITLE
DATE 2 April 1979	DATE	DATE

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I. THE PROGRAM

Introduction

The consequences of severe restriction of food intake have been repeatedly assessed. However, mild to moderate deficits of food intake for energy in relation to physiological, social and behavioral functioning have seldom been studied directly even though many more people are affected by these conditions. Thus there is a significant gap in our understanding of the true consequences of undernutrition. The research proposed here addresses these major issues directly; the methodology proposed is multidisciplinary and multivariate in conceptualization. It will lead to a better understanding of the effects and possible solutions to the problems caused by moderate malnutrition.

Approach and General Objectives

In order to understand the functional consequences of food energy deficits, it is necessary to examine human-environment interactions in terms of the dynamic adaptive mechanisms--biological, social and behavioral--which people use to cope with marginal food supplies. The three major objectives of the proposed research are as follows:

1. To determine, through quantitative measurements and in a prospective manner, relationships between mild to moderate deficits of food energy intake in individuals and five areas of human functional performance, i.e., 1) disease response, 2) reproductive competence, 3) work output/physical activity, 4) cognitive function, and 5) social competence in the household context, in a rural Egyptian setting.
2. To develop and validate measures and techniques for identifying and assessing the relationships stated in Objective 1 above in Egypt. These measures and techniques should be applicable in a wide variety of cultural and environmental settings so that their development will provide a firm base for future research efforts.
3. To assist the development of resources and infrastructure for nutrition research and programs in Egypt. This will be accomplished by conducting the research cooperatively and in full collaboration with Egyptian colleagues. Emphasis will be placed on training and research development via expertise transfer from U.S. universities to collaborative Egyptian scientists. Thus much of the research will be done in Egypt.

Specific Objectives

A comprehensive evaluation of the effects of mild to moderate undernutrition in humans requires that quantitative measures be obtained in each of the functional areas of interest. Accordingly, specific objectives for each of these areas are provided below. Particular emphasis will be given to disease and immune responses to it and reproductive competence. Cognitive development, social competence and work output measures will be studied as the program develops.

1. Cognitive Function
   - i. Determine psychomotor performance in undernourished adults,
   - ii. Assess the effects of marginal energy nutrition on information processing functions,
   - iii. Determine the relationship of moderate caloric deficiency in the mother and/or child on cognitive development and auditory competence from infancy to adolescence,
   - iv. Measure the role of nutritional stress on parent-child interactions in the first years of life,
   - v. Assess variability in cognitive development accounted for by a combination of marginal malnutrition, health status, and parent-child interactions.

2. Disease Response

i. To determine and document the reciprocal effects of food intake, infectious disease (including mild infections) and nutritional status in children up to the age of five years,

ii. Measure the effects of marginal malnutrition on humoral, secretory, and cellular immunity,

iii. Study the effects of moderate energy undernutrition in the aged on host defenses and disease morbidity,

iv. Develop immunological parameters as improved methods for assessment of nutritional state in the aged,

v. Study interactions of nutritional state, growth, maturity, and parent-child interactions on selected host defenses against and morbidity to Streptococcus mutans, rotavirus, parasites causing diarrhea, and shigella,

vi. To assess and document prospectively the effects of disease and sickness episodes on growth patterns and to further assess the influence in gender on catchup growth phenomena following the stress of disease and sickness,

vii. To determine the effects of acult and chronic illness of adult household members on the health and food intake of children,

viii. To explore the relationship between illness (defined culturally), its perceived severity, and both quantity and composition of food intake.

3. Physical Activity and Performance

Measurement of changes in maximal and submaximal work capacity due to nutritional or disease stresses.

4. Reproductive Competence

i. To determine the effects of mild to moderate energy deficits during pregnancy under different conditions of physical activity on fetal growth and development,

ii. To investigate interrelationships among energy intake, physical activity, and intake of selected micronutrients on the pattern and duration of lactation and composition of breast milk,

iii. To investigate, prospectively, the effects of repeated child-bearing (under conditions of marginal to moderately deficient energy intake)on maternal function with regard to work performance, disease response, social competence, and cognitive function,

iv. Assess the relationship between pregnancy and lactation as an integrated process and mild/moderate malnutrition as evaluated by food intake, and anthropometric and biochemical measurements,

v. Relate the pattern and amount of weight gain during different trimesters of pregnancy to pregnancy outcome, specifically to complications of pregnancy and low birth weight infants,

vi. Examine birth weight in relation to future morbidity, mortality, neurological development, behavior and growth,

vii. Determine whether the levels of milk gonadotropin-releasing hormone and growth factor are determinants of observed changes in the functional and physical development of the offspring.

5. Social Competence

i. To determine if incremental changes in energy intake have observable effects on the social competence of the adult individual in terms of his/her self-concept, in person-person interactions, and in person-environment interactions at different periods of time,

ii. To determine relationships between self concept, life changes, role performance and dietary intake, in the mild to moderately undernourished adult,

iii. To determine relationships between levels of social competency and

a) disease response, b) cognitive function, c) reproductive competence, and d) level of energy intake in the adult,

iv. Stimulate research into nutritional problems by Egyptian scientists and aid in their professional development,

v. Disseminate basic concepts learned about marginal-moderate caloric deficiencies and their actions on the various members of family groups to both the lay public and key health-care professionals.

Rationale and General Approach to the Problem

In contrast to the classical laboratory experiment in which one focuses on a single variable at a time and attempts to "control out" all other relevant variables, this program will "control in" as many theoretically important variables as possible within the constraints of practical feasibility and a rigorous research design. In this way, we will be able to identify the process of mutual accomodation between dietary intake and physiological, physical, social and behavioral functioning. Straightforward naturalistic observation, combined with careful evaluation of specific dependent variables, can bring to light critical features of the inter-relationships between dietary intake and human function.

A central question that will be posed in investigating the consequences of a range of adequate to moderately deficient intakes of energy will be "In a marginal to mildly inadequate situation, why do some individuals become malnourished (or ill) while others do not?" This questions will be asked continually throughout the course of the research program, and signs of adaptive changes in each of the functional domains in the household and in the individual will be examined as relating to this central question. A related and equally vital question is "What specifically are people doing (consciously or unconsciously) that is protective?" Then it will be easier to determine what protective measures can and/or should be taken to improve the health of the large number of marginally malnourished. The extent to which the individual and family are placed at greater risk, not only to physical damage (disease), but mental stresses and changes (cognitive and social competence) can be accurately assessed.

It is important not only to identify the "high risk" individual and the reasons for that risk, but to do the same for those "not at risk." Even in populations in which the prevalance of malnutrition is high, some individuals achieve functional competence in all areas. The epidemiology of good nutrition where poor nutrition is the norm had received some attention in recent years; however, the epidemiology of adequate functioning under conditions of marginal food supply has not. Obviously, a great deal of the effort to answer this questions will be focused on social and behavioral adaptations, or measures of social competence.

The following explanations are in order:

1. Each of the variables to be addressed is in fact a general term for a complex of related variables. In each case, it will be necessary to select for measurement those variables which are most directly related to nutritional status, and hence food intake, and those which are possible to measure simply and follow longitudinally with repeated observations of the same households over a period of several years.
2. Because the household unit is the unit of study, interrelationships not only among the five domains but among individuals in the household must be studied. For example, changes in the status of a household member with regard to food intake, health, work performance, etc. will produce effects not only on that individual but most likely also upon other members of the household.
3. Each of the domains noted is in a dynamic state and may be expected to change over time. Individuals age and food supplies change, health status alters; social, political, technological and cultural change affect variables in all domains. These changes must be taken into account.
4. All of the functional domains of interest, including food consumption patterns and energy intake, take place within cultural contexts. Interpretation of

patterns and changes in each of these functional domains depends upon accurate knowledge of the framework of the local culture. Therefore it is advantageous for this research to take place in populations which are relatively culturally homogeneous and in which key member(s) of the research team are thoroughly familiar with the local culture.

5. When food intake is marginal or moderately deficient, we may assume that various adaptive mechanisms are utilized to maintain functioning in the various domains. The interrelationships among these adaptive mechanisms may be elucidated when a stress occurs which upsets the preexisting balance. Significant life changes, such as the arrival or departure from the household of an economically productive adult, illness in a key adult family member, or change in employment status are examples of life events and/or stresses which may change the relationships among variables in several domains. Therefore, particular attention must be paid in the research design to documenting significant events in the lives of individuals and household units over the course of study.

The project we propose here will incorporate all core elements of design and measurement which are agreed upon for the research program as a whole for projects in other parts of the developing world. The additional detail which is provided here is preliminary and subject to modification as time and planning progress. Specifically, we plan two meetings of the three U.S. investigators and one additional with these three plus Dr. Hekmat in the first six months of the project in order to work out the details of study design and implementation.

A. Background: The Population and Environment

Most of Egypt is a hot, dry desert covering 96% of the country. The population density in the usable land exceed 2400 people/square mile and is growing (1975) at a rate of 2.5%/year (2). Almost 50% of the work force is employed in agriculture, like many less developed countries (LDC). Egypt continues to have major problems in supplying an adequate diet to all its growing population using food subsidies. Egypt is one of 37 countries in the world which has had significant decreases in their per capita caloric intake in the past few years. Since the 1967 war, rising prices and shortages of consumer goods have eroded the standard of living of many of the poor. "Observers believed that by the mid 1970's, conditions (real per capita income) had returned to the pre-1952 situation; population was again growing faster than the economy" (2). Both calorie and protein intake had risen since 1952 until about 1967, and since then there has been a significant decrease in Egypt (3). It is expected that the difficulty in supplying food in adequate quantities to the population will increase unless deficiencies are more clearly defined and understanding of the human component improves (1,2). The research proposed by Purdue University to AID will increase research experience by Egyptian nutritionists, dissemination of new information in Egypt, and training of young scientists in the problems of marginal-moderate nutritional deficiencies. This is a critical aspect in changing the human component in Egypt's nutritional problem. Overall health of the poor may be significantly improved by programs based upon knowledge of the effects of marginal-moderate energy undernutrition on disease resistance, learning and work ability. Since marginal-moderate malnutrition affects many more people then severe deficiencies, its effects need to be measured. Of critical importance is to determine its effects on the child's growth, learning ability and the mother. Then the means and need for prevention can be shown clearly to governmental and health care officials. It is often difficult to extrapolate from changes caused by severe nutritional stresses and to estimate what would occur in children suffering from marginal or moderate stresses. Unfortunately many human studies have emphasized severe rather than marginal deficiencies because the changes observed are often more dramatic. Gershon in a recent Trulson Memorial Lecture said, "Programs to alleviate malnutrition in children in developing countries need revision. Intervention field trials in Thailand, Tunisia, and Guatemala, based on amino acid fortification and supplementary vitamins and minerals, have had little effect on children. In fact, it is often a misconceptio

that frank deficiencies are common characteristics of malnutrition in developing countries. Rather stunted growth—caused by caloric deficiency often in the presence of adequate food supplies--may be the most prevalent form of malnutrition.' We feel that the proposed study of marginal-moderate energy deficiency, although requiring much effort and time, will produce data which are very pertinent to understanding the most prevalent nutritional deficiency in many parts of the world. The scientific results should be partly applicable in Egypt and other Arab lands, although general observations should be extrapolatable to many cultures. We expect that the age of the family members will affect both their dietary needs and nutritional intake (1); hence all aged family members will be studied.

The relationship between the quantity and quality of nutrition and the course and the outcome of pregnancy and lactation also needs detailed study which is possible in our longitudinal program. The problem is particularly complicated in mild/moderate malnutrition. This study takes into account the multiplicity of environmental factors associated with nutrition which may act synergistically with it in the health and well-being of mothers, infants and children. The problem of malnutrition clearly involves more than food intake alone. Chronic malnutrition can be understood and dealt with more effectively by considering the socioeconomic and cultural matrix in which it exists. Nutritional and health status will be assessed in relation to food intake, anthropometric and biochemical measurements with quantitation of disease, work capacity, physical activity, parent-child interactions, cognitive development and social competence. Longitudinal investigation of the social and biological complexities of undernutrition of children will be undertaken. In most cases, studies of children have been follow-up invewtigations of children who experience severe malnutrition in infancy. Behavior correlates with malnutrition are essentially unstudied for preschool age children. The longitudinal approach to be used in this study should aid in resolving some of the questions concerning the complex interrelationships of socioeconomic and biological variables with mild/moderate malnutrition of mothers, infants and children.

For this research program to be of greatest benefit we will have to function in helping the Egyptian scientists, physicians and eventually government health-care officials to help their own people to help themselves. Thus a major portion of the research project, increasing each year, will be to involve Egyptian scientists in every aspect of the project. Some graduate or post-doctoral students may have to do some of their research in the U.S. We will build bridges between members of the scientific communities at all levels which will strengthen the growing relationship between Egypt and the United States governments. As the team develops information on the effects of marginal energy undernutrition we expect to make extensive efforts to aid the Egyptian collaborators to disseminate information and relevant ideas among health-care people, physicians and educators as indicated by our data to eventually attack and change the human aspects of the problem at the village level. The project needs to be of long-term in duration both to test the data generated as well as to do studies which require years to reach conclusions. This sort of a study will be expected to use only small amounts of limited resources, as many Egyptian researchers in nutrition are currently underutilized, need and want the stimulation of a research effort with extranational support.

B. Household Selection

The bulk of Egyptians live in agricultural communities (2). The basic units of organization are built around kinship ties and, as such, offer excellent research opportunities for our study. In most villages, a number of economic levels can be identified in essentially the same environmental conditions (disease-education) (2). The small number of "rich" peasants have similar contacts with disease, the same water sources and the same insdequate sewage disposal facilities as the poorer one The second group of well-off peasant own somewhat smaller, but still significant land holdings. The third economic group of peasants own only very small slivers of land. The truly landless, which are about 1/3 of the average village, work as hired

laborers (2). Thus in the same or highly similar setting of the village, a gradation of economic abilities are represented with a large number of the poor and very poor people whose financial abilities limit their access to an adequate diet (1). Our study will be conducted in one or more villages located north of Cairo, sufficiently distant to avoid many changes caused by urbanization; yet fairly convenient to our labs.

The villages selected to be studied will have a high prevalence of mild to moderate undernutrition as well as at least 15% of the households with good nutritional status. Communities near the station will be selected with an emphasis on homogeneity of variables not essential to the proposed research. Thus, the communities will not be a random sample, in any sense, of the country; rather they will serve as test sites for intensive study of the nutritional and functional variables of interest. Of course, the statistical ideal of eliminating all uncontrolled variation is impossible to attain in practice. Therefore, variables quantifying the inhomogeneity of the samples will be recorded for possible use as covariates in the subsequent analysis. For example, since age is negatively with immunity and work capacity then the variable of interest will be adjusted for age as a covariate. The general principle here is to control as much as possible and measure the rest. Households which have one or more children between 1-4 years of age (family groups) will be recruited into the study. Some of the children from these households will be receiving an inadequate energy intake and will be considered "marginally energy malnourished." Households with children who are clinically, biochemically and nutritionally normal will be used as controls. Families, which at time of recruitment, have a child who has cancer, tuberculosis or some other major disease or who is severely malnourished (grade III, PCM) will not be recruited. (However, they will be counseled as to necessary medical care.) In year 01 we will enroll and study 95-145 households with 4-7 individuals/household (approximately 1-2 families per day over 8-10 months). The households will be selected by (A) the presence of a 1-4 year old child, and (B) the presence of a woman of childbearing age. We expect to add about the same number in year 02 and 03. In year 04 and 05 we will add as necessary to make up for any who withdraw from the study and the few special groups (such as aged) that are needed. All participants will benefit by the information obtained, selected routine immunizations, improved access to physicians for major illnesses, non-nutritional additions to the households such as toys or soap, etc. The regular nutritional assessment interviews, anthropometric measures, cognitive and work capacity measurements will be done on the monthly visit to the family and/or correlated with more frequent visits required by additional information to be collected in pregnancy, lactation and early infancy.

In this long-term, longitudinal study some children or adults may have a major illness, become more severely malnourished or have a prolonged bout of diarrhea. These family groups will remain in the study. In this way, the family's interactions with disease can be studied. Based upon other research done in Egypt, we expect that some of the children will be anemic and some will have low vitamin A and/or zinc nutriture. Therefore, biochemical evaluations for several nutritional deficiencies which we expect to be prevalent in Egypt will be performed. The role of these nutritional deficiencies will be studied to a limited extent in the cases where it becomes necessary to supplement the child or adult. This will occur after the initial diet, nutritional and sociology survey. Dietary supplementations of zinc or vitamin A would be stopped after 4 months and only reinstituted if a severe deficiency reappears.

Within the chosen communities, households will be selected as the units for analysis. If possible, factors, such as number of children, will be used to guide the selection. Typical high and low values of the factors will be chosen for levels. Partially replicated designs will be considered if appropriate.

The construction of variables for analysis is the second major area for statistical input. In many instances, the variables to be measured are somewhat

standard and no problems should arise. In other cases however, the identification of the relevant variables for analysis will require some preliminary statistical analysis. Finally, the elucidation of quantitative relationships between levels of food energy intake and the five functional capabilities will require substantial statistical effort. The nature of the problem is multivariate. Standard types of multivariate models will be used such as path-type analyses and canonical correlation techniques can be used to relate variables in the different functional areas. For qualitative variables, some log-linear analyses will be tried. In the course of this research, questions which can be answered by the application of standard statistical techniques will be treated accordingly. However, if the need arises, other statistical methods will be derived to address research questions which do not conform to this mold. Data processing and computer aided analyses by Dr. McCabe and Dr. Anderson will be supported by L. Weaver using Purdue's extensive data processing library, hardware and software. (See Appendix III)

Dietary Intake Assessment. Cereals supply the mainstay of the Egyptian diet, supplying more than 60% of the protein and 75% of the calories. Corn and wheat are principle cereals consumed, followed by rice and barley. Legumes, the second most important food group, supplements the nutrition offered by grains. Animal protein appears only rarely in the diet of the poor. Only seasonal glut brings fruit within reach of the poor and many families are offered only small quantities of vegetables (1,2). The Moslem religion practiced by most traditional villagers prescribes alcohol so that little is consumed. Our dietary survey, its accuracy and its ease is aided by the custom of most Egyptian villagers to construct their three daily meals around a small range of foods (1). For example, breakfast usually includes bread or rice, tea, plus only occasional cheese or condiment. The midday meal, in addition to vegetables in season, may include beans or potatoes. The evening meal usually resembles one of the other two depending upon the families means. In traditional families, social patterns appear to intensify malnutrition, as the men generally ta their meals before the women and children (2). The women and children, therefore, have reduced access to the available food. We can thus weigh the amount prepared and the amount remaining after the men are through eating. Consumption by women and children during preparation will be investigated by direct observation by trained dietitians. The portion or amount of the food consumed will be estimated with the aid of pre-quantitated food models and measurement utensils.

Dietary Intake. Dietary intake measures will be done as mutually agreed upon by the various U.S. and LDS representatives (including Dr. Hekmat, Dr. Watson and Dr. Harrison for the Egyptian project) in California in December 1979. This is detailed elsewhere in the core portion of the proposal. We will do a pilot project to determine the extent of any major "contaminating" nutritional deficiency which would influence a study of moderate energy undernutrition. Briefly we will do the following. Egyptian paraprofessionals will be trained by Dr. Hekmat, Director, Egyptian Nutrition Institute, in the methods of interviewing to be used in obtaining valid and reliable estimates of food intake. Also estimates of intake of water and nonnutritive substances, caffeine, alcohol, tobacco, drugs and etc. will be obtained by the interviewer. Proposed intake measures will be tested for their validity on a neighboring village before data collection is initiated for the study early in year 01. The pilot project will determine the frequency of dietary records necessary to get a reliable measure of nutritional status in Egypt. Based upon the results it may be less or more frequent than planned in the core description of dietary intake measures for all countries being studied. This will be done by Dr. Hekmat and co-workers. Since zinc, iron and chromium deficiencies if present in significant numbers of the study population, would be expected to interfere with some disease, immunological and diet measurements. Therefore blood, hair, saliva and tear sampl will be taken from the pilot study participants to measure for selected mineral and vitamin deficiencies which might interfere by Dr. Liu and Watson with collaboration by Dr. L. Hopkins. If present in significant amounts, a non-energy (mineral or

vitamin) deficiency may be necessary to treat in the study population. If treated, the importance of the mineral or vitamin deficiency on disease, cognitive, etc. measures can be determined. For example a zinc deficiency would be relatively cheap and easy to treat in a less developed country with a health care system like Egypt. Country-specific data for food composition will be used whenever practicable, however, some food analyses may be necessary. For example, if we find that zinc levels are routinely low in the diets of the villagers, Dr. Liu, Dr. Hopkins and an Egyptian graduate student from the Nutrition Institute of Egypt will measure the actual mineral content of the foods eaten in year 02 or 03. The weights (g) of foods consumed will be calculated from the recall data. For complex dishes, quantities of ingredients will be calculated from the recipes by Dr. Liu. The food items will be coded according to numbers from the USDA Handbook 456 after comparison with values for any local foods which have been analyzed. For those foods commonly used in the village diets for which all the necessary nutritional data are not available for Egypt, the staff of Purdue University's Food Science Institute will analyze local foods for protein, energy, vitamin and mineral content during year 02 of the project. The magnetic tape of USDA Handbook 456, modified by the Department of Foods and Nutrition at Purdue University to include five additional nutrients: vitamin B-6, folic acid, vitamin B-12, zinc and magnesium, will be used for analysis by computer. Trace elements usually have strong complexing action with phytate or fiber. Therefore, trace elements may become marginal deficient in a place such as Egypt where whole grains are major dietary staples when the dietary intakes in the foodstuffs making up the diet are marginal or inadequate. Marginal protein deficiency may also affect the nutritional status of trace elements. Certain trace minerals, such as chromium, are better absorbed and better utilized if it is in the complexed organic form from animal origin. The absorption and transportation of the trace elements often depend on protein carrier, which will be low when dietary protein level is low. Moreover, febrile disease, parasitic diseases and hepatitis influence the nutritional status of trace elements. For the reasons mentioned above, the incidence and severity of trace elements deficiencies will be assessed in our study population. Levels of iron, zinc, selenium and chromium in the Egyptian diet will be estimated by Dr. Liu.

Nutritional Status. We will do the nutritional assessments agreed upon by all teams. In the evaluation of nutritional status, we will distinguish between variables which indicate present nutritional status and those which indicate past nutritional experience. Ideally, the study design should allow evaluation of the effects of both types of variables on performance levels and on their interactions. While the proposed study will deal mainly with present nutritional status, it will be possible to provide some inferences on the relevance of previous conditions based on retrospective analyses and on experience over the five-year span of the project.

Since the emphasis in this program is on the functional effects of variations in energy intake in relation to need, the measurement of nutritional status will focus upon indices of energy adequacy. This means that serial anthropometric measurements will form the basis for the assessment of nutritional status. In infants and young children, growth is the most sensitive indicator of energy status. In adults, changes in body composition reflect energy balance over periods from several weeks to many years.

Anthropometric measurements to be included in the regularly scheduled evaluation of all individuals in study households include:

Weight
Height (length for children under 2 years)
Head circumference (under age 2 years)
Chest circumference (under age 2 years)
Mid-upper arm circumference
Maximum thigh circumference (children under 2 years)
Triceps and subscapular fatfolds
Sitting height or crown-rump length

additional anthropometric measurements may be added for particular age groups or during pregnancy as appropriate.

Although growth and body composition are the best indices of energy adequacy, our definition of nutritional status will keep in mind that energy utilization is not limited to the adequacy of food intake but is mediated by a variety of micronutrients. Therefore, we plan to extend the program of work to include assessment of the micronutrient status of the study population.

In the first year of the project, the nutritional status with regard to Fe, vitamin A, and Zn and other nutrients deemed appropriate in these two populations will be assessed. If marginal or more severe deficiencies are found, the second year studies will determine the effects of supplementation on work performance, reproduction and disease response.

Analyses of blood and hair levels will be followed in a small sample size even if the dietary analysis of zinc and iron appear to be adequate. Blood concentration is the most commonly reported survey technique. On the other hand, hair may be more valuable in assessing "marginal" mineral deficiency than serum samples since hair tends to collect the nutrients that are extra to the body's vital needs. In the state of marginal deficiency, blood concentration may or may not indicate the suboptimal body storage, but hair concentration are usually low. Marginal zinc deficiencies in the diet will be identified by measuring the concentration of zinc in hair. Hair samples are easy to collect, to store, and to ship. In many cases, trace elements in hair are higher in concentration than that in serum, thus are much easier to be analyzed. Proximal hair samples (1-2 cm) will be cut as close to the scalp as possible with a forged stainless steel scissors. Approximately 30 pieces of hair will be obtained from the center right, left, front and back of the head. Zinc and iron levels in hair and serum samples will be analyzed by atomic absorption spectrophotometer. Blood samples will be drawn with vacutainer tubes whose stoppers are especially prepared to reduce mineral contamination.

A history of daily energy expenditure will be obtained by the interviewer at the time dietary intakes are recorded. The total daily energy output will be subdivided into three parts according to time spent in (a) bed (b) work and (c) non-occupational activities according to the procedures described by FAO/WHO (11). Estimates of total time spent in activities (sleep, light sedentary activities, gardening, walking, standing, etc.) will be converted to energy expenditures (kcal, MJ) using the data of Durin and Passmore (30) and FAO/WHO (11). The actual energy expenditure of some most common activities may also be estimated in some of the subjects in year 02-04. Oxygen consumption or energy expenditure (1 liter O_2 = 4.825 calories) will be measured by a matabolator while the subjects are actually performing the activities. This way the energy expenditure for different types of exercise, different age, sex and food intake (considering specific dynamic action of foods) can be adjusted for Egypt's climate and general nutritional status (prolonged malnutrition may decrease the metabolic rate as much as 20-30%).

Anthropometry will be done by a trained paraprofessional. Body weight will be measured with a beam scale with non-detachable weights. Young children will be weighed unclothed whenever possible. Infant length will be measured by use of a portable tape board equipped with a headboard and footboard. Height (cm) of older children (2 years) will be measured against a true vertical flat surface. The child will stand on a horizontal platform with his bare heels together, back straight with heels, buttocks, shoulders and head touching the vertical surface. A block squared at right angles against the vertical surface will be brought to the crown of the head and the measurement made. Relative height for age, sex, and weight will be calculated as an indicator of nutritional status. Subscapular and tricep skinfold thickness (mm) will be measured by use of a Lange skinfold caliper. Measurements will be made according to the procedures described by Tomon (31). Triceps are measured midway between the acromium and olecranon in the posterior midline of the nondominant arm while the arm is hanging relaxed. The subscapular measurement is inferior and lateral to the inferior angle of the left scapula in the

line of the natural skin cleavage. Readings will be made to the nearest 0.5 mm approximately three seconds after application of caliper. Upper arm muscle size will be determined using the same site as for skinfold measurements. The tape is placed gently, but firmly, around the arm to avoid compression of the soft tissue. The measurement is made to the nearest millimeter. Muscle area will be calculated from circumference and diameter measurements according to the procedure of Frisancho (32).

Effects of Moderate Energy Deficiencies on the Mother and Child (Reproductive Competence). The primary objective of this portion of the study is to quantify the relationship between reproductive competence and mild/moderate malnutrition, disease, work output/physical activity, cognitive and sensory development and social competence. Because of the predominant importance during the period of pregnancy and lactation for fetal and infant survival and subsequent development, special emphasis will be directed toward nutritional and health status during gestation and infancy. A secondary objective is to longitudinally assess the nutritional and health status of the child from infancy through adolescence.

Severe maternal malnutrition has been implicated frequently as one of several environmental factors which influence adversely the course and outcome of human pregnancy (4,5). The effects of mild/moderate levels of maternal malnutrition are less clear (6). Waterlow (7) emphasized the need to know the risk of functional impairment which corresponds to different degrees of nutritional deficit. He points out the need to determine whether retardation in physical growth is accompanied by retardation in mental and behavioral development and to what extent does inadequate nutrition and other social factors contribute to the impairments. In relation to this concept, Latham (8) cautions that control of malnutrition of mothers and infants should not be undertaken in isolation and in particular, emphasizes the importance of infection and nutrition interactions.

Estimates of the total energy cost of human pregnancy range from 30,000 (9) to 80,000 Kcal (4,10), the latter does not take into consideration decrease in activity during the third trimester. The increased energy requirement specific to pregnancy may be balanced in part by reduced physical activity; however, quantitative data are lacking (11). The influence of potentially confounding variables such as infections, disease and work output/physical activity should be considered also in any energy needs assessment of pregnancy. The energy needed for adequate utilization of protein in normal pregnancy has been reported (12) to be at least 36 Kcal/kg pregnant body weight. Caloric supplementation of Guatemalan women during pregnancy increased birth weights and reduced the incidence of low birth weight infants whereas protein supplementation (protein and calories) of Colombian women during pregnancy increased the birth weights of male infants and was associated with an improved ability of the neonate to respond to and process visual information (13,14).

Desirable total weight gains in normal human pregnancy are generally agreed to be 11 to 12 kg (4,10). However we recognize and will determine the extent that undernourished women may benefit from greater weight gains than these. Inadequate maternal weight gains have been associated with low birth weight infants and increased risks to the newborn (15). Also a strong positive association has been found between prepregnancy weight of the mother and birth weight of the infant; increasing prepregnancy weight diminishes the impact of maternal weight gain on birth weight (16). Extensive storage of fat occurs normally during pregnancy. The deposits are in central, rather than peripheral sites and reach a maximal rate about mid pregnancy (17). Effects of mild/moderate malnutrition on the fat reserve and the relationship of the reserve to pregnancy outcome and to adequacy of lactation require investigation.

The epidemiology and the causes of lactation failure are not clear (18). Some studies (19,20) indicate a surprising perseverance of lactation in chronically poor and malnourished mothers whereas other investigators (21,22) report low volume and changes in nutrient content in milk of poorly nourished mothers. During the first 6 months of lactation, milk yields of women in developing countries have

been reported to vary from 400 to 700 ml/day as compared to 600 to 800 ml/day for women in developed countries (11). In the U.S., energy content of human milk has been reported to range from 45 to 119 Kcal/dl (23). A mean of 75 Kcal/dl is used for calculating energy intake of breast-fed infants. The additional energy needed for lactation is proportional to the quantity of milk produced and will be greater for women suckling more than one infant (10). In well-nourished women, the efficiency of energy conversion to milk is greater than 80 per cent (24), however, this may vary in malnourished women. Further studies are needed to determine whether the increased body fat stores which accumulate normally in pregnancy constitute a needed reserve for lactation. Information is lacking concerning food energy allowances for lactation when maternal weight is below standard weight/height ratio or when lactation continues beyond the period when maternal fat deposits are depleted. Quantitation of energy needs under these conditions require investigatic

Hanafy et al. (25) found that the nutritional status of Egyptian infants was highly correlated with volume and proximate constituents but not specific nutrients in their mother's milk. In less severe malnutrition, only maternal postpartum weight and percent of standard weight for height were correlated with lactation adequacy (18). Some investigators have observed increased milk volume following energy supplementation to malnourished mothers (19). There was a significant difference between the energy intakes of women who lactated successfully and those who did not (26). Recent studies from our laboratory (27,28) relate long term use of oral contraceptive agents (OCA) prior to pregnancy with low levels of vitamin B-6 in maternal and cord serum and in milk of lactating women. Poor diets and prolonge lactation (commonly observed in developing countries) in conjunction with OCA use may increase the needs for several nutrients which if not met would increase the risks of poor reproductive competence. Use of contraceptives in Egypt is reported to be directly related to income and influenced little by the Moslem religion (1). With a continued population explosion we expect that the use of OCA may receive increased governmental emphasis. This suggests a need for information on OCA potential positive nutritional benefits to moderately malnourished women via reduction of the frequency of childbirth as well as potentially adverse nutritional effects such as we have reported in nutritionally normal Indiana women (27,28) which may be accentuated by malnutrition. Therefore, as we expect only a few to use or have used OCA in our longitudinal study, in year 02 and 03 we will recruit women who attend birth control clinics. Ms. A. Sallam, who has worked in these clinics in Egypt, will assist in the sociological nutritional follow-up of the women and their families upon starting OCA and some who expect to quit using OCA to become pregnant. We expect that the number of women in our longitudinal study will be so few that outside households would have to be recruited for this aspect of the main study.

Klagsbrun (29) has recently reported the presence of a human milk growth factor which is capable of stimulating DNA synthesis and cellular replication in cultured fibroblast cells. This factor appears to differ biochemically from the growth factor in human serum. The effects of reduced levels of the human milk growth factor on infant development warrant investigation.

<u>Adequacy of Lactation</u>. Growth criteria will be based on the classification of nutritional status in early childhood proposed by McLaren and Read (33). Using weight/length/age calculated from Egyptian standards (1), a child will be classified as overweight (110% of standard), within normal range (90-110%), underweight including milk protein-calorie malnutrition (PCM) (90-80%), moderate PCM (85-75%), severe PCM (75%) (2,18). Mothers of infants with a weight/length/age ratio 90% will be considered to have inadequate lactation and those 90% to have adequate lactation (unless more than 20% of infant's energy requirement is derived from supplementary feeding.) The role in causing malnutrition of specific pathogens causing diarrhea will be evaluated as described later in this proposal. Whichelow found highly significant differences between energy intakes of women who were able to lactate successfully and those who did not. For selected subjects who use interval

feeding, infants may be test weighed before and after each feeding during a 24 hour period. Pediatric scales accurate to 5 g will be used. The use of scales will be demonstrated and instructions for recording data will be explained by a paraprofessional to the mother.

In most households, close contact can be maintained with maternal subjects before and after childbirth, with infants during early childhood and with older children throughout adolescence. The women will be interviewed during a home visit, anthropometric and dietary data will be obtained and blood samples will be taken for hormonal and nutritional evaluation. Data will be collected at monthly intervals during lactation and then after lactation terminates at three month intervals for infants to 18 months of age; 6 month intervals (dry and wet seasons) for children and adults; following each trimester of pregnancy, after the first week postpartum and thereafter monthly throughout the period of lactation. Information obtained by the interviewer will include age, maternal place of birth, parity, number of children alive, number of children dead, age at death, cause of death, number of miscarriages, serious illnesses, medication, lactation history and previous nutritional and disease history. The collection of work capacity, immunological samples and cognitive learning will be correlated to the routine visits for nutrition and disease assessments by Dr. Gabr and Dr. Hekmat (Program Directors in Egypt).

Our principal aims in studying women from the households with malnourished children include: (1) Assess the relationship between pregnancy and lactation as an integrated process and mild/moderate malnutrition as evaluated by food intake, and anthropometric and biochemical measurements. (2) Relate the pattern and amount of weight gain during different trimesters of pregnancy to pregnancy outcome, specifically to complications of pregnancy and low birth weight infants, (3) Examine birth weight in relation to future morbidity, mortality, neurological development, behavior and growth, (4) Relate the pattern and duration of lactation as well as quality and quantity of milk to mild/moderate malnutrition, (5) Determine whether the levels of milk gonadotropin-releasing hormone (GnRH) and growth factor are determinants of observed changes in the functional and physical development of the offspring, and (6) Explore the impact of hormonal contraception, alcohol use, smoking, maternal education and the timing and characteristics of supplements to human milk on lactational performance.

Composition of Milk and Its Effects on Growth of Infants. Milk samples will be obtained whenever possible at 3, 14, 28 days and monthly thereafter during lactation. Samples will be collected by the subject following milk letdown at the first morning feeding. About 5 ml of milk will be expressed from the same breast before and after the feeding. The samples will be mixed and stored frozen in plastic vials containing an antioxidant. Milk samples will be analyzed for kilocalories, total protein (casein and non-casein fractions), carbohydrates and lipids. On the basis of dietary information, additional nutrients may be analyzed in milk samples. The laboratory facilities and the lab's equipment for processing and assaying biological samples are described in Appendix V.

A portion of the milk sample will be stored frozen until time of assay. Milk GnRH will be assayed by Dr. Maher, Dr. Watson and Dr. Petro (post-doctoral fellow) using the procedure of Baram et al. (35) in which isolation by electrophoresis and bioassay by pituitary tissue incubation will be done. Human milk growth factor will be assayed utilizing the procedure of Klagsburn (29) in which gel filtration chromatograph will be used to obtain eluted fractions that stimulate DNA synthesis in human skin fibroblast cultures. Further characterization will be done by isoelectric focusing to confirm isoelectric point and molecular weight. The presence of other growth factors in the colostrum, such as epidermal growth factor, multiplication stimulating activity factor, nerve growth factor, and fibroblast growth factor will be examined using available radioimmunoassay protocols by Dr. Maher (36). Other aspects of the qualitative and quantitative changes in mother's milk which will be investigated include relationships between specific and non-specific host defense

components of milk and infantile diseases, especially diarrhea. Therefore S-IgA, lysozyme, IgG, lactoferrin and specific antibodies to rotavirus, E. coli etc. will be measured in the milk samples as described in detail later in the proposal.

Effect of Maternal Malnutrition on Digestive Capacity of the Infant. We will also study the development of digestive enzymes of infants as influenced by maternal malnutrition. The reduced quntity of milk or increased incidence of disease due to changes in the host defense components of milk may influence the nutritional state of the infant and hence the growth or development of the child's secretory systems. Dr. Watson, Dr. Sherman (University of Illinois), and Dr. Karn will investigate the development of lipidase, amylase and peptidase activities as measures of development important to protein and energy utilization in the oral cavity and serum. We will use whole saliva and in children over three years we will obtain parotid saliva. We have shown that some of these enzymes in secretions are (amylase-43, 54-56) and some are not (aminopeptidases, 57) susceptible to nutritional stress in older children. However, little is known about the developmental delay, if any, of amylase, aminopeptidase, S-IgA or lysozyme due to malnutrition in infants. Serum IgA takes 9-12 years to reach adult levels while we (39) have shown that S-IgA in tears reaches near adult levels by 1-1.5 years. Thus early nutritional stresses could affect development rate of S-IgA. We have described routine development of the latter 3 proteins with age in normal children (39,48,57). The technique of Watson (38,57) to measure aminopeptidase activity with 21 different L-amino acyl β-napthylamides as substrates will be modified to several di- and tri-peptides linked to chromo-phores to measure di- and tri-peptidase activity. Aminopeptidase activity is necessary to hydrolyze small peptides into free L-amino acids, which occurs in the stomach, intestinal tract serum and some intracellularly. These enzymes play roles in amino acid utilization. We will measure changes in aminopeptidase activity in the serum and selected secretions.

The ability of the infant to produce various lipids may reflect the child's or adult's state of nutrition and will be investigated. We will analyze serum samples for triglycerides, cholesterol, and phospholipids. The lipids will be extracted, then separated and measured using a gas chromatogram. Dr. Sherman will supervise and conduct the analysis of these samples in this portion of the study.

II. Role of Nutritional State, Age, and Work Output Immunosuppression and Disease

For centuries man has recognized the association between malnutrition and disease. It is not merely by chance that famine and pestilence are two of the dreaded "Four Horsemen of the Apolcalypse". They might well have been depicted riding the same horse, so close is the historical association. Therefore, we will measure disease incidence, duration of infections, immune responses to specific pathogens and the general interactions with health, growth and nutrition in families with marginally malnourished children. The effects and interactions of the aged immune systems will be studied in detail for the first time in a LDC. Some aspects of the immune systems in these aged adults will be developed as indicator systems of nutritional state since they play key roles in the health and survival of the aged.

Effects of Marginal Malnutrition on Humoral Immunity. Most malnourished children have normal concentrations of serum immunoglobulins (IgG and IgM) (40-42). We have also observed normal levels of serum IgM and IgG in both marginally and more severely (Grade III) malnourished children (43). We have shown for the first time that IgA is significantly suppressed in secretions of marginally malnourished children (43) and undernourished animals (11) where it is a major component of host defense of the mucosal surface. We (44) have also found recently that renutrition rapidly restores suppressed secretory IgA levels. Little is known of non-nutritional stresses or forces on secretory host defense. For example, a poor work efficiency could lead to mental stress. Mental stresses in some medical students at examinations affects their body's control of latent herpes simplex Type I viruses. Then the viruses escape from the host defenses to invade surrounding tissues causing overt disease. In our recent reviews of the literature we found the nutritional requirements that produce optimum humoral responses in aged adults are essentially unknown (45,46). The literature cited above suggests that IgG and IgM are resistant to various nutritional stresses and would not be useful to assess dietary needs in the elderly while IgA levels would be useful. Also only one study (43) has dealt with the effects of marginal malnutrition on secretory immunity, let alone the other parameters such as disease, work output and learning which we will study concurrently in families with well-nourished as well as malnourished children. We (Watson, McMurray and Ekladious) will study these same systems in marginally energy undernourished children and their families. We will correlate changes with nutritional state, work capacity and disease morbidity. All assays and initial measurements will be done using patient number and correlated retrospectively.

Complement components C_1-C_9 are a group of proteins which react in sequence following binding of a humeral antibody to an antigen. Their reactions amplify the results of the antibody identifying the antigen as foreign. They cause significantly improved phagocytosis which plays a major role in host defense to infectious diseases. Suppressed levels of components of the complement system are associated with the greater severity and slower resolution of systemic infection in malnourished children (44,47). We have shown reduced C_3, C_2 and C_9 in young and adult guinea pigs (48) receiving a low protein diet and in malnourished children (47). Our data in young adult animals (48) suggest that insufficient dietary protein could suppress complement activity in aged adults. However, no study to date has dealt with marginal energy intake and its role in complement activity in children, mother, or other adults in the household.

Complement components half-lives are relatively short (2-5 days) compared to IgG (23 days) or albumin. Their rapid turnover time should increase their sensitivity to changes in nutritional state and permit their use to monitor changes in nutritional status. To determine the value and develop measurement of comple-

ment components as a tool for immunological assessment of marginal energy and protein undernutrition, we will take a portion of the routine serum samples for analysis for all family members. We expect that some will be undernourished by various clinical criteria, others will become so or will become well-nourished and some will have non-energy nutritional deficiencies. In year 03, the complement technique will have been adequately tested against other measures and its diagnostic value proven. Since complement is a key host defense system, it will be a routinely measured parameter in the immunological assessment of our population.

We have routinely measured total hemolytic activity as well as individual component activity such as C_8 by hemolysis of red blood cells with added anti-red cell antiserum and serum which contains C_1-C_7, C_9 but is C_8 deficient (48). (This human serum is 1 of only 3 C_8 deficient sera known.) Where possible, we will measure individual components of complement by immunodiffusion using the Mancini technique as we and others have done in malnourished humans (40,49). Most individual components of human complement can be easily quantitated by immunodiffusion using the Mancini technique which is technically much easier than measuring functional activity by hemolysis. For example, human C_3 levels are measured by placing rabbit anti human C_3 antigen into agar. Then samples are added to wells and the precipitation occurs at the equivalence zone. By the use of standards and based upon the diameter of the precipitation ring formed, the C_3 level will be accurately measured as we do in humans for IgA, IgG, C_3, C_4, and albumin (40,49). In collaboration with Dr. Ekladious (Cairo University, Faculty of Medicine), Dr. Ekladious' graduate student and an immunology technician will set up the above assays in Egypt. Samples collected in the first part of year 01 will be aliquotted so that they can be frozen at -70°C for assay later in year 01 in Egypt. Those aliquots returned to the United States for additional assays will be hand carried in dry ice in each case.

Non specific host defenses

Flow rate, lysozyme, lactoperoxidase and lactoferrin in secretions will be measured in year 02-05 since they play important roles in host defense against a variety of pathogens and normal flora. We have previously shown significant decreases in lysozyme and flow rate in severely as well as moderately malnourished children. The well-defined role of moderate energy nutrition alone and in conjunction with the several other nonnutritional aspects need to be carefully evaluated on non-specific (wide spectrum, non-immunologically mediated) host defenses.

Lactoferrin may play an important role in host defense of the mouth (50). It can bind iron atoms and withhold metabolically essential iron from invading bacteria. Unstimulated parotid saliva will be collected, centrifuged, aliquoted and frozen for assay later. Quantitation of lactoferrin is performed by electro immunodiffusion using the modified Weeke technique. The flow rate will be determined by the amount (ml) of saliva collected in 20 minutes.

Lactoperoxidase is also part of the non-specific host defenses of the human oral cavity (51). Because of its ease of collection we will use the saliva as a model for other secretions and their interactions with diet and disease. Lactoperoxidase in saliva has been suggested to be one of the factors controlling the accumulation of plaque (51). The enzyme plays a critical role at the solid-liquid interface in the survival of bacteria. Lactoperoxidase is capable of inhibiting growth of many oral and intestinal bacteria. This includes cariogenic streptococcus mutans as well as many gram positive and gram negative bacteria. Diet may influence lactoperoxidase presence or activity. The administration of xylitol orally or feeding by gastric intubation did not affect lactoperoxidase activity in saliva (52). Thus it appears that the type of diet is less important than its nutritional value. We will measure lactoperoxidase activity by absorbance at 400 nM as described by Pruitt and Adamson (53). Lactoferrin, aminopeptidase, and lactoperoxidase will be assayed in years 01 in Indiana by Dr. Watson.

In year 02 an Egyptian graduate student during his year of training at Purdue will learn the assays. We will continue their use in Cairo as part of his thesis work with Dr. Fleita (American University of Cairo).

Amylase and aminopeptidase will be measured as we have done previously by Dr. Watson and Dr. Karn (54-57). Briefly, amylase activity is measured in secretions by modification of the saccharogenic serum amylase method. Amylase functions significantly in the degradation of starches in the oral cavity and thus plays an important role in both the nutritional milieu of the mouth and the conversion of dietary carbohydrates into absorbable sugars. We found that in utero malnutrition followed by dietary protein deficiency at weaning resulted in a significant decrease in salivary amylase secretion in the rat pups (55). The effects on this important digestive enzyme of low caloric diet or high workout in both adults and children with a marginally adequate protein intake. A decrease in amylase could affect the efficiency of the breakdown of cereal carbohydrates. The effects of marginal and severe malnutrition on both pancreatic and salivary amylases were investigated by us in malnourished Colombian children (54,56). Significantly lowered or altered amylase activity was found. Such changes could affect the pH of the stomach and/or influence the degradability of some dietary carbohydrates in the stomach or intestine. Dr. Karn and Dr. Watson (54) have measured pancreatic as well as salivary amylase changes with nutritional status using urine and saliva. This will be done with samples from all subjects. Therefore, amylase activity will be measured in salivary secretions as well as urine (which contains both pancreatic and salivary amylase) from aged as well as the young members of our family units as its level may significantly affect energy nutrition and carbohydrate utilization.

Cell-mediated Immunity.

Cell-mediated immunity (CMI) is critical for host defense against most tumors, many intracellular pathogens (such as viruses) and some extracellular pathogens. Children can live to adulthood without antibodies but die by 1 year of age without CMI (59-61). Our review of the literature showed that suppression of CMI parallels the severity of the nutritional deficiency (61). Preliminary evidence supports the hypothesis that severe nutritional deficiencies interfere with lymphokine production (soluble protein mediatos of cellular immune function) by T lymphocytes and may alter the T lymphocyte sub-populations which have a suppressor function. In addition, the efficacy of vaccines which stimulate primarily a cell-mediated immunity (e.g. BCG) may be impaired in severely malnourished people. However, our review revealed essentially no information on the effects of marginal energy malnutrition on cell-mediated immunity (61).

Hereditary zinc deficiency is associated with thymic atrophy and impaired cell-mediated immunity (62,63). Recent reports indicate that nutritional zinc deficiency may also cause cellular immune suppression especially in populations whose diet is high in plant fiber and low in meat (64). Although zinc is present in considerable amounts in cereals and other plant products, it is relatively unavailable. Low meat, high plant diets are characteristic of poor and aged populations. For this reason, the zinc status will be measured and corrected where necessary in those where the intake is low in our study population. We may assess the effects of zinc deficiency when combined with marginal energy intake on immune responses.

T-cells play a direct role in immunity by attracting and activating macrophages. We have observed no change in T-cell numbers in aged, malnourished mice (unpublished data). Therefore, we will assess, in aged humans and children, CMI functions of T-cells that are affected both by age and nutrition. CMI assays will be done in Egypt by the immunology technician trained by Dr. Watson and working with Dr. Ekladious (Immunologist - Cairo University School of Medicine). Little or nothing is known about the nutritional requirements needed to prevent nutritional suppression of CMI which is already partly age suppressed other than

our animal studies (unpublished data - Watson and Haffer). Our recent data in aged BALB/c mice show that their dietary protein needs to maintain optimum CMI are much less than young, growing animals also fed a low protein diet. After 2-3 weeks, the response to PHA is reduced in the young animals while it took 11-12 weeks in the aged mice. However, the decrease in the aged CMI following malnutrition was more severe in the aged mice (decreased 80% compared to a 45% drop in the young mice after 11 weeks). The general state of systemic CMI in normal and malnourished Egyptians will be monitored by the lymphocyte transformation technique (44). Our technique is based upon DNA synthesis in peripheral blood lymphocytes and undergoing blastogenesis and mitosis in response to mitogens. We use heparinized blood obtained by vena puncture as done in children by us (44). The mitogens we use are phytohemagglutinin (PHA) and Con A. PHA is less specific than Concanavalin A but still largely a T-cell mitogen. Briefly, we use lymphocytes which are partly purified from heparinized blood by centrifugation on a ficol-hypaque gradient. The assay is cultured at 37°C in the presence of mitogen, PHA or Con A or media alone as the control. Radioactive label (^{3}H-thymidine) is added 24 hours before harvesting of cells and its incorporation into DNA is measured as an indication of cell division driven by the mitogens. We wi also sensitize with DNCB (synthetic hapten) and BCG vaccine. The ability to be sensitized while undernourished as well as the response of sensitized T-cells in vitro and in vivo (skin test) will be studied as we have done previously (44).

We recognize that changes in some cellular responses such as suppression of cellular immunity, poorer cell growth, or production of complement protein levels, growth hormones and other materials secreted by the cells could be caused by (a) changes in cells or (b) changes in components serum that surrounds them. In years 03-05 we will evaluate several systems in vitro to determine the importance of changes in serum components on cell growth. One model system will be cellular immunity where a recent publication on malnourished children suggests that changes in serum components more than the T-lymphocyte cells are affecting cellular immune functions (65). We will incubate normal T-cells with varying amounts of control or malnourished serum. We will then add back such serum components which may be low and affecting cell growth such as zinc, cholesterol, ets. or try to selectively remove those that may be inhibitory such as high corticosteroids. These assays will be done in Indiana by Dr. and Dr. Petro (Post-doctoral fellows with Dr. Watson).

Nutritional Stresses in the Aged: Interaction With Host Defenses and Diseases

Even in the well-nourished elderly the risk of disease is greatly increased as they suffer from suppressed host defense systems. At the recent American Medical Association's National Conference (Dec., 1978) Dr. Bortz's panel concluded that evidence indicated human beings are biologically and genetically capable of living to be 120 years old. Dr. Bortz said, "Nobody dies of old age; you die of disease." Malnourished children and adults suffer increased morbidity and mortality to infectious diseases in part because nutritional deficiencies impair their immune systems. The aged in family units represent a particularly poorly studied group. Their quality of life is affected by nutritional state and our study will determine the indirect effects of marginal energy nutrition in the aged on the rest of the family. Their nutritional state is more difficult to clinically assess when they suffer moderate malnutrition than in growing children. Their immune systems decline with age and are susceptible to nutritional stress which will further suppress their resistance to disease. We will determine the optimum ranges of calories, protein and/or zinc intakes to produce the highest level of secretory and cellular immunity without being immunosuppressive in the elderly. This will be accomplished by (A) surveying aged in our population groups and (B) supplementing the diets of aged adults who are not part of our longitudinal study In years 03 and 04 until immune responses no longer increase (see below for details) dietary supplements of protein, energy and/or selected will be given

Part B will require families not in the long-term study groups. We will also develop some of the assays of immunological status as measures of the adequacy of nutritional state in the elderly where anthropometric tests are less useful then children.

We will document chronic diseases in the study population and relate their presence to behavioral patterns which may impact upon functional areas under study not only for the affected individual but for other members of the household as well. Patterns of bone loss with aging and the prevalence of osteroporosis have not been studied in this populations. In the third and fourth years of the project, information will be collected on bone density and body composition of adults of all ages in the study households, in order to enable comparison with data collected in Mexico by one of the project's associates (Stini). The relationship between patterns of childhood growth and later patterns of chronic disease and bone loss will be compared for the two populations. The Mexican population will be studied (other funding) in years one and two of the present study, so that comparison will be possible.

Levels of Immunoglobulins and Enzymes in Secretions of the Elderly.

The effects of marginal energy and/or protein undernutrition on components of the secretory immune system in an aging population will be characterized for the first time. Since we have found that S-IgA levels are very sensitive to marginal dietary deficiencies in children (43) and mature guinea pigs (42) we believe it will be a useful tool to assess adequacy of dietary protein and energy. In addition S-IgA levels are vital for host defense of mucosal surfaces and dietary intakes reducing their general levels would be expected to be disadvantageous to the elderly. Throughout the study, Dr. Watson, Dr. Petro and Dr. Lim will measure the amounts of secretory IgA (S-IgA), IgG, lysozyme, free secretory component in tears and saliva. Saliva and tears will be collected as we have done in children (43). Tears are collected by placement of a sterile 2 x 4 x 2 mm Weck-Cel sponge between the conjunctiva and the eye for 45-60 seconds. Tears are expressed by centrifugation in 0.4 ml Hruden tubes yielding 25-40 µl/person. This is sufficient to measure S-IgA, IgG, lysozyme, free secretory component, and total protein (42,43). Saliva and tears are immediately stored at -20°C. Both techniques have been used without problems in over 400 children by Dr. Watson. Protein-calorie malnutrition and zinc deficiencies significantly increase the susceptibility to infection in children. Most initial infections occur on or near mucosal surfaces which are protected from pathogens by secretory IgA, and, to a lesser extent, IgG and lysozyme. Briefly, IgG and IgA, in serum and secretions, will be measured by radial immunodiffusion using onspecific antisera as we have done previously (42,43). Lysozyme (muramidase) activity in secretions is measured based on hydrolysis of Micrococcus lysodeiktricus in agar plates (42,43).

Development of Immunological Methods for Nutritional Assessment on the Elderly.

Nutrition has been shown to play an important role in the overall health of the aged. Barrows (66) says "Nutrition is the only environmental factor that has thus far consistently increased life span of animal model systems. It is an environmental factor that lends itself well to beneficial manipulation in humans." Various factors may influence the diet of the aged adversely, predisposing to increased disease morbidity. For example, old rats on a reduced calorie diet lost more weight and reached an equilibrium more slowly (67). Increased morbidity in the elder with the manifestation of chronic degenerative disorders resulting in physical disabilities (dentures, for example) is often the cause of nutritional food intake (68). This may then result in mental disturbance of nutritional origin and further force the person into a downwardly directed spiral of increased incidence of malnutrition, infectious disease and ill health (68). Changes in a number of processes basic to digestion and absorption of basic nutrientssuch as calcium decrease after age 65, whereas others, such as glucose absorption are unaffected. These studies are done with aging populations from Industrialized

countries (68) so that little is known about the nutritional condition in the increasing aged populations which are often exposed to poorer sanitary conditions and have significantly fewer economic resources.

Three important objectives to be determined using elderly members of the households in the study are (A) to measure the incidence of nutritionally mediated immunosuppression in aged adults and its effects on work capacity, (B) to determine the optimum dietary intakes necessary to maintain maximum immune responses in the aged adult. This will be determined by showing improved host defenses following dietary supplementation of a special group of aged and by comparison of well- and undernourished aged in the survey households and (c) to identify in the well-nourished aged the normal levels of easily measured immune responses for use to improve nutritional assessments. Part C will be definition of this novel technique to assess dietary needs in the elderly. Then it will be available for subsequent broad application to study the nutritional value of varied sources of protein, calories, minerals and vitamins in the aged. Part B will require diet supplementation of some elderly people not in our general study. It will be directed and clinical examinations provided and/or supervised by Dr. Massoud, M.D. (Ain Shams Medical School).

A recent study done by Purdue University (69) indicates that the average aged resident of Indiana receives near the RDA of calories and protein, and only about 65% of the RDA of zinc. However, the adequacy of the RDA in maintaining optimum host defenses in the aged is not known especially in a LDC or in maintaining optimum host defenses. Extremely little is known about the effects and incidence of various nutritional deficiencies including marginal energy intake among the elderly in less developed countries. A special group of aged individuals (90 persons)60-70 years will be recruited into a short-term portion of the study in year 03. They will not be part of the large household survey. Each patient in this special group will serve as his own control and will be sampled twice before their diet is supplemented for (A) nutritional status by diet measurement and recall, (B) serum levels of zinc and protein for biochemical assessment of nutritional state and (C) selected secretory, cellular and humoral immune responses. Changes in his psychomotor function and ability to work will be measured. The amount of diet consumed will be observed and recorded on three days during two weeks and the dietary intake estimated. We will screen for the presence of low iron, vitamin A and vitamin C to treat for these deficiencies before supplying a high energy diet. Then one-half of the patients will be given an increased amount of protein (increase to current RDA or 20% increase over current consumption, using whichever is larger) and will receive zinc supplementation. The others will receive increased dietary carbohydrates. Our research with children in Colombia (44) shows that both nutritionally repressed cellular immune responses and C_3 levels begin to significantly increase after two weeks on a high protein diet. Therefore, the patients will be encouraged to eat the increased supplementation for 6 weeks. (Sufficient foor or supplementation will be supplied so as to increase consumption of the house with encouragement to the aged member). We will sample for immunological assessment dietary intake and nutritional state at 4 and 6 weeks. Changes in psychomotor function will be measured as well as changes in serum zinc, etc. Compliance will be checked by observation by a trained dietitian.

At that point, the supplementation of each group will be reversed. The actual consumption of the supplementation will be measured by observation twice/week. Nutritionally suppressed host defense systems and work capacity will be expected to increase except in those aged individuals receiving an adequate dietary intake. Thus a minimum intake for various functions will be established based upon optimum immunocompetence.

Longevity - Cellular Immune Enhancement by Marginal Energy Deficiency

It is generally assumed that malnutrition is life threatening, results in increased disease, and is immunosuppressive. Most studies involve severe PCM or protein undernutrition where these conclusions are very correct and reproducible as briefly described above. Certain systems are suppressed by moderate malnutrition such as the levels of S-IgA as we have shown (43). A better understanding of the effects of marginal energy malnutrition on all immune systems, disease incidence and selected infections is a major goal of the survey. However some data, cited briefly below suggest that cellular immunity and longevity might be enhanced under marginal dietary restriction. Therefore a long-term aim (years 04-08) of the longitudinal follow-up of malnourished newborn children will be to determine what positive benefits, in particular, delayed development of cellular immunity occurs. We realize that analysis for this delay may be difficult statistically even though it can be shown in laboratory animals. The data will be tabulated as part of the overall survey and re-evaluated to look for delayed maturation of immunity as discussed below.

Marginal energy and marginal protein intakes alone in laboratory animals often cause significantly prolonged life spans. In a survey reviewed by Ross (70) of a sizeable number of very old people in Czechoslovakia, it was found that all of them came from large, poor families and by today's standards had a very modest diet during their childhood, likewise the more severe the nutritional restriction in young rats without producing frank starvation the greater the initial losses due to death. For example, decreasing the dietary intake of calories 30% below normal at 21 days of age, the life expectancy increased in rats more than 1100 days. Rats fed ad libitum had only a 600 day life expectancy. In other studies, tumor incidence, lung infections, etc. in the stressed adults were reduced. A study by Walford (71) showed that moderate protein or protein-energy restrictions increased cellular immunity along with increased longevity in rats.

The prolonged lifespan can be tentatively explained on an immunological basis. Prolonged marginal energy undernutrition in young rats resulted in retarded maturation of CMI and significantly prolonged life. We (72) and others including Robert Good (60) have data from marginally malnourished animals which indicate that there is an increased incidence of sub-clinical infections, stimulating cellular immunity. We proposed (72) that the resulting increase in antigens from increased subclinical infections (perhaps permitted by reduced S-IgA) stimulated the T-cells which activated the killer macrophages. This produced improved cellular immunity. Therefore, the routine guinea pig diet had an unhealthily high level of protein or energy as far as host defense against tumors and certain pathogens was concerned. Since the CMI system was activated, the marginally protein or energy malnourished child would be expected to destroy cancers and intracellular pathogens better. Thus as far as the cell-mediated immune system is concerned, a high intake of calories or proteins is not necessarily better than marginal malnutrition. (The effects of an environment with a large infestation and exposure to pathogens, such as Egypt, may cause the results to be different from the animal studies.) We believe that the animal experiments suggest that moderate malnutrition reduces development of cellular immunity which may be advantageous to the adult and measureable immunologically. This reduction in development may be very advantageous when disease exposure and severe nutrition can be reduced in childhood, and vital to understanding moderate malnutrition's actions. Therefore, we will analyze nutritional, immunological, and disease data in the longitudinal study of host defense systems to attempt to determine the possible roles of moderate malnutrition in suppressing some (such as S-IgA) and elevating others (such as cellular immunity) immune responses. This study represents a special opportunity to test animal studies in man showing retarded development. Although the benefits of this delay on life expectancy can not be assessed, comparison of levels of host defenses in the poor elderly with those of wealthy elderly in Egypt (year 05) or an industrialized country with a presumed lifetime of high calorie diets, may show

differences in the rates of decline of the immune system.

Disease: Incidence, Roles in Altered Nutritional States, Immune Responses, Learning and Energy Output.

We recognize the roles of diseases such as diarrhea in causing protein and energy losses in severely malnourished children. Therefore we measure the interactions of disease with marginal-moderate malnutrition. We will have regular (2 times/year) examinations by physicians. Stool samples will be measured in Egypt by the parasitology technician supervised by Dr. Gaafar (Purdue), Dr. Rifaat, MD (Professor of Parasitology at Ain Shams Medical School) and Dr. Masseod, MD (Ain Shams Medical School). Worm burden, parasitic egg count and speciation of major parasitic infestations will be determined. Alterations in secretory host defenses by diet could affect overall secretory immunity and relative resistance to parasites. As a model of changes in secretory immunity of the gut, we will measure changes in S-IgA, IgG, etc. in saliva and tears. Even a small decrease in secretory immunity or increase in disease morbidity may be associated with poorer energy utilization and ability to function in daily tasks. Trained auxiliary nurses will visit each household on a regular interval (2 times/month) to (A) assess current symptomatic infections by presence of catarrah, runny nose, congestion, etc. of children and mothers as we have done previously (40,43) as a measure of disease incidence and morbidity as well as (B) a disease history of the other members of the family. Where possible these brief visits will be coordinated with other testing or sampling. The nurse, by observation and survey, will assert the incidence of various clinical signs of disease. Other visits for diet surveys, disease incidence, and biological samples will be correlated as described above to keep to a minimum the interactions of the study members and the villagers. Some sampling will be done in the early evenings, non-religious holidays and Saturdays (no work will be done on Friday, the Moslem Sabbath) to increase participation of older students and working men in all aspects of the study. We will observe the incidence and relative age at occurence of selected diseases such as measles in children. Thus some of the serum of young children will be screened regularly for the appearance of, for example, measles antibodies after their maternal antibodies have disappeared which occurs at about 5 months of age. We will study the immune responses to selected pathogens as models for the body's general ability to respond to pathogens.

Disease: Oral Health.

Inadequate oral health will, at least in the aged who have lost many teeth, affect dietary intakes. Since Streptococcus mutans is ubiquitous pathogen ("normal flora" of the month), we can measure the affects of variations in dietary energy intakes on its growth and oral disease. Although some epidemiological studies have not shown a clear association between moderate to severe malnutrition and dental caries (84), we have shown a decrease in salivary immunoglobulins in malnourished children (40,43). Our animal studies (55) show a significant increase in plaque and numbers of S. mutans as well as a decrease in amylase secretion. Studies in marginally and severely malnourished children showed a decrease in amylase (40,54). Juan Navia (82,83) recently summarized the interactions of moderate nutritional stresses on oral health in animals. Several processes are significantly affected including (A) mineralization, (B) oral protein-synthetic reactions, (C) saliva flow and composition, (D) implantation and colonization of plaque flora. Our longitudinal study in Egypt will allow us to compare tooth and gum development as well as oral disease and host defenses to oral pathogens over a long-period in the same individuals who will either have normal or moderately low caloric diets. Specific anti-S. mutans antibody production will be measured. Since S. mutans is a common oral flora and as causative agent in dental caries, it can be studied in detail. We will measure specific oral secretory immune responses in saliva, caries, plaque and development of teeth and gums in both normal and undernourished family members.

Dr. Kafrawy, D.D.S. (Egyptian dentist at Indiana University Dental School) and Dr. McDonald (Indiana University School of Dentistry) will consult, direct the initial collection of plaque, and verify the techniques of plaque and caries incidence at the beginning of year 02. Each 1.5 years thereafter, similar samples will be taken.

Disease: Nutrition and Host Defenses in Breast Milk.

There is little doubt that breast feeding is a highly desireable and beneficial practice for both mother and infant (73,74). It has long been recognized that breast-fed infants experience less morbidity due to gastro-intestinal and respiratory diseases. It is now apparent, however, that increased disease resistance in the suckling newborn is due, at least in part, to the passive protection conferred by antimicrobial substances in human milk (75). These include (76,77) immunoglobulins (IgA) and specific antibodies, immunologically competent lymphocytes, lysozyme, lactoferrin, and complement components which will be measured as described earlier in this application. Immune responses stimulated by exposure of the respiratory or gastrointestinal tract seem to be preferentially expressed in the milk to protect the child's gut as they are not absorbed by the child. This implies that the mother's immunological experience is critical in stimulating the secretion of antibodies to prevalent pathogens. Rotavirus, a fairly recently described common cause of diarrheal disease in infants, may not infect adults as routinely and therefore may not often stimulate anti-rotavirus antibodies in milk. Artificial exposure of the lactating mother to rotavirus may help to fill this "gap" in the passive protection afforded the infant by breast milk and enhance the child's nutritional status by decreasing rotavirus caused diarrhea. Maternal diet and nutritional status have been found to significantly influence both the quantity and quality of milk. In a recent review (78) the Jelliffes point out that malnourished mothers often produce milk which is suboptimal in quantity and quality, with deficiencies of watersoluble vitamins, protein, calcium and fat. They also report that dietary supplementation of such mothers seems to lead to increased milk output and improved milk quality. Most human studies have concentrated upon the effect of maternal nutrition on the nutritional quality of breast milk, and very few have examined the effect on the protective factors discussed earlier. We will evaluate milk of mothers with moderately malnourished children as far as ehergy intake is concerned. Some of the mothers are expected to be undernourished while others will not. We have observed both a nutritionally mediated suppressed and rapid recovery of protective substances in secretions upon hospitalization and renutrition of severely malnourished children (44,49). Reduced levels of IgC_3 and hemolytic complement were found in the colostrum and milk of malnourished animals (79,80). These results suggest that maternal malnutrition may impair the protective qualities of colostrum and milk with a concomitant increase in morbidity in the breast-fed newborns of malnourished mothers. In return for their participation, the mothers will be offered free routine immunizations (BCG, DPT, Measles, Polio) for their infants and access to the participating physicians.

All newborns and their mothers will be examined at frequent intervals throughout lactation as described elsewhere in this proposal. A stool sample will be taken for bacteriologic and parasitologic examination, and additional stool samples will be obtained during bouts of diarrhea. Mothers will be instructed to bring the child to the Health Service Center for their group of villages during each episode of diarrheal disease. A complete physical exam will be carried out. Stool samples will be examined by routine culture techniques with specific emphasis on identification of prevalent local enteric pathogens. The specimen will also be screened for evidence of intestinal parasites. Rotavirus will be detected in stool samples by binding to specific

antibodies fixed to a solid matrix and then visualizing the bound virus using either immunofluorescent or enzyme-linked anti-rotavirus antibody by Dr. McMurray at Texas A&M University School of Medicine. Rotavirus antibody will be measured using either the complement fixation test or the enzyme-linked immunosorbent assay (ELISA) employing antigen from the Simian agent, SA-11 virus (81). Specific antibodies against enteropathogenic E. coli, Shigella, Salmonella and Klebsiella will be measured in child's serum and mother's milk by Dr. McMurray. Levels of immunoglobulins and specific antibodies will be related to total levels of serum protein and albumin. Cell-mediated immunity will be assessed in the host country both in vivo and in vitro. Both mother and infant will be skin tested at delivery and every three weeks during lactation by the intradermal injection of purified protein derivative (PPD), candidin, and streptokinase-streptodornase (SK-SD). In vitro measures of CMI will be measured as described elsewhere in this proposal. Upon thawing for laboratory analysis, the milk samples will be centrifuged at 20,000xg for one hour at 4°C. The clear whey will be separated and analyzed for the following substances: immunoglobulins - IgG, IgA, IgM, complement - C3, C4, lysozyme (muramidase), lactoferrin, free secretory component, total zinc, zinc-binding ligands, specific antibodies - E. coli, Shigella, Salmonella, Klebsiella, rotavirus. We will attempt to associate the nutritional state of the mother, the presence and level of antibodies to specific pathogens in her milk to the type of agent causing diarrheal disease in the child. If moderate energy undernutrition in the mothers significantly reduced host defenses of the milk and appears associated with increased diarrhea in the child, then in year 04 and 05, we may attempt to determine the ability of malnourished and well-nourished lactating mothers (not in the longitudinal study) to produce milk antibodies in response to oral immunization to selected pathogens. The immunizing suspensions will contain either whole, killed microbial organisms or viable, attenuated or avirulent microbes. Where possible, vaccines prepared from human enteric pathogens will be used. Toxoids may also be prepared from E. coli or V. cholerae enterotoxins and used to immunize lactating mothers. We would determine the time-course of antibody secretion following immunization, the persistence of milk antibodies, the effect of booster doses of the immunogen, and, most importantly, the influence of maternal malnutrition on the timing and quantity of secretory antibody responses. This may represent a way to increase the nutritional status of children by decreasing the incidence of early diarrheal disease. It could be relatively inexpensive if employed in conjunction with immunizations of children.

III. Effects of in utero childhood and/or adult marginal-moderate energy deficiency on physical work capacity.

A variety of nutritional deficiencies exist in the Egyptian population. Their investigation and treatment by clinicians has usually been directly related to the severity of the deficiency. We feel that marginal-moderate nutritional deficiencies, because of their much greater prevalence, may be much more damaging to the country and the general health of the population than severe PCM or severe iron deficiency anemia. Little is known in Egypt or the Middle East (1, Darby-Personal Communication) about the effects of moderate nutritional deficiencies on the ability to expend energy in physical activity in either children or adults. A search of the recent literature revealed no article dealing with malnutrition and work capacity in the Arab Middle East. Clearly many children are marginally or severely undernourished with reduced growth rates (1,2). This carries on into adulthood with extremely little known about the incidence of marginal nutritional deficiencies on the aged and their effects on work, learning or disease incidence. Infection is known to affect energy utilization (102) and may also change the ability to expend energy in work. Dr.

Ismail will correlate moderate nutrition with recent disease status and work capacity. We will attempt to determine the effects of moderate energy undernutrition early in life on later work capacity via the longitudinal study of our households. Some energy restriction have been shown in rats recently to not cause a decrease in the ability to swim as measured by endurance time or oxygen consumption (100). On the other hand in a study in humans Maximal 02 consumption (VO2max) and maximal endurance time at 80% Vo2max were determined in 49 subjects with varying degrees of nutritional compromise. Vo2max was lower by 21% and 52% in subjects with moderate and severe undernutrition, respectively, when compared to men with mild nutritional compromise (105). As our study progresses we will take advantage of the fact that our study groups will contain children who were undernourished when the study began and others who were well nourished. The other family members of these two groups of children may have varying nutritional states, but otherwise are expected to be very similar as far as religion, economic status, disease environment (housing and village location), school and type of work of the head of the family. Since nutrition is an important factor influencing physical work capacity in general, it is of prime importance to study the influence of nutritional status of the work capacity of the members of the household in Egypt and relate it to disease, immune responses, general health, etc. of the family and the individual.

To determine the effects of marginal-moderate calorie deficiency on the work output of the various family members, we will study the following areas: (A) a survey of their assigned tasks and activities, (B) their actual activities as measured by observation, and (C) their capacity to do various types of mental, physical or psychomotor activities in an experimental setting. Parts (A) and (B) will be done in the nutritional survey as described earlier in this proposal. Part C will be emphasized to understand the interactions of malnutrition with work capacity since work capacity is more easily quantitated with much better reliability than actual work output. It also is less subject to motivation where physical work output by an individual may reflect his ownership (or lack thereof) of the land, or such factors as his position in the family (father-daughter, etc). Therefore we will carefully associate capacity with nutritional status, disease, etc. more than actual work output. Since physical work capacity is frequently associated with and in certain cases is the result of a combined psychological and biochemical reaction in the human body, we will attempt to measure work output of key members of the household. In particular, this segment of the study attempts to investigate the difference between well and poor nutritional conditions on (A) maximal and submaximal work capacities (Dr. Ismail) (B) psychomotor performance of members of Egyptian households (Dr. Salvendi) and (C) information processing functions (Dr. Knight). We will compare two nutritional discrete groups (well and poor nutritional conditions) on: a) maximal and submaximal work capacities which reflect the general physical capabilities of the individual; b) psychomotor performance which reflects on the specific capability related to the individual's work efficiency; c) psychological measures associated with mental decision making and human information processing capabilities. We will determine the relative importance of each variable measuring maximal, and submaximal work capacities, as well as psychomotor performance in discriminating between the two nutritional groups. We will assess the daily tasks of each school age and adult member of the family by survey described earlier in the proposal as well as by observation of those who work in the house (women, children and the aged).

Maximal and submaximal work capacity assessment: All experimental and control subjects will undergo physiological evaluation which includes a graded exercise test using a quinton 16-50 cardio-exercise treadmill. The test will be conducted in accordance with the guidelines outlined by the American College of Sports Medicine (85) and administered by an Egyptian female assistant trained by Dr. Ismail. Because of our experience in field research in the Middle East we will scruptuously observe the customs of the people. Therefore here and elsewhere we will try to use Egyptian or at least

Arabic personnel in dealing with the villagers. In addition local customs which do not permit a man into a house in the absence of the head of the household will necessitate that many aspects of the survey be conduced by 2 women (nurses or auxiliary nurses). Each subject will be tested in a mobile van equipped for physiological testing. Some anthropometric measures described earlier will be done in the van. The van will permit semi-privacy in the field from children and others who are not participating in the tests. However, women will still perform the testing to enhance the ease of the testing. In addition some married women in the traditional setting of the village may not want any male outside of their family to see their face. Based upon our experience we forsee no difficulties in performance of the following tests as we will work with and use the local customs rather than work against them. The subjects will be tested using a motor-driven treadmill (Quinton 16-50). The prime purpose of this test is to obtain the submaximal and maximal work capacity of each participant. Prior to implementing it in the study population, the training of the assistant and any calibration will be done by Dr. Ismail. The subject then rests on a bed for 10 minutes during which time electrodes will be attached to various sites on his/her body in order to monitor the EKG responses during exercise using an electrocardiogram. At the end of the 10 minute rest, the heart rate as well as systolic and diastolic blood pressures will be measured. The subject will then walk on the treadmill at a speed of 3.5 m.p.h. with the grade being elevated two degrees every two minutes for the first 10 minutes and four degrees thereafter to maximum of 18 degrees. During the walk the heart rate will be monitored regularly to insure that the individual does not exceed his/her predetermined submaximal and near maximal work limits. The submaximal performance will be below 70 percent of maximum based on maximum-adjusted heart rate. For the assessment of the near maximal performance a 90 percent limit will be adopted based on age-adjusted heart rate (85). A minimum of two respiratory gas samples and heart rates will be collected for each submaximal and near maximal performances. The expired air volumes for the submaximal and near maximal work capacities will be collected via a three-way "J" valve into a 150 liter Tissot gasometer equipped with a Kymograph. Duri the last 30 seconds of last minute of each of the submaximal and near maximal performances, air samples will be collected and the minute volumes for each performance will be obtained. Each minute volume will be multiplied by .133 (the Tissor correction factor and the volume will be corrected to STPD. Each of the submaximal and near maximal expired air will be analyzed for oxygen and carbon dioxide percentaged using Beckman Oxygen Analyzer and Beckman Medical Gas Analyzer. The two instruments will be calibrated periodically using gas of known percentages in the case of CO_2 analyzer and room air in the case of the O_2 analyzer. The average percentage for O_2 and CO_2 obtained from each of the work capacities will be applied to a nomogram reported by Consolazio, et al (86) and the true O_2 percentage for each performance will be achieved. Finally, each of submaximal and near maximal oxygen uptakes will be corrected for body weight to obtain the desired values per kilogram of body weight per minute. During the testing program, the testing supervisor will look for any signs of fatigue and frequently engage the subjects in conversation to insure that they are not exceeding safe levels of effort. Should any subject show any signs of fatigue or indicate discomfort, the exercise testing will be terminated. The testing program described above has been used routinely in Dr. Ismail's laboratory and proven to be a successful one. We have publishe several studies using the same testing protocol or a slight adaption of it (87-95).

Psychomotor performance assessment. Although we are using rural families as our initial study groups and may only as the study advances include urban poor families, we recognize that the percentage of the population that is rural is often decreasing in LDCs. In Egypt it is still near 50% of the total population (2). Young adults from the rural areas are moving to the city to improve their economic lot in life. Therefore we will measure the effects of marginal-moderate energy malnutrition on the ability to perform the more complex work functions of industrialized, urban society by measuring psychomotor performance. Over the past 25 years, studies have supported

the notion that the factor structure of psychomotor performance could be identified by the following factors: 1) control precision, 2) multilimb coordination, 3) rate control, 4) arm-hand steadiness, 5) finger dexterity, 6) manual dexterity, 7) reaction time, 8) response orientation, 9) speed or arm movement, 10) wrist-finger speed, 11) aiming (96-98). Although all measure different functions or capacities we have initially selected 5 for study.

PSYCHOMOTOR FACTORS*

1) Control Precision	Common to tasks that require highly controlled and precise muscular adjustments of controls where larger muscle groups are involved, extending to arm-hand as well as to leg movements.
2) Multilimb Coordination	Ability to coordinate the movements of a number of limbs simultaneously, in operating controls. It is general to tasks that require coordination of two feet, two hands, or hands and feet.
3) Rate Control	Involves the precise timing of continuous responses relative to changes in speed are minimized. It is general to tasks requiring steady limb position or moving the limb steadily in a lateral or to and from plane.
4) Arm-Hand Steadiness	Ability to make precise arm-hand positioning movements where strength and speed are minimized. It is general to tasks requiring steady limb position or moving the limb steadily in a lateral or to and from plane.
5) Finger Dexterity	Ability to make skillful, controlled manipulations of tiny objects involving primarily the fingers.
6) Manual Dexterity	Skillful, well-directed arm-hand movements are involved in manipulating fairly large objects under speed conditions.
7) Reaction Time	Speed with which the individual is able to respond to a stimulus when it appears.
8) Response Orientation	General to tasks requiring rapid selection of controls to be moved or directions to move them in.
9) Speed of Arm Movement	Represents simply the speed with which an individual can make a gross, discrete arm movement; accuracy is not required.
10) Wrist-Finger Speed	Requires rapid tapping of the pencil in relatively large areas.
11) Aiming	Best measured by highly speeded printed tests requiring dotting in series of small circles.

*Adapted from Fleishman (97,98)

If a person has a high or low performance on one type of psychomotor task, that has no bearing on how that person will perform on another dissimilar psychomotor task since there are eleven distinctly identifiable psychomotor factors (in the statistical sense) or ability attributes. Since the factor structure of a psychomotor task varies significantly as a result of practice (96) and since we (99) have found that there is a very low (less than 0.5 correlation) relationship between initial performance, rate of learning and final performance on a task, all of the above three performance measures must be assessed in performance evaluation. An example may well illustrate this

notion, for an effective initial performance of a power press operation, eye-hand coordination abilities are essential for a trainee (i.e., to reach, grasp and move the material - while the operator is seated - to the power press). However, as the trainee acquires the necessary performance attributes of a skilled operator, he will shift from an eye-hand coordination requirement to a kinesthetic ability need. Thus if the operator has a good eye-hand coordination, he is likely to have a high initial performance, but if he has a low kinesthetic ability, he may have both a low rate of learning and a low final performance on the power press operation. In a world of changing, developing technological and labor market changes, it is essential to identify the effects of nutritional stresses on the attributes and capacities of those individuals who can rapidly acquire a high level of performance. The following procedure will be carried out to assess the psychomotor performance of the experimental and control nutritional groups: (A) We will use eleven tests which represent the 11 psychomotor ability factors for the population of a LDC (Egypt). These tests will be, where possible, a combination of commercially available tests and the development of appropriate computer software to be linked with the commercially available tests (e.g., for rate control and control precision, the computer software will generate the pattern for trucking). In 10 of the tests little modification will be necessary to apply them to the Egyptian setting. In year 01, Dr. Salvendy working with colleagues at the Egyptian National Research Center will conduct a laboratory pilot study on a select representative group, 30 subjects from a village similar to the ones involved in the longitudinal study. They will establish the shortest possible administration time per each test for the purpose of derivation of information on rate of learning and final performance on specific ability tests. As the tests are applied the Egyptian technicians who will administer the test as well as the collaborating Egyptian scientists will be trained. We will administer the ability tests from the table above (A) 1-3 months after a family group is recruited into the study, (B) whenever the nutritional status of a member changes significantly and (C) when young children enter school. Data will be analyzed for each ability test with regard to initial performance, rate of learning and final performance. Statistical comparison of these data between groups will be made. The relative influence of each of the 11 ability factors on the productivity of the country where the study is done will be efaluated based on multi-dimensional job-skills analysis methodologies which we have outlined previously (99). The possible impact of these 11 psychomotor ability factors in converting the current economy (in the country of study) to a modern technologically oriented industrial nation will be evaluated based on job-skills analysis methodologies referred to above. An effective methodology for measuring the attributes associated with factors 1 and 3 has been developed by us (Boydston and Salvendy, 115). For factor 1, computer software displays a two dimensional pursuit three sine waves track on a Hazeltine. For factor 3, the computer software generates one dimensional compensatory display utilizing eight tracking patterns, each of which is composed of six sine waves. The subject tracks these display patterns with either a joy stick (factor 1) or knob control (factor 3). The RMS score - the difference between the displayed and tracked pattern - is derived for each trial through computer software. Initially, 50 trials of 30 second duration each will be carried out. An effective methodology for measuring the attributes of factor 4 has been developed by Salvendy (116). The task requires positioning of the hand, while blindfolded, in different angles and distances away from the subject's body. A cycle lasts three minutes and the cycle is initially repeated 10 times. The results are scored manually. For factor 5, One-Hole test (117), which is marketed by Lafayette Instrument Company, will be utilized. The test will be administered for 15 cycle of one minute duration each. The test is scored through computer and ability measures for each of the four basic motions - reach, grasp, move, and position - will be derived. For factor 7 a visual reaction time task will be utilized.

In this task visual stimuli will be generated by computer at random intervals. The subject will require pressing a button as fast as he can after the appearance of the stimuli. The elapse time between the onset of stimuli and the pressing of the button in the reaction time. This time is measured and recorded by computer. The tasks for the other factors will be the same as those proposed by Fleishman with the exception that this proposed study, they will be computer administered and scored.

Effects of Marginal Malnutrition on Information Processing Functions. Human abilities to successfully cope with environmental demands rest largely upon cognitive resources. These critical cognitive functions include obtaining information, processing available information effectively, and executing an appropriate response on the basis of prior information processing outcomes. Furthermore, as environmental demands become more extreme, we expect information acquisition, processing, and problem-solving to become increasingly important in the human-welfare maintenance system. Thus the potential impact of marginal nutritional deficiencies upon information processing and problem-solving functions is critical. We feel that it is critical to evaluate marginal moderate malnutrition on problem solving abilities because of the pacity of information in this area of Egypt. Two dimensions of human information processing are relevant for this research proposal in adults. The first follows the flow of information through the human and includes the three stages mentioned above: (1) information acquisition, (2) information combination and utilization, and (3) information output or response execution. A person may behave in non-optimal ways if he is unaware of significant pieces of environmental information; parents, for example, may not perceive significant features in the behavior of their children or may not have access to technical information (nutritional practices, medical techniques, etc.,) that could be used to generate more appropriate behavior. Furthermore, even if information can be acquired or is available in memory this information must be utilized effectively for successful solution of environmental problems. Issues of information availability vs. accessibility or retrievability are relevant here:information stored in memory must be retrieved to be usefully processed. Knight, unpublished data (110) showed that different strategies for using available information can affect the efficiency with which this utilization occurs. In particular we have (110) demonstrated that different sequences of information processing steps can increase the cognitive load imposed by a given task. Finally, after a decision as to an appropriate response to environmental demands has been derived, this solution must be effected. Miller, Galanter, and Pribram (111) emphasized that carrying out a complex response plan requires continued input of new information as well as additional processing to adapt the action plan to unexpected environmental variations. Response monitoring is also a significant factor in current views of human learning. Even in the context of very simple information processing skills, Adams (112) emphasized the problem-solving nature of human learning and the need to carefully utilize information provided by the consequences of previous decisions in acquiring improved adaptations to one's environment. It is evident that acquisition of new behavior patterns as well as successful utilization of available abilities rests upon information processing skills. Thus, successful adaptation to one's environment requires a continuous, closed-loop flow of information through the human. Deficiencies at any point in this cycle can be expected to yield sub-optimal behavior. Hence it is critical to identify potential impairments in this information-flow process that may be caused by marginal or moderate malnutrition or associated conditions such as disease.

In addition to the functional dimension just described, a second dimension, information processing complexity, may be conceptualized. Current hierarchical views of information processing emphasize that complex problem-solving rests upon more fundamental functions such as pattern recognition, memory search, and response

selection. Thus to understand deficiencies in high-level problem-solving (such as deciding how to allocate one's family resources to achieve maximum return in food, education, health, etc.) it is wise to examine limitations in simple tasks (such as pattern recognition as related to reading skills). Also related to this complexity dimension are issues of psychophysiological arousal. It is well known that informati processing tasks of varying complexity are best performed within different ranges of psychophysiological arousal (i.e., the Yerkes-Dodson function). Since physiological arousal levels may be related to marginal malnutrition we might hypothesize a more or less direct link between information processing skills and chronic nutritional situations.

Fundamental information processing functions: A series of testing methods will be developed for investigating information processing and problem-solving abilities within the outlined two-dimensional framework. Information acquisition, utilization, and output will be investigated primarily utilizing inexpensive, easily-administered paper-and-pencil tests. Since basic cognitive functions such as pattern recognition, stimulus detection, or response choice are relatively free from educational influence, evaluation of these processes should be valuable in localizing deficiencies in higher-level, more complex tasks that might be particularly sensitive to experiential or educational variables. Some of the following specific information processing aspects will be examined in years 02-04 by Dr. Knight:

Function	Primary stage involved
1. Stimulus detection	acquisition
a) visual search rates	
b) memory search rates	
2. Short-term memory storage	utilization
3. Pattern matching	
a) physical level	acquisition
b) conceptual	utilization
4. Donders' B reaction (response choice)	utilization & acquisition
5. Donders' C reaction (response choice)	acquisition & utilization
6. Memory maintenance and decay	utilization
7. Response compatibility affects	output
8. Processing capacity limits	acquisition, utilization, output

The basic format for these tests will involve school age adult and aged members of t family groups completing a series of problems printed on a single or consecutive pages of paper. For example, visual search can be tested utilizing Neiser's (113) paradigm in which subjects scan a page of printed alphanumerics looking for a specific symbol. Neiser's test will be modified after translation into Arabic numerals and sample testing with school children in year 02. To examine detection rates in more detail, subjects will be asked to circle targets found during search. Memory search would be similar except that subjects would memorize a larger set of target symbols prior to scanning the printed page (which would be organized in a visually-simple form to minimize perceptual difficulties). By varying the numbers of stimulus and response alternatives on these tests, measures of available processing capacity limits can be derived as we (Kantowitz and Knight, 114) have recently shown. Total time taken to complete a long series of such problems will be measured and specific error patterns will be noted. By using total time, as a dependent measure, detection of small time differences in individual problem solving processes will be possible without complex instrumentation. Also such tests can be administered to a large number of volunteers in a short time. Performance on consecutive sections (i.e., pages) of a specific test will be used to assess learning rates in basic information processing tasks.

Complex information processing is likely to depend significantly upon experience, education, and intelligence, and personality. Since these factors are likely to be correlated with nutritional history, their effects must be carefully considered. Analysis of covariance or other statistical techniques will be utilized to evaluate or remove the influence of these factors based upon pre-experiment responses on standardized instruments. In addition, tests of complex problem-solving styles and abilities will, where possible, be constructed to minimize the need for specific educationally required skills, such as reading. Three aspects of such complex information processing will be particularly investigated: (1) the ability to combine or utilize several sources of information and (2) the influence of functional fixation in limiting problem-solving effectiveness and (3) the ability to objectively evaluate the effectiveness of generated problem solutions. It is likely that such tests will be structured as simple games and utilize physical objects rather than printed problems. Such tests could involve, for example, arranging scaled furniture in a model room, to achieve experimenter-defined objectives. Time and solution features will serve as dependent variables.

All the work capacity data will be analyzed by two statistical approaches: Univariate and multivariate. In the univariate an appropriate analysis of variance model will be selected in order to determine the significant differences, if any, in each of the work capacity and psychomotor measures. In this model, the significant differences will be examined relative to the main effects (poor-vs-well nourished groups, age groups, location groups and sex groups) as well as the interaction results. The Newman-Keuls method for mean comparisons will be used whenever the analysis of variance results yield significance. In some cases, analysis of covariance will also be considered. In the multivariate approach, several discriminant function analyses will be performed to differentiate between poor vs well-nourished groups, age groups, location groups, and sex groups. In this technique, the best discriminators will be identified by the magnitude of the coefficient associated with each variable of interest. Thus regardless of the nature of the scaling of the variables, discrimination power of each variable will be obtained using multivariate criteria.

Role of Moderate Undernutrition and Disease on Cognitive and Sensory Development

The evidence for the role of malnutrition upon physiological and psychological development has been documented in a number of reviews, the most recent being that of Brozek in 1978 (118). As with other reviews, the research noted by Brozek (118) revealed highly inconsistent and contradictory data. As a function of malnutrition, deficits are reported in some studies but not in others. Two major factors seem relevant for this inconsistency. First, the pattern of inconsistent evidence relating malnutrition to development is strikingly similar in nature to patterns reported when socioeconomic variables are related to early cognitive development. At least for the latter area, a number of researchers (120) including Wachs (119) have presented data indicating that much of the inconsistency is due to the use of a composite criterion score such as an IQ or DQ. These authors suggest that highly specific environment-development relationships may be masked when these relationships are combined with other, non-specific relationships in a composite score. Although evidence is limited, a similar factor may be at work in the malnutrition-development area. For example, supplemental nutrition affects children's verbal performance but is unrelated to memory processes (121). The relationship of nutrition to verbal performance would undoubtedly have been lost had verbal and memory parameters been combined in a single score such as an IQ or DQ. Secondly, as a number of researchers have noted, it is often difficult to unequivocally assess the role of malnutrition per se upon development since, in most studies the effects of malnutrition have been confounded with that of inadequate rearing environments (122,123). Thus, it is often unclear if the lowered rate and level of development in malnutrition is a function of the malnutrition, inadequate patterns of rearing, or a combination of the two(124-6). The problem becomes even more complex when the potential influence of nutritionally associated conditions such as disease, pregnancy complications, or lack of educational opportunity are considered. Based on the above a multivariate longitudinal project is called for. Such a project would investigate the relationship of specific cognitive and sensory parameters to individual differences in nutritional status, health status (including pregnancy) and quality of rearing environment. Such a project is being mapped here. As measurement of disease-nutritional parameters are discussed elsewhere in this proposal, the present plan will focus primarily on cognitive, sensory and environmental measures. The research to be proposed here has a number of distinctive features. One of the major features of the proposed project is that it will be longitudinal in nature; i.e., a sample of potentially malnourished and nourished infants will be identified at birth and followed up through adolescence on a variety of age appropriate cognitive and sensory measures. This type of strategy, while time consuming, has been woefully lacking in the malnutrition research area and, according to a recent report from the National Academy of Sciences (127) is critically needed. This study will be primarily prospective rather than retrospective since, the confounding of nutrition, environment and disease in retrospective studies makes it difficult if not impossible to separate cause and effect (125). This study will also concentrate on specific patterns of caretaker-child interaction. With some exceptions (128) the majority of studies in this area have only speculated at the kind of rearing factors that might be associated with malnutrition (129) or have used fairly gross measures of interaction often based on interviews rather than observation (130-2). Finally as noted earlier specific, critical cognitive and sensory components will be studied individually rather than as composites. The overall goal of the proposed research is to attempt to determine the specific patterns of relationship occuring between development and malnutrition, health status, and environment. Our methodology will also allow us to look at specific interrelationships among predictors (i.e.: the relationship between maternal malnutrition and mother-infant interaction).

A regular part of the visits by all personnel to Egypt will be to have regular seminars and data discussions with the staff, students, and post-doctoral fellows to improve learning, develop new questions, and look for direct applications of the answers to previous questions. All cognitive measures will be made "blind". Correlation with nutritional status and disease incidence will be done at Purdue using household and family members' numbers periodically by Dr. Wachs, Dr. Kirksey, Dr. Watson and Dr. El Sadr.

Our primary population will consist of newborn infants and their mothers plus other caretakers such as aunts and grandmothers within the households. By means of a longitudinal approach we will follow-up those infants and their caretakers from infancy through childhood into adolescence. In addition, for comparative purposes older children adults will also be tested on a number of cognitive sensory measures.

Mother-child and caretaker-child interaction measures. In general for the first six months of life there are few standardized measures of adaptive social functioning which apply to infants and those which exist have not been used systematically in cross-cultural research. For the present project we will use relatively culture-free microanalytic observation techniques of naturally occurring, in-home interactions between mother and infant. Dr. Fogel directing this section already has a substantial body of mother-infant interaction video tapes which were made in other cultural settings: (1) working and middle class mothers from Chicago, Illinois, and from Lafayette, Indiana. (2) rural Navajo Indian mothers and (3) urban Hopi Indian mothers. These data should provide an important baseline for understanding the component of variance due to cultural differences, apart from any factors due to nutrition. The focus will be on the development of mutual social communicative and emotional expressiveness during the first 6 months of life. If nutritional factors affect the mother's or the infant's emotional involvement with each other, this should show up as a failure of non-verbal communication.

At six months of age a shift will be made from microenvironmental analysis of child-caretaker interaction to macroanalysis techniques by Dr. Wachs. This shift is, in part, due to the increasing range and mobility of the young infant as well as increasingly complex patterns of infant behavior. As a result, macroanalysis techniques are needed to give a more complete picture of the nature of the parent-child interaction for the older infant. From 6-12 months codes based on the Yarrow social environment scale (130) will be utilized. From 12-24 months, codes based on our Purdue Home Stimulation Inventory (PHSI) will be utilized (119). It should be emphasized that these instruments will form the basis from which actual measures will be developed. Both insturments have been normed with the age ranges noted and the normative groups have included poverty children. However, in all cases the inventories are based on North American populations and field testing will be required to determine if all inventory categories are applicable for Egyptian populations. This testing will be done in the first year of the project. The social enrichment scale developed by Yarrow has been validated for use with infants in the first year of life. Based on time sampling, the Yarrow (133) social interaction scale measures 45 item categories of specific child-caretaker interactions including proximity of caretaker, extent of caretaker's focus on child, number of caretaker vocalizations to the child, contingency of caretaker vocalizations, affect of caretaker, response to child distress, handling of child, encrouragement of child's exploratory behavior and encouragement of gross motor responses. Evidence indicating significant interobserver reliability and construct and predictive validity of the social interaction scale can be found in the volume by Yarrow (133). PHSI contains 45 item codes with multiple alternatives under each code. Codes are obtained through direct observation of all child-environment transactions during a specified observation period. Included among the PHSI item codes are parental reactions to child's exploratory behavior and ongoing activities, number of contingent and non-contingent vocalizations to the child, physical contact with thild, response to distress, parental strategies used with the child and parental involvement and affect. Data on interobserver reliability, item stability, and predictive validity of PHSI are currently being analyzed. Item overlap between the Yarrow (133) social scale and PHSI appears to lie in the areas of attentiveness to the infant, vocalization (contingent and non-contin-

gent) to the infant, amount of handling, parental affect and parental encouragement of exploration.

Beyond the second year of life, few useful observational codes have been developed During the first two years, older sibs of our target population will be observed interacting with parent and caretaker. From these observations, codes for study of our target population after the first two years will be developed.

Parent-child interaction variables will serve both as criterion measures in the study of the effects of nutrition and health status and as predictors in a multivariate serve for subsequent cognitive and sensory impairment which may also be associated with malnutrition and health status.

Cognitive Measures (Infancy). Infant cognitive development in the first two years of life will be studied using Piaget-based Infant Psychological Development Scale (IPDS). The Infant Psychological Development Scale (IPDS) was developed in an attempt to operationalize and standardize the techniques used by Piaget in his study of intellectual development. As utilized in the present project, eight separately scored subscales will be employed. Thus, a pattern of sensory-motor abilities can be developed for each child. The scales are: (1) object permanence, (2) development of means for achieving desired environmental ends (3) the development of foresight, (4) the development of schemes in relating to objects, (5) the development of an understanding of causality, (6) the construction of the objects in space, (7) the development of vocal imitation, (8) the development of gestural imitation. Each subscale consists of a number of separate ordinal steps with each step delineating a stage in the development of the ability measured by the subscale. As constructed, each of the IPDS subscales has significant observer reliability, stability, predictive and construct validity, and the ordinality required of a Piaget based infant scale (134-135). Being an infant scale and thus not heavily dependent upon language, the IPDS seems ideal for cross-cultural research. Piaget type instruments have been used in a number of cross-cultural settings. Since the instrument has not been used in the Middle East, some of the first year of the study will be used for field testing by Dr. Wachs to determine any modifications that must be made in the instrument prior to actual use.

In addition to the IPDS, pre-language measures will also be taken. Specifically, language development depends, among other things, on the development of mother-child interactions, such as mutual gaze and child following mother's line of regard. Three observations will be made under Dr. Fristoe's direction of mother-child pairs from the low energy intake control group. The dependent variable is the incidence of such interaction occuring in a twenty-minute period in a standard play situation. Does it differ for the two groups? Do low energy intake mothers and children have fewer interactions? Is attention different? This can have implications for future communication development which can eventually affect cognitive development (formal operations) and educational progress (136).

In addition to the above infant cognitive functioning will also be assessed via the technique of cross-modal transfer. This technique presents stimuli along one modality (ie.visual), and asks for recognition in a second modality (ie. tactual recognition). It has been used to demonstrate deficits in high risk (prematures) infants (137) and in mentally retarded populations (138). It appears to be sensitive to high risk infant deficits and can be administered simply and inexpensively. As part of the technique measures of initial visual attention/exploration and habitation will be utilized if pilot testing determines that these lab measures can be translated to the field.

Finally, measures of infant adaptive behavior in the first years of life will be developed by Dr. Wachs through modification of items from the Alpern-Boll Developmental Profile (139). This instrument is a comprehensive inventory of children's skills from birth to 10½ years of age. The Alpern-Boll estimates the individual's level of adaptive behavior across 5 areas. These are: (1) physical development, (2) self-help development, (3) social development, (4) academic development, (5) communication development. Information is obtained through detailed questioning of the mother about the child's specific skills in each of the above areas. Evidence supporting the reliability and validity of the Alpern-Boll can be found in their monograph (139) as well as in recent work by Wachs-DeRener (140).

Pre-school Cognitive Tasks. As a general measure of preschool competence, Dr. Ottinger will explore the feasibility of adapting a standard intelligence measure such as the Stanford-Binet to an Egyptian pre-school population. However, the major focus will again be on specific cognitive measures. Through use of more complex stimuli, the cross-modal transfer measure described earlier will continue to be utilized through the pre-school period. In addition, we will also investigate specific aspects of competence in the pre-school child. Competence includes the child's ability to observe, attract, utilize, and profit from his/her environment and sources of information. Means of assessing competence throughout the pre-school period have been developed by White amd Watts (141). The competence scale consists of 5 competence dimensions: (1) obtaining an adult's attention, (2) using adult as a resource, (3) expression of emotion to adults, (4) pride in product, and (5) use of adult role play. The scale is based upon observation of child-adult interaction. The scale has been used successfully with children from 1 through 6 years of age. Studies based on the competence performance of children from different environmental backgrounds indicate significant interobserver reliability and construct validity for the social competence scale.

Our final preschool measure involves a personality namely the concept of locus control. This variable assesses the degree to which the person feels in charge of the events and outcomes in his/her life. Differences in this variable have known correlations with learning, persistence, and motivation to achieve. A scale for the Egyptian culture will be developed following the criteria spelled out by Nowicki and Duke (142). Malnutrition, poverty and opportunity have been shown to produce differences in locus of control and it should be assessed in this project.

Childhood and Adolescence Cognitive Tasks. A wide range of cognitive tasks will be used for childhood and adolescence. The tests used at specific ages will be determined during pilot work but the following will give some specifics on the types of measures that will be considered for inclusion. Attention has been shown to be an important variable in the learning and memory processes that have been studied in mentally retarted children (142-144). Like retardate, malnourished children should show differential approaches to learning, memory, and problem-solving tasks, most particularly in the ways that they organize material at input for some later use (145). The intent of one series of studies will be to isolate specific differences in the approaches of nourished and malnourished children or children with undernourished parents, to particular attention, learning, memory, and problem-solving tasks that have been employed with children, both nonretarded and retarded, in the developed nations. Subjects will include elementary and junior high school age children (range 6-14 years). Specific tasks to be employed by Dr. Whittemore will include those from three general areas: 1) a developmental hierarchy of classificatory skills as representative of learning strategies in general; 2) organizational and neumonic skills in memory functioning; and 3) strategy skills in problem-solving tasks indigenous to children of all cultures (ie. board games, tic-tac-toe, Tower of Hanoi, and Twenty Questions).

One alternative procedure which has been used to assess flunctuations in cognitive functioning related to small changes in blood chemistry (140) will be used by Dr. Fristoe to look for similar changes related to energy intake fluctuations. This procedure was developed because it could be done by persons with a wide range of education and and skills, even by those exhibiting functional illiteracy. The subject watches a screen filled by one of four colors - red, blue, green, and yellow. The subject must classify the color as soon as it appears as "red" or "not red" by moving a joystick toward a symbol representing red or not red. The dependent measure will be reaction time. Similarly, subjects will be asked to match and to label these colors by using the joystick in a similar manner. Performance under the high and low energy intake conditions will be compared. Subjects will be representative of several age groups from 8-18 years of age.

Materials to be used for all tasks can easily be adapted from the educational materials that are common in most schools. Pilot testing in the Egyptian population

of all the above tests will occur in year 01 and 02. In addition to the above basic processes, evidence will also be taken on more global cognitive measures. Specifically pilot work will be done in the first two years of the project to adapt standard academic achievement tests for elementary school children to an Egyptian population. This may be a particularly interesting measure, since anthropological evidence indicates the existence of a problem called "education loss". This problem results from the fact that up to 40% of the children in Egyptian villages skip school for months due to either illness, family needs, or frustration at the educational process. The relation of predictors to amount and cause of education loss may well be a valuable approach in our study of cognitive processes and would be put into the study in year 02 by A. Sallam. In addition to achievement tests, locus of control scales will also be given during the childhood per-od following the procedure described earlier.

In addition to behavioral and educational approaches cognitive process may also be studied on a physiological level. The approach we will be using involves monitoring EEG during task performance. Specifically, tasks are used which engage the subject in cognitive processing for a specified period of time, during which EEG data can be collected which are free of movement, eyeblink, or other artifactual sources of noise in the data. While the exact tasks to be utilized with the children and adults in this study remain to be finalized, examples of tasks currently used will illustrate the general procedures. One task entails repetitive arithmetic calculations: the subject is asked to repeatedly add one digit to a cumulative total until requested to stop. A task with similar timing features requests the subject to engage in mental imagery for a specified period of time. For each of these tasks, EEG data are recorded during the period of time the subject is performing the task. A digit span task has also been adapted for use with computerized EEG data acquisition procedures. The experimenter reads a string of digits at a rate of one per second. EEG data are collected from the point at which the experimenter begins reading the digits until the point when the subject is asked to repeat the digit string. All procedures will, of course, be field tested prior to actual data collection. Initial training of Egyptian postdoctoral fellows in this technique will be done by Dr. Tucker of the University of North Dakota.

Measures of Sensory Capacity. Sensory measures will primarily involve assessment of auditory capacity and functioning. This is in part due to the wide amount of evidence available linking hearing impairment with mental retardation and other developmental disabilities (147-48). Starting at 12 through 36 months of age auditory capacity will be assessed through the use of a special operant auditory assessment procedure developed by Lloyd (149). Essentially the technique developed by Lloyd provides either tangible or visual reinforcements for all children responding by button pushing or head turning to the presence of pure tone stimuli. After 36 months of age the equipment can be used for standard audiometric examinations to plot audiograms for older children. For both the operant and standard examination thresholds will be obtained for 800 through 800 hz for each subject. In addition to the above measures of auditory capacity other more detailed measures of auditory functioning will also be assessed by Dr. Fristoe. One approach used will be similar to that used in the GFW Selective Attention test (150). This auditory figure (ground procedure) measures the subjects ability to attend to auditory stimuli in the presence of varying types or degrees of auditory distraction. As with other tests the first year will be used to pilot the approach to accommodate to language and culture of target population.

Procedures for Environmental, Sensory Cognitive Assessments. Specific details of procedure will, of course, be modified for the Egyptian setting during the period of field testing of the instruments. Dr. C. Osman (Ph. D., working in development of mental capacity at the Egyptian National Research Center) will be asked to assist in setting up this aspect of the project as well as aid Dr. Wachs as described above. However, certain general procedural variables can be noted to avoid contamination of results. Persons collecting data in other areas (nutrition, health status) will not be those administering cognitive, envrionmental or sensory tests. Further persons taking environmental measurements on a particular child will not subsequently test that child on cognitive or sensory

tanks. To avoid halo, persons testing the child on cognitive or sensory measures at one age will not be those doing cognitive or sensory testing at a subsequent age. All persons doing cognitive sensory or environmental tests will be trained by the co-principal investigators to a standard of acceptable reliability. Frequent checks will be made during testing to determine if the standard is being maintained. Regular retraining sessions will also be scheduled during the course of the study.

In terms of administration, the cognitive measures will be administered at 6 month intervals, during the first two years of life. When appropriate, measures such as visual attention may be given soon after birth. After 24 months of age, cognitive measures will be administered at one year intervals. Microanalytical observational procedure will be given at birth and at 2-month intervals until 6 months of age. Starting at 6 months of age, macroanalytical environmental assessments will be made once a month for a complete wake-sleep cycle for a maximum period of 3 hours.

Graduate and Post Graduate Training: Egyptian Human Nutrition Research. Purdue University has extensive experience in foreign graduate student training. For example, Dr. Smith's office supervises the graduate training of 200 Brazilian Science students a year from their Visa acquisition to housing, course, and university selection. A number of the senior U.S. investigators have extensive experience working, living and/or doing research in the Middle East. Dr. Watson lived in Iraq for over 2 years and did immunology-ocular microbiology in Saudi Arabia villages as part of a team from Harvard University School of Public Health. Dr. Salvendy recently returned from a sabbatical in the Middle East. Dr. Ismail, Dr. Loverde, Dr. Woodruff, Dr. Gaagar and Dr. Raghed at Purdue University have worked, done research, and lived in Egypt.

Arab graduate students training will emphasize basic course work in nutrition, disease, immunology or psychology, etc. depending upon their area of specialization at Purdue University for 12 months following their first year of graduate work in a Middle Eastern School. All graduate students will take some nutrition coursework so that no matter what their area of specialization, they will have a minor in nutrition with an appropriate appreciation of malnutrition. The major component of graduate and postdoctoral training will be development of a searching mind and associated research skills. Research will be the overriding objective of the last 2 years of the Ph.D. program for any graduate research assistant. Non U.S. nationals will be encouraged to do their research in Egypt either in the villages or in the laboratories of collaborating scientists at Ain Shams and Cairo Medical Schools. Egyptian preceptors, Purdue University staff on visits to Egypt, and regular progress reports will be used to aid the graduate students. Each major aspect of the project will have at least one Egyptian scientist and one U.S. scientist. They will serve as preceptors when graduate students and postdoctoral fellows are involved. For U.S. participants, both students and staff, Ms. A. Sallam has developed and will teach Purdue University's basic spoken Arabic course. Even though all the senior Egyptian personnel in the project speak English, any U.S. participant who will be in Egypt longer than 3 weeks will study basic spoken Arabic from Ms. Sallam at Purdue University. Ms. Sallam will be teaching basic spoken Arabic at Purdue University beginning September, 1979. All research will be submitted for publication simultaneously to an appropriate U.S. or International Journal as well as an Egyptian or Middle Eastern Journal. The latter publication may be in Arabic or English. The student's research and educational progress will be evaluated in detail each year in a report each will prepare. This will be part of the report to AID which will be translated into Arabic for the Egyptian Ministry of Health and all principal Egyptian participants. These general policies which Dr. Watson and Dr. McMurray have used in Colombia will be implemented for the publicity part of the study. All major findings, publishable material and reports will done in both English and Arabic. The study will emphasize dissemination of information bilingually. In years 03 and beyond efforts via Egyptian collaborators will be undertaken to discuss nutrition and the well-established information of the study in the lay press, sophomore medical classes, and particularly the radio.

E. Social Competence

For purposes of this study, social competence is defined as the degree to which an individual is able to identify, secure and utilize personal and environmental resources in order to initiate action for achieving positive outcomes, and/or for responding appropriately to ongoing or recurring social constraints and stressful situations. There is little if any evidence currently available regarding the relationship of malnutrition to the development of social competence in childhood, adolescence or adulthood. It is one of the aims of this proposal to begin to obtain such information. For the study of social competence both a longitudinal and a cross sectional strategy will be used. Overlapping data points in adolescence will enable us (Dr. Jerome with collaboration from Dr. Wachs Ottiigener, Gruen and Egyptian colleagues) to generalize our multidimensional etiological data taken in infancy and childhood (effects of malnutrition and inadequate environments upon competence) into the adult years when such multidiversional etiological data will not be available. This strategy will also allow for the estimation of cohort (generational) influences upon social competence. Thus children will be repeatedly tested on measures of social competance starting at three years of age and continuing through late adolescence. Simultaneously, both adolescents and adults will be studied, cross-sectionally, on their social competance skills. Overlap of measures will occur through the adolescent years. A description of measures used is given below. For the longitudinal component the same population described in the cognitive section will be used.

Longitudinal Component

Pre-school competence. Social competence traditionally has not been studied until the pre-school years. Means of assessing social competence throughout the pre-school period have been developed by White and Watts (141). The competence scale consists of 5 competence dimensions: (1) obtaining an adult's attention, (2) using adult as a resource, (3) expression of emotion to adults, (4) pride in product, and (5) use of adult role play. The scale is based upon observation of child-adult interaction. Observation will be made twice a year between two and four years of age. Studies based on the competence performance of children from different environmental backgrounds indicate significant interobserver reliability and construct validity for the social competence scale. D. R. Ottinger will be responsible for obtaining these measures.

School Age and Adolescent Social Competence. In this investigation the indices of school age and adolescent social competence were selected because they get at relatively specific behavioral dimensions that can be measured quantitatively. G.E. Gruen will be supervising the data collection in this area.

Social competence can be broadly defined to include emotional, motivational and social-interactional characteristics. However, several specific characteristics can also be detailed, including apathy, non-purposive, non-goal directed behavior; impulsivity; emotionality, unpredictable aggression; and failure to respond normally in social interactions. While the latter (responding normally in social interactions) will be emphasized in this project, several of the other characteristics will be measured also.

In order to get at purposiveness and goal-directed behavior, two measures will be employed--the Diggory card-sorting task (151, 152) which gets at expectancies of success or failure and level of aspiration; and the Wechsler Mazes (from the WPPSI, WISC-R, and WAIS), which tap planfulness, goal-directedness, and ability to anticipate outcomes. While the latter measure is usually though of as a measure of intelligence, it gets at a very specific ability that can be characterized as goal-directed behavior. Both of these measures are appropriate across ages four to adulthood. Each measure will be given once each year starting at age 5.

Kagan's (153) Matching Familiar Figures task, in which the child is required to match a standard stimulus with an identical figure selected from a number of very similar stimuli, is a well-known and often used measure of "impulsivity-reflectivity." This dimension is evident as early as two years of age and seems to be relatively consistent and stable through the elementary school years (154,155). This test will be administered once a year between 7-12 years of age.

Social awareness will be measured in children three to ten years of age via a battery of social-cognitive tasks previously used by Gruen (156). These include measures of empathy (157), social-perspective taking, and awareness of others' intentions as we have done previously (DaRener & Gruen 154). Although these measures are not well developed psychometrically, they are among the most often used measures of social-cognition. Both measures will be administered once a year starting at age 4 and continuing through age 11. Pilot work will insure validity and adaptability of all of the above instruments to an Egyptian population.

The most important measure of social competence in this investigation, will be behavioral observation of children's social interactions. A coding system based on a procedure used by Gottman, Gonso, and Rasmussen (158) will be employed using a time-sampling procedure. These procedures can be used with children from preschool through adolescence. The specific classes of behavior this adaptation of Gottman, et al's, procedure will be designed to tap include 1) low frequency of peer interaction (social isolation), 2) amount of positive peer interaction, 3) amount of negative peer interaction, 4) the distribution of the child's interaction and 5) entry behavior (asking for something, offering something). These observations will be made in appropriate group centers such as nursery schools, schools, or other groups available for observation. Observations will be sampled from three situations: (1) the family, (2) school or work situations, (3) free-time observations will be made twice a year starting at 4 years of age.

Longitudinal-Cross-sectional Overlap.

All adolescents in the cross-sectional population will be administered the following instruments, which have also been administered to their counterparts in the longitudinal portion of this investigation: (1) The Diggory cards sorting task; (2) The Wechsler Mazes; (3) The Social-Cognitive Battery; (4) Observation of Social Interactions. The first three measures will be given once; the latter will be administere twice over a six month period.

Cross-Sectional Component.

For the cross-sectional component all adolescents living in the families of our target population will be administered the instruments described under the longitudin cross-sectional overlap section by Dr. Jerome in year 02-05. In addition, all adolescents and adults living in the families of our target population will receive the following battery of three instruments. In the cross-sectional investigation each individual will be assessed once on each instrument.

Measurement.

The society and the local community must be considered the best judge of the qual ties adjudged to fall within the realm of social competency. To this end, the emic-etic approaches utilized in anthropological studies will be pursued in the field to further develop and refine the social competency categories. Cultural variations wi be taken into account in developing, refining and validating the instruments and in pretesting them for reliability. This strategy will ensure the inclusion of a wide range of appropriate categories and dimensions. A review of the literature indicate that the following categories and dimensions seem appropriate:

Social Competency Categories	Dimensions
1. Self (personal characteristics)	Ego strength; risk taking; flexibility time perspective; self-direction; self-management;

Social Competency Categories	Dimensions
1. Self (personal characteristics) (cont'd)	independence; cooperation; self esteem; trust; optim
2. Self (personal skills)	Role performance; food procurement; food preparation; food distribution; waste disposal; household manager; perception of health
3. Child rearing and parenting	Role performance; perception of child (health; attention to child(ren's) health; participation in child(ren's) academic education; participation in child(ren's) religious education supervision and participation in child(ren's) social life; participation and/or supervision of children's recreational activities; standards of nutrition
4. Family/household relations	Role performance; relationship with children and other household members; sharing
5. Extended family	Role performance; relationship with own parents, sibling, relatives and in-law, sharing
6. Social functioning	Social role performance; friendship patterns and support; sharing; involvement in community life; use of community resources
7. Family provider	Role performance; thrift; household management; time perspective; multiple occupations or sources of support

A second instrument will be designed to assess the individual's perception of his/her environment, social situation and coping styles. Subjects will be asked to judge the appropriateness of different behaviors in different kinds of situations modified for the Egyptian setting by Dr. Jerome during years 01 and 02. Subjects will list current life situations and will give three descriptions and ratings of them. Through factor analysis, situations will be grouped toward which individuals show similar patterns of feelings and behavior. Four possible social-situational categories have been selected for use in this instrument -- microsystem, mesosystem, macrosystem, and exosystem. These four systems focus on the progressive accomodation and changing relation between the individual and the changing environments in which one lives and develops throughout the life span. Again pilot work will be done to insure the validity of situations used for the Egyptian population.

Environment and Social Situation Categories	Dimensions (examples)
1. Microsystem - the complex of relations between the person and environment in an immediate setting containing that person.	Daughter-parent at home, in kitchen, in backyard engaged in an activity
2. Mesosystem - the interrelations among major settings containing the person at a particular point in his or her life.	Interactions among family, school, workplace
3. Exosystem - an extension of the mesosystem embracing other specific social structures that do not themselves contain the person but impinge upon and directly affect the person.	Neighborhood, government agencies, mass media, transportation facilities
4. Macrosystem - the overarching institutional	Ideology, custom, norms

4. Macrosystem -(cont'd)
patterns of the culture or subculture such as economic, social, educational, legal, and political systems, of which micro-, meso-, and exosystems are the concrete manifestations.

A third instrument, an adaptation of Holmes and Rahe's Schedule of Recent Events tool (1967) will be pretested and then administered to the female household head in order to tap the significant life events which might have triggered major or minor adjustments on the individual's part. Life change assessments are a promising approach to the understanding of competencies, especially since coping styles would have been assessed in the other instruments described above.

Methodologically, the three instruments to be developed to assess social competence will require a mix of qualitative ethnographic research and vigorous quantitative measurements during the first year of field work. These methods and procedures would ensure that the salient points of the culture are tapped appropriately and measured objectively.

APPENDIX I

Purdue's International Programs and the Administering Center

Purdue University has demonstrated a commitment to participation in AID's development assistance programs for more than 20 years. A Purdue University Task Force has examined carefully the potential role of the Complex under Title XII and recommend that:

> "[Purdue University] commit itself to aggressively seek opportunities to expand its involvement in efforts to resolve problems of hunger and poverty in the world; that the expanded program be a coordinated effort combining country development activities, on-campus research efforts and outreach activities."

The Task Force further recommends in its report that tenured faculty positions be expanded as appropriate to serve Title XII demands, and that a number of personnel management and policy changes be made to strengthen the international component of Purdue's program. Purdue places high priority on long-term institutional projects, particularly with institutions conducting research, teaching, extension, or some combination of these functions. Purdue has a long and productive history of involvement in programs which assist in the development of technology and of institutions which will provide the poor countries of the world with the indigenous capacity to develop modern technology appropriate to their needs and conditions. This commitment of both faculty and administration to a high quality international involvement is complementary to and an integral part of the overall mission of the University.

International Experience. Purdue's historical involvement in international programs has focused on (A) development of indigenous institutions, (B) international research programs, (C) training programs, and (D) consultancies. Purdue's experience in parts (B) and (C) are most relevant to our proposal and are outlined very briefly below:

International Research Programs. Purdue's international research program has been designed to speed the development process and improve conditions existing in the less developed world, and to provide new and appropriate technology. Selected examples of research are:

1. Agronomic research aimed at the development of varieties of maize and grain sorghum with superior nutritional characteristics and desirable agronomic and utilization characteristics.
2. Efforts to better understand the nature of low income among small farmers in Brazil and the potential role of technology transfer in improving conditions for this significant group of people.
3. Efforts to provide a better understanding of socio-economic constraints to the production of traditional food grains in Sahelian Africa and an economic analysis of small scale irrigation systems in that critical part of the world.
4. Focus on interdisciplinary nature of problems associated with the production and marketing of ruminant livestock in tropical, less developed countries.
5. Efforts to better understand the nature of international trade.

Training Programs. Purdue has a distinguished history of providing trained people for the developing countries of the world through its graduate and undergraduate training programs. Currently, more than 1100 international students are enrolled at the University. These students come from more than 88 institutions of higher education, research, extension or agricultural policy within their home government. The graduate training received can have a very significant long-term impact on the development process. Purdue also provides training program management and administrative services for less developed country institutions, including academic and other counseling services tailored to the needs of their students and staff.

Current Institutional Capabilities. Purdue's current capacity for involvement in international programs derives both from the strength of its domestic research, teaching and

extension programs, and from its past experience in international activity. The Agricultural Complex (Experiment Station, Cooperative Extension Services components, Schools of Consumer and Family Sciences, and Veterinary Medicine) at Purdue University is one of the strongest and largest in the United States. Its faculty is broad in terms of training, interest and experience. The large size of the faculty provides considerable depth and a critical mass of scientific expertise in many disciplinary and problem areas. Existing faculty, and their research, extension and teaching programs, constitute a tremendous potential capacity for contributing to the development of the less developed countries of the world.

Many departments, including Biology, Geosciences, History, Political Science, Psychology, and Sociology and Anthropology, have faculty resources with considerable potential for contributing to Title XII activities of the University.

Well-established University administrative organizations support international programs. The Office of International Education and Research is responsible for coordination and stimulation of the international dimension of programs at the university level. This office assists the faculty in securing resources to support international activities, assists in the development of faculty exchange opportunities, coordinates study abroad programs in several countries, administers overseas projects, publishes an international newsletter and has a cooperative program with the Peace Corps to recruit technically trained volunteers. It is this office that will coordinate the various interdisciplinary departmental teams involved in this project. It will serve in an administrative support role in expediting travel, purchasing, fiscal arrangements, contracts with individuals and organizations. It will assist in communicating on a day-to-day basis those policies and procedures, fiscal and academic unique to Purdue with Washington AID officials and with officials of collaborating institutions in Egypt.

APPENDIX II
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APPENDIX III

COMPUTER AND DATA PROCESSING FACILITIES AT PURDUE

The Purdue University Computing Center (PUCC) provides computing services in support of instruction and research to faculty, students and staff. The computing systems and most Computing Center staff offices are in the Mathematical Sciences Building. Two major remote Computing Center sites are located in the Engineering Administration Building (ENAD) and Stewart Center with facilities for job preparation, job submission, job retrieval and tape exchange. These sites contain a large number of public terminals attached to Computing Center systems. A smaller public remote site is in the Krannert Building. Other remote sites and terminals are in various schools and departments.

The major computing system operated by the center uses one Control Data Corporation (CDC) 6600 computer with $131,072_{10}$ ($400,000_8$) 60-bit words of central memory, two CDC 6500 computers each with $131,072_{10}$ ($400,000_8$) 60-bit words of central memory, two central processing units, 10 peripheral processors and 12 high speed input-output channels. These units share access to $512,000_{10}$ ($1,750,000_8$) words of extended core storage and to more than a billion characters of fast disk storage. Magnetic tape drives and other input-output and peripheral devices can also be accessed. Word processing and plotting is accomplished through the VERSATEC printer and CALCOMP plotting devices with full software support.

The Computing Center supports interactive computing (time sharing) and remote job entry through PROCSY 2.0 (Purdue Remote On-Line Console System). PROCSY 2.0 uses three MODCOMP II Communications Processors as front-end computers to provide an interface between the main CDC system and a large number of remote terminal stations.

The Computing Center also has a large Digital Equipment Corporation (DEC) PDP-11/70 time sharing system to provide interactive computing support for instruction and research. The PDP-11/70 also operates as a network of remote stations attached to the CDC system through a MODCOMP front-end computer.

The Computing Center recently acquired a DEC VAX 11/780 providing instruction and research computing support on an interactive basis. Much of this facility is reserved for the Computer Science department and graduate instruction.

The Computing Center actively supports numerous programming languages such as FORTRAN, PASCAL, COBOL, BASIC, BASIC-PLUS, APL, COMPASS, SNOBOL, LISP, GASP, and ALGOL. Six specialized compilers for the FORTRAN language alone are maintained.

For data analysis, the Computing Center maintains several libraries and statistical packages. These include SPSS (Statistical Package for the Social Sciences, University of Chicago), BMD (BioMeDical) and BMDP (BioMeDical p-series) UCLA, SOUPAC (Statistically Oriented Utility Package, University of Illinois), IMSL (International Mathematical Statistical Library), DTSS (Dartmouth Time Sharing System), Project DELTA and the

PDP MINITAB. EDLIB, and STATLIB are maintained by Purdue staff members.

Statistical consultants for both design and user programming are available. Design service is offered jointly through PUCC and the Department of Statistics.

PUCC also has a user services department which provides and maintains user programs, user education, general and statistical consulting, and disseminates information concerning the Center's activities. In addition, the User Services Department provides over 400 documents at no cost to the user covering virtually every common topic of Computing Center use and program preparation.

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IN REPLY REFER TO:
NAMRU-3-07-MMM-dk
3900
29 March 1979

Professor Ron Watson, Chairman
Task Force on Foods and Nutrition
Title XII Project
Department of Foods and Nutrition
Purdue University
West Lafayette, IN 47907.

Dear Professor Watson:

Through a discussion with Dr. Philip Loverde, I have learned of your University's application for a title XII grant to do research on the phenomena of marginal undernutrition to be centered in Egypt. I would like to take this opportunity to tell you that we, here in NAMRU-3, have been particularly interested in this problem especially as regards the interaction of malnutrtion and immunity during infection. The idea of your coming to Egypt to do collaborative research along these lines is excellent and should prove to be very fruitful to all parties concerned. We will be happy to collaborate technically and scientifically as a team with counterparts from your university. The facilities and expertise of our laboratory that have been developed throughout several years of working on this problem will be utilized in every way possible to assist in attaining the goals of this project.

Best of luck and we look forward for a fruitful collaborative research in the near future.

Sincerely yours

MOUSTAFA M. MANSOUR, Ph.D.
Head, Biochemistry Department.

Professor Ron Watson, Chairman
Task Force on Foods and Nutrition
Title XII Project
Department of Foods and Nutrition
Purdue University
West Lafayette, IN 47907

The American University
Department of Physical Sciences
Cairo
Egypt.

Dear Professor Watson,

It is our understanding that your university is making appliction for a Title XII grant to do research on the phenomenon of mild to moderate energy restriction, with that research being centered in the Egyptian nation. We would like to take this opportunity to endorse this proposed Purdue project and ivite you to come to Egypt to pursue this research, which we consider to be of significance. We will be happy to collaborate technically and scientifically as a team with counterparts from your university. Rest assured that our research facilities and our faculty will assist in every way possible, upon your request, in attaining the goals of your project.

I suggest the following topics which might help in the early detection and prevent of the development of malnutrition in Egypt:

1) Study of some biochemical indices of :-
   a) Pregnant and nursing mothers (in families where malnutrition is common).
   b) Mothers milk and its effect on the growth and development of their off springs.

2) Study of the Anthropometric measurements and some biochemical indices of marginal undernourished children and infants.

Yours truly

Daisy Fleita

Dr. Daisy Fleita

Dr. M. A. Rifaat
M. B. B. Ch. ((Cairo) D.T.M. & H. (Eng and)
Ph. D. (London)
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دكتور محمد على رفعت
أستاذ الطفيليات ورئيس قسم الميكروبيولوجى
كلية طب جامعة عين شمس - العباسية - القاهرة
جمهورية مصر العربية
تليفون رقم ٨٢١٥١١ ، ٨٢١٨٩٤

DR. S. M. Gaafar
Professor of Parasitology
Department of Veterinary Microbiology
Pathology And Public Health
Purdue University
School of Veterinary Medicine

Cairo, 1/4/1979.

Dear Dr. Gaafer

I thank you for your letter concerning cooperation in a project on parasitic diseases.

I contacted my collegues Prof. Dr. Aly Masoud Prof, of Public Health and Community Medicine and Prof. Farid El Asmar Prof. of Biochemistry at our Faculty and a number of our Staff who expressed willingness to cooperate in the subject proposed.

Please accept my best wishes and sincerest regards.

Yours Sincerely

Prof. Dr. M. A. Rifaat

APPENDIX V

Laboratory and Equipment for Nutrition Research in Egypt

Dr. Hekmat, Chief of the Nutrition Institute of Egypt, has offered to provide as part of her institute's collaboration in the project, laboratory space for the necessary biochemical and nutritional status assays. This will involve two rooms in her institute of about 1200 sq. ft. of space. They are equipped with some basic items of routine use which will be supplemented by the equipment described in the attached budget. During the initial few months of the study (until appropriate transportation can be purchased). Dr. Hekmat suggested that 1 or 2 of her institute's vehicles be used for the pilot stages of the field study on a leased basis. As her institute has a field station and laboratory near the proposed study site (50-55 miles north of Cairo), a portion of the building will be used for sample storage and initial processing (centrifugation, etc.).

Dr. E.M. Ekladious, Department of Bacteriology, Faculty of Medicine, Cairo University has facilitated an equipped laboratory for the project primarily for immunology and microbiology measurements. It is located on Kasr El-Eini St. near Ein Shams University Hospital and the Pediatric Hospital. It is a converted apartment with 4 rooms, a hall, 2 bathrooms and a veranda (900 sq. ft.). The equipment in the lab includes the following: gas chromatograph, spectrophotometer, two microscopes, two incubators (dry), photometer calorimeter and transformer, two centrifuges, electrophoresis system, three balances, electric balance, micro haematocentrifuge, flame photometer (Zeiss), pH meter, water distiller, blender, hot plate, two magnetic stirrers, deep freeze, oven, two refrigerators, water bottles, compressor for air, dessicator. Additional facilities and faculty support are available courtesy of our senior Egyptian collaborators:

1. Dr. A.A.E. Massoud, Chairman, Dept. Public Health and Industrial Medicine, Faculty of Medicine, Ain Shams University, Cairo.
2. Hekmat Aly, M.D., Chief, Nutrition Institute, Cairo, Egypt.
3. D.H. Fleita, Chairman, Dept. Materials Engineering and Physical Sciences, The American University of Cairo.
4. M.A. Rifaat, Vice Dean for Postgraduate Studies and Research, Chairman, Dept. Microbiology, Ain Shams Medical School.
5. E.M. Ekladious, Dept. Bacteriology, Faculty of Medicine, Cairo University.
6. I. Nawar, Chairman, Dept. of Nutrition, Alexandria University
7. S.R. Morcos, Head, Dept. Nutrition and Food Science, National Research Center, Cairo.

Only for the senior Egyptian co-investigators have biographical sketches been attached.

Since the Egyptian rural health officers (M.D., and D.P.S.) will need to be involved in the actual village field studies, we will invite their participation before the grant begins. In Egypt each group of villages has these health officers attached and their vital participation will be obtained by Dr. Hekmat as she has done with recent nutrition surveys and studies in Egypt.

Project Direction and Administration. The Office of International Education and Research will provide fiscal and administrative support and oversight to this program in order to facilitate coordinating among participating administrative units of Purdue University and between Purdue University and the Agency for International Development, and governments and institutions of foreign countries in which the research will be conducted. After year 01 each participant will prepare a short progress report, plan of research for the succeeding year and budget request. Then Dr. Watson (principal investigator) will meet with Dr. Harrison (Food Intake - Univ. of Arizona), Dr. Hekmat and Gabr (Center's Research Directors in Egypt), Dr. McMurray (Disease and Immunology at Texas A&M), Dr. Ismail (Work Capacity at Purdue), University's Title XII officer or his representative, Dr. Wachs (Cognitive Development at Purdue), and Dr. Jerome (Social Competence) to set goals, evaluate research, and generally fine-tune the ongoing or new research. (If one of the committee cannot attend, written comments will be sent prior to the meeting). We will try to program this 2-day planning session to occur at the annual AIN meeting, National Pediatric meeting, etc. or in conjunction with a similar meeting for the education of the Egyptian team members as well as to enhance data dissemination. This meeting will, of course, have to fit the date and time constraints placed upon reports and budget by AID and the grant's initiation date. Dr. Watson, having the responsibility for the overall scientific direction of the project, will make the final decisions on the budget with concurrence of the majority of the above research participants, will direct daily administrative and budgeting portions of the Center's activities. However the multidisciplinary nature will require regular input as described above by a key U.S. and Egyptian participant in a variety of areas. Both the multidisciplinary and binational natures of the project will be emphasized. Dr. William J. Darby (President of the Nutrition Foundation and author of "The State of Nutriton in the Arab Middle East"(1) has agreed to be the non-study consultant and advisor. His extensive nutrition experience in Egypt will be used either by a yearly review in writing of the program and at the planning session.

APPENDIX VII Human Investigations Approval for Study Protocol

Purdue University
Committee on the Use of Human Subjects
HS-7 (3-21-79) DSP/HOVDE

COMMITTEE ACTION [illegible] TO THE USE OF HUMAN SUBJECTS

1. Activity or Project Title: Egyptian Setting

2. Identifying Number:

3. Funding Agency:

4. Responsible Individual: Ron Watson/R. Smith

5. Committee Action: General Approval

The Responsible Individual identified above has been granted approval to use human subjects in the above-titled activity following the procedures stated in the application, with the following stipulation(s):

General approval is given for this program of studies. It is understood that if this proposal is funded, each specific study must be approved as the details of the study are available and prior to any data collection for each study.

It is understood that this approval applies for this project only and only under the conditions and procedures described in the application. Any changes in the protocol or conditions set forth in the application will require separate approval. This approval will be followed by surveillance procedures which will require periodic review of the project by consultation with the Responsible Individual and the examination of the appropriate records of the activity. It is further understood that individual identification of human subjects in any publication is an "invasion of privacy" and requires a separate executed "informed consent."

Prior to initiation of activities involving human subjects, unless specifically exempted, properly executed informed consent must be obtained from each subject and/or the person legally responsible for him and such forms retained on file by the Responsible Individual for a minimum of three years after termination of the project. Copies of signed informed consent for high risk projects must be filed with the Committee if checked here. ☐

Additional information and advice on matters relating to the use of human subjects may be obtained from individual members of the Committee or by calling the Associate Provost Office, 749-2224.

D.R. Brown, Committee Chairman
Associate Provost Office

Date: April 9, 1979

TITLE XII NUTRITION (Tentative budget - 22 Jan 1980)

Purdue Portion	Person Months	Year 1 1/1/80-12/31/80 AID Funding	Year 1 1/1/80-12/31/80 Purdue Support	Year 2 1/1/81-12/31/81 AID Funding	Year 2 1/1/81-12/31/81 Purdue Support
A. Senior Personnel					
1. P.I./P.D., R. Watson	6	$14,950		$16,202	
2. Co P.I./P.D., A. H. Ismail	2.4	8,200		4,390	$ 4,390
3. A. Kirksey	1	3,270		3,500	
4. T. Wachs	2.4	6,616		7,076	
SUBTOTAL		33,036		31,168	4,390
B. Faculty and Other Senior Assoc.					
1. Assistant Project Coordinator	6/12	9,300		20,000	
2. V. Anderson	.6		$ 1,911		$ 2,046
3. G. McCabe	2.4		5,542		5,932
4. L. Weaver	.6		778		833
5. D. R. Smith	1.2		3,655		4,045
6. P. Loverde	1.2	2,330		2,495	
7. S. M. Gaafar	.6		1,895		2,028
8. D. Woodruff	.6 (Year 2)				1,482
9. H. S. Ragheb	.6 (Year 2)				1,246
10. J. Knight	1.2	1,320	1,320	1,413	1,413
11. G. Salvendy	.6		2,184		2,339
12. V. Liu	2.4	4,860		5,200	
13. D. Morre	2.4		4,660		4,986
14. R. Maher	2.4		4,176		4,466
15. R. Abernathy	.6		2,090		2,235
16. J. Story	1.2 (Year 2)				3,320
17. D. Ottinger	1.2	2,428	2,428	2,598	2,598
18. A. Fogel	1.2	1,248	1,248	1,335	1,335
19. M. Fristoe	1.2	1,495	1,495	1,600	1,600
20. L. Lloyd	1.2		3,850		4,120
21. C. Whittemore	1.2		1,885		2,020
22. B. Cooper	1.2		3,053		3,268
23. J. Waddell	.6		1,697		1,817
SUBTOTAL		22,981	43,864	34,641	53,129

Purdue Portion	Person Months	Year 1 1/1/80-12/31/80 AID Funding	Year 1 Purdue Support	Year 2 1/1/81-12/31/81 AID Funding	Year 2 Purdue Support
C. Other Personnel					
1. (2) Postdoctoral Assoc. (Hoffer,Petro)	14.4	$13,215		$14,140	
2. (3) Graduate Students	21	15,000		15,210	
3. (1) Clerical	12	7,000		7,490	
4. (1) Technician	9.6	8,000		8,560	
TOTAL SALARIES & WAGES		99,232	43,864	111,209	57,519
D. Fringe Benefits		19,444	9,482	22,665	12,432
E. Materials and Supplies		25,750		29,100	
F. Domestic Travel		500		500	
G. Foreign Travel Year 1--16 Round Trips, Egypt Year 2--17 Round Trips, Egypt		38,400		50,600	
H. Computer Services		1,000		4,000	
I. All Other Direct Cost					
1. Subcontract with cooperating institution		2,400		12,400	
2. Overseas allowances				26,500	
J. TOTAL DIRECT COSTS		$186,726	$53,346	$256,974	$69,951
K. Indirect Costs					
1. Off Campus		4,139		8,900	
2. On Campus		62,593	30,529	63,481	40,033
L. TOTAL DIRECT & INDIRECT COSTS (Purdue)		$253,458	$83,875	$329,355	$109,986
M. TOTAL DIRECT & INDIRECT COSTS (Univ. of Arizona)		31,570	10,523	25,100	8,367
SUBTOTAL		$285,028	$94,398	$354,455	$118,353

PORTION OF PROJECT IN EGYPT	Year 1 AID Funding	Year 2 AID Funding
I. General Project Coordination and Operation		
A. Office space rental ($350/mo. x 10 months) Yr 2 - 12 months	$3500	$4200
B. Laboratory research space rental, 1,100 sq. ft. at ($500/mo. x 10 months) Yr 2 - 12 months	$5000	$6000
C. Apartment rental for Purdue staff ($1000/mo. x 6 months) Yr 2 - 12 months	$6000	$12000
D. Office personnel		
1. Project Director Dr. Gabr and/or Dr. Hekmat $400/mo. Yr. (1) - 6 months Yr. (2) - 12 months	2400	4800
2. Administrative Assistant $200/mo. Yr. (1) - 6 months Yr. (2) - 12 months	1200	2400
3. Office Secretary $200/mo. Yr. (1) - 6 months Yr. (2) - 12 months	1200	2400
Subtotal Office Personnel	$4800	$9600

	Year 1 AID Funding	Year 2 AID Funding
E. Office Equipment		
1. Four (4) desks	$1600	
2. Two (2) tables	500	
3. File Cabinets	300	200
4. Electric typewriter	900	
5. Manual typewriter		200
6. Copy machine		2500
7. Three (3) calculators	1200	
8. Power supply - generator	3000	
Subtotal Office Equipment	$7500	$2900
F. Office supplies	$6000	$7000
Subtotal I	$32,800	$41,700
II. Research Equipment		
A. Four (4) wheel drive van/vehicle one each year - equipped with:	$12,000	$13,000
1. air conditioner	500	500
2. small refrigerator	500	500
3. small freezer unit	500	500
4. power supply - generator	1000	1200
5. portable chairs/tables	600	600
6. modifying van for research usage	1000	1000
7. shipping costs	2000	2500
Subtotal van	$18,100	$19,800
B. Automobile for project use		$8000
C. Laboratory equipment		
1. power supply	2000	
2. refrigerators - Yr. (1) - 1	1000	2000
Yr. (2) - 2		
3. freezers - 1 per year	2500	2500
4. microscope	1800	

	Year 1 AID Funding	Year 2 AID Funding
B. continued		
5. incubator	1200	
6. heater/stirrer	150	
7. pH meter	700	
8. caliphers, scales etc. for nutr. assess.	1200	
9. M.A.C.H. unit	1400	
10. bench model centrifuge	400	
11. work-output equipment (see attachment 1 A)		17,055
12. cognitive/sensory equipment (see attachment 1 B)	4500	20,500
Subtotal lab equipment	$16,850	$42,055
C. Shipping costs for research equipment and automobile	4300	12,500
Subtotal research equipment	$39,250	$82,355
III. Research personnel		
A. Two grad assistants for data processing $100/mo. each - 6 mos. Yr. (1)	1200	2400
B. Drivers for van $100/mo. each - 2 in Yr. (2)	600	2400
C. Nurses - Yr. (1) - 2, Yr. (2) - 3 $200/mo. each	2400	7200
D. Three (3) lab technicians $200/mo. each	3600	7200
E. Two (2) post-doctoral students $150/mo. each (nutrition and cognitive-social Compt.areas)	1800	3600
F. Student assistants - Yr. (1) - 2, Yr. (2) - 5	500	2500

	Year 1 AID Funding	Year 2 AID Funding
III. continued		
G. Consulting physicians 40% on project	$4000	$8000
H. Consulting dentists 20% on project	1600	3200
I. Consulting psychologist 50% on project - Yr. (2)		8000
J. Consultants - Ph.D. level $1200 each	9600	19,200
K. Interviewers $1000/Yr. x 4	2000	4000
Subtotal Research Personnel	$27,300	$67,700
IV. Supplies and Expenses	$21,000	$50,000
V. Gas, maintenance, repair insurance on project vehicles	$7500	$25,000
VI. Travel to U.S. for Egyptian Research Personnel		
A. Air fares		
1. Six (6) in Yr. 1 Eight (8) in Yr. 2	$7200	$11,200
2. Per Diem 6 x 30 days x $60/d 8 x 30 days x $70/d	10,800	16,800
Subtotal Travel	$18,000	$28,000
VII. Total Project Costs in Egyp	$145,850	$294,755

TENTATIVE BUDGET
FOOD INTAKE - GROWTH MEASUREMENTS
UNIVERSITY OF ARIZONA

	YEAR 1		YEAR 2	
	AID	MATCH	AID	MATCH
I. Personnel				
G. Harrison 25% (senior personnel)	$ 5,000	2,500	$ 3,240	3,240
Grad. Assistant 100%	10,000		10,800	
Secretary 50%	2,000		2,160	
Investigators				
W. Stini 5%		2,000		
C. Weber 5%		1,878		
SUBTOTAL	$17,000	$6,378	$16,200	$5,070
II. Fringe Benefits	2,890	1,084	2,754	862
III. Other Direct Costs				
Statistical consultation	1,500		1,500	
Office S&E/comm.	1,000		1,000	
IV. Total Direct Costs	$22,390	$7,462	$21,454	$5,932
V. Indirect	$ 9,180	$3,061	$ 3,646	$2,435
VI. Grand Total	$31,570	$10,523	$25,100	$8,367

OVERALL NUTRITION PROJECT	AID Funding	Matching Support	AID Funding	Matching Support
I. On-campus/Purdue Portion	$253,458	$83,895	$329,355	$109,986
II. On-campus/Arizona Portion	31,570	10,523	25,100	8,387
III. Off campus/Egyptian Portion	145,850		294,155	
TOTAL*	$430,878	$94,398	$648,610	$118,353

*These are unofficial budgets to be used for informational purposes only.

TENTATIVE BUDGET FIGURES FOR YEARS 3-5

	Year 3		Year 4		Year 5		Years 3 - 5	
	AID	PURDUE	AID	PURDUE	AID	PURDUE	TOTAL AID	TOTAL PURDUE
1. On-Campus Support	480,600	160,200	514,200	171,400	550,200	183,400	$1545,000	$515,000
2. Off-Campus Egyptian Support	300,000		321,000		343,500		964,500	
3. Total	$780,600	$160,200	$835,200	$171,400	$893,700	$183,400	$2,509,500	$515,000

ATTACHMENT 1A

EQUIPMENT FOR WORK-OUTPUT PORTION OF PROJECT
Year 2

CAPITAL EQUIPMENT

Quantity	Description	Price
1	Model 16-50 Cardio-Exercise Treadmill; 1-7 MPH, 0-25°1 Electric Elevation; 115 Volt, single phase, 60 Hertz	$ 3,250.00
1	Model 621-B-1 Exercise ECG Monitoring System including Oscilloscope, ECG Recorder, and ECG Esolation and Amplifier System in one unit, single lead	3,165.00
1	Model 4666 Handrail Mounted Emergency off switch	65.00
1	Model 644 Automatic Program Control 115 Volts, 60 Hertz	1,385.00
2	Mode: 5211 Additional Program Card for Model 644 @ $145.00	290.00
		$ 8,155.00
1	Model #149148 LB-2 Medical Gas Analyzer (CO_2)	5,000.00
1	Model #47592 OM-11 OM-11 Oxygen Analyzer (O_2)	3,900.00
		$ 8,900.00

	$ 8,155.00
	8,900.00
Grand Total	$17,055.00

ATTACHMENT 1B

EQUIPMENT FOR COGNITIVE AND SENSORY CAPACITY

		Year 1	Year 2	Total
1.	Camera/Recorders One in Year (1) Three in Year (2)	1100	3300	4400
2.	Data mytes		6200	6200
3.	Troca unit and visual reinforcer	1650		1650
4.	Audiometer		6000	6000
5.	Calibration equipment		4000	4000
6.	Electro acoustical device		1000	1000
7.	Video-time generator	1750		1750
		$4500	$20500	$25000

Joint University of Arizona/University of Kansas budget

Due to the incomplete nature of the Purdue/Arizona/Kansas budget, the Planning Contractor calculated an addition to the Purdue submission which should allow the work to proceed in the Egyptian location as the merged project directed by the Steering Group. This budget is of necessity an estimate and needs to be negotiated as a first priority of the management institution.

The Purdue budget for the first three years is the largest of the three institutions. Purdue has special studies outside the probable core design which are adding significantly to the total cost in years 2 and 3. The expense of these studies may need to be reduced so that more thorough nutritional status/food intake and social competence studies could be undertaken which would be more comparable with the Connecticut and California proposals.

Table 1 is a summary of the Planning Contractor's estimate of the Arizona/Kansas budget. Correspondence from Watson, Harrison, and Jerome is attached concerning the Arizona and Knasas budgets.

TABLE 1

Tentative Budget

University of Arizona and University of Kansas

	Year One	Cost Sharing	Year Two	Cost Sharing
Personnel				
G. Harrison (25%)	5000	2500	3300	3300
Grad. Assistant (100%)	10000		10800	
Investigators				
W. Stini (5%/10%)		2000		4400
C. Weber (5%/0)		1878		
N. Jerome (25%)	7170	3585	7670	3835
R. Hassanein (25%)	2000	1000	2140	1070
Nutr Anthroplogist (75%)	12000		13200	
Secretary (50%)	6000		6600	
Clerk (50%)	2000		2200	
Programmer (0/50%)			6000	
Fringe (18%)	8000	2000	9300	2300
Office s/e, communications	2000		2200	
TOTAL DIRECT COSTS	54170	12963	63410	14905
Indirect Costs (approx.)	16830	4037	19590	5095
TOTAL	71000	17000	83000	20000

PURDUE UNIVERSITY DEPARTMENT OF FOODS AND NUTRITION

25 January 1980

Dr. Doris Calloway
Dept. of Nutritional Studies
Univ. of California
Berkeley, CA 94720

Dear Doris:

Enclosed are our suggested budget changes for the Egypt/Purdue project as part of the program with USAID on "Intake and Function". We have not changed the Egyptian portion of the budget, except as suggested by Dr. Harrison and Dr. Hekmat in California. These include post-doctoral fellows in Egypt for Anthropology and Nutrition work. The bottom line of the work done in Egypt was not changed. This means that people to do nutrition and social competence measurements will be under the direction of Dr. Harrison and Dr. Jerome and Dr. Wachs and were previously budgeted.

We did try to strengthen the U.S. portion of the grant as you requested. Since we reduced the input by several Purdue investigators on nutrition and, immunology and disease, we were able to reduce the Purdue request. Therefore this reduction was used for strengthening the grant and work in nutrition, food intake and growth by the people in Arizona. It was not possible to incorporate their efforts without expanding our overall request (see attached page). Dr. Harrison and I felt she needed even a little more support for research assistance in Arizona, which I did not ask for, so that our overall request was not greatly increased (as you requested in December 1979).

I have not received enough information from Dr. Jerome (no costsharing, overhead) to send in strengthening requests for increasing effort in social competence. We designed the work in this area. I feel for year 01 it should not exceed $8,500 and in year 02, $16,000. When I get the necessary facts I will get them to you, hopefully in time. I was not allowed to put on this estimated need onto our request, but this letter makes you aware of it.

I rearranged Purdue's budget so that foreign travel is set aside for food intake-social competence people. I increased our domestic travel for

West Lafayette, Indiana 47907

correlation. I also added some funds for a U.S. scientist like Dr. Wood for year 01 in Egypt. It has been very difficult to keep a modest request with many people in it to only a modest increase in budget for strengthening.

Sincerely,

Ron Watson

Ronald R. Watson, Ph.D.
Associate Professor of
Nutrition & Immunology

RRW:cm

Enclosure

PURDUE UNIVERSITY DEPARTMENT OF FOODS AND NUTRITION

January 10, 1980

Dr. Gail Harrison
Dept. of Family & Community Medicine
The University of Arizona
Tucson, AZ 85724

Dear Gail:

I received your materials and will finish editing them. Then I will type them. I will call if there appears to be any major area which needs discussion at this point. As soon as Ted Wachs finishes writing the social competence in youth and adults from Norge's material, I will send her a copy for similar review (hopefully early next week). I looked over your budget and it is "bare-bones". The whole grant is that! I am trying to keep the budget supplement for the added expertise in level with what might be acceptable to Dr. Calloway for presentation to USAID and still moderately reflect your needs. Some of the funds you requested can come from cutting back Purdue's efforts in nutrition in the project (elimination of Dr. Abernathy's participation and reduction of Dr. Kirksey's with concommittant salary decreases). Dr. Kirksey would not direct the food intake portion, but you would. There is very little of this that I can do and still maintain our effort.

As we discussed in California, we are doing as much as possible via training Egyptians in Egypt and conducting assays, data analysis, etc. there. Thus, the research associate in nutrition (M.D. or Ph.D.) you requested, should work in Cairo not Arizona. This person would work closely with you and Dr. Hekmat on the diet intake-growth data. This can be readily done with you, Dr. Hekmat and Dr. Jerome interacting and training him/her. Last month in California, you indicated that your salary, a part-time technician and a full-time graduate research assistant would be needed in Tucson. I agreed to that as possible to get out of our current budget. However, adding a research associate now in the USA would raise the budgetary supplement too much (raise by $27,000) and make it more difficult to get funds for Dr. Jerome's social competence work via a supplementary request. You will see that there are 14 man months of total post-doctoral effort in the US, primarily for some biochemical and nutritional assays which appear initially very difficult to do in Cairo. That was to cost about $14,000-15,000/year with post-doctoral level overhead and it needs to stay in the budget. I have heard nothing from Dr. Hopkins, so I will call him tomorrow about the pilot mineral assays. I am looking forward to a good collaboration.

Sincerely,

Ron

Ronald R. Watson, Ph.D.
Associate Professor of Immunology
and Nutrition

West Lafayette, Indiana 47907
(317) 494-8647

cc: Dr. Smith
Dr. Calloway
Dr. Abernathy
Azza Sallem

P.S. Azza Sallem, is an Anthropology student who you will [illegible] she will [illegible] returning to Cairo. She has helped on the [illegible] to [illegible] her PhD here. She [illegible] and wants to work [illegible]

THE UNIVERSITY OF ARIZONA
HEALTH SCIENCES CENTER
TUCSON, ARIZONA 85724

COLLEGE OF MEDICINE
DEPARTMENT OF FAMILY AND COMMUNITY MEDICINE (602) 882-6244

January 7, 1980

Ronald Watson
Dept. of Food and Nutrition
Purdue University
West Lafayette, Indiana 47907

Dear Ron,

Please excuse the poor typing and hand scrawls on the enclosed; it has been done at home, in the interests of time, and I won't take time for retyping.

I have essentially cut and pasted, adding parts of our proposal into yours and removing where possible references to particular individuals in Egypt or elsewhere. I hope it makes sense. I have not duplicated what Norge sent you, but rather just noted where it should be.

The face sheet should list as investigators you, me, Norge, and Dr. Gabr. Other investigators, (Hassanein at Kansas, Stini and Weber at Arizona, Hekmat and your Purdue people) should,I think,be listed on a separate sheet,if necessary.

The budget I enclose is informal, as we discussed. It is really bare bones, if Arizona is to assume responsibility for the aspects we discussed (careful growth data as part of reproductive, disease and nutritional status sections, and analysis of same; integration of dietary with other data; and selected aspects of the disease and n ritional status aspects). I have shown cost-sharing, which comes out to slightly more than the required 1/4. I have not included funds for travel, other than to specify an estimate of need. Nor have I estimated indirect costs. The University of Arizona usually gets 43% for on-campus functions from government agencies, for everything except capital expenditures. The list of field equipment enclosed is of course for the Egyptian side, but includes some items not in your original budget which I thought you might not think of.

Please note, I have not included any of the Texas Tech work, with Dr. Hopkins. His request was minimal, essentially for some laboratory equipment and technician salary; my assumption is that Dr. Liu and Dr. Hopkins are working out this aspect together and you can incorporate it better directly with Dr. Liu than with me acting as intermediary.

I have also not made any effort to incorporate Norge's budget, since you have it separately.

Also, regarding budget, I want to reiterate my conviction that a full-time or almost full-time statistician with epidemiologic experience is essential to the project. This ideally should be someone either in Cairo or at Purdue; please do find a way to budget for it. One way to handle it would be to centralize data processing at Kansas, with Ms. Hassanein responsible

under Norge's direction; she is certainly qualified and it might be worth exploring by phone with Norge.

There are gaps in what's here, re: the proposal of course, based on not having the materials from the Berkeley meeting.

Call me if you need to as it goes along. I'll be in town all along the next few weeks. Home number is 602-326-3190.

All the best,

Gail G. Harrison, Ph.D.
Assistant Professor
Department of Family & Community Medicine
and Pediatrics

GGH:kag

cc: Norge Jerome
Doris Calloway

Minimal Budget
University of Arizona
Year 01

Personnel		from AID	Cost-sharing
Co-Investigator (G. Harrison)	25% time	$ 5000	2500
Research Associate (PhD or MD)	100% time	22000	
Research Assistant	50% time	5000	
Secretary	50% time	2000	2000
Investigator (W. Stini)	5% time		2000
Investigator (C. Weber)	5% time		2000
		$34,000	$500
Fringe benefits @ 17%		5780	1445
SUBTOTAL PERSONNEL		39,780	9945
Statistical consultation and computer services		1500	500
Office supplies, postage, xerox, telephone, telegraph		1000	300
GRAND TOTAL		42,280	10,745

Travel: Please plan two round trips to Egyptian field site in the first year, and three domestic planning meetings for Watson, Jerome & Harrison (at Purdue, Arizona or Kansas).

Year 02

Drop G. Harrison time to 20%
Increase W.Stini time to 10%
Increase all personnel salaries & wages by 8%
Plan two trips to Egyptian field site and two domestic planning meetings

Year 03

Increase all personnel by 8%
Increase statistical consultation & services to $2000 from AID and $1000 cost-share
Plan one trip to Egyptian field site and two domestic planning meetings

ANTHROPOMETRIC EQUIPMENT NEEDED

Scales - 3 portable beam balances @ $400 =	$1200
3 pediatric scales @ $300	900
Skinfold calipers - 5 @ $140	700
Fiberglass tapes - 10 @ $10	100
Infant measuring boards (5 to be made for project @ $50)	250

EQUIPMENT FOR FOOD INTAKE STUDIES

Dietetic scales - 20 @ $30	600
Standard weights and measures	400

OTHER FIELD EQUIPMENT NEEDED

Clipboards, notebooks, pens, misc. toys, balloons, etc.

PURDUE UNIVERSITY DEPARTMENT OF FOODS AND NUTRITION

January 10, 1980

Dr. Norge Jerome
Dept. Community Health
University Kansas Medical Center
Rainbow Blvd. at 39th
Kansas City, KS 66103

Dear Norge:

Let me reconfirm what Dr. Smith (for Purdue), Dr. Wachs (for the Cognitive-Social Competence people) and I said in our hour long phone conversation Monday. We have a strong interest and hope that you will develop tests for the Egyptian setting as well as study youth and adult social competence, and the interaction of diet with it. Dr. Wachs, as agreed, is writing up that portion of the application to send to Dr. Calloway. He is using the materials that you sent to me plus his own ideas as the revised grant is due by January 15, 1980 to Dr. Calloway. Gail Harrison told me yesterday that she had sent her suggestions already which I expect to receive later this week.

I am glad that you appreciate that this sort of a grant and undertaking requires some sacrifice and a concerted effort at communication and team effort. Nevertheless, there can be only one chief (principal investigator) and I will continue to function in that capacity. As described in the first application we will meet once a year (preferably at a national meeting to cut travel costs) to evaluate progress and revise funding and goals (internally). As described in the first Purdue application this group will involve each section chief and several Egyptian co-investigators. Where necessary this internal revision will be done by mail when someone cannot attend. Hence you would be involved in our ongoing research and budget efforts as the section chief for the Social Competence research.

The mandate from the reviewers was to strengthen the Purdue proposal in several areas. The option of choice was to take interested people from the Kansas/Arizona proposal although we could go elsewhere at Purdue and other campuses for the needed expertise. I have asked Gail to take over the US input into the nutrition studies relating to food intake. To budget Gail's salary it meant that Dr. Kirksey reduced her effort and Dr. Abernathy withdrew his effort, salary support and most of Dr. Kirksey's salary. Gail's time and expertise will involve working with Dr. Hekmat who must closely supervise and do most of the nutrition field work. Gail will surely be very important in seeing that the best techniques are used dealing with diet history problems (beyond what can be done

West Lafayette, Indiana 47907

in Egypt) and quality control. Our emphasis is to do the majority of the work, training, etc. in Egypt (both from a cost point of view and from the development aspects for local Egyptian scientists). I will be writing her to say that the Egyptian budget will be increased to have an Egyptian Ph.D. or M.D. research associate work with her full-time. She may need to then increase her US technician's effort some; but we must do as much as possible in Egypt where our expertise will benefit the local nutritionists.

This is the philosophy of Dr. Wachs and the seven senior US scientists that are working with him on the Cognitive Development measures and studies. The first year they will spend about 16 months of effort on the project, modifying assays, interactions interacting with Egyptian colleagues and beginning pilot studies done in Egypt by Egyptians. Thus their US expenses are four trips to Egypt, about $15,000.00 in salary support by US AID (Primarily summer salary for people with nine month appointments) and $19,000.00 of effort by them paid from Purdue University funds. The US portion is similar in year 02 with about a 150% increase in the Egyptian efforts. Dr. Calloway in California last month strongly suggested that if any project raised its budget significantly it would make it difficult for her to present in February, even realizing the changes wrought by OPEC on travel and inflation on salaries. You may not have been fully aware of these sort of realities and philosophies when you wrote on 28 December 1979. I now need your help in bringing your needs for Social Competence research in line with the philosophy of our plan and the budget realities. For example, the second year budget for salaries of about $66,000 for Kansas people you suggested with an overhead like Purdue's of 65% translates into more than $100,000. It would have to be taken from other portions of the grant or requested as a budget supplement. Elimination of Dr. Wachs and company, for example, would provide only about $28,000 of that amount and would greviously weaken the grant, especially as the Work Output studies and the Disease-Immunology ones would have to be removed also. Well, I think that you see the problem. Please help us to involve your expertise and strengthen the grant in a fundable fashion. We need to emphasize training and work by Egyptian colleagues; that is the main object of the effort.

The Connecticut and California projects envision the major efforts in Social Competence to occur in the middle and end of the research five years. This would mean that you would need to go to Egypt and need to spend a month or so of your time on the project, develop an initial pilot study. Then in year two see if the tests can be modified for the Egyptian environment working with an Egyptian psychologist or anthropologist supported by grant in Egypt who would do much of the work and benefit from your expertise. In year two this effort would probably have to double. In subsequent years it would further increase where it is easier to ask for supplements and revise our budgets based upon the experience of the first and second year.

I would think that we need to have a pretty sizeable item for phone calls and incidental office expenses for you and Gail. Trips to Purdue could be made as you go or return from Egypt. (There is only one domestic trip budgeted in the grant per year.) To change that, I will add to the supplemental portion of the request for two US trips for you and and Gail to Purdue, but I won't reduce

trips to Egypt for work for that purpose. We are going to get extra help here for data analysis, as the majority of US personnel would have a more ready access to the statisticians. As much as possible will be done in Egypt, particularly in year 02 there are eight technicians (interviewers), several psychological consultants (Ph.D.) and an anthropologist in Egypt, computer facilities, transportation, etc. budgeted for already to work on Cognitive and Social Competence parts of the grant.

I recognize the difficulties of adding to an existing program and appreciate your coming to Purdue this fall and your other efforts. Look over your budget again. Please include cost-sharing amounts (25% of total), what effort on the project will be by the University of Kansas. Also include in the figures your university's current overhead. Please recognize that Purdue as well as the California and Connecticut proposals discussed Social Competence, but none gave it the importance of Cognitive Development, Disease, or Nutrition parts of the studies. Also the actual experimentation in Social Competence will be a final group decision where you will be representing the team with similar people from Mexico, California, Egypt, etc. I would suggest, therefore, that your budget for year 02 be less than that of the eight professional people at Purdue and the one at the University of South Dakota in the Cognitive Development part of the program. The total funds (excluding those spent in Egypt and travel) for the Cognitive part are about $21,000 including overhead. Call as well as send me as soon as possible your suggestions for this budget breakdown so I can figure how to reduce other programs and expenses in the USA without drastically weakening the program. Please continue to help us make the team work and function.

I appreciate your position and want to make it a good and scientifically useful collaboration. I have had a very similar experience in Colombia these past six years working on a Tulane University funded NIH project. It was very productive scientifically and I hope that this one can be even more so.

To summarize, we want and need your assistance on the project in the area of Social Competence. Please revise your budget to reflect this. We will urge Dr. Calloway to request a significant budget increment to assure and increase your involvement in the project in years 2-5.

Sincerely,

Ron R. Watson

Ronald R. Watson, Ph.D.
Associate Professor of Nutrition
and Immunology

cc: Dr. Smith
Dr. Calloway
Dr. Abernathy
Azza Sallem

P.S.- Ms. Azza Sallem has participated in the project development. She will get her Ph.D. in anthropology soon at Purdue. As she continues to be interested in doing research in Egypt when she returns, I expect she will write to you soon. I will be in Cairo I expect the first two weeks in February 1980. Can you detail the sort of scientist you would like to collaborate with there and I will visit the Social Science Institute to look for prospective candidates.

THE UNIVERSITY OF KANSAS MEDICAL CENTER
COLLEGE OF HEALTH SCIENCES AND HOSPITAL
RAINBOW BOULEVARD AT 39TH • KANSAS CITY, KANSAS 66103

SCHOOL OF MEDICINE
SCHOOL OF NURSING
SCHOOL OF ALLIED HEALTH
UNIVERSITY HOSPITAL

DEPARTMENT OF COMMUNITY HEALTH
(913) 588-~~3170~~ 7337

December 28, 1979

Dr. Ronald Watson
Director of Purdue/Arizona/Kansas/Egypt Project
Associate Professor Nutrition-Immunology
Purdue University
Lafayette, Indiana 47907

Dear Ron,

As suggested by Gail Harrison after the planning meeting in Berkley a few days ago, I am sending you the University of Kansas' contribution to the Purdue/Arizona/Kansas-Egypt project. My understanding of the conversation with Gail is that since I was not present at the Berkley meeting to meet face-to-face with you and with her to work out a strategy for integrating the strengths of the two proposals as Dr. Calloway had suggested, I should do the best that I can, working independently. As we had concluded earlier, this is the least desirable procedure for integrating two proposals but I'll give it a good shot.

In my July 17, 1979 letter to you, I had described the original division of labor in the development of the Arizona/Kansas-Caribbean project. This should be referred to again along with the Berkley report showing the relative strengths of the two proposals. Kansas will continue to accept responsibility for the areas in which it has demonstrated strength i.e. (1) dietary intake (2) design and data analysis (3) social competence (adults). Materials pertaining to these three areas are attached for inclusion in the integrative process. Naturally, these will be modified to accomodate the Egyptian site and resources.

I have also enclosed a budget for personnel and some materials. It does not include travel costs to and in Egypt, Purdue, Arizona and Berkley; please complete this item for me. However, I have indicated what I believe to be the minimum for accomplishing the objectives of the project. I am

Dr. Ronald Watson
Purdue University

sure that you would wish to confer with me by telephone on the budget for travel, overhead and other institutional commitments before submitting the proposal. I can be reached at the office (913-588-7357) during the day and at home (913-268-3838) at night.

My wishes for a productive 1980.

Sincerely,

Norge W. Jerome, Ph.D.
Professor

NWJ:mn

cc: Gail G. Harrison
Doris H. Calloway
Ruth S. Hassanein
Bernard Keele, Director, Research Administration,
University of Kansas

BUDGET - UNIVERSITY OF KANSAS

		YEAR 1
Senior Personnel		
Norge W. Jerome, Ph.D.	3 man months/year	$ 10,750.00
Ruth S. Hassanein, MSPH	1.5 man months/year	3,000.00
Other Personnel		
Research Assistant - Nutritional Anthropologist	12 man months/year	16,000.00
Secretary	6 man months/year	6,000.00
Total Salaries and Wages		$ 35,750.00
Fringe Benefits (18% of salaries and wages)		6,435.00
	TOTAL	$ 42,185.00

Supplies: Office, Cassettes, film, reproduction	$ 2,000.00
Telephone and Telegrams	600.00
Postage	200.00
TOTAL	$ 2,800.00
GRAND TOTAL	$ 44,985.00

Travel Please include in integrated budget:

1 trip to Egyptian field site each year

2 trips to Purdue University each year for Senior personnel

1 trip to program meeting each year

BUDGET - UNIVERSITY OF KANSAS

		YEAR 2
Senior Personnel		
Norge W. Jerome, Ph.D.	3 man months/year	$ 11,503.00
Ruth S. Hassanein, MSPH	1.2 man months/year	3,210.00
Other Personnel		
Research Assistant -	Scientific Computer Programmer 12 man months/year	17,120.00
Research Assistant -	Nutritional Anthropologist 12 man months/year	17,120.00
Secretary	6 man months/year	6,420.00
	TOTAL Salaries and Wages	$ 55,373.00
	Fringe Benefits	9,967.00
	TOTAL*	$ 65,340.00
Supplies		2,000.00
Telephone and Telegrams		700.00
Postage		200.00
	TOTAL*	$ 2,900.00
	GRAND TOTAL	$ 68,240.00

*Add 7% per year for years 3,4 and 5.

BUDGET JUSTIFICATION

Senior Personnel

Calendar months devoted to the project by senior personnel represent projected actual time commitment. Salaries are based upon current annual salaries plus seven percent cost of living increase per year.

Other Personnel

Two research assistants are requested to work full time in implemending the three areas of the project. One secretary at half-time employment has been included.

APPENDIX IV-5

PL 480 Project Proposal

in collaboration with

National Institute of Nutrition

Hyderabad, India

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

Grant Application

Title: ENERGY INTAKE AND HUMAN FUNCTION

Principal Investigators: Dr. S. G. Srikantia
Dr. M. Swaminathan
National Institute of Nutrition
Jamai-Osmania, PO
Hyderabad 500-007, AP India

Submitting Institution: National Institute of Nutrition
Jamai-Osmania, PO
Hyderabad 500-007, AP India

I. OBJECTIVES

An increasingly important emphasis in nutritional research is on the interrelations between people and their environment. The environment includes not only the biophysical but also cognitive and sociocultural dimensions. Such an emphasis is encompassed within the specific objectives and research design of this study. The long-term orientation of the proposed research is toward understanding, within the general domain of intake/function foci, the nature of certain processes and their consequences for various individuals and social units, both singly and as a combined dynamic system.

The specified primary objective of the proposed research is to define the relationships between food intake, functional competency, and overall life experience so as to generate information that can be used effectively in the development of strategies to achieve sustained improvement in the nutrition, health, and welfare of affected populations. To achieve this goal it is necessary: a) to establish relationships in quantitative terms between a range of food energy intakes (above severely underfed but less than adequately fed, by existing criteria) and a range of competencies in the areas of disease, reproduction, activity and work performance, cognition, and behavior; b) to elucidate the processes, paths, networks, or institutions through which inadequate food energy intake impairs the function of self and others; and c) to identify key points, levels, or mechanisms for the most effective intervention(s) through the various sectors (health, agricultural, economic, social/governmental).

The objective of Phase I is to develop and test instruments needed for the field investigation, to train personnel in the administration of the instruments and processing of the data obtained, to determine the variance within and between individuals with respect to food intake, morbidity and nutritional status parameters, and from this to evaluate the feasibility of the proposed larger study and to refine the experimental design if it is determined to be feasible.

Because this project is seen as but one component of a larger research program, it incorporates the objective of providing empirical data and conceptual-theoretical formulations which may serve as a basis for cross-societal comparisons.

II. RESEARCH PLAN

A basic core research design for the multinational multi-institutional research program is in the process of development as a joint activity of all the cooperating institutions. Details of exact methodology to be used in evaluating such functions as work performance, cognitive development and social competency are yet to be decided. Agreement has already been reached as to the minimum core measurement of food intake, anthropometry, morbidity and special sub-routines to coincide with critical physiological events (pregnancy, lactation) and with disease episodes and death. Any or all of these may be expanded and refined on the basis of the Phase I study. What follows represents the activity proposed for Phase I.

Community-Wide Screen

After obtaining informed consent of the community, there will be a systematic collection of information, involving both examination of existing records and collection of *de novo* information, about communities tentatively selected for

study, on the basis of criteria summarized in Table 1.

The purposes of this data collection are:

a) to confirm that appropriate communities have been selected
b) to provide a sample frame for the selection of families to be included in the study
c) to provide a baseline description of the community and its situation as it relates to the variables of interest in the research study.

The content of the data collection may be inferred from statements of principles which apply to all projects. The specific content and specific approach to data collection shall be determined in the context of individual projects. However, the initial screen must provide evidence from existing data sources or rapid assessment that data vital to the purpose of associating intake with outcomes can be gathered. These data ultimately must include features relating to the dependent variables and explanatory factors, such as: birth rates (including demographic distribution of births), abortions, still-birth rates, perinatal mortality, neonatal and infant mortality rates and causes, fertility rate, birth control practices, lactation patterns; age and sex structure of the population; family and household size and composition; acute disease incidence, parasitism prevalence by major agents for the community, prevalence (or incidence) of symptom complexes (e.g. diarrheas) where finite disease diagnoses do not exist or cannot be assumed, prevalence of diseases grouped together (such as respiratory) where finite diagnoses cannot be confirmed, causes of mortality by age and sex; health care facilities available; occupational class distribution, including seasonality. The initial survey will also characterize the community in such a manner that the criteria of selection can be confirmed, including a general assessment of nutritional conditions (e.g. prevalence of specific nutritional inadequacies). This, in turn, will facilitate comparisons across projects and may serve as a determinant of specific, recurring, nutritional assessments which must be included within the research design of specific projects for the statistical control of potential confounding variables in data analyses.

It is seen as desirable that over the course of the multiple-year Phase II study the general situation of the community be monitored through repeated data collection. The objectives would be to provide an assessment of general changes taking place in the community during the period of the research and to provide a base for public health action programs that might be implemented in that community following completion of the research program.

The Sampling Frame

The prime objectives of the research relate to the examination of the relationships between total food intake and a series of functions, with particular reference to the range of mild and moderate undernutrition, so it is essential that the study population include an appropriate range of the independent variable (and of the dependent outcomes). It seems probable that from the standpoint of efficient research design, certain segments of this range will be overrepresented in the community. Therefore, it would seem desirable to plan for differential sampling ratios across strata of the population. Such stratification would be for the purpose of selection of a study population; it would not be a continuing stratification of study design or data analysis.

A two dimensional stratification is planned.

For primary stratification, measures of nutritional state, referred to

energy, shall be employed. These may include such measures as height, weight, weight for height, other anthropometric measures, family food intake, etc. In the well-nourished stratum it would be desirable to include families in which there is reasonable assurance that all existing family members are well nourished. At the opposite extreme it would be desirable to exclude families with very serious nutritional disease (severe malnutrition) as a general pattern; this may imply rejection of families with more than one member with weight for height below 60% of reference standards or other analagous criteria. Families not excluded by such criteria (or other criteria as described below) will be ranked or stratified by discriminant analysis approaches adding variables as required to obtain what is judged to be, for that community, an appropriate scaling of apparent family nutritional state.

Secondary stratification will then be attempted to separate, in each nutritional stratum, a differentiation by socioeconomic variables (e.g. housing, occupation, income, etc.). This may not be necessary in communities where socioeconomic homogeneity prevails to such an extent that the socioeconomic factor(s) would not confound the independent variable. Its use as a basis of sampling will strengthen the research design by facilitating a separation of effects of food intake from those of socioeconomic variables during data analysis (e.g. multivariate analyses).

The sampling frame might take the following form:

		Household Nutritional State				
		WELL NOURISHED		... .		SEVERELY MALNOURISHED*
Family Socioeconomic Status**	HIGH			... .		
	LOW			... .		

*Excluded
**Scaled within nutritional state stratum; will not necessarily have a common definition across strata

The sampling ratio will be a function of:

a) the total sample size needed for data analysis
b) the expected attrition rate
c) the number of individual families within each cell.

In the final study population, each cell would contribute an equal number of families/households.

For the purpose of the present design, certain characteristics of a family/household will determine inclusion/exclusion from the sample frame. Inclusion/exclusion criteria:

a) only a small proportion of non-fertile families, not actively reproducing, should be included so as to avoid inordinate increases in sample size requirements (for the fertile component).
b) families containing members with severe nutritional or other diseases, apparent on clinical examination at the time of initial screening, should be excluded.
c) families representing atypical cultural, ethnic or genetic characteristics for the selected community should be excluded.

After the community data have been collected, and before the family selections have been made final, the precise criteria proposed in each project shall be reviewed.

The households must be selected in identical fashion across all country studies. "Volunteer" households should not be accepted as this may introduce the bias of differences in their characteristics from the general pool of households and particularly from those who refuse to participate.

The households must be willing to undergo repeated examinations and surveillance and give informed consent.

For Phase I, a sample population will be drawn, by the above or other criteria.

Elements of the Core Research Design

Features of research design to be incorporated in all projects are based upon a tentative sample size of 200 families (1000-1200 individuals) living in one or more adjacent communities. This sample size considers the anticipated number of events (births, disease episodes, deaths, etc.) that might occur over a two-year study period, the probable demographic structure and thus age representation of the study sample, and the opportunity for observations over time (e.g. growth rates) as conditioned by the independent variable and by such natural phenomena as seasonal, agricultural and economic cycles. The sample size for Phase II may be modified upward or downward as further information is gained during Phase I and during the intial stages of the research about such matters as the actual variability of both independent and dependent variables, birth rate in the selected families, mortality rates, and frequency of occurrence of infections and other events having analytical significance. The Phase II sample size must be increased in accord with expected attrition rates; this will be subject to adjustment in the light of experience in the particular project.

If it is subsequently deemed that the selected sample size is too small to detect observed relationships with sufficient certainty, two options remain open. The design selected permits the addition of more families (increased sample size) during the study. The design permits also the extension of observation of the same families since many of the relationships may be expected to be repeated in subsequent yearly cycles (increased duration). A reassessment of the adequacy of sample size will be made within the first year of operation.

This approach is deemed preferable to a prolonged pilot study designed to test certain of the assumptions over time, as it is more economic of time, effort and expenditure.

Table 2 provides a preliminary estimate of the numbers of pregnancies and cohorts for growth rate or other longitudinal measurements, even assuming the necessity to analyze these over time sequences (e.g. births in certain seasons with disparate nutritional or infectious disease patterns). It is anticipated that common infectious disease episodes, such as diarrheas, will occur with a frequency of 5-10 events in the first year of life and somewhat lower frequency in older ages. The two year time frame provides for repetition of phenomena recurring on a yearly cycle. It is also of sufficient length to provide at least minimal observation of a complete reproduction cycle in many of the reproductively active women (average birth intervals for the selected regions

appear to be 20-27 months).

Although individual members of family or household may ultimately be singled out for interhousehold or intercommunity comparisons, the basic analytic approaches must continue to consider the family or household as an interactive unit. Thus this unit must be held intact for observational purposes throughout the study.

The scheduling of observations (Figure 1) in the core research design is on a 3-month cycle. That is, all core measurements will be made in phase such that analysis by moving 3-month groupings can be undertaken. A major determinant of this 3-month cycle has been consideration of the precision of the estimate of the independent variable, food intake. Preliminary data suggest that 6 independent one-day observations, representative of weekly cycles in food intake, should be averaged to provide a single estimate of usual intake; this would imply biweekly intake estimates over a three-month cycle and a moving three-month time frame for the definition of "usual". The choice is a compromise between the need for sensitivity in the detection of changes in intake (as with seasonal or agricultural cycles, or with growth, pregnancy and similar physiologic conditions) and logistic feasibility (imposition on the family). The actual schedule may be modified in the light of preliminary experience but the principle of phased, recurring observations will be observed.

The design provides for concurrence of measurements on all family members. This will be necessary if data are to be linked across members as in the portrayal of profiles and relationships at one instant in time--and changes in these relationships over time and with other events.

The design provides for a core of measurements, to be conducted in a scheduled manner in all projects (Figure 1). These are the minimal measurements that must be made a) for longitudinal observations of food intake and functional outcomes, and b) for inter-project comparisons and data aggregations. The details of a number of these observations will be decided by the collaborating investigators prior to implementation. Preliminary suggestions have been included in the project proposals.

In addition, it is anticipated that special studies of particular functional outcomes, the results of which may be linked at the data interpretation level to the core measurements, will be undertaken on sub-samples of the population or at particular points in time. Both the method and schedule for these observations will be determined on the basis of pilot testing in Phase I.

Core Measurements

The focus of measurement is the individual within a household. An extension, for some aspects of the research, is the household within a community and an ecological setting. A definition of household will be developed to encompass the structures of such among the several communities collaborating in this research. The independent variable of primary interest is food intake measured as energy intake. A related interest is the quality of the diet consumed (nutrients), the energy density of the diet consumed, and the source (commodities) of the energy consumed. In the case of lactation, information about the quantity and quality of breast milk is needed both as an independent variable (infant intake) and as a dependent variable (lactating woman's secretion).

The intended data analyses require linkage of data at the level of the individual and the household.

Food Intake

Food intake is a primary independent variable. Reliable estimates of intake are needed at the level of the individual. Two aspects of methodology affect the design--variability of intake from day-to-day (intraindividual variation) and method of collecting data on a particular day.

Estimates of intraindividual variation in industrialized societies suggests that it is about 25% of the mean for energy. On the basis of this estimate a standard error of about 10% would be obtained in the estimate of usual intake with 6 independent observations reasonably representative of the days of the week. In the absence of information on intraindividual variation in the study communities, the above estimate has been used in design planning. In Phase I, estimates of intraindividual variation will be obtained (by analysis of variance of repeated observations on a limited number of subjects of appropriate age/sex/socioeconomic groupings). The frequency of observation in the experimental design (Figure 1) will be adjusted to the findings in each community.

The methodology of food intake measurement in the core design will involve 24-hour recalls and weighing/measuring at the time of consumption. These different techniques of intake measurement may yield different results not only for individuals, but also across cultures. It is not possible to validate either measure against a reference standard. Therefore it will be important to conduct a pilot study at each site to determine: a) the magnitude of difference between food intake data obtained by recall method compared to the weighing and measuring method, and b) for each method, the number of measurements required to produce a valid estimate of caloric intake.

Validity, for these purposes, will be defined as an acceptable ratio of intra-individual to inter-individual variance, or the magnitude of change in the mean ± standard deviation for each individual when an additional observation is made. For each project, the frequency with which each measurement must be made will be determined by a) the short term food cycle of a household (resulting from cycles in purchasing practices and income, etc.), b) the seasonal food cycle, c) the results of the pilot study, and will comply with minimum frequency specified by the core design.

If the recall and weighing methods yield substantially similar results, the number of the more time-consuming and costly weighed observations may be reduced. If the day to day variability in individual food intakes is low, then the total number of observations may be reduced.

In a subsample of the study population, special events such as illness may provoke the need to follow food intake of a specific individual for several consecutive days. This will provide valuable information on the effect of illness on food intake. Events such as pregnancy and lactation may also require more frequent observations.

Determination of food patterns, behaviors and beliefs requires study not only of individuals, but the households and communities in which they live. Reasons for food patterns will be sought in sociocultural terms, and information on these patterns will be obtained collaboratively by anthropologists and nutritionists.

FOOD MEASURING AND WEIGHING.

For this technique, all eating activities of each household member will be

observed during an entire day. All food and liquid consumed by each individual will be measured or weighed. The interviewer will enter the house, unannounced if possible, before the first meal of the day. At the kitchen level all ingredients, including water, will be measured or weighed before they are used. This will provide a close estimate of the final composition of a mixed dish. If food is provided to each family member as a serving, the size of each food item in the serving will be measured or weighed. If food is served in a communal pot, the investigator will count the number of spoonfuls, handfuls, etc. the person takes from the container; the amount of food represented by a spoonful or handful will be measured in each case. At the end of each meal measurements will be made of the amount of food left unserved and the amount of each food left on individual plates. The fate of unconsumed food will be recorded.

Weighing of foods on a gram scale, or precise measurement of liquid volumes, is a relatively time-consuming process. For this reason, weighing and precise measurement will be routinely used only at the kitchen level of food preparation and for plate waste. In order to minimize interference and delay in food consumption, food served on plates will be estimated after weighing the quantities represented by the cups, spoons, and other utensils used to serve the food. With practice, the investigator should become skilled at "measuring by eye" amounts of food and liquid served. These estimates will be checked by weighing or measurement at regular intervals.

Household members who are absent from the house during the day will be questioned about food consumed outside the household. If the amount of food eaten by an individual outside the home is large, or difficult to estimate reasonably, the intake for that day will not be used in data analysis.

It should not be necessary to collect frequent food samples from a household for nutrient analysis, since the proportions of individual ingredients in mixed dishes will be measured prior to cooking. However, collection of samples will be necessary if the meal was not prepared in the presence of the interviewer (e.g. if it was prepared on the previous day, brought to the household as a gift or purchased, etc.). Because water loss is significant during cooking, the pot and contents should be reweighed shortly before serving.

Since the weighing and measuring technique requires an interviewer to be present in a household for an entire day, this time can also be used for appropriate observations or questions on behavior of household members, such as activity, morbidity, social competence, etc.

24-HOUR RECALLS.

The 24-hour recall is a rapid, and therefore potentially efficient, technique for estimating food intake. Recall data will be obtained by interviewing all members of the household able to report responsibly (age > 12 years, alert, etc.) about their food intake during the previous day. This interview will occur during the day of weighing and measurement in order to minimize the number of interviewer visits to the household, and to increase the likelihood of contacting each household member. Mothers will be asked to provide the information on food and fluids consumed by infants, children, or other household members unable to report responsibly. Whenever possible, estimates of quantity will be improved by referring individuals to containers or food samples available in the household. All members of the household will be interviewed on the same

day so that individual intakes can be aggregated to provide a household average intake figure and distribution pattern.

The person who prepared the meals for the household will be questioned about the types and amounts of foods served. As a check, the amounts reported as served should be similar to the sum of the amounts consumed at home in the recalls of individual family members.

INTAKE BY INFANTS.

Intake of breast milk by infants can only be known by weighing the infant before and after each feeding. A local worker will carry out and instruct the mother in this procedure during 12 daylight hours. If it is locally acceptable, a worker will remain in the household for the 12 remaining hours to continue the observation; if not, infant scales with automatic print-out will be left in the house for the mother to use during the other 12 hours. The technician and the mother will record any food or fluid given to the baby during the 24 hours. A milk sample will be obtained by completely emptying one breast with a pump at the mid-day feeding while the baby suckles at the other breast. A sample of breast-milk will be placed in a sample bottle for later analysis, and the remainder will be placed in a clean nursing bottle and fed to the infant.

Supplementation of breast-milk is an important topic of study. Records will be kept of all foods and fluids given by any person in the house to breast-fed infants and weanlings on all occasions when food intake is measured. On days when infants are being test-weighed these supplementary feeds will also be weighed. The frequency and source will be noted and inquiries made of the mother as to the reason for supplementation and selection of specific foods. When infants are weaned from the breast, records of milk-substitute and other food intake will be kept on the same schedule as other family members (i.e. every 2 weeks). Attention will be paid to cleanliness in food preparation, and hand-and body-washing practices to determine the likely relationship of aspects of sanitation to the occurrence of diarrheal and other common diseases.

PERSON-FOLLOWING.

As another validating method, the "child- or person-following" observation technique will be used. In this technique all eating activities of the subject are observed with permission and recorded for one complete day, from the time of waking or rising until s/he has retired for the night. Each item taken into the mouth (food, liquid, drug, other) is recorded, including amount. If the individual leaves the dwelling, the investigator accompanies him/her, recording ingestions as they occur. Food and fluid intakes and other ingestions will be determined for a small sample (n=35) of lactating women and preschool children (n=60). Observations on lactating women included in the energy expenditure study will be done every three months on the days on which their infants are weighed. Children 2-5 years of age selected from those being examined in the cognitive study will be followed singly for one day at a time to observe and record everything each puts in his mouth and swallows. The observations will be repeated as time and availability of team personnel allow but should be made on the child during at least two other periods during one year.

ALTERNATIVE METHODS.

Any or all of the following may be used, as time and availability of personnel allow, to validate food availability, intakes and distribution within

families: meal watching; "dropping in" at meal time; spot checks of food on hand; and food diaries and/or food purchase records (kinds and costs) kept by literate family member.

DIETARY HISTORY.

On a subsample of the population, habitual intake, frequency, and amount of specific foods consumed will be determined during the second and third quarters of the study, using the same open-ended questionnaire with records obtained in the preliminary survey to determine reliability of the instruments.

If the respondent is a pregnant or lactating woman, questioning will be used to determine diet changes during pregnancy and lactation, as well as changes in appetite and taste. Questions will probe to include information on practices such as pica, use of drugs, intake of caffeine, alcohol, herbs, or other substances that could interfere with or alter metabolism.

NUTRITION HISTORY.

Open-ended questioning will attempt to reconstruct nutritional life experiences such as crop failures, natural disasters, family economic problems and periods of nutritionally disturbing illness. Such a history should be obtained for each individual in the study population in the course of the 2-year investigation. Results of replies to early queries may produce a more structured set of repeatable questions for subsequent use by the nutritionists and/or other team members who have received initial training from the nutrition supervisors in types of answers to seek.

CALCULATION OF ENERGY AND NUTRIENT INTAKE.

All quantified food intake records will be coded for computer analysis of nutrient content. The compositional data to be entered will be derived from local food tables, supplemented by international tables and, as the project progresses, by analysis of food samples. Initially, values will be entered for water, ash, protein, fat, carbohydrate, energy, calcium, phosphorus, iron, vitamin A (retinal equivalents including carotenes), vitamin C, thiamin, riboflavin, niacin, and vitamin B12. As the project develops, an attempt will be made to complete entries for dietary fiber, zinc, copper, folacin, and vitamin B6 for at least the dominant foods used.

For analysis, a series of representative diet composites will be made, if the digestibility of the major energy and protein sources is not known. The diets will be fed to rats to determine true protein digestibility, and energy absorption by bomb calorimetry.

INDICATORS OF FOOD INTAKE.

Some foods comprise the regular diet of low to middle class consumers. We will use the data from the proposed study to determine if the consumption of selected "super" foods could be used as indicators of total food patterns. This method of assessment of nutrient intake could prove to be a relatively simple, low-cost pragmatic measurement tool.

TRAINING DIETARY INTERVIEWERS.

Qualified Indian staff will be trained as field supervisors and dietary interviewers. As part of the training program, behavioral objectives will be

formulated, and pragmatic experiences in interviewing and measuring under supervision are anticipated.

Indicators of Nutritional Status

Information needs to be gathered on a group of indicators of status. In this study, indicators will serve as an intermediate variable, and statistical techniques will be used to identify factors relevant to the observed states over the 2-year period. Indicators may also have explicative power. An attempt will be made analytically to identify parameters which capture meaningful relationships, have a low variability over time, and are highly sensitive to nutrition inputs. If this goal were accomplished, nutritional status and changes in nutritional status could be monitored effectively.

Meaningful analysis of height data requires that age be known accurately and that there are norms based on adequately nourished people of similar genetic background in a like environment. This project will rely on anthropological techniques to elicit and cross-check ages. Initially, international growth norms will be used; but the project ultimately will use height of its own adequately-fed population as the reference for analysis.

Most methods of assessing body composition are far too complicated for field use. Collection of a timed 24-hour urine sample would allow for measurement of creatinine excretion which is a fairly reliable index of total muscle mass. In addition to collection from lactating women as specified in the core, collections will be obtained from a representative subsample of men and women.

Some development features may serve as nutritional markers: age of tooth eruption; age at menarche; age at maturity of pubic hair in boys (Tanner stage 4); age at first pregnancy; age at menopause.

There is some evidence to indicate that the basal metabolic rate (BMR) is lower in underfed people than in the adequately nourished. As this information is needed for other components of the study, BMR will be measured in a sample of adults. Body core temperature is thought also to be lower and the simplicity of this measure warrants an attempt to verify the notion. The BMR will be measured every 3 months in 35% of female heads (1/3 each pregnant, lactating, and other) and 10% of male heads from the same households as the women studied. Body temperature will be recorded when the BMR is measured in adults and at 3 fixed times of day in infants when breast-milk intake is recorded.

Anthropometric measurements

Height, body weight and indices of body composition (triceps, biceps, suprailiac and subscapular skin fold thicknesses and arm circumference) will be measured as indicated in Table 3, using the following methods:

1) Height. Length will be measured to the nearest 0.1cm for children up to 36 months and height will be measured in older children. Portable, rigid height/length boards of 120cm length, locally made, would be suitable. This instrument can be folded in the center and conveniently transported on a bicycle luggage rack.

The adult scale should have a sliding measuring rod for height estimation which suffices for height measurement to the nearest cm, for children over five years and adults. It is only necessary to measure adult stature twice, the second as a cross-check for the first.

2) Weight. (Lightly clothed, without shoes). Weight will be measured to the nearest 0.1kg for children up to five years of age. The scale must be reliable for fieldwork, sturdy, durable, easily transportable, available at low cost. A basket should be used for very young children and trousers for

those age one to five years. Variability in day-to-day weight measurement may be as much as 0.2kg, due to non-nutritional factors (food, feces and fluid).

An adult scale would be suitable for older children and adults. During measurement the knife edge position needs to be checked and the double reading area requires added care. Checking at zero must be done prior to every session and whenever the scale is moved. Scales must be frequently calibrated using reference weights.

3) Skinfold thickness. Subcutaneous fatfold will be measured to the nearest 0.2 or 0.5mm, depending on the instrument used. Precision calipers include the Lange, Harpenden and Holtain-Tanner/Whitehouse. The Lange caliper may be preferable because it is available in the U.S. However, the other two have a larger scale face so that calibrations are of smaller dimensions (0.2mm).

Surveyor performance must satisfy rigid trial criteria before these measures will be considered. In addition, the project must be sensitive to the possibility that frequent fatfold measures in young children may compromise their cooperation for other more important tests. Fatfold measurement reliability is far better within than between observers. Hence the number of surveyors for this study must be kept to a minimum, especially for fatfold.

4) Circumferences. Head and upper arm circumferences will be measured to the nearest 0.1cm using either flexible plastic coated steel tapes or Zerfas insertion tapes.

A suitable wider tape will be devised for arm circumference of neonates and young infants. This is to reduce errors in this age range due to the difficulty in maintaining a reliable tension.

Measures of actual gestation length will be available from the menstrual history solicited on a continuing basis throughout the study, at least for pregnancies conceived after the study begins. The age of puberty will be documented retrospectively on the basis of peak height increase velocity in boys and menarche in girls. For this purpose, enquiry about menarche will be made at 3-month intervals after the age of 10 years.

Other Indicators of Nutritional Status

A minimal set of hematologic and biochemical indicators are listed in Table 4. Other measures regarded as highly desirable (but not mandatory if blood sampling limits participation or compliance) include serum transferrin, alkaline phosphatase activity, iron and ferritin. Analysis of blood or urine for parameters of vitamin and mineral status is to be undertaken only if there is presumptive evidence of deficiency, as these assays add appreciably to project complexity and cost.

Local workers are to be trained to identify simple, routine signs of nutritional deficiency, and these are to be recorded whenever anthropometric measurements are made.

Projects are also to quantify major local species of parasites (and ova if indicated) in participants' feces, initially and annually, because of the important relationship of parasitism to nutrient utilization and requirement.

SUBROUTINES.

Special protocols will be initiated when predetermined marker events

occur. These include at least the following:

1) Birth - weight, length, maternal postpartum weight , health status of mother and child, Dubowitz examination for infants under 2800g. A behavioral/activity pattern study will be initiated.

2) Lactation - breast milk volume and composition studies as per previous description.

3) Deaths - solicit history and record apparent course of death. A behavioral/activity pattern study will be initiated.

4) Pregnancy - selected measurements and behavioral/activity pattern studies will be initiated and will continue through lactation.

5) Disease - for a selected sample of disease events, distributed across families, a special subroutine to include records of the disease, food intake and behavioral/activity pattern studies will be initiated. (See below.)

Unit of Analysis: Individual

1. DISEASE (EXPERIENCE AND RESPONSE)

Disease experience of individuals in the study households needs to be known both as an outcome variable related to energy intake and as an independent or confounding variable in studies of other competency areas. The sample population is far too small to permit meaningful analysis of any but the most prevalent diseases, so this component will concentrate on diarrheal diseases and upper respiratory infections, especially of children. It will be necessary to keep a running account of family health in general, however; e.g. days lost from work and school may profoundly affect individual and household welfare. Some concept of the demographic effects of disease may be developed from retrospective records. During Phase II the project will assess the immune status of a subsample, utilizing simple procedures not requiring a sophisticated laboratory in the field, that will indicate a) overall immunocompetence, including contributions of B and T cell systems, and b) presence of chronic infection.

With respect to chronic diseases, the nature, duration and recovery will be investigated by means of structured questioning. Emphasis will be placed on issues of appetite, food withholding, and food therapy as well as medications and treatment. Other questions will be concerned with family response in order to identify contacts but, more importantly, to learn how nursing and required work are reassigned, what work is regarded as expendable, and so forth. Morbidity due to acute infective episodes such as common colds, upper respiratory infections, gastrointestinal infections, communicable diseases, and skin infection will be recorded. Changes in food intake, both qualitative and quantitative, during the period of illness and immediately thereafter, will be specifically recorded. In addition, the following data will be obtained:

DAYS OF DISABILITY: restricted-activity days; bed days; school-loss days (ages 6-16 years); work-loss days (reported for wage- and self-employed persons of all ages); days worked but not fully recovered.

HEALTH CARE: number of visits to health center, hospital, clinic, physician in office, dentist in office, other (specify); principal nursing care given in the home.

CURRENT FAMILY PLANNING PRACTICES: oral contraceptive (specify); mechanical contraceptive (specify); other (specify); none.

Several of the questions will not provide unequivocal answers because persons define sickness differently, both for self and others. Definitions of "diarrhea" are not uniform, even among professionals. Both personal and medically defined answers are required for understanding of the disease setting. Because all projects will focus on some diseases in common,definitions should be developed for use throughout the CRSP;but information based on the informal/indigenous definitions should also be sought.

Phase II.

A sub-sample of approximately 200 children will be drawn from the study households for disease response studies. The intention is to closely interrelate any sub-sample immuno-response investigations with disease experience inquiries. The studies will be co-ordinated with the nutritional-biomedical determinations.

PHYSICAL EXAMINATION. (at least once/year, preferably once/season, to provide a picture of the community and the prevalent disease conditions there.) Tonsillar size will be graded on individuals from 0 to 3+ according to Smythe et al.: 0 indicates that a trace or no tonsils are seen; 1+ indicates that the tonsils are clearly visible but do not extend beyond the faucial arch; 2+ indicates that the tonsils are enlarged beyond the arch but not beyond the midpoint between the arch and uvula; and 3+ indicates that the tonsils extend beyond the arch-uvula midline. In addition, lymph node, liver and spleen size are recorded.

HUMORAL IMMUNITY AND COMPLEMENT FIXATION. These are assessed by measurement of IgG, IgM, and IgA levels by radial immunodiffusion and IgE by PRIST radioimmunoassay, tetanus and measles titers by hemaglutinin assays already established in our laboratory, C3 by radial immunodiffusion, and C3 breakdown products by counter immunoelectrophoresis respectively. C3 breakdown products are useful to determine *in vivo* complement activation, usually a result of a concomitant infection.

CELLULAR IMMUNITY will be assessed *in vivo* by cutaneous delayed hypersensitivity to 3 ubiquitous antigens to which nearly all subjects develop a delayed hypersensitivity response. These include *Candida albicans*, Streptokinase-Streptodornase and tetanus toxoid antigen (1:5 dilution fluid tetanus toxoid). Skin test results are at 48 hours.

For children who have cutaneous anergy, a plasma will be obtained for Bach's thymic hormone assays. He has found this a useful measure of T cell function in cellular immunodeficiency and in aging populations.* Its validity in malnutrition will be assessed. In addition, selected anergic children may have T cell enumeration (by E rosetting) and PHA activation on peripheral leukocytes. IgE levels, being under strong T cell control, also indirectly assess T cell competence.

These studies will be particularly meaningful when performed serially to determine dynamic changes with time or when acute infection appears.

Although work focuses primarily on several viral diseases, laboratory conditions permitting, cultures may be taken for bacterial, respiratory and diarrheal infections.

1) Respiratory syncitial virus (RSV) constitutes a large percent of respiratory illness among young children. Diagnosis of RSV infection can be accomplished quickly by fluorescent antibody techniques. Field staff encountering acute respiratory infection will take a swab of nasal secretion and spread this out on a glass

*Since the test is done on serum it obviates the need of a cellular immunology laboratory and the need to work on fresh specimens and separate lymphocytes.

slide and fix it in acetone. These can be examined either at the field clinic laboratory or in a laboratory in Hyderabad.

2) Diarrheal disease. Rotovirus infections are universally common. High maternal IgG antibody levels are found early in life, which decline between three to five months. Rotovirus antibody then rises at seven to eight months. Stool specimens can be obtained either by rectal swab or actual stool collected from all children encountered with diarrhea. The specimens should be kept cool (4°C) and examined in the field laboratory or sent to Hyderabad for further testing. A most appropriate technique, however, for field study identification of rotovirus is the enzymatic labeled antibody test (ELISA). Elisa is stable, requires no radioactivity hazard, and requires no sophisticated equipment. The test can be read by the naked eye or with a simple colorimeter. A large number of specimens can be examined in a relatively short period of time. The method is efficient and as sensitive as the electromicroscope method and the radioimmuno-assay methods. Stool or rectal swab filterates can be used or a 2% unfiltered specimen can be examined. A field laboratory could be set up to identify rotoviruses in stools. Because the role of breast milk secretory IgA antibody in rotovirus needs to be evaluated, antibody levels can be obtained and measured in breast milk and would not be difficult to do under field circumstances.

2. REPRODUCTION.

A primary purpose of this project is to determine the significance of biological, sociocultural, environmental, and nutritional factors associated with maternal morbidity and mortality, perinatal mortality, low birth-weight, low infant growth rate, and lactational failure. Knowledge gained from other functional areas of the project will permit this.

Because all women in the sample population are to be studied, food intake will be known for some women before, during, and after pregnancy, as will body weight on a month-to-month basis. Similarly, some women will be studied throughout lactation. Knowledge of milk intake of breast-fed infants will permit calculation of the energy cost of lactation. The variety of reproductive histories likely to be encountered should also enable assessment of the cost to the mother of repeated reproductive cycles at different levels of intake. For this reason, the study will include women nearing and beyond menopause.

Information about disease experience is, of course, critical to interpretation of reproductive events. Activity patterns will be known for all as will BMR and energy cost of activities for a representative sub-sample (see section 3 below). The anthropologists will gather information about what women are expected to do (to be contrasted to what they can and actually do) and will explore the involvement of fathers and other household members in parenting activities. All the social science components will yield information on the potential for and availability and provision of general aid and assistance to pregnant and lactating women from household, community and institutional resources. The cognitive development of children born in these described households will be followed (see section 4 below).

Continuing from the third year, appropriate cases will be followed longitudinally through project years 4 and 5. It is possible that a suitable intervention can be devised to test a specific hypothesis concerning linkages among nutrition, disease, work requirements, etc., so that reproductive outcomes can be compared at different and improved nutritional intake levels. In this connection it should be made clear that qualified members of the investigating team will provide requested advice to individuals who wish to practice family planning, irrespective of considerations of study design.

For project purposes, reproductive competency is seen as encompassing the outcomes specified initially and also the life-long nutritional and health state of women. The contribution of men, other household members, community, and institutions to the post-conceptional phases of reproduction are seen in one sense as confounding variables but also as indicating potential points for subsequent intervention to improve reproductive outcomes.

To accomplish this task, a study will be made of all pregnancies and the outcome (live births and perinatal deaths) of products of conception of mothers in the study population within a 24-month period (see Appendix B). One of the requirements is that staff trained in obstetrics, pediatrics, and community medicine are included among project personnel drawn from the overseas institution.

It is proposed that all known and possible sources of information and contacts in the study community be utilized to keep a register of pregnancies, still births, live births, and early neonatal deaths in the entire population as well as the study sample. Such possible sources include: attendance at clinics (prenatal, child welfare, postnatal, rehydration); delivery in or by health center staff; traditional birth attendants; midwives; doctors (employed and in practice); community leaders; school teachers; agriculture extension workers; staff serving community feeding programs; and usual community enumerators.

All measurements relating to reproduction will be carried out as specified in the core as well as gathering current information on spontaneous and induced abortion; labor and delivery; and presence of congenital malformations. For the 24-month period, the causes and associations of low birth-weight and perinatal mortality will be sought. Information on food intake, body weight, disease, behavior, etc. (as described separately) will be used in this assessment.

Many accounts from different parts of the world suggest that malnourished women often lactate with unexpectedly little clinically obvious deterioration of their nutritional status. However, in recent years there may be increasing evidence of shorter periods of satisfactory lactation than previously, at least in some parts of the world. The effect of maternal malnutrition may be partly hormonal, with decreased secretion of cortisol and possibly prolactin. The cumulative effects of sequential reproductive cycles, including prolonged lactation, can lead to general maternal depletion, as shown by progressive weight loss and a prematurely aged appearance. More specific nutrient deficiencies may occur with repeated reproductive cycles--for example, an increasingly large goiter, anemia, osteomalacia or nutritional edema, all of which will be monitored in our study.

Lactation performance will be evaluated in terms of milk composition and quantity ingested by the infant (as specified in the core) but more importantly by infant growth rate and the need for early supplementation. Test-weighing of infants will provide needed information on infant suckling patterns and maternal-infant interactions. The causes of lactation failure will be studied, including such diverse factors as maternal and/or infant disease, introduction of supplementary foods, method of contraception,

insufficient maternal fluid or food intake and weight gain during pregnancy.

3.ACTIVITY, BEHAVIOR, AND ENERGY EXPENDITURE.

This component of the project is designed with two major dimensions, one which focuses on comprehensive activity and behavior, and a second which is concerned with determining the physiological energy cost of the activities engaged in by study household members. It is important to know how availability of food energy (within ranges currently encountered in the diets of poor people) affects habitual physical activity patterns. If activity is decreased with decreased intake, as is to be expected, it is important to know how choices are made about activities to be foregone and the impact of forced choices at various intakes on individual physical well-being and on the functioning of individuals, households, and community. Energy balances of individuals may well undergo periodic or occasional changes while the energy balance of the household as a whole does not show any change, as a consequence of redistribution of food supplies and shifts of task allocation.

Restriction of food intake in childhood that results in diminished growth (skeleton, musculature) and development (cognitive, sensorimotor, social) has the potential to limit work performance throughout life. It may also set patterns of activity and behavior that have lasting consequences reflected in attitudes toward activity, work, and societal obligations. Currently low intakes must limit activity unless body mass is expended; the mass available for expenditure is a function of immediate past intakes and activity requirements. Decisions as to what to do and not do may well be affected by the individual's perception of his reserves and potential for replenishment; ultimately the sacrifice of tissue is a physical limitation.

ACTIVITY AND ENERGY EXPENDITURE.

The energy expenditure component of the study will focus in detail on activity patterns of a subset of male adults (n=30), women in three reproductive phases (pregnant, lactating, intergestational; n=35 each), and children. This sample will be the same as those adults in whom basal metabolic rate is to be measured, and the children in their households. In the first three months of the study, the men, women and older children (> 10 years) will be asked to keep a diary record, or to recall in a structured interview, all of their activities for a 24-hour period each month. These records will be obtained in conjunction with the 24-hour food intake records. From these records and observations made by field team members, lists of most common activities engaged in by men, women and children will be constructed.

The energy expended during the activities that occur frequently and occupy significant portions of time will be measured by respiration calorimetry. Each activity will be tested on two occasions at appropriate seasonal intervals for all adults noted above and for 10 children per age/sex category (males 15-18 years, females 13-16 years, males 11-14 years, females 10-12 years). Monthly records of activity will continue throughout the study and energy cost of other activities will be measured if there are significant differences over time.

Using these energy cost figures and records of the daily activity patterns (time budgets), total daily energy expenditure will be computed. In lactating women, a correction will be made for the cost of breast-milk as determined from the intakes of their infants (by test-weighing and analysis of milk for energy content). Energy intakes of the sample population will be known and this information, plus data on changes in body weight and estimated fatness (skinfold thickness) and musculature (urinary creatinine) will allow construction of energy balances. Energy expenditure data will also be used to construct tables of energy cost of various occupational and self-selected activities, by persons of different body weight and estimated body composition, that can be applied to the larger study population.

It is not feasible directly to measure energy expenditure of young children in a field study of this scope. However, detailed records of activity will be obtained whenever a child is followed for other study purposes, and children's activities will be randomly sampled as will activities of other household members not included in the energy-expenditure sub-sample. A rough estimate of the energy available for activity of young children will be derived from data on their food intakes, growth and body composition measures. Energy costs of growth and maintenance will be computed as suggested by Waterlow and others. The difference between recorded energy intake and the growth-maintenance estimate is the amount theoretically available for activity and this should compare with observed patterns if both measures are reliable. In the second year of the study, an attempt may be made to obtain a more quantitative assessment of children's activities using miniature heart rate and activity recording equipment, but our experience with these devices indicates that the method has little promise for field application. The tests will be carried out only if the effort is warranted by observations made in the first year.

Men, nonpregnant women, and older children will have administered a simple work test (Harvard step test or equivalent) in a preliminary attempt to determine if activity patterns are related to physical fitness for work. More sophisticated measures of the various components of performance capacity are deemed not feasible under anticipated field conitions. It is very likely that activity patterns will be severely constrained by availability of resources (food, but also employment, land, equipment, etc.). When these constraints have been defined by the present study, it will be possible to design an interventional study from which the residual due to performance capacities can be determined. This should be done in years four and five of the project.

ACTIVITY AND BEHAVIORAL PROFILES.

The broadest aim is to determine which activities/behaviors are suppressed/expressed under varying levels of energy intakes, which tradeoffs are implicated, and what consequences these tradeoffs have for nutritional status and the functions specifically under study in this project. Data will be analyzed with a view to determining the ways and extent to which time, sociocultural preferences, technological items, and other environmental factors are themselves constraints on behavior independent of possible energy constraints.

Intensive open-ended interviews with reliable informants and participant observation will determine how individuals in the community expect activities to be done, what ideals of performance are, how these expectations vary in the local population, and how structured and refined this knowledge is for the various segments of the local repertoire of activities. Local presumptions of the systemic/strategic character of differing behaviors and activities will be determined, i.e.,what the perceived functions and consequences of particular actions are.

The whole population of the community will be surveyed to define locally appropriate descriptive categories of behaviors and activities. Coding procedures for activity analysis will be developed and data recording methods will be pretested and refined. These will be used to collect data on time allocation for 300 households. For verification the time allocation profiles will be checked against the 24-hour activity records collected on the subset of households previously described.

4.COGNITIVE AND SOCIAL DEVELOPMENT

In approaching the problem of assessing cognitive and social competence across a major portion of the life-span, a strategy has been adopted which directly addresses a number of well documented problems associated with cross-cultural research in this area. First, the assessments will involve cognitive functioning that is both relevant to a wide range of cultural contexts and is epistemologically powerful. For example, basic logical, causal, spatial and social concepts will be assessed using a variety of problems and situations. The problems chosen minimize the importance of verbal skills by focusing on object manipulations and predictions for the physical-spatial problems, and on prescriptions and proscriptions in the social problems, rather than abstract conceptions and exact "correct" solutions. Some of these procedures have already been used successfully in other cultures. The specific problems administered to subjects will include objects and situations indigenous to the population studied. In devising these problems, principles designed to assess the structural equivalence of problems will be used. Intensive collaboration with Kenyan counterparts will also be useful here. Second, the same basic concepts will be assessed in infants, classificatory skills in children, and combinatorial operations on classifications in adolescents and adults. Because the approach is developmental (the conceptual advances have been ordered in an ordinal and inclusive sequence), extent of development is an easily interpretable dependent variable.

The relationship between nutrition and growth and development of individuals has of course been studied for some time. However, until recently not as much has been studied about how family interactions, child-rearing styles, and general social competence affect the growth and development of the child; including the parameters of physical, cognitive, and emotional development. Family and cultural factors influence individual health not only in the specifics of dietary practices, the provision of a healthful and sanitary environment, the seeking-out and utilization of appropriate medical care when necessary, but equally in the social inculcation in children of perceptions and attitudes about health and illness, life-styles, etc. Such aspects of family functioning as socio-demographic features, family cohesion, tension management and conflict resolution, emotional

climate, problem-solving skills, support connections, organization and task division, values and cultural orientation, should be considered in conjunction with the various assessments of cognitive processes specified below.

Also, there are indications that caregiver sensitivity to a child, and caregiver structuring of the environment can be linked to the child's ability to be tuned into salient features of the milieu. As we study the ability of malnourished children to select features of the environment to respond to, and to maintain attention appropriately, we will also attempt to document variation in caregiving behaviors. The quality and quantity of these interactions will interact with a host of health and nutrition factors and impact on the course of psychological growth. Analysis of caregiver variability may provide another promising way to study differential outcomes in the developmental course in addition to the set of specific assessments. The study will thus also seek to assess family social functioning and social competence as a variable factor in the nutritional, health and developmental status of children. This assessment is interrelated with and relies on other components of the overall study.

To assess the relationship between nutritional intakes and cognitive development adequately, a two-phase study is proposed. The first phase is cross-sectional and will be completed during the first three-year period of the project. The goals of this phase are: (a) to establish reliable assessments of levels of cognitive development across most of the life-span; (b) to extend these procedures where necessary to include a structurally parallel set of procedures based on objects and activities indigenous to the population studied; and (c) to establish through correlational means the relationship between levels of current nutritonal intake (and retrospective reports of nutritional history) and current levels of cognitive and social development.

The second phase of the study is longitudinal and is proposed for years four and five of this project. All individuals seen during the first phase of the study will be seen two years after the initial assessments. This will allow for a detailed analysis of the relationship beteen nutritional intake and cognitive functioning over a two-year period. For example, individuals assessed at the same level of development at Time 1 may not show equal cognitive advances as a function of nutritional history. In addition, the number of individuals available for establishing adequate norms for cognitive development will be effectively doubled. For those subjects born during the first phase, almost complete life records of nutritional intake will be available for that period which previous studies have indicated is critical for subsequent cognitive development.

Because of the time required to obtain reliable assessments of cognitive and social competence, it will not be possible to assess all individuals who are part of the overall study. A sub-sample that has been screened for sensory capacity will be selected on the basis of age, sex, and nutritional status,as follows.

Age	Assessment Time			Age	Assessment Time		
	N	hrs/S	E		N	hrs/S	E
6-12 months	30	1.5	45	9-10 years	30	9	270
13-24 months	50	2	100	11-13 years	30	10	300
2-4 years	60	4	240	14-16 years	30	11	330
5-6 years	30	8	240	17-19 years	30	11	330
7-8 years	30	9	270	20-40 years	30	7	210
					350		2335

Half of the subjects at each age range will be male and half female. With the exception of adults over 20 years of age, half of the sub-sample will consist of individuals that have been judged by the nutritional-medical team to have had an adequate history of nutritional intakes and half will have been judged to have had an inadequate nutritional history. To avoid the possibility of confusing mental retardation with sensory deficits, only individuals that are found on examination to have adequate vision and hearing (and those who are not incapacitated by disease) will be included in the study of cognitive and social competence. In addition, the medical examiners will assess adequacy of sensory and memory functions for the individual cognitive tasks. A problem is not foreseen, however, except for the younger children and infants, for whom the pediatrician's assessments will be critical.

Because of the need for these prior evaluations, this component of the project will begin in the second quarter. During the two-year study phase, the oldest subjects will be seen first. The youngest children will not be seen until the second year of data collection. Hence, for the 6-month-olds, extensive data on the mother's nutritional history during pregnancy will be available. Similarly, extensive nutritional data will be available for the entire life span of the one-year-olds and probably the 18-month-olds.

The sample of subjects over 20 years of age will include only adequately nourished individuals. Long-term nutritional histories are the least likely to be known accurately but every effort will be made to select subjects of the best probable state in order to establish upper ranges of cognitive development attained in the study population under prevailing biophysical and sociocultural conditions.

The procedures for assessing cognitive and social development are divided into two content domains: those concerned with the development of logical-physical concepts and those concerned with the development of social judgements. A broad range of cognitive and social tasks will be used, yielding a comprehensive assessment of the subject's levels of cognitive and social competence. The concepts to be assessed at critical age periods are:

	Concepts		
Ages	Logical Development	Physical Concepts	Social Concepts
6mo - 2yr	Pre-Classification Seriation	Object, Space, Causality	
2yr - 5yr	Same as above	Identity Space Causality	Social Identity Social Regulations Positive Justice
4yr - 12yr	Classification and Seriation	Identity, Space, and Causal Concepts (as above)	Social Identity, Social Regulations, and Positive Justice (as above)
		Conservations of Continuous and Discontinuous Quantity and Length	Social Organization and Conventions
10yr and older	Classification: Class Inclusion and the Duality Principle Combinatorial Formulation	Volume Conservation Causal Inferences Density and Specific Gravity Proportionality	Social Organization and Conventions Social Regulations Moral Judgements

Note that the comparability of assessments across ages is insured because: (i) the same problems are used across a range of ages, and devleopmental advances in the same concepts are assessed across all ages.

Logical-physical development. To insure breadth of cognitive assessments, the research strategy is to assess the development of logical concepts on the one hand, together with the development of related physical, spatial, and experimental concepts on the other. And, in addition to utilizing problems indigenous to the population studied, two further modifications in the conventional assessment procedures will be introduced. First, all individuals assessed will receive the same problems on two separate occasions. The first administration will serve as a familiarization session for the subject and as a diagnostic session for the interviewer. Information obtained will be used to facilitate communication during the second session. Second, beginning with the 6- or 7-year-olds, a training session will be introduced between the other two sessions. At this session the principles underlying each problem will be taught to each subject individually. For these subjects, additional, structurally parallel problems will be introduced at the third session to assess transfer of training. Combined, these modifications will greatly enhance our ability to assess cognitive competence rather than the ability to adapt to unfamiliar problems in unfamiliar settings.

Social development. The assessment of social development has two components, interviews and behavioral observations. All individuals 4 years of age or older who are selected for cognitive assessments will also be assessed on their level of social-cognitive development across a number of content domains. These will include procedures for assessing the development of: (a) social identity; (b) concepts of positive justice in young children; (c) moral judgements in childhood, adolescence and adulthood; (d) concepts of social organization and conventions; and(e) concepts of laws and regulations. Intensive consultations will be made with overseas colleagues in order to insure that the measures of social development are appropriate to the population studied.

A behavioral measure of social development will be obtained by taking narrative records of each subject's activities during critical periods of the day. For the children, a play period in the natural setting will be included. This naturalistic observation will focus on peer interactions. The second observational period will encompass the major meal time. These observations will focus on parent-child and parent-parent interactions. For adults, the meal-time observations will be supplemented by including observations on adult interactions outside of the home. This component of social assessment will be coordinated with the general random time sampling of behaviors described in preceding section.

G. Unit of Analysis: Household

1.FOOD PATTERNS AND RELATIVE DEPRIVATION.

A major interest of this research component is examination of the ability of a household unit to support itself nutritionally in a given

environment. This interest requires investigation of food patterns and their environmental contexts, synchronically and diachronically. Food patterns include: procurement, preparation methods, storage, distribution, and consumption; knowledge, values and attitudes about food; food uses on special occasions (e.g. festivals) and under special circumstances (e.g. ill-health); food and dietary histories. Also to be examined are the relationships of food patterns to the sociocultural and biophysical environments. Assessments of the effects/results of the patterns is part of the broader investigation, with dietary assessment a major emphasis. The latter is multi-purposed and provides part of the core of the informational base of the project. Other assessments include the more biographically-oriented aspects of the proposed research project, as well as the subjective assessment, relative deprivation which is the special concern of this component. Two parts of this component are explicitly diachronic: a) collection of food and dietary histories, especially on the household level, in part to ascertain pervasive nutritional experiences; and b) determination of relative deprivation (see below). The synchronic orientation encompasses: a) ongoing management and manipulation of food patterns to current assessments and biological states (e.g. pregnancy and lactation). Investigation of food patterns and relative deprivation is one of the interfaces between the nutritional/biological and the economic-administrative components. Clearly not separate from these other parts of the research, this area provides opportunities for integrating several research topics and activities.

For purposes of this research, food patterns may be usefully divided into resources and strategies. Three specific objectives of this part of the project are: 1) to examine management of nutritionally relevant resources (e.g., cash, credit, commodities, kinsmen, comestibles) and the environmental context of such manipulation; 2) to describe resulting household food patterns; and 3) to explore the relationship between food patterns and people's sense of well-being in terms of relative deprivation.

Relative deprivation is defined as the gap between preferred and actual levels of food intake, although in the literature this terminology is not consistent or precisely defined. In addition to food itself, the comparison with former (perhaps also 'rightful' or 'expected') status vis à vis food is of concern here. It is expected that preferences and such self-comparisons or evaluations will include aspects of food constituting culturally defined qualities as well as desired food quantities. The concept therefore can be applied more broadly to food patterns rather than being restricted to intake levels.

Since this component of the research project is closely linked with the independent variable food intake, some of the data collection will coincide with sampling procedures and field survey enumeration described for the nutritional and health status component of this research. For example, the household food inventory schedule provides one opportunity to elicit particular information on food procurement, storage, and inter-household distribution, and uses of nutritionally-relevant resources. This information will be obtained through interviewing techniques such as limited structured, serial structured and unstructured interviews. Structured observations in conjunction with the household sampling schedule will also be possible. As is true for the entire proposal, a combination of nutritional/biomedical and social science approaches will be utilized in data-gathering. The general approach of this component is an anthropological field study incorporating the use of respondents and participant observation. Participant observation simply implies that the field researcher

takes part to varying degrees in daily and special activities of the study population. Field data records will include field notes, maps, photographs, unstructured interviews, questionnaires (if needed), structured observations, food intake measures (e.g. quantitative child-intake records obtained by the child-following technique), and such elicited materials as household case histories. Insofar as possible, independent measures of related data on the household level will be sought in order to cross-check information.

Since the research design of this component is a field study and not merely a survey, the cross-check procedures are feasible. It should be noted that some research activities listed below are concurrent, some ongoing, and some recurrent; some of the activities are shared with other components. The tentative outline of major anthropological research activities is as follows: a) initial preliminary census interviews and selection of household sample; b) description of the household units and environmental contexts; c) ascertainment and utilization of public information (public records, maps, etc.); d) implementation of food intake survey (includes the household food inventory); e) implementation of a community census; f) involvement in unstructured interviews on food patterns (includes both quantitative and descriptive data); g) development of a measure of relative deprivation; and h) collection of other elicited material (i.e., nutritionally-important resources). Participant observation will be used in these eight activities as well as particular techniques and methods as needed.

Methodologically, this anthropological component is designed to fulfill the need for detailed, ongoing household information to complement and complete the nutritional/biomedical information and the need for linkages between the household unit level of study and the broader community and institutional levels. Other social science components also provide some of these linkages.

Conceptually, this component will relate to nutritional/biomedical assessments of capacities and capabilities. For example, the research concern with relative deprivation focuses on a subjective judgment of capacity which complements the traditional emphasis on "nutritional status," an objective multi-measurement of capacity. Capability relates to ability and competence. Examination of food patterns is a particular aspect of such capability. The basic conception of a human system with capacities as well as capabilities also is included in other economic-administrative components. This conception is linked back to the focal relationship between intake and function by regarding that relationship as part of a multi-dimensional feedback loop involving both biological and societal concerns.

2. THE INTERDEPENDENCE OF INTAKE AND PRODUCTION.

This component and a second economic investigation (see next section) aim, in part, to explain the role of food intake, and of the need to insure minimal intakes, in governing patterns of household and village economies. Starting with an overall conceptualization of a community of households, each unit may be described in terms of its evolving resource patterns (including its pattern of labor force, its transactions, and its command of further resources, goods (including food), and services). The purpose is to enable simulation of the process of evolution of household arrays

(in which the size and composition of households is related to their access to resources and employment) in order to understand the key determinants of change in the numbers of dependent households (households unable to ensure adequate intakes by their own resources.)

Emphasis is on the consequences of malnutrition, together perhaps with the threat of hunger; for household behavior as this in turn governs subsequent household productivity and earning, intake patterns, behavior, and function generally. An understanding of these relationships might contribute to the design of social action to reduce malnutrition and minimize its repercussions. Next, research will focus on general equilibrium and dynamic properties of communities of interacting households with respect to patterns of intake and function of different categories of households (to be defined by the study) and attempt to identify characteristics of the institutional framework (e.g. inheritance, land use rules, credit institutions) that are significant in producing the observed and postulated patterns of intake/function. Ultimately, a model will be developed to simulate long-term trends in intake and function and in relevant institutional changes in the community. The significance of this research is that it studies the role of social institutions in mediating the relationship between intake and function, i.e. the two-way relationship in which intakes affect and are affected by social institutions.

The central methodology of this component is linear programming used as a technique for exploring alternative household strategies for allocating time and resources and for appraising observed household behaviors as they relate to the provision of food and its destribution over time and between people. The final outcome is seen as a definition of the social/institutional framework in which households interrelate and which mediates the cumulative social impacts of experiences or threats of malnutrition.

H. Unit of Analysis: Community and Institutions

1. ADMINISTRATIVE MECHANISMS OF FEEDBACK AND ERROR CORRECTION.

The ultimate purpose of the research project is to strengthen the capacity of developing nations to deal with the problems associated with malnutrition. Since the project focuses upon the consequences and not the causes of low intake, it will establish how serious the problems are but will not directly indicate how they might be solved. The utility of the entire project to policy-makers will be greatly increased by this social science research component which supplements and draws on the findings produced by the project's life scientists. The purpose of this investigation is to indicate the manner in which the particular systems under study could most appropriately be strengthened in their capacity for dealing with malnutrition. This research is a central component of the study of the relationship between deficient intake and "social competence" in a community, studying, especially, societal competence in response to the threat or existence of malnutrition.

The social, economic and technical conditions of production and existence are changing constantly, and the past and future thus pose an unending series of challenges to the nutritional status of some individuals and communities. It is impossible to anticipate, much less prevent, the nutritionally damaging components of all change. Many of these challenges are met by adjustments in the market and in the behavior of families. Other changes are not met effectively by these relatively micro-level responses, however, and produce pervasive problems of deficient intake. A nation therefore needs an institutional framework for dealing with changes in nutritional status as much

as it needs policies attuned to dealing with current malnutrition. Social competence exists at the levels of family, market, community and national behavior and is both affected by and affects nutritional deficiencies.

A set of community and national feedback and error-correction institutions depends on the effectiveness of three components: (1) problem identification mechanisms, which will detect the existence of a nutritional problem quickly and reliably; (2) decision-making institutions, which will make competent and binding decisions to deal with the problem; and (3) implementation mechanisms which will move forcefully and effectively to execute the decisions made. The effectiveness of a nation or community in feedback and error correction on nutritional matters depends on the interaction and operation of all three components. Frequently one finds situations in which error correction is better dealt with by three imperfect components which work very well together than by a system which has excellent components which are poorly articulated with one another. For example, a problem identification mechanism which is highly proficient and located in a Ministry of Health, with decisions and implementation being undertaken in a Ministry of Agriculture,might work less well than a set of mechanisms that were separately less proficient but were all in one or the other ministry. The "best" is often the enemy of the practical, and a major objective is to discover what will work.

A community's and nation's feedback and error-correction institutions for nutrition will be investigated in the following manner: a sample of present and past challenges to nutritional status will be drawn; and the experience of the community and the state and national administration in identifying and dealing with these problems will be investigated. The sample will be composed of two parts. The first will be the present and past nutritional problems which are identified by the larger research project itself. (This sample, because it focuses on problems that remain pervasive, will tend to highlight the shortcomings of the existing institutional structures. It is important that it be supplemented by another sample in which there is a good chance of finding successful responses, where problems were solved before they became pervasive.) The second sample will be drawn from an investigation of government initiatives for change in agricultural production in the area. Government files will be checked and local respondents interviewed concerning the potential problems which the initiative posed for nutrition.

Having identified situations in which nutritional problems needed to be solved, the research will then focus on the manner in which the feedback and error-correction processes worked, where they were successful and where they were subject to delays, blockages and mistakes. This investigation will be conducted through study of relevant government files and interviews with community and administrative informants. The researchers intend to be open minded and broad about the range of community and administrative institutions which will be explored. The point is to identify the ways in which a community or nation deals best with its nutritional problems, not to evaluate any one particular institution. In principle, effective response mechanisms might be found in any one of the following: informal community social structures (traditional or new), community official councils, religious bodies, the courts, administrative personnel operating at any level from the village to the capital, functional administrative bodies composed of anything from generalists to health or agricultural specialists, private medical practitioners, and so on. Thus this research component attempts to discover whether nutritional problems in practice are best dealt with by institutions which are: private or governmental, centralized or decentralized, generalist or specialized, a particular type of specialty, or

some combination of these types of structures. The prospects are that it will be found that some types of challenges to nutritional status are well dealt with by one set of institutions and another type by a different set.

A brief methodological note is in order here about units of analysis and quantification. The units of measurement for this particular study are challenges to nutritional status. These units will be systematically selected. However, the intent is to be unstructured and diagnostic in collecting data on what institutions responded to these challenges and how. Systematic, quantitative analysis of the relative success of different feedback and error-correction "treatments" to challenges will then be made. This will be supplemented by qualitative analysis of the same material.

The research proposed here seems essential if the results of the larger project are to be translated into effective policy recommendations. At a minimum, it will be conducted at the site assigned to the University of California, Berkeley. Ideally, such research would be carried out at all the sites, however. This broader coverage would facilitate the development of policy recommendations for those sites. In addition, the observations common to the funded projects would indicate generalizations about appropriate institutions that would have a high probability of applicability to a range of other developing countries. The greater the degree of institutional variation between research sites, the greater the richness and reliability of the findings will be. In particular, it would seem desirable to have differences between countries in which this kind of study is being done along the following dimensions: centralization, colonial heritage (as each metropolitan country tended to create a similar set of institutions), orientation of national policy toward the poor, and relative importance of subsistence agriculture.

2.NUTRITION AND ECONOMIC FUNCTION IN COMPARATIVE COMMUNITIES.

Most economic analysis has been developed under the implicit assumption that people are adequately nourished. Ratioanl economic functioning then is interpreted as a choice about consumption and production,based on utility and profit maximization. However, when the level of income is so low that it barely suffices for marginal fulfillment of basic needs, such as food, clothing, and shelter, the functioning of indiviudals, households and communities as economic units and the nature of the economic environment in which they operate are drastically altered. Not only is the individual's transformation between available labor-time and productive labor-time affected, but the processes of wage determination and of the allocation of the use of land and credit are affected as well.

It is hypothesized that a major criterion of the organization of the village economy is to ensure low-income households of adequate, stable food supplies in the face of seasonal and weather-induced fluctuations in their marketable surplus. This is accomplished by institutional arrangements which interlink the provision of access to credit and land to low-income households to the provision of peak-time labor and crop-sharing contracts to the landlord. Departure from standard patterns of food production via, for instance, improved technology are seen as intensely risky, and their adoption depends very much on the initial level of well-being of the individual. The research described in this component will attempt to analyze the economic functioning of local institutions under conditions in which many indiviudals in different communities have very low food intakes.

A comparative study is proposed encompassing economic groups in different sociocultural conditions and varied levels of food intake. It is proposed that the study be carried out using appropriate study communities included in the total CRSP as case studies. By controlling for the few separate factors that have affected the evolution of the communities differently, common patterns of economic behavior are likely to emerge that can be generalized into a theory of economic function under subsistence and uncertain food supply conditions. The evolution, over time, of the affected economic groups will be studied in a model of household behavior and interaction in subsistence communities. The internal as well as external constraints imposed on household functioning at these low-income levels will be identified, and their relationships with the maintenance of poverty will be clarified.

This research component will implement an empirically well-grounded mathematical model of the household decision processes in the survival-oriented institutional framework of the traditional village economy. The dynamic evolution of a population in a number of household categories will be traced as they interact in the quasi-markets for labor, land, credit, and commodities within the risk-minimizing village economic intitutional setting. It is expected that the combined result of the institutional ways of insuring against falling below subsistence food requirements is, in the medium run, to perpetuate poverty and quasi-feudal economic relations within a stagnant agricultural village system. Another expectation is that when the traditional system is replaced by a pure market system, without any extra institutional provisions directly or indirectly to ensure subsistence food supplies, the situation of the poor becomes actually worse: a process of successive marginalization, displacement, greater indenture, and indebtedness increases the numbers falling below subsistence. Simple solutions are not forthcoming because the structure of the economic system under which many undernourished people function does not allow for the efficient conduct of nutrition intervention and other development policies. It is the relation between this structure and the people affected by it that this research will attempt to untangle.

A rigorous formal theory of economic functioning under subsistence conditions has not emerged from previous research. Absent are explanations of the reasons for the structure of land, credit, and commodity markets and the reasons for the structure of the labor markets within which outside employment is sought by the subsistence farmers. Several studies have examined the imperfections in the labor, credit, and other factor markets as explanations of poverty. The research concentrated on how the interlinkage of various factor markets reinforces poverty, on how individual transactions are interlocked and result in maintenance of stagnant subsistence agriculture, and how differential adjustment mechanisms operate in the different markets. Many of the basic assumptions of the models remain untested and the need exists for constructing a rigorous analytical framework to incorporate all meaningful relations.

This research will evolve in three general phases, each lasting approximately one year. First, a preliminary theoretical background for the study will be formulated as a basis for subsequent data collection. The theory will provide the appropriate hypotheses to be tested by the data and formulate the models that will from the basis for later analyses. After visits to field sites and collaborative interdisciplinary discussions a feasible empirical research package will be designed that will yield information necessary for the analysis in the later phases. The second year will involve extensive data collection in the field. The initial design and programming of relevant modeling software for the subsequent empirical

analysis will also be started during this phase. The final phase will involve mainly analysis of the data; refinement of the models developed; and other aspects of write-up and dissemination as stated for the overall research project.

I. Data Management

Data management is an ongoing concern throughout the three major phases of this research project, although certain phases and research components present particular concerns. Major responsibilities of data management include: coordination with work force and equipment needs in the active data collection phases of the project; non-duplication of data collection efforts; facilitation of computer processing; and ensurance of accessibility, distribution, and security of research data and materials. It is anticipated that field data will be directed to a central field location for initial processing. Subsequently, data management centers will be established at both of the main collaborating institutions.

The management of data will be as follows:

1. Each person in the community will be assigned a code number. The code identification will be kept in a separate locked file with controlled access. This file of information will be kept current and available only to senior scientific investigators. This coding will preserve the confidentiality of the individual respondents. Any basic information gained by any investigator will be added to this file.

2. A second file will be kept by household. Each household will also be assigned a code number. The correspondence between household and number will be kept confidential in a separate locked file with controlled access. This identification number will be catalogued with the code numbers of all members of the household. The membership composition of the household will be kept current and avaiable to only senior scientific investigators.

3. A third file will be kept on community data.

4. A fourth file will be kept on environmental data

5. Each investigator has defined a topical area with a data core for which s/he is responsible, as presented in the research components. Each researcher will also identify specific data which are likely to provide complementary interconnections between various components. All data collected by scientific participants will be available to all other such participating researchers upon request.

6. Types of data to collected and methods of analysis as well as any special concerns or considerations will be shared with all investigators before fieldwork begins. Any changes or emerging collection or management problems will also be discussed by all researchers as soon as possible.

Adequate computer facilities exist at participating U.S. institutions. It is anticipated that language and data storage and retrieval systems will be agreed upon by all participants in the CRSP, to which this project will conform.

Statistical methods of multivariate, multifactorial analysis may be another area for CRSP standardization, supplemented by initiatives of individual project statisticians.

TABLE 1

Criteria for Selection of Communities

Characteristics Sought	Indicators of Characteristic
Stability- to minimize attrition and loss of repeated data collection capabilities and need for follow-up in different settings	low migration rates, minimal labor translocations, reasonable assurance of absence of major disruptions of the socio-political milieu of the community
Homogeneity- Particularly if more than one village needs to be utilized. To reduce variability of biologic variables, divergence of food patterns and family structure and interactions.	Variables not essential to the hypothesis, but likely to confound, are homogeneously distributed across the selected community,(e.g. water supplies and health facilities). Little genetic, ethnic and cultural diversity in the selected community.
Appropriate Size-	Provides either an adequate sampling frame for sample size ultimately determined or, if smaller communities need to be utilized, large enough for a whole population sample (preferably) or: Each of several communities selected must fulfill all criteria and in addition be comparable to each other in vital, ethnographic, demographic and environmental characteristics.
Appropriate Range of Nutrient Intake-	Evidence such as observable status or previous studies provides a reasonable judgement that a suitable range of nutrient intake levels exists in the population.
Adequate Infrastructure-	Sufficient organization to provide continuing communication with the population, to assist in obtaining informed consent, and to assist in maintaining population cooperation to minimize attrition.
Exclusions- Commu ies which do not satisfy all the c ria above must not be considered for the project.	Other conditions requiring exclusion are a high prevalence of a complicating variable (e.g. diabetes, endemic malaria, voluntary abortion rate), a very low birth rate, atypically high mortality rate among young adults.

Table IV-2 - Projected Numbers of Births and Cohorts for a Sample of 200 Families Over 2 Years [1]

Months of Study \ Age in months	Births	0-2	3-5	6-8	9-11	12-14	15-17	18-20	21-23	
0-2	12	11.0[2] (1.0)	-	-	-	-	-	-	-	
3-5	12	11.0 (1.0)	10.5 (0.5)	-	-	-	-	-	-	
6-8	12	11.0 (1.0)	10.5 (0.5)	10.0 (0.5)	-	-	-	-	-	
9-11	12	11.0 (1.0)	10.5 (0.5)	10.0 (0.5)	9.50 (0.5)	-	-	-	-	
12-14	12	11.0 (1.0)	10.5 (0.5)	10.0 (0.5)	9.50 (0.5)	9.10 (0.4)	-	-	-	
15-17	12	11.0 (1.0)	10.5 (0.5)	10.0 (0.5)	9.50 (0.5)	9.10 (0.4)	6.75 (0.35)	-	-	
18-20	12	11.0 (1.0)	10.5 (0.5)	10.0 (0.5)	9.50 (0.5)	9.10 (0.4)	6.75 (0.35)	6.50 (0.25)	-	
21-23	12	11.0 (1.0)	10.5 (0.5)	10.0 (0.5)	9.50 (0.5)	9.10 (0.4)	6.75 (0.35)	6.50 (0.25)	6.25 (0.25)	total deaths 3.75 = 31.25%
Total with complete history from birth	96 in age	88.0 (8.0)	73.5 (3.5)	60.0 (3.0)	47.5 (2.5)	36.4 (1.6)	26.25 (1.05)	13.0 (0.5)	6.25 (0.25)	

Footnotes to Table 2

[1]Assumptions of model

attrition rate : 0 (on decision, sample size will increase)

birth rate (live births) : 48/100 couples/year in study population (selected as reproductively active)

reproductively active couples comprise 50% of the families

rates:

0-3 months mortality rate	40/1000 live births
4-12 months mortality rate	40/1000 live births
1-4 year mortality rate	100/1000 live births
1-4 year death rate	40/1000 children in age group

[2]Remaining subjects (deaths)

Table 3

Core Anthopometry Measurements

Group	Measurement	Frequency
newborn	birthweight* length head circumference	once withtin 24 hours of birth
first year 0 - 12 months	weight length head circumference iliac crest to heel length	monthly
second year 13 - 24 months	weight length head circumference arm circumference skin folds**	monthly
prepubertal 3 - 11 years	weight length-height arm circumference skin folds**	every 3 months
	head circumference	initially then once/year
puberty - 18	weight height arm circumference skin folds**	every 3 months
	head circumference	initially
adulthood > 18 years	weight arm circumference skin folds**	every 3 months
	head circumference height	initially
pregnancy	weight arm circumference skin folds**	upon detection of pregnancy and monthly thereafter
lactation	weight arm circumference skin folds**	monthly through weaning***

* Dubowitz exam for all infants < 2800 grams
** Triceps, biceps, suprailiac, subscapular
*** Weaning = breast feeding < 3 times per day

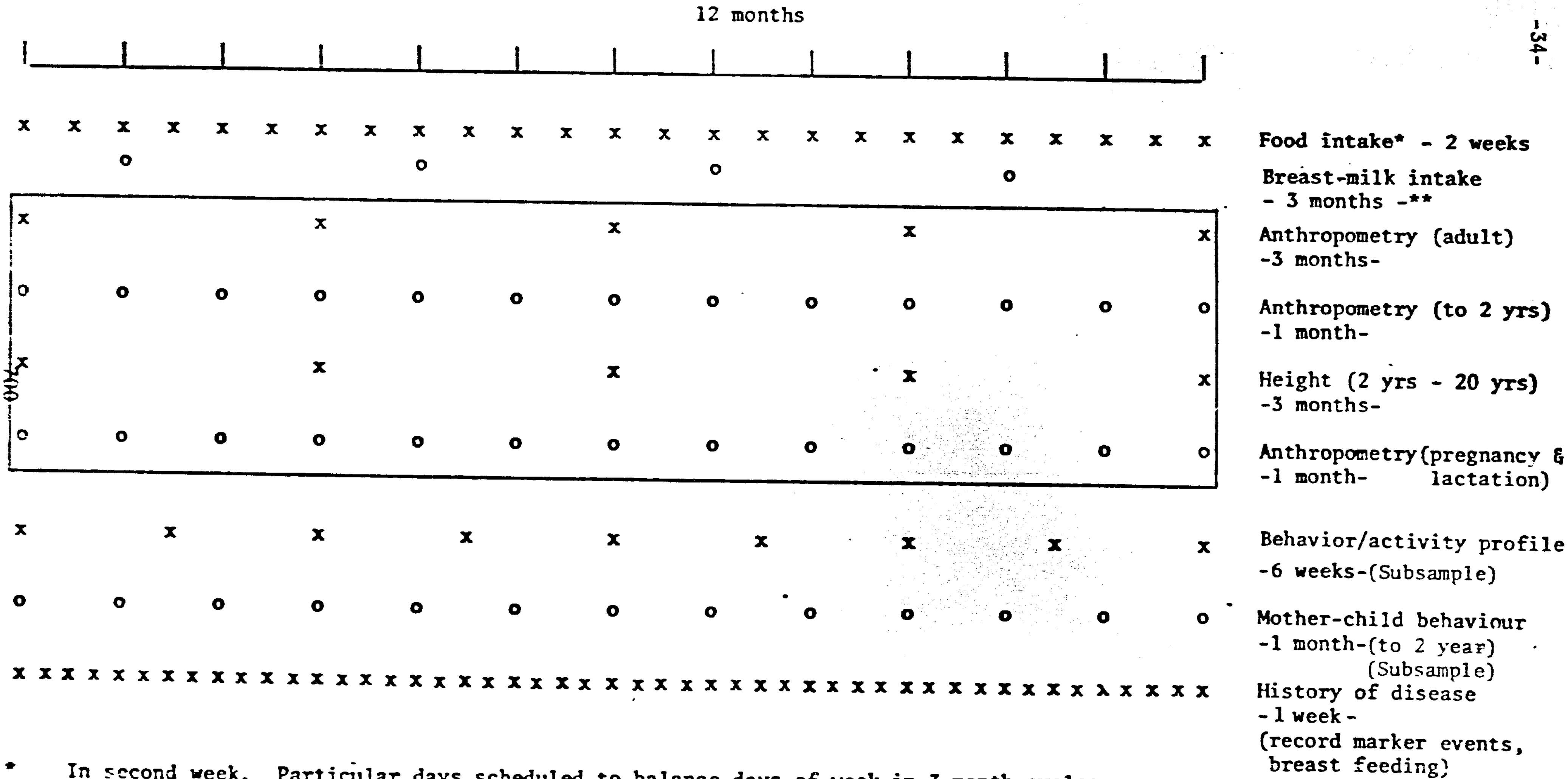
Table 4

Other Indicators of Nutritional Status to be Recorded

Indicator	Minumum Frequency
Clinical signs/symptoms of nutritional deficiency	Initially and with anthropometry
Hematocrit, serum albumin	Initially and two times per year
Urine osmolarily/specific gravity	Adults -- seasonally and, in lactating women, when breast milk output is measured
Urine 24-hour creatinine	Lactating women when breast-milk output is measured
Serum/blood/RBC/urine levels of vitamins, minerals (especially vitamin A, carotene, folacin, vitamin B-6, B-12, riboflavin, thiamin, iron, zinc, copper)	As indicated by clinical signs, probable intake, or previous experience.* If indicated, once per year.

* Individual projects should regularly measure status of those vitamins, minerals, etc. found to be significantly low in 20% or more of the population.

Figure 1---Core Research Design: Minumum Measurement Cycles



* In second week. Particular days scheduled to balance days of week in 3-month cycles.
** In fourth week after birth and 3-month intervals thereafter until weaning.
NOTE: Above describes intervals for an individual family. Across study population, families would be phased to distribute load. Cycle to be repeated in the second year.

INDIA PROJECT

Budget Summary; Year 1 (March, 1980 dollars)

	Rupees $ equivalent	US actual dollars
Personnel	49,000	47,000
Equipment & facilities	15,100	19,100
Supplies & Expenses	33,100	2,500
Travel	30,200	4,800
Fringe benefits & overhead(provisional)	----	18,800
	127,400	92,200

Detailed Budget, Year 1

A. PERSONNEL .....$49,500 (R)*
$47,000 (US)**

1. Salary and Wages, India $49,500(equivalent Rupees)

a. Professionals:

1. Physicians (none full-time)	4.0 @ 2,000	8,000
2. Registered nurses	2.0 @ 1,800	3,600
6, 1 mo. each		
1, 2 mo. each + training time		
1, 12 mo.		
3. Lab. technician/chemist	3.0 @ 1,800	5,400
4. Economists	2.0 @ 2,000	4,000
5. Post-graduate trainees	4.0 @ $ budget	
6. Statistician/programmer	1.0 @ 2,000	2,000
7. Statistical clerk	2.0 @ 1,000	2,000
b. Auxiliary Nurse-Midwives	3.0 @ 800	2,400
c. Enumerators/Interivewers	13.0 @ 1,200	15,600
d. Administrative Assistant	1.0 @ 1,800	1,800
e. Secretary(ies)	1.0 @ 1,500	1,500
f. Office and clerical	1.0 @ 1,200	1,200
g. Van driver	1.0 @ 1,000	1,000
h. "Housekeeper"	1.0 @ 1,000	1,000

2. Salary and Wages, United States $47,000(US dollars)

a. Senior social scientist	.025	8,000
b. Social scientists, field res.	.075 (year 2, 1.5) (year 3, 2.0)	15,000
c. Indian post-doctoral trainees, stipends and fees	3 FTE	24,000

*(R) = rupees, U.S. equivalent
**(US) = actual U.S. currency

Detailed Budget, Year 1

B. EQUIPMENT AND FACILITIES.....15,100 (R)
19,100(US)

1. Furniture:

Office (some from collaboration).....1,600(R)
Housing (some from collaboration).....2,000(R)
Typewriters, 3 @ 1,000 each.....3,000(US)
Bicycles, 5 @ $100 each..... 500(R)
Central office space -- to be provided.....No charge

2. Vehicle.....10,000(R)

3. Electronic balances (infant-weighing).....8,000(US)

4. Audiovisual equipment.....6,000(US)

5. Skinfold calipers..... 600(US)

6. Portable scales, adult..... 500(US)

7. Miscellaneous small equipment.....1,000(R)

C. SUPPLIES AND EXPENSE.....33,100 (R)
2,500(US)

1. Chemicals and glassware.....8,000(R)

2. Gasoline and upkeep of van.....2,500(R)

3. Housing.....2,400(R)

a. A house in a study village, having three sleeping rooms for two persons each; electric current and septic tank if possible, @ $100/month..... 1,200
b. Living quarters for local field workers nearby but not in the study villages, @ $100/month..... 1,200

4. Forms and paper supplies.....5,000(R)

5. Computer time.....2,500(R)

6. Communication & shipping... a.(India).....5,000(R)
... b.(US).....2,500(US)

7. Film processing..... 500(R)

8. Food and transport for survey teams:
yrs 1, 2, and 3: 24 people @ $10/day for 30 days.....7,200(R)

D. TRAVEL

1. Domestic: a) U.S. staff: capital → site → return
12 trips/yr@approx. $150/trip..2,000(R)
b) Local officials, collaborators:
capital → site → return
12 trips/yr@approx. $150/trip..2,000(R)

2. Foreign: a) 3 trainees to US@$1000 each
(one-way in year 1).....4,000(R)
b) 3 senior staff to US @ $2,000 each.....6,000(R)
c) 6 US staff to India + $10 per diem
each @ $2,700.....16,200(R)
d) US per diem + misc. US expenses
for Indian scientists.....4,800(US)

BUDGET JUSTIFICATION

A. PERSONNEL

1. Estimate and Justification of Overseas Field Staff Requirements

a. Survey, preliminary and follow-ups

1) 1 M.D.
2) Collaborating professionals and medical students
3) 2 Nutritionists (1 local + 1 US or collaborating professional;no charge)
4) 1 R.N. = auxiliary

1-4) Assume 24 persons surveyed/team/day; 4000 persons to be surveyed per year; thus 167 team-days/survey
One survey per year in years 1, 2, and 3

Need 6 teams to complete annual survey in one month.

5) Laboratory technician for PCV's, etc..... 0.5 FTE**technician

b. Food intake..... from 3rd qtr. of yr 1 through 3rd qtr of yr 3

1) 24-hr recall with heights, weights and medical form:
2-person team; 2 hr/house; 4 hshlds/day; 100 hshlds/mo.. 2 FTE

2) 24-hr recall only:
1 person; 0.75 hr/house; 6 hshlds/day; 500 hshlds/mo.... 4 FTE

3) Inventory with meds.:
1 person; 2 hr/house; 4 hshlds/day; 100 hshlds/mo..... 2 FTE

4) Dietary history:
2 person team[a]; 1 hr/house/ 6 hshlds/day;
300 hshlds (one time only); 50 days total..... O.T.*

[a]US field nutritionist + local.

5) Nutrition history:
2-person team; 1 hr/house; 6 hshlds/day;
300 hshlds (one time only); 50 days total..... O.T.*

6) Infant test-weighing (n=75)
(with body temp. record; with observ. maternal intake)
12 hr/infant; 0.75/day; n=25/mo; 33 working days/mo

7) Child-following (n=60)
12 hr/child; 0.75/day; n=180 observ./yr; 240 days/yr.... 1 FTE

8) Food analysis..... ca.1 FTE Technician

---

* O.T. indicates one time only.

** FTE = full-time equivalent, may be more than one individual

A. PERSONNEL (cont'd)

1. Estimate and Justification of Overseas Field Staff Requirements (cont'd)

c. Nutritional and health status

1) Comprehensive medical exam, including sensory, to supplement survey exam:
n=1500; 16 persons/day, each nurse+M.D. team; 100 days total O.T.*

2) Basal or resting metabolic rates (with temperatures)
45/month; 6/day in about 2 hr=eight quarter-days/mo.
Technician (24 days/yr).....ca.025FTE Technician

3) Urinary creatinine:
n = 100 samples/mo.....ca.025FTE Technician

d. Disease

Data base from above
Community records -- clerical
Participating M.D. collaboration -- community med. or P.H.

e. Reproduction

Data base from above
Community records -- clerical
Participating M.D. collaboration-
- obstetrician and pediatrician.....1 FTE

f. Activity

Energy expenditure, at work
300 subjects x 6 activities = 1800 measures/yr

36 measures/day, thus 50 days/yr, requiring 1 Technician
with US staff (2 mo.Technician=ca.0.15 FTE Technician)...0.5 FTE Technician

g. Activity diaries

Coding and transcription: 1 hr each; 300-500/yr.....0.25 FTE Technician
(2-3 mo. Tech. = ca. 0.15-0.25 FTE Tech.)

Random sampling activity.....1 FTE
Post-graduate, for training, 1 on U.C. budget
Clerical

h. Cognitive.....2 FTE

Translators and recorders
Post-graduate, for training, 1 on U.C. budget
Clerical

i. Diet potential

Local professional-level economist.....1 FTE
Clerical

j. Administrative mechanisms

Clerical only

k. Nutrition and economics

Local professional-level economist.....1 FTE
Post-graduate, for training, 2 on U.C. budget
Clerical

*O.T. indicates one time only.

A. PERSONNEL (cont'd)

2. US Personnel

Social scientists are needed for on-site training of Indian professionals and for participation in the initial research effort. In the first three years it is anticipated that a senior scientist will devote 25% time to the effort and others the equivalent of 75% time. In year two contribution of field investigators should increase to 1.5 FTE and in year three, to 2.0 FTE. If the project extends to years 4 and 5, the work would mainly be the responsibility of Indian professionals trained in years 1-3. It is anticipated that about three other US professionals will participate in the research, at no cost to the project except travel.

APPENDIX V-1

Correspondence Received Regarding Management

Dept. of Nutritional Sciences
University of California
Berkeley, CA 94720

August 30, 1979

T. Kelley White
Office of the Director
International Programs in Agriculture
Purdue University
Agricultural Administration Building
West Lafayette, Indiana 47907

Dear Dr. White:

I have received your communication on the nature of the management entity and fear that there are fundamental misunderstandings concerning the consultation recently held and issues of future scientific and fiscal management.

I convened the meeting on August 13 and 14 at the University of California, Berkeley, to consult with members of institutions that might be included in the Nutrition CRSP if the projects are acceptable to the USAID, their country missions and to BIFAD. We stated explicitly at the meeting that binding decisions could not be taken at that time. The purpose of the consultation was to discuss alternative styles of management that should cover the concerns of any future group of collaborators. It is my expectation that, even if the four institutions consulted are the institutions initially selected, the CRSP will ultimately include additional institutions. Management design should provide for this additional participation with full partnership of these principals in a future expanded CRSP.

It has been my experience in consultations of this kind that the offering of a working paper is conducive to bringing focus efficiently to bear on key issues. I thought that all members understood that the working paper from Berkeley like the documents provided by Purdue, was submitted with that in mind. The working papers from both Berkeley and Purdue did stimulate discussion of the management structure and helped the participants resolve important issues.

The consultation appears to have succeeded because most of the criteria you have listed for guiding decisions concerning the management structure were in fact resolved in the course of the two-day meeting as the enclosed minutes of the meeting show. The group concurred in a decision to recommend to AID the formation of a Scientific Coordination Committee that would advise and guide the Program Director in matters of scientific coordination and management. While decisions concerning research protocols and methods, etc. have financial implications, the decisions concerning what must be done and how best to proceed with research can only be taken by the investigators themselves. I believe that all of the investigators

would be happy to have their institutional administrative/financial officers resolve matters of a purely administrative nature with AID. The group recommended that there could be an Inter-Institutional Administrative Committee that could fulfill these functions. What needs to be resolved are the boundaries of authority and responsibilities of both the proposed committees.

The participants in this consultation recognized that the nature of this Nutrition CRSP is different from that of the existing CRSP's. We are dealing with longitudinal human experimentation and the need to consolidate information obtained across all projects if stated program objectives are to be met. This requires a larger investment in scientific management to ensure the smooth functioning and integration of the individual projects. For this reason the group concluded that scientific management and other administration must not be separated but be vested in one institution. This does not indicate subordinate scientific roles for any of the participants but does presume that scientists themselves can manage scientific collaborative research and can work together in a spirit of cooperation and mutual trust. (There appears to be a pervasive notion that scientists cannot administer. It surprises me that this view persists in spite of the demonstrated administrative capabilities of deans and provosts who have emerged from academic ranks.)

Although I did not solicit further recommendations at this time on the nature of the management entity, I am grateful for your comments. Your letter does not, however, indicate, as was requested, whether or not Purdue would wish to be considered for designation as prime contractor and if so the person to be named scientific Program Director. I also asked for suggestions of people to serve on an External Advisory and Review Committee, including an administrator (preferably from a research foundation or similar body).

The institution to serve in the capacity of prime contractor obviously cannot be selected until the principals are known. The institution and the Program Director will then be chosen by USAID. What we seek now is information from which to develop elements of a possible entity that will form the basis of further communication among the principals and that ultimately I can recommend to USAID, JRC, and BIFAD, as the planning grant obligates me to do.

I appreciate your constructive criticism and hope that you yourself may participate in future meetings where financial and related issues are to be adjudicated.

Sincerely,

Doris Howes Calloway
Professor of Nutrition

DHC:jj

Enclosure

PURDUE UNIVERSITY INTERNATIONAL PROGRAMS IN AGRICULTURE

Office of the Director

August 23, 1979

Dr. Doris Calloway, Chairman
Department of Nutritional Sciences
University of California-Berkeley
Berkeley, CA 94720

Dear Dr. Calloway:

I am writing to follow up on the meeting held in Berkeley on August 13 and 14 by representatives of the four institutions which will constitute the Nutrition CRSP. I have had briefing sessions with Drs. Smith and Watson, and we have had a meeting with faculty and administration at Purdue University who will be intimately involved in Purdue's portion of the nutrition program. It is our understanding that, while there was considerable discussion of the administrative and management structures that could be adopted for implementation and operation of the collaborative program, there were differences of opinion and that no firm concensus was reached. Further, we understand that each institution was asked to submit to you expressions of their interest in serving as the administrative entity or suggestions for other institutions that they would prefer as the administrative entity and to provide recommendations for individuals to serve as program director. We are concerned that the participating institutions have failed, thus far, to reach agreement on an administrative-management structure which will define the roles and interrelationships among the member institutions, the administrative entity (primary grant recipient institution) and the program director. We also feel that it is premature to make decisions concerning the institution to serve as grant recipient and administrative entity or to identify an individual to serve as program director before the broader and more fundamental questions of the administrative-management structure are decided.

While AID requires that the collaborative research support grant be made to a legal entity which in most cases will be a single university and that the management entity will make subgrants to other participating institutions as a mechanism for distribution of funds, this does not necessarily imply a superior-subordinate relationship between the administrative entity (institution) and other members of the CRSP in the development and execution of operational policies and procedures or program objectives. In fact, it is our feeling that if this nutrition CRSP is going to be successful in the achievement of the objectives that have been set forward, it is imperative that the participating U.S. institutions and their respective faculties enter into this endeavor as a collaborative venture to which they have a joint commitment and in which they will have co-equal status. Further, we believe that it is very important that mutual agreement be reached on a management structure which reflects this joint commitment and co-equal status of

IPIA Agricultural Administration Building
West Lafayette, Indiana 47907
(317) 494-8753

participating universities prior to the naming of a university to serve as the management entity or the identification of a project director.

There are, I am sure, numerous ways that we can choose to organize ourselves in order to achieve the desired collective goal. However, I feel that there are a couple of characteristics that must be inherent in the management structure if it is going to adequately serve the needs of the CRSP in the long-run. First, there should be a representative body which serves the role of primary decision-maker with respect to broad policy issues and budgetary allocations among participating institutions as well as decisions concerning expansion and contraction of participation in the CRSP. With a small CRSP such as this one, this body probably should have representation from each U.S. institution. It is also probably preferrable that institutional representatives on this body be administrative rather than faculty personnel, although this may not be absolutely essential. It should be recognized that the purpose of a representative administrative decision-making group is not to look over the shoulder of the principal investigators, but to represent their interest in questions involving inter-institutional allocations and in dealing with AID and foreign country institutions.

Secondly, while the program director will, by necessity, be employeed by the institution serving as management entity, the program director should be jointly selected by participating universities through this representative group and should serve at the pleasure of the representative group. The director should be responsible for day-to-day implementation of policies mutual agreed upon by all participating institutions (or a majority thereof).

Third, we believe that the grant receiving institution (administrative entity) should look upon its role as one of serving the administrative needs of the member institutions in the conduct of the CRSP.

Fourth, there probably should also be a representative technical group made up of principal investigators who deal collectively with issues of research objectives, methodology and location of field activity over time. The technical committee should work closely with and be an advisory group to both the administrative group and the program director.

Fifth, the BIFAD and AID require that there be structured an external review committee which will provide oversight and guidance to the program over time.

We feel strongly that the long-run interest of the Nutrition CRSP will be better served if a management structure is adopted which possesses these general characteristics. As I have reviewed the paper which you distributed at the meeting in Berkeley for a suggested management organization, it appears to lack several of these characteristics. Specifically, it appears to suggest a superior-subordinate relationship between the institution serving as administrative entity and other participating institutions. I would suggest that

it may be necessary to reconvene representatives of the four universities who will be participants in the CRSP to further discuss management structure and reach a concensus prior to the submission of your recommendations to the Joint Research Committee.

In case you have not had an opportunity to look at it, I am enclosing a copy of the Memorandum of Understanding that has been signed by participating universities in the Sorghum/Millet CRSP which sets forth a management organization and defines the roles and responsibilities of various structural components in a fairly concise way. While I do not feel that the Nutrition CRSP need necessarily adopt the structure that has been agreed upon by the Sorghum/Millet CRSP, I do feel that the management structure adopted by the Sorghum/Millet CRSP incorporates those characteristics which demonstrate the recognition of mutual commitment and co-equal status of participating universities.

I will be happy to discuss any of these issues with you by telephone should you so desire.

Sincerely,

T. Kelley White

T. Kelley White
Director

TKW:vr

cc: Dr. Fred Hutchinson
Dr. D. Woods Thomas

Enclosure

August 18, 1979

Dr. Doris Calloway
Department of Nutritional Sciences
University of California
Berkeley, CA

Dear Doris:

Greetings from Hyanipom/Hayfork a most delightful area! It is hard to focus on the outside world from here!

The meeting on 8/13 and 8/14 was extremely helpful to me in providing a much better grasp of what this Title XII program is attempting - a very ambitious undertaking and a real challenge. Also the hospitality was appreciated - especially the Chinese Feast.

In giving some thought to the "management entity" and program director in terms of UCLA - doesn't the primary contractor have to be a land grant college? If this is not so an appropriate administrative unit on our campus might be OCOP or Office of Coordination of Overseas Projects. Possibly the School of Public Health could be the focus. The problem is that I will not be able to discuss this with anyone until the second week in September when I return.

As for a possible project director this is really difficult. The only individuals at UCLA School of Public Health that would be capable and experienced enough with field studies in a LDC are those who recently completed the project in Ghana. Several of the individuals might be available but none have had primary backgrounds in nutrition. Dr. Max Milner, although you have reservations about, has stated a desire to come to UCLA in some capacity.

Quite honestly it would seem that the most logical management entity belongs at UC Berkeley, with yourself as program director. If you could get strong administrative help than you would be able to play the key role of providing scientific leadership....

Charlotte Neumann

University of Hawaii at Manoa

College of Tropical Agriculture and Human Resources
Gilmore Hall 202 • 3050 Maile Way
Honolulu, Hawaii 96822

Office of the Dean and Director

August 29, 1979

Dr. Doris Calloway
Department of Nutritional Sciences
University of California
Berkeley, CA 94720

Dear Dr. Calloway:

This will respond to your request for follow-up written positions from the universities represented at the August 13-14 meeting at Berkeley.

First, let me express my personal appreciation for the chance to meet and participate with the representatives of the universities from the four states in attendance. I was, however, disappointed that the other universities did not have similar senior administrative participation, even though Purdue sent a well-briefed member to represent their administration. Since the meeting, I have held telephone discussions with both Dean David Schlegel of your College and Director Kelley White of Purdue. This has helped clarify the views I will set forth in this letter.

I strongly support your position that this CRSP should be based on a carefully developed, clearly defined research program with common goals, objectives and research methodology at the core of the program. This should allow for some flexibility for additional initiatives through the individual projects between participating universities and their host country counterparts, provided the common goals and objectives are fulfilled as a primary responsibility.

In order to do this, the program must be developed, coordinated and administered through a mutually agreed upon program director with high dedication and competence with full-time commitment to the success of this CRSP.

The areas that I do not feel comfortable about are how issues such as the commitment of participating universities, and arbitration of policy and administrative matters such as decisions ranging from budget allocation to policy issues involving USAID and host country participation can be adequately handled to insure a common program with mutual commitment among the partners rather than an umbrella contract to cover separate university programs funded under a pass through mechanism.

AN EQUAL OPPORTUNITY EMPLOYER

I would like to reiterate that each of the universities is committing state matching monies and reputation on this CRSP. I feel it must, therefore, have administrative commitment based on intimate understanding if the results are to be successful.

After having a chance to examine the agreement under which the sorghum millet CRSP will operate, which was distributed at the meeting, I feel it has substantial merit in meeting my concerns. This could fit into the general format in your "Proposal for Establishing Management Entity for Collaboratives Support Program on Nutritional Intake and Competecy" provided the Board of Directors outlined on page 5 of your document and in the first organizational chart were comprised of the administrators of the contracting universities.

I feel relatively satisfied with the structures proposed for technical development and filling the USAID evaluation requirements that evolved from the Berkeley meeting. This was primarily because the main representatives were the scientists. Perhaps, there was disproportionate time spent without agreement being reached on the role of the administrators and their part in insuring that the program was a mutual operation with one of their numbers handling the thankless job of being the management entity for the non-scientific functions. This is understandable under the circumstances of only partial administrative representation, which was not your intent. I feel this issue must be settled before the matters on contracting university and selection of program director are completed.

Hawaii does not seek being the contracting institution, but if for any reason the other institutions are not acceptable, we would be willing to take this responsibility. Our choices because of travel convenience would be either University of California or Purdue University.

We feel the most competent person to apply for the Program Director position should be recruited by the contracting institution upon recommendation of a selection committee representative of the participants and approved by their administrators. The director should serve the participating universities as their program director with the contracting university providing the means of hiring as a service to the participating institutions.

I understand you would like to be considered a candidate for this position. This would appear highly appropriate if you are willing to meet the conditions established for this position and the selection and approval process concurred. Undoubtedly, this would be most acceptable to you if the University of California was selected as contracting university.

Dr. Robert Van Reen will respond separately to your letter on rather detailed program and technical issues. He may wish to suggest additional names for the position of program director.

I would hope that the governing mechanism can be agreed upon soon, since, until this is done, I do not feel comfortable in seeing additional action on development of program details, selection of program director and contracting university.

Sincerely yours,

William R. Furtick

William R. Furtick
Dean

cc: Dr. Fred Hutchinson
Dr. D. Woods Thomas

APPENDIX V-2

University of Connecticut: Submission for Management

The University of Connecticut

STORRS, CONNECTICUT 06268

COLLEGE OF AGRICULTURE
AND NATURAL RESOURCES
Department of Nutritional Sciences

August 23, 1979

Dr. Doris Calloway
Professor of Nutrition
Department of Nutritional Sciences
University of California
Berkeley, California 94720

Dear Dr. Calloway:

This letter is in response to your request for a statement from the principal investigators concerning the institutional management and program director for the CRSP. The University of Connecticut would be pleased to accept the responsibility for the institutional management of the program, and there are a number of reasons why it would be appropriate for the program to be based here. These are detailed below. However, in the event that the University of Connecticut is not selected we cordially endorse your candidacy.

We expect that close contact between the program director and one of the on-going projects would facilitate the director's understanding of problems and issues -- to the enhancement of overall program management.

Advantages of the University of Connecticut as the Institutional Management Entity:

1. The "start-up" project of the CRSP is likely to be based at the University of Connecticut. Pending approval of the American Embassy in Mexico we should be ready to begin as soon as the project approval is given. The ethnographer for the initial stage of research (E. Messer, Yale) already has an approved leave-of-absence for the second semester of the 1979-80 academic year. Our Mexican Co-P.I. is also eager to move rapidly.

There are considerable advantages to having the larger administrative structure developed in close association with the initial stages of a project. Communication of problems and issues can be simplified by close proximity. Although the scientific aspects of the Mexican project and its management appear to be in hand, the project will be, in a sense, a field trial for the operation of the entire program. We perceive a great advantage in proximity of the start-up project as the central management. The benefits of this experience will then flow seriatim to all the projects in the program. The start-up project will have served as a de-bugging device, and subsequent projects will have the advantage of a smoothly functioning organization.

It is especially important for all of us that the initial project develops as smoothly and rapidly as possible to ensure that we maximize our opportunity for a favorable initial review by the funding agency.

2. The structure of research administration at the University of Connecticut. For several reasons, we feel that Connecticut is in an excellent position to serve as the managing institution for the CRSP. These include: (a) institutional commitment to international research, including the inauguration of a new Vice President and President who have strongly affirmed their intention to support and develop international research efforts, and (b) the structure of research administration.

a. University Commitment and Experience in International Research.
In our initial response to the CRSP request (November, 1978) we indicated the relatively extensive involvement of the University in international research. Since the preparation of our initial document, the Latin American Studies Center has received a grant, together with Yale University, to further develop its program. In addition, the School of Business Administration has also received U.S.O.E. support for internationalizing its curriculum. A proposal for establishment of a Middle East Study Center and a Center for World Education (largely School of Education) are under consideration by the University's administration. For many years our Institute of Public Service has provided, with federal assistance, training programs for a wide range of professionals, chiefly from the lesser developed countries. The newly-appointed Vice President for Graduate Education and Research has presented a plan to coordinate and encourage the development of the University's international research activities recognizing the requirements this entails for additional resources of space and funding. Thus, there is a particularly propitious climate for establishing the CRSP managment program here.

b. The University of Connecticut Research Foundation.
All research grants at the University of Connecticut are administered through a structure that is quite unique among state universities. The Grants and Contracts Office works closely with the Research Foundation, and indirect costs of grants and contracts are returned to the Foundation. The Connecticut General Assembly has condoned the use of such funds to support a variety of programs including faculty research, travel, graduate fellowships, and various forms of research program support.

3. Proximity. Compared to the other participating institutions, Connecticut has the advantage of relative proximity to the funding agency. This proximity, which could significantly reduce transportation and communication costs, would be an advantage to the program as a whole.

4. Finally, we should note that the University has an excellent Computer Center available for inter-project data analysis.

5. Program Director for the CRSP. We would not, of course, recommend that the management of the CRSP be based at the University of Connecticut without recommending an outstanding candidate for the position of Program Director. Dr. Kirvin L. Knox, currently Head of the Department of Nutritional Sciences, would be willing to assume the role of Program Director. He is an excellent scientist with a strong commitment to multidisciplinary research, and with a clear vision of the kinds of problems which such research entails. In our experience he has great insight into theoretical and methodological problems of this type of research, in part demonstrated by his development of a nutrition department that includes inter-disciplinary graduate studies and community-based research. He has worked closely in planning the outreach activities of the department. Moreover, he has extensive administrative experience, and is widely recognized in the University for administrative abilities.

Whatever institution is selected we feel it is important that the program director makes a long range commitment to the program in order to ensure continuity during the critical "phase-in" period and coordination thereafter. Dr. Knox is willing to make this commitment.

We are in the process of preparing a list of nominees for the external Scientific Advisory Board.

We hope that you will find these comments helpful, and we are looking forward to further discussion about them.

Sincerely yours,

Lindsay H. Allen

Lindsay H. Allen
Associate Professor
Department of Nutritional Sciences

Gretel H. Pelto

Gretel H. Pelto
Assistant Professor
Department of Nutritional Sciences

LHA/GHP/tcn

cc - V.P. for Academic Affairs, - K. G. Wilson
V.P. for Grad. Studies, - Dr. DiBenedetto
Dean Hugh Clark, Research Foundation, Dean Kersting, CANR & K. L. Knox

The University of Connecticut

STORRS, CONNECTICUT 06268

COLLEGE OF AGRICULTURE
AND NATURAL RESOURCES
Department of Nutritional Sciences

September 5, 1979

Dr. Doris Calloway
Professor of Nutrition
Department of Nutritional Sciences
Agnes Fay Morgan Building
University of California
Berkeley, California 94720

Re: Program Director - USAID Title XII: Collaborative Research Support Program on Intake and Function

Dear Professor Calloway:

I have discussed with Dr's Allen and Pelto and the University of Connecticut Administration the possibility of our University becoming the USAID Title XII "Lead Institution" and of my being designated "Program Director". I support Gretel's and Lindsay's nomination of the University of Connecticut as the USAID Title XII Institutional Management Entity, and if that were to become a reality I would agree to become Program Director as proposed.

Lindsay and Gretel have delineated the reasons for suggesting that the University of Connecticut be named the Institutional Management Entity and I shall not reiterate those but rather emphasize some additional points; 1) the Department of Nutritional Sciences was founded in 1970, in part to foster collaborative scholarship and teaching. We have established both intra and inter-University research models that continue to be successful (documentation is available upon request). 2) The department was among the first to develop a Community Nutrition Program based upon collaborative efforts between our faculty and community agencies and groups, primarily, but not exclusively within Connecticut. 3) The department is an original contributor to and a participant in the pioneering of an Urban Health Education Center (AHEC). The Hartford AHEC, of which we are a member, is a collaborative effort between urban Hartford and the University of Connecticut Health Center and Medical School. 4) The University has a first rate research organization that meets the criteria and requirements for the Institutional Management Entity. 5) I am personally committed to the substance and philosophy of the work proposed in the CRSP on Intake and Function. I have been directly involved in the preparation of the Allen/Pelto proposal because it represents an immensely important opportunity to put into effect collaborative nutrition strategies to quantify the relationship between dietary intake and function. The need for such a program and the development of the expertise to carry it out has been the subject of our internal discussions and planning for several years. My long standing concern for, and interest in such a program is testimony to the depth of my commitment to and support for it.

The matter of my becoming Program Director is somewhat complicated by virtue of my current responsibilities. I have discussed these concerns with the University Administration and although a number of changes would be necessitated, I am assured that we could negotiate acceptable solutions. There would have to be adequate staff support for the Program Director's Office and University support to pick up some of my current departmental duties. Further definitions of the role, responsibilities, and expectations of the Program Director are needed. The first 12-18 months of the program will be especially critical and time consuming if the program is to be launched appropriately. If the proposal that the University of Connecticut become the Institutional Management Entity is accepted, I would be prepared to devote at least 50% of my time to the role of Program Director during the first critical year.

I have appended a brief biography for your perusal and to document my administrative experience and other activities. Should the University of Connecticut be given serious consideration as the Institutional Management Entity, I would want to have further discussions with the Principle Investigators and USAID officials before a final decision is rendered.

Best personal regards.

Sincerely yours,

Kirvin Knox

Kirvin L. Knox
Professor & Head
Department of Nutritional Sciences

KLK/tcn
cc - Hugh Clark, Graduate School
E. J. Kersting, Dean CANR
G. H. Pelto
L. H. Allen

THE GRADUATE SCHOOL
UNIVERSITY OF CONNECTICUT RESEARCH FOUNDATION

Biography, Bibliography and Professional Summary
OF
Kirvin L. Knox, Professor and Head, Department of Nutritional Sciences

Revised 2/79

Birthdate: [redacted] Birthplace: [redacted] [redacted]

Date of Appointment
1972

Education:

B.S.	1958	Fresno StateCollege
M.S.	1960	Colorado State University
Ph.D.	1964	University of California

Experience:

1958-60	Research Assistant, Colorado State University
1960	Chemist, Escalon Packers, Inc., Escalon, California
1960-64	Research Assistant, University of California, 1960-61; Member, Davis Tracer Team for Metabolic Research, 1960-64; N.I.H. Pre-doctoral Trainee, 1961-64
1964	Chemist, Escalon Packers, Inc., Escalon, California
1964-71	Assistant Professor, Departments of Animal Science and Physiology and Biophysics, Colorado State University, 1964-67; Director, Metabolic Laboratory, 1965-71; Associate Professor, Departments of Animal Science and Physiology and Biophysics, 1967-71; Professor of Animal Nutrition, 1971
1971-78	Professor, University of Connecticut; Head, Department of Nutritional Sciences, 1972-78
1978	Research Associate; Visiting Professor, University of California, Berkeley - sabbatic leave
1979	Head, Department of Nutritional Sciences

Professional Societies: Society for Nutrition Education, American Affiliate-European Association for Animal Production - Energy metabolism, American Dairy Science Association; New York Academy of Sciences; American Association for the Advancement of Science; American Institute of Nutrition; American Society of Animal Science; Phi Kappa Phi; Gamma Sigma Delta; Sigma Xi' Alpha Zeta

Honors or Distinctions: Colorado State University 1964-72

Offices, Committees: American Society of Animal Science (Physiology Program Committee, 1968-70 (Chairman, 1969-70); Graduate Student Research Evaluation Committee, Western Section; Editorial Committee, Energy Utilization); American Dairy Science Association (Physiology Program Committee, 1970-72; Membership Committee, 1970-72); Energy Evaluation Representative, European Association for Animal Production;

Grant Review Panels: NSF Biomedical Science Support Grant Committee; Western Regional Committee W-46 Colorado Representative, Chairman, 1969; Western Regional Committee W-88, Colorado Representative

Guest Lectureships (Other Universities): University of Missouri, 1970

Special Honorary Lectureships (U.S. and Abroad): International Atomic Energy Association, Belgrade (Zemun) Yogoslavia, 1970; Regional AGR Lecture, Nutrition and World Problems, 13th Annual Colorado Veterinary Conference, Colorado; Colorado Extension Conference; 5th Washburn Lectures, 1969; Equine Conference, Denver, 1971; IAEA Training Program, Colorado, 1971

International Symposia: 5th International Symposium on Energy Metabolism, Vitznau, Switzerland, 1970

U.S. Symposia: University of California ASAS Symposium on Energy Metabolism, 1971; University of California ASAS Symposium on Environment and Nutrient Requirements, 1971; University of Georgia Nutrition Conference, 1972; Colorado Nutrition Conference, 1972; Guest Speaker, Delegate 9th International Nutrition Conference, 1972

Other Activities: Chairman, Colorado State University Nutrition Institute, 1969-71; Advisory Board.

University of Connecticut 1972 -

Departmental:

Promotion, Tenure & Reappointment. 1977/78 - chairman.
New Faculty Selection - chairman 1972-78.
Courses & Curriculum - member - 1972-78.
Ad Hoc Committees for specific purposes 1972-78.

College/University:

University Senate (elected) 1973 -
Univ. Budget Committee - chairman- 1967-78.
Univ. Growth & Development Committee 1977/78.
Faculty Review Board - University Wide (elected) 1977-80.
Program Review Board - University Wide (appointed by Pres.) 1976
President's Selection Committees for: Dean, School of Home Economics & Family Studies; Dean, School of Allied Health Professions; Vice-Pres. for Research & Graduate Studies (1977/7
Graduate School Executive Committee (Pres. appointed) 1975-78.
Veterinary Medicine Study Committee (Pres. appointed) 1976-78.
Senate Committee to Study Graduate School 1976/77.
Senate Committee on State Legislature (meets with legislators) 1975-78.

AAUP Budget Committee 1977-

Invited Presentations (lectures/talks):

Nutrition in Connecticut - Conn. Nutr. Council
Nutrition & Health T.V. Series - Hartford Panel & Host
Applied Animal Nutrition - Canadian Veterinary Ass'n. Spon.
Nutrition Update - Cooperative Extension - 1-2 talk/yr. in Conn.
Dietary Goals - National Food Editors - NYC
Nutrition Education - Pub. Health Nutr. Faculties - Chicago, Ill.
Nutrition Careers - Manchester High School CT.

State/Nation:

Connecticut Nutrition Council
Connecticut WIC Advisory Board
Thompson: Putnam VNA Advisory Board
Northeastern Open University Study Group (Durham, N.H.)
Am. Soc. Animal Sci. Awards Committee
European Society for Animal Production - Energy Metabolism
Review Panel - Nutrition Programs in 1890 schools
Food & Nutrition Study Group, Northeastern States - Danforth Spon.
State (CT.) Educ. Department Nutrition & Day Care
State (CT.) Health Department Nutrition Awareness Committee
IX Int. Nutrition Congress - Mexico City AIN Spon. attendant.

Field of Specialization:
Comparative Nutrition Research Interests:

Energy metabolism, kinetics & utilization of vitamin A, nutrition education and behavior, food habits and nutritional adequacy.

Publications: SUMMARY ONLY

Books and monographs	4
Journal articles	37
Abstracts of papers presented	26
Conference reports	4
Technical reports	4
Total	75

Teaching: 1972-78 only.

Undergraduate:

NUSC 166-Man and His Food
NUSC 165-Fundamentals of Nutrition
NUSC 252-Biology of Human and Therapeutic Nutrition
NUSC 266-Community Nutrition
NUSC 281-Experiences in Community Nutrition
NUSC 299-Independent Study

Graduate:

NUSC 300-Advanced Nutrition
NUSC 370-Field Work in Community Nutrition

Graduate Students:

M.S. 30
Ph.D. 9

Research Grants: 1964-72 Colorado State University

NIH	$250,000
NSF	20,000
Experiment Station	50,000
Industry	100,000
	$420,000

1972-79 University of Connecticut

UConn Research Foundation	$15,000
Storrs Agriculture Experiment Station	50,000
ACTION	116,000
Industry	20,000
	$201,000

APPENDIX V-3

University of Minnesota: Submission for Management

UNIVERSITY OF MINNESOTA
TWIN CITIES

Division of Epidemiology
School of Public Health
1360 Mayo Memorial Building
420 Delaware Street S E
Minneapolis, Minnesota 55455

14 January 1980

Dr. Doris Calloway
Department of Nutritional Sciences
Morgan Hall
University of California
Berkeley, California 94720

Dear Dr. Callaway:

Please accept this letter and its attachments as our intent to compete for the management entity for the research program on nutrient intake and function. The attachments exhibit not only our interest but our capabilities and facilities in this regard.

I fully realize the magnitude of the responsibilities of this management entity and am ready to devote 50% time to the project.

Sincerely yours,

L.M. Schuman, M.D.
Professor and Director

Attachments

LMS:law

Interest in and Capabilities for the Operation of A Management Entity for the CRSP on Intake and Function

L.M. Schuman, M.D.
University of Minnesota

January 11, 1980

I. PRINCIPAL INVESTIGATOR COMMITMENT AND KEY DEPARTMENTAL PERSONNEL

Dr. Leonard M. Schuman, Professor and Director of the Department of Epidemiology can commit himself to serve as the Principal Investigator of the Management Entity and would provide 50% of his time to the undertaking. The Department has a wide spectrum of resources among its faculty and other research personnel. As will be noted later, in Section II, our staff has expertise in case-control, prospective and longitudinal studies, in areas of environmental, occupational, cancer, other chronic disease and infectious disease epidemiology including a concentration of inquiries on dietary factors in disease production. Their consultative and collaborative assistance will be readily available.

Dr. James Stebbings has an interest in household environmental risk factors for cancer, chronic respiratory and acute respiratory diseases which may confound dietary factors under study. He has extensive background in the analyses of time series of lengths corresponding to the weekly through seasonal patterns of fluctuations in nutrition which may need to be related to physiological and biochemical measurement reflecting such variations in attack.

Jack Mandel has had experience in a variety of epidemiologic studies, particularly with reference to study design, data collection, tracing methods and study management and execution.

MISSING PAGE
NO. _____

7. Epidemiology of Central Nervous System Neoplasms (1963-66)

8. Blood Pressure Studies in High School Students (1970-78)

9. Epidemiology of Gastrointestinal Cancers in Relation to Dietary Patterns (Case-Control Study) (1964-68)

10. Prospective Study of Mortality in an Insured Cohort of Lutheran Brotherhood Members (1964-continuing)

11. Regional Participant in Third National Cancer Survey (1968-74)

12. Survey of Incidence and Prevalence of Skin Cancers in the Minneapolis/St. Paul Standard Metropolitan Statistical Area (1971-72)

13. Prevalence and Epidemiology of Cariogenic Micro-organisms (1972-76)

14. Survey of Malocclusion and Periodontal Disease in Montserrat (1974-78)

15. Study of Breast Cancer in Relation to Exogenous Hormones (1973-continuing)

16. Survey of Prevalence of Mental Retardation and Mental Illness in North Minneapolis (1973-75)

17. Survey of Epidemiologic Factors in Cholelithiasis, Cholecystitis and Gallbladder Cancer (1972-75)

18. Epidemiologic Study of Etiologic Factors in Prostatic Cancer (1975-continuing)

19. The Use of Screening Techniques for Blood in the Stool as a Means of Detecting Early Cancer of the Bowel (1975-continuing)
20. Design of an Experiment to Assess the Impact of Multi-Site Screening on Total Cancer Mortality (1975-76)
21. Endocrine and Thermorhythmometry on Japanese and North American Female Volunteers of Different Age Groups with a View of Temporal and Other Patterns that may Differ in Relation to Mammary Carcinogenesis (1975-79)
22. Epidemiology of Malocclusion, Dental Caries and Periodontal Disease (1972-76)
23. Cancer in Spouse Pairs (1975)
24. Copper-Nickel Environmental Impact Health Studies (1976-77)
25. Epidemiology of Cancer in Immuno-deficiency Families (1976-79)
26. Health Status of American Men (1977-continuing)
27. Epidemiology of Skin Cancer (1978-79)
28. Health Study of Plutonium Workers (1978-continuing)
29. Great Lakes Pollution Study (1978-continuing)
30. Multiple Sclerosis and Pet Exposure (1978-continuing)
31. Mortality Study of Minnesota Iron Ore Miners (1977-continuing)

32. Nutrition and Diabetes in Austin, Minnesota (1978-continuing)
33. Epidemiology of Cervical Cancer (1978-continuing)
34. Epidemiology of Kidney Cancer--Case-Control Study (1979-continuing)
35. Epidemiologic Study of Alzheimer's Disease (1979-continuing)
36. Gastrointestinal Cancer in Duluth (1974-continuing)
37. Prevalence of Heroin Use in Hennepin County (1975-76)

For the specific areas of expertise, we offer first a tabular display of our various studies with relevant characteristics of the type of study design, the methods of sample selection, methods of data collection, data preparation and processing, and record linkage (see page 7). Selected areas of capabilities relevant to this proposal are described in greater detail in the following:

A. Development of Household Interview Forms, Instructions and Training of Interviewers

In the vast majority of the studies outlined above we have had to develop the specific interview forms and instruments in highly structured fashion, and frequently of great complexity, in order to explore the subject matter in depth by personal interview. In virtually every instance, a manual of interviewing procedures was developed not only for reference purposes but as a teaching device and source of information in the training of interviewers. The latter have always been carefully

INVENTORY OF EPIDEMIOLOGIC SURVEYS AND STUDIES ILLUSTRATING EXPERIENCE OF DIVISION OF EPIDEMIOLOGY, SCHOOL OF PUBLIC HEALTH, UNIVERSITY OF MINNESOTA

AREA

SURVEY OR STUDY

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selected and trained to rigid adherence to such structured interview forms. We have had long experience in the training of interviewers who have been drawn from a number of disciplines including graduate nurses, medical students, graduate students working on their masters and doctoral degrees in epidemiology and students in psychology and sociology. In some studies (Health Status of American Men and Kidney Cancer Studies), we have recruited and trained over 170 interviewers. We have also trained and supervised as many as 17 telephone interviewers at any given time.

B. Collection of Data Via Household Interviews

Virtually all of our studies have depended upon the predevelopment of interview forms for application, either to whole population groups or samples of households within specific areas. For example, this was the modus operandi in the Tri-State Leukemia Study. The 10% sample of the Third National Cancer Survey for cost of cancer care was also subjected to the household interview method as were the populations studied for cancer in immuno-deficient families, and those being studied for the relationship of breast cancer to exogenous hormone use as well as in the various case-control studies including the most recent study of Alzheimer's disease.

C. Development of Abstract Forms and Procedure for Selected Source Record Information

We have had long experience in the development of special forms upon which to transfer data from existing records for purposes

of collating such material with data obtained from direct interviews or questionnaires. As indicated in the accompanying table, forms will obviously have had to be devised for the abstracting of information from a diversity of records in hospitals, physicians' offices, vital statistics divisions of health departments, autopsy and pathology reports. In every instance, the utilization of such special forms have necessitated the detailed training of abstractors in the process and the development of procedures for use of such forms.

D. Participation of Sources of Record Information in Studies

We believe we have an enviable record in the cooperative participation of hospitals, physicians, health departments and voluntary agencies in permitting us to utilize their records as data sources for our purpose. As illustrative of this fine rapport which we have established with these various groups over the many years of our experience, there may be cited the 100% participation of all the pathologists in the area in providing us with unstained histologic sections of biopsy and autopsy materials in our gastrointestinal cancer studies and the total participation of all 45 hospitals in the Third National Cancer Survey in the five-county Minneapolis/St. Paul Metropolitan Area which involved total entree to all of the medical records in these institutions for abstracting of relevant information for the survey. To this must be added the almost universal blanket permission which the practicing physicians of this area have

granted us in the interviewing of patients as the studies demanded. This rapport was carried over into the much more formidable operation of obtaining entree for specimen collection in our breast cancer and exogenous hormones study. Some of our more recent studies, which involved the total ascertainment of incident cases in the standard metropolitan statistical area of Minneapolis/St. Paul (7 counties), have recently won the endorsement of several medical specialty societies and the unanimous cooperation of all physicians.

E. Data Preparation and Processing

As noted in the tabular material, in every study we have prepared our own data for processing. In every instance, except for five studies, we have done our own data processing as well. The five exceptions include those studies representing our participation in the Third National Cancer Survey, a four area skin cancer survey for the National Cancer Institute, a collaborative study on breast cancer and exogenous hormones in which the data were processed at Johns Hopkins, a nine area (U.S.) Skin Cancer survey with processing at NCI and the Health Status of American Men Study with processing at the coordinating center at UCLA.

The analyses of the data of most of our studies have been performed in collaboration with our Department of Biometry and Health Information Services. This Department provides us with consultation and services in the following areas: study design, sampling methods, data collection forms, coding, key punching,

programming, systems and statistical analysis (including data management and processing). Dr. Richard McHugh of that Department and an internationally known biostatistician has agreed to assume responsibility for the statistical aspects of the management entity. Dr. Eugene Johnson, Professor of Biometry and Health Information Systems and Director of the Health Sciences Computer Service Center has agreed to assume responsibility for the data management and processing aspects of the management entity.

F. Facilities and Equipment

1. The Division of Epidemiology has moved into expanded quarters in the new Health Sciences Building, Unit A. These quarters are fully equipped with all the necessary modern computational and scientific laboratory equipment, including ultra-deep-freeze storage facilities for biologic specimens. Adequate space for the housing of additional field investigating teams exist. Office and equipment facilities sufficient for the housing of eleven data processing personnel are also available.

2. Computer Facilities

Facility: University Computer Center (U.C.C.)

Computers: Cyber 74 and Cyber 172

Core Memory Capacity: The Cyber 74 has a maximum of 321,000 core memory words (in octal) available to any single user. The Cyber 172 has 400,000 core memory words (in octal) available to any single user.

Peripheral Equipment: Several remote terminals and keypunc machines are located in many locations on campus. A card reader and several line printers are located across the street from the Epi department. 7 and 9 track tape drives are located at the Lauderdale facility.

Software: Several computer programming languages are available on the Cyber 74 and 172; SIMULA, SNOBOL, FORTRAN, ALGOL, LISP, COBOL and others. The Cyber 74 and 172 also have a large library of callable subprograms useful in statistical analysis. In addition, several packaged programs, such as SIR, SPSS, and BMD are available on the Cyb 74 and 172.

Facility: Administrative Data Processing Dept. (ADP), University of Minnesota, Minneapolis

Computer: IBM 370

Core Memory Capacity: The IBM 370 has a maximum of 1,200,0 core memory words (in decimal) available to any single use

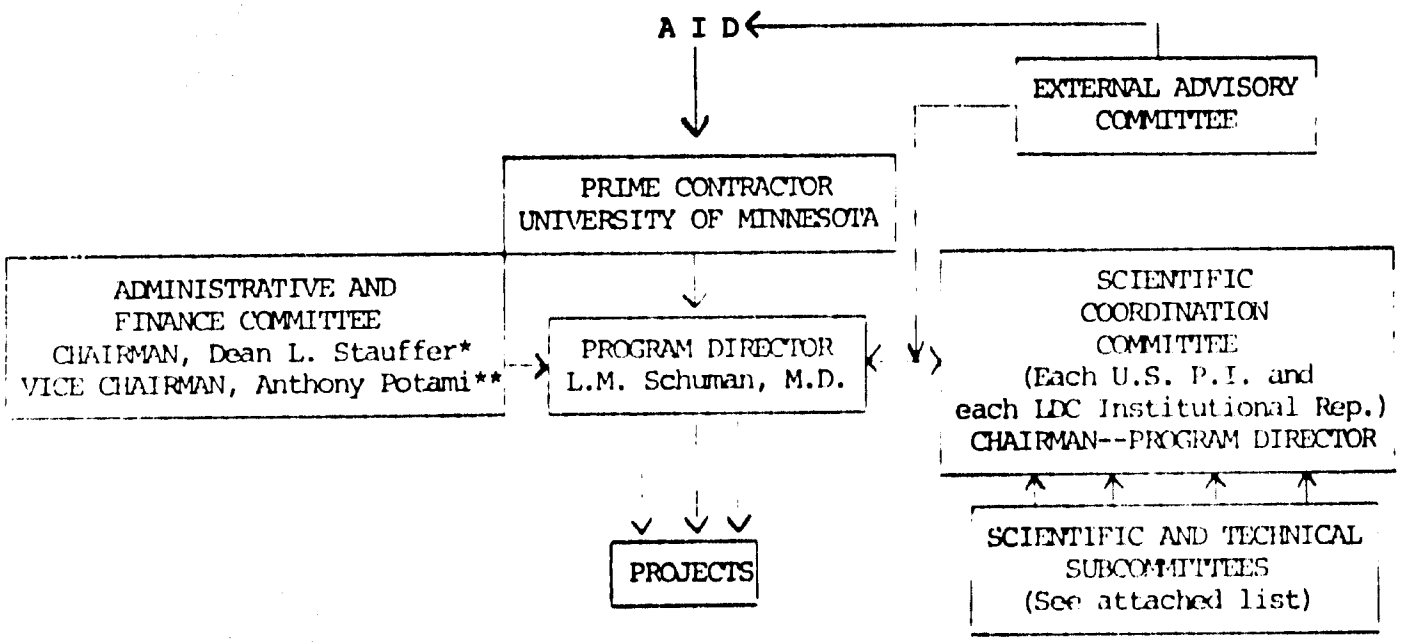
Peripheral Equipment: Remote terminals, keypunch machines, card reader, line printers, and 9 track tape drives are located approximately 1 mile from campus.

Software: Computer programming languages such as SNOBOL, FORTRAN, ALGOL and COBOL are available on the IBM 370.

G. Structure of the Management Entity

Our concept of the management entity can best be described by the following diagram whose basic structure follows in

principle the majority view of the participants at the August 13, 14, 1979 meeting at Berkeley. We subscribe to this basic structure concept with the added configurations and suggested compositions noted below:



<u>Suggested Scientific and Technical Mimimum Subcommittees</u>:

Design and data collection

Analysis

Data management and processing

Quality control

<u>ad hoc</u>

Nutrient intake and nutritional status assessment

Behavioral science (psychological testing; social function)

Physiologic and biochemical testing

Disease appraisal

*Dean, School of Public Health, University of Minnesota

**Director, Office of Research Administration, University of Minnesota

It is our opinion that the scientific coordination committee must include representation from the LDC institutions to encourage the concept of partnership and collaboration and to facilitate compliance with the common aspects of the protocol.

Biographical Sketch

Leonard M. Schuman, M.D., Professor of Epidemiology, School of Public Health, University of Minnesota

Birthdate: [redacted]

Birthplace: [redacted]

A.B. Oberlin College, 1934

Teaching and research fellow in Hygiene and Bacteriology, School of Medicine, Western Reserve University, 1937-1939

M.Sc., Graduate School, Western Reserve University, 1939

M.D., Western Reserve University, 1940

Internship, U.S. Marine Hospital, Chicago, Illinois, 1940-1941

Commissioned Officer, U.S. Public Health Service, 1941-1947

Assistant Epidemiologist, Illinois Department of Public Health, 1941-1942

District Health Superintendent, District #2, Illinois Department of Public Health, 1943

Assistant Chief, Division of Local Health Administration, Illinois Department of Health, 1943-1945

Medical Officer in Charge, Southeastern U.S. Nutrition Research Unit, USPHS, 1945-1947

Fellowship in Nutrition (Rockefeller Foundation) Vanderbilt, September-October 1946 and Hillman Hospital, Birmingham, Alabama, 1946

Chief, Division of Venereal Disease Control, Illinois Department of Public Health, 1947-1950

Acting Chief, Division of Communicable Disease, Illinois Department of Public Health, 1949-1950

Deputy Director in Charge of Division of Preventive Medicine, Illinois Department of Public Health, 1950-1951

Military leave as epidemiologist to Korean Cold Injury Research Team, U.S. Department of Defense, October 1951- February, 1953

Deputy Director in charge of Division of Preventive Medicine, Illinois Department of Public Health, 1953-1954

Visiting Lecturer, University of Illinois, School of Medicine, Chicago, Illinois, 1947-1954

Lecturer in Communicable Disease, Springfield Memorial Hospital Nursing School, 1947-1954

Associate Professor, School of Public Health, University of Minnesota, 1954-58

Professor of Epidemiology, 1958-present

Diplomat, American Board of Preventive Medicine, 1950

Member, National Advisory Committee of Poliomyelitis Prophylaxis, 1952-55

Member, Advisory Committee to Salk Vaccine Evaluation Center, University of Michigan, 1953-55

Secretary, National Subcommittee on Epidemic Intelligence, 1953-54

Consultant to Communicable Disease Center, USPHS, 1955-

Consultant to Minnesota State Health Department, 1955-

Consultant in Pediatrics, Hennepin Co. General Hospital, 1955-

Secretary, Council on Research, American College of Preventive Medicine, 1956-59
Chairman, 1959-1964

Consultant to Air Pollution Medical Program, USPHS, 1958-

Consultant to National Cancer Institute, USPHS, 1958-

Member, National Cancer Control Committee, 1959-1962

Member, National Leukemia Study Committee, National Cancer Institute, 1959-63

Chairman, Conference of Chronic Disease Training Program Directors, 1960-72

Chairman, Biometry-Epidemiology Panel, National Cancer Institute 1961-62

Member, Field Studies Board, National Advisory Cancer Council, 1961-62

Consultant, Training Program in Epidemiology for Veterinarians, USDA, 1961-

Chairman, Infectious Disease Monograph Subcommittee, APHA, 1961-68

Consultant, Division of Radiological Health, USPHS, 1961-69

Consultant, Air Pollution Medical Program, California State Health Department, 1962

Member, Surgeon General's Advisory Committee on Smoking and Health, 1962-64

Chairman, National Conference on Research Methodology in Community Health and Preventive Medicine, 1962

Member, Committee on Evaluations and Standards, APHA, 1962-66

Member, Committee on Evaluation of Hazard of Enovid (U.S. FDA), 1963

Member, Accident Prevention Research Study Section, Division of Research Grants, NIH, 1963-66

Consultant, Chronic Disease Division, USPHS, 1964-72

Member, Governing Council, APHA, 1964-70

Member, Resolutions Committee, APHA, 1964, 1965

Member, Advisory Committee on Bio-effects of Radiation to USPHS, 1966-69

Chairman, Subcommittee on Drugs, APHA, 1964-65

President, American Community Cardiovascular Association, 1965

Fellow, Council on Epidemiology, American Heart Association, 1965

Vice Chairman, Epidemiology Section, APHA, 1966

Chairman, Epidemiology Section, APHA, 1967

Chairman, Program Area Committee on Communicable Diseases, APHA, 1966-70

Member, Technical Development Board, APHA, 1966-70

Member, Task Force on Smoking and Health, 1967-68

Member, National Advisory Urban and Industrial Health Council, 1968-69

Member, Secretary of Health Education and Welfare's Advisory Committee on Health Protection and Disease Prevention, 1969-71

Member, National Advisory Environmental Control Council, 1969-71

Member, Cancer Research Center Review Committee, NCI, NIH, 1971-75

Member, Task Group on Smoking, Task Force on Epidemiology of Respiratory Diseases, NIH, NHLBI, 1978-

Member, Task Group on Interstitial Lung Disease, Task Force on Epidemiology of Respiratory Diseases, NIH, NHLBI, 1978-

Member, Steering Group, Research Program on Relationship of Nutritional Intake to Functional Competency, Agency for International Development, 1978-

Member, Policy Board, Mid-Career Medical Fellows, Bush Foundation, 1978-

Chairman, Association of Epidemiology Program Directors in Schools of Public Health, 1974-

Member, Executive Board, Society for Epidemiologic Research

Vice President, American Epidemiological Society, 1978.

Member: American Association for Advancement of Science
American Association of Public Health Physicians
American Association University Professors
American College of Preventive Medicine
American Epidemiological Society
American Heart Association
American Public Health Association (Fellow, Epidmeiology Section)
American Thoracic Society
American Venereal Disease Association
Association Military Surgeons of United States
Association of Teachers of Preventive Medicine
International Epidemiological Society
International Society for Cardiology
International Society on Thrombosis and Hemostasis
Middle States Public Health Association
Minnesota Public Health Association
New York Academy of Sciences
Public Health Cancer Association
Society for Epidemiologic Research

Elected: Phi Beta Kappa (Oberlin) 1934
Alpha Omega Alpha (Western Reserve) 1940
Phi Zeta (University of Minnesota) 1963
Phi Society (Western Reserve) 1932
38th Parallel Medical Society Korea, 1951
Xth Corps Medical and Dental Society Korea, 1951
Preventive Medical Society Korea, 1951
Selective Service Medal, U.S. Government, 1945
Sigma Xi (Minnesota) 1972

PUBLICATIONS

1. Diphtheria Infection and Morbidity in Cleveland, 1937-1939, Am. J.P.H., Vol. 30, pg. 16, March 1940.
2. Rapid Treatment Program for Syphilis, Illinois Med. Journal, Vol. 91, No. 4, pg. 192, April 1947.
3. BAL in Treatment of Arsenical and Mercurial Poisoning, Illinois Med. Journal, Vol. 92, No. 2, pg. 80, August 1947.
4. Relation of Animal Diseases to Public Health, The North American Veterinarian, Vol. 29, No. 2, pg. 81, Feb. 1948.
5. Rapid Treatment of Asymptomatic Neurosyphilis, Illinois Medical Journal, Vol. 93, No. 5, pg. 241, May 1948.
6. Stimulating Venereal Disease Morbidity Reporting by Private Physicians, J. Ven. Dis. Inf., Vol. 30, No. 6, pg. 160, June 1949.
7. Nutritional Status of Negroes, J. Negro Education, Vol. 18, No. 3, pg. 291, Summer 1949.
8. Special Contact Investigation of the Patients of Private Physicians, J. Ven. Dis. Inf., Vol. 31, No. 11, pg. 286, November 1950.
9. Practical Office Syphilology, Illinois Med. Journal, Vol. 101, No. 2, February 1952.
10. Role of the Veterinarian in Public Health, Proceedings of the American Vet. Medical Association, 88th Meeting, pg. 293, August 1951.
11. Air Contamination, Transactions 39th National Safety Congress, Vol. 11, Food Section, pg. 10, October 1951.
12. Symposium on "Possible Relationship between Paralytic Poliomyelitis and Subcutaneous Injection of Immunizing Agents and other Medicinal Substances", Pediatrics, Vol. 9, No. 3, Pg. 370, March 1952.
13. Voluntary Reporting of Venereal Diseases in Contacts previously Reported not Infected, Public Health Reports, Vol. 68, No. 8, Pg. 780, August 1952.
14. Epidemiology of Frostbite, Army Medical Research Laboratory Report No. 113, pg. 205-568, April 1953 (Subtask 8K, Cold Injury Studies, Environmental Physiology, A M R L Project No. 6-64-12-028).
15. (As member of Committee) Evaluation of Gamma Globulin in Prophylaxis of Paralytic Poliomyelitis in 1953. Summary Journal American Medical Association, Vol. 154, pg. 1086, March 27, 1954.
16. "Epidemiology of Cold Injury in Man", Transactions of 2nd Conference on Cold Injury, The Josiah Macy Jr. Foundation, New York, 1954.
17. (As member of Committee) An Evaluation of the Efficacy of Gamma Globulin in the Prophylaxis of Paralytic Poliomyelitis as Used in the U.S. in 1953. Public Health Monograph No. 20, U.S.P.H.S., May 1954.
18. Evaluation of Gamma Globulin Prophylaxis of Poliomyelitis in 1953, Illinois Medical Journal, Vol. 106, No. 1, pg. 1, July 1954.
19. The Epidemiology of Cold Injury, Bulletin University Hospitals, Vol. 26, p. 400, February 18, 1955. University of Minnesota
20. Epidemic Intelligence, Illinois Med. Journal, Vol. 107, No. 3, March 1955.
21. Immunity Levels at Danger Point, Nursing Outlook, Vol. 3, No. 4, April 1955.
22. The Practicing Physicians Role in the Control of Poliomyelitis, Illinois Medical Journal, Vol. 108, No. 4, October 1955.
23. "Silo-Filler's Disease": A Newly Recognized Syndrome Caused by Nitrogen Dioxide Inhalation with a Report of Six Cases, University of Minnesota Medical Bulletin, Vol. 27, P. 234, May 1, 1956.
24. "Silo-Filler's Disease" - A Syndrome Caused by Nitrogen Dioxide, Journal American Medical Association, Vol. 162, p. 153, Sept. 15, 1956.

25. "The Efficacy of Poliomyelitis Vaccine with Special Reference to its use in Minnesota, 1955-56", Vol. 28, p. 210, February 15, 1957, University of Minnesota Medical Bulletin.
26. "Efficacy of Poliomyelitis Vaccine with Special Reference to its Use in Minnesota in 1955-56", Journal of the American Medical Association, Vol. 166, No. 9, pp. 1027-1035, March 1, 1958.
27. "Epidemic of ECHO-9 Aseptic Meningitis in Minnesota, 1957" (With H. Kleinman, D. Rogers, P. M. Ellwood, Jr., H. Bruhl and H. Bauer). University of Minnesota Medical Bulletin, 29:306-328, March 15, 1958.
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38. "An Epidemiologic Study of Childhood Leukemia," (with E. A. Ager, H. M. Wallace and A. B. Rosenfield), University of Minnesota Medical Bulletin 33:253-275, March 1962.
39. "Methodological Problems and Design of the Tri-State Leukemia Study" (with S. Graham, M. L. Levin, A. B. Lilienfeld, J. E. Dowd, R. Gibson, L. H. Hempelmann, P. Gerhardt), Annals of the New York Academy of Sciences, 107:557-569, May 22, 1963.
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42. "The Final Enovid Report" (with I. S. Wright, B. Alexander W. M. Allen, W. Crosby, R. Hertz, G. D. Penick, J. S. Spittel and C. L. Spurling) J. of New Drugs 3:201-211, July-August 1963.

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45. "Smoking and Health" (with S. Bayne-Jones, W. J. Burdette, W. G. Cochran, E. Farber, L. F. Fieser, J. Furth, J.B. Hickam, C. Le Maistre and M. H. Seevers) PHS Publication No. 1103, U.S. Government Printing Office, January 1964.
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48. Nitrogen Dioxide Production from Silage II. Detailed Field Survey, (with J.V. Scaletti, J.J. Jezeski, C.E. Gates), Agronomy Journal 57:65-67, 1965.
49. Chronic Disease Research, Journal-Lancet 85:197-201, May, 1965.
50. Effect of Sodium Bisulfite Additions to Corn Silages, (with J.C. Meiske, R.M. Prouty and J.V. Scaletti), Journal of Animal Science 24:705-710, August, 1965.
51. The Epidemiology of Thromboembolic Disorders, Journal of Chronic Diseases, 18:815-845, August, 1965.
52. "Thromboembolic Disorders" in "The Heart and Circulation", Second National Conference on Cardiovascular Diseases, Washington, D.C., 1964, Vol. I. Research, pp. 231-233, Federation of American Societies for Experimental Biology, Bethesda, Maryland, 1965.
53. "The Role of Epidemiology in the Investigation of Occupational Exposure as the Cause of Disease", American Association of Industrial Nurses Journal Vol. 14, Issue 1, pp. 19-21, January 1966.
54. "Preconception, Intrauterine and Postnatal Irradiation as Related to Leukemia," (with S. Graham, M.L. Levin, A.M. Lilienfeld, R.M. Gibson, J.E. Dowd and L. Hempelmann.) in National Cancer Institute Monograph No. 19—Epidemiologic Approaches to the Study of Cancer and Other Chronic Diseases, pp. 347-371, January 1966.
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72. The Benefits of Cessation of Smoking, Chest 56:421-427, 1971.

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75. Epidemiology of Diseases in Adult Males with Leukemia (with R. Gibson, S. Graham, A. Lilienfeld, M. Levin and M. Swanson) J. Nat. Cancer Inst., 56:891-898, 1976.

76. Epidemiologic Study of Prostatic Cancer: Preliminary Report Cancer Treatment Report, 61: 181-186, March/April, 1977.

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78. Research on Smoking Behavior, National Institute on Drug Abuse Research Monograph 17, (eds. Jarvik, M.D., Cullen, J.W., Gritz, E.R., Vogt, T.M., West, L.J.) U.S. Government Printing Office, December 1977.

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80. Smoking and Health, Introduction and Summary Chapter in "A Report of the Surgeon General" U.S. DHEW Public, No. (PHS) 7950066 U.S. Government Print. Off. Washington D.C. 1979.

Reports:

Schuman, L.M. and Gullen, W.H. "Background Radiation in the Etiology of Congenital Malformations." Final Report to the National Center for Radiological Health on Contract Nos. SAph 76303, 76497, 76559 and 76498, September 30, 1967.

In Press:

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Discussion: Epidemiologic Perspective in Health Services Research. Monograph on Social Science Aspects of Health Services Research.

International Studies of Human Host and Tumor Rhythms with Multiple Frequencies Lead Toward Cost-Effective Sampling (with F. Halberg, G. Cornelissen, R.B. Sothern, L. A. Wallach, E. Halberg, A. Ahlgren, M. Kuzel, A. Radke, J. Barbosa, F. Goetz, J. Buckley and J. Mandel) Chapter 37.

Prostatic Cancer in Blacks. Proceedings of a Workshop on Esophageal and Prostatic Cancer: The Basis for Black-White Differences in Incidence. Washington D.C. October 23, 1979. J. Prev. Med. (with J. Mandel)

Epidemiology of Prostatic Cancer. Chapter in Cancer Epidemiology. Oxford Press (with J. Mandel)

Curriculum Vitae

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Education

Institution	Degree	Year	Field
St. Louis University, St. Louis, Missouri (1955-1960)	Hons. B.S.	1960	Geography
The Johns Hopkins University, Graduate School (1960-1962), Baltimore, Maryland	—	—	Geography
The Johns Hopkins University, School of Hygiene and Public Health (1962-1967), Baltimore, Maryland	Sc.D.	1969	Epidemiology (Chronic Diseases)

Professional Employment

Associate Professor, Division of Epidemiology, School of Public Health, University of Minnesota, (December) 1979 -

Group Leader, Epidemiology Group (H-14), Health Division, Los Alamos Scientific Laboratory, Los Alamos, NM, 1979, Staff Member, 1977-1979.

Epidemiologist, Air Pollutants Branch, Population Studies Division, Health Effects Research Laboratory, Environmental Research Center, Environmental Protection Agency, Research Triangle Park, NC, 1974-1977.

Assistant Professor, Division of Epidemiology, School of Public Health, University of Minnesota, 1970-1973.

Project Director, Respiratory Disease Study, Medical and Health Research Association of New York City, Inc., 1967-1970.

Research Assistant in Epidemiology, University of Buffalo, Buffalo, New York, 1963

Professional Appointments

Clinical Associate, Department of Family, Community and Emergency Medicine, School of Medicine, The University of New Mexico, 1977-

Adjunct Associate Professor, Department of Epidemiology, School of Public Health, University of North Carolina, 1975-1977

Adjunct Assistant Professor of Environmental Medicine, New York University, 1968-1970

Instructor in Epidemiology, Columbia University, School of Public Health and Administrative Medicine, 1969-1970

Assistant in Epidemiology, Columbia University, School of Public Health and Administrative Medicine, 1968-1969

Publications

1. Stebbings, J.H.: Additions to the Illinois and Missouri Earthworm Fauna. American Midland Naturalist 67:504-505, 1962.

2. Stebbings, J.H.: Endemic-Exotic Earthworm Competition in the American Midwest. Nature 196:905-906, 1962.

3. Partridge, R.A., Stebbings, J.H., Elsea, W.R., and Winkelstein, W.: Outbreak of Acute Eye Irritation Associated with Air Pollution. Public Health Reports 81:153-158, 1966.

4. Stebbings, J.H.: Chronic Respiratory Disease Among Nonsmokers in Hagerstown, Maryland. I. Design of the Study and Prevalence of Symptoms. Environmental Research 4:146-162, 1971.

5. Stebbings, J.H.: Chronic Respiratory Disease Among Nonsmokers in Hagerstown, Maryland. II. Problems in the Estimation of Pulmonary Function Values in Epidemiologic Surveys. Environmental Research 4:163-192, 1971.

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7. Stebbings, J.H.: Chronic Respiratory Disease Among Nonsmokers in Hagerstown, Maryland. IV. The Effect of Urban Residence on Pulmonary Function Values. Environmental Research 4:283-304, 1971.

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9. Stebbings, J.H.: A Survey of Respiratory Disease Among New York City Postal and Transit Workers. III. Anthropometric, Smoking, Occupational, and Ethnic Variables Affecting the FEV_1 Among White Males. Environmental Research 5:451-466, 1972.

10. Stebbings, J.H.: Two Observed Associations Between Respiratory Allergies and Hypertension in Nonsmokers. American Journal of Epidemiology 97:4-15, 1973.

11. Stebbings, J.H.: A Survey of Respiratory Disease Among New York City Postal and Transit Workers. IV. Racial Differences in the FEV_1. Environmental Research 6:147-158, 1973.

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13. Stebbings, J.H.: Chronic Respiratory Disease Among Nonsmokers in Hagerstown, Maryland. V. Age at Onset of Hay Fever and Pulmonar/ Function in Later Life. Environmental Research 7:99-109, 1974.

14. Stebbings, J.H.: The Relationship of Allergies to Hypertension and Other Chronic Diseases: Some Methodologic Considerations. American Journal of Epidemiology 100:161-164, 1974.

15. Stebbings, J.H.: The Fractional Carbon Monoxide Uptake in an Employed Population. Thorax 29:505-510, 1974.

16. Stebbings, J.H. and Hayes, C.G.: Panel Studies of Acute Health Effects of Air Pollution. I. Cardiopulmonary Symptoms in Adults, New York, 1971-1972. Environmental Research 11:89-111, 1976.

17. Stebbings, J.H.: The Relevance of Automation to Organizational Problems in Cytogenetic Epidemiology. In: Automation of Cytogenetics. Asilomar Workshop, Pacific Grove, California, November 30-December 2, 1975. Edited by M.L. Mendelsohn. Division of Biomedical and Environmental Research, U.S. Energy Research and Development Administration, Publication No. CONF-751158, pp 170-173.

18. Stebbings, J.H., Fogleman, D.C., McClain, K.E. and Townsend, M.C.: Effect of the Pittsburgh Air Pollution Episode upon Pulmonary Function in Schoolchildren. Journal of the Air Pollution Control Association, 26:547-553, 1976.

19. Stebbings, J. H.: Panel Studies of Acute Health Effects of Air Pollution. II. A Methodologic Study of Linear Regression Analysis of Asthma Panel Data. Environmental Research, 17:10-32, 1978.

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Other Publications

1. Stebbings, J.H., Hasselblad, V., Chapman, R.S. and McClain, K.: NO_2 Exposure and Ventilatory Function in Schoolchildren. (Abstract). American Journal of Epidemiology 102:445-446, 1975.

2. Stebbings, J.H., Townsend, M., Fogleman, D. and McClain, K.: Effect of the Pittsburgh Air Pollution Episode upon Pulmonary Function in Schoolchildren. (Abstract). American Journal of Epidemiology 104:334, 1976.

3. Stebbings, J.H.: Cytogenetic Effects of Oxidant Air Pollution and Oxides of Nitrogen: Preliminary Results from Environmental Protection Agency Studies. (Abstract). American Journal of Epidemiology 104:360, 1976.

4. Stebbings, J. H.: Privacy Protection in Epidemiology: A Technological Quibble. (Letter). American Journal of Epidemiology 106:433-434, 1977.

5. Stebbings, J. H., and Tietjen, G. L.: Means or Maxima in Lung Function Testing? (Letter). American Review of Respiratory Disease 117:399-400, 1978.

6. Stebbings, J. H., Voelz, G. L. and York, D. A.: Mortality Follow-up of Los Alamos Workers Occupationally Exposed to Plutonium. (Abstract). American Journal of Epidemiology 108:240, 1978.

7. Voelz, G. L., Stebbings, J. H., and Haxton, L. K.: Cancer Mortality and Incidence in Males in Los Alamos County, New Mexico. (Abstract). Health Physics 35:916, 1978.

Other

Principal Investigator, "Cardiorespiratory Changes in an Employed Population" (EC-00233-06, OH-00353-01, 02), 1 June 69 to 31 December 73, from the National Institute for Occupational Safety and Health.

Faculty, University of Minnesota Graduate Summer Session in Epidemiology, 1971. Taught "Epidemiology of Chronic Respiratory Disease."

Organizer, "Workshop on Health Surveillance around Point Sources of Pollution," Chicago, October 4-5, 1976. Sponsored by U. S. Environmental Protection Agency.

Consultant, Minnesota Department of Health, Minneapolis, 1976-1977.

Member, Inhalation Toxicology Committee, National Center for Toxicological Research, Jefferson, Arkansas, 1977-1978.

Sessions Organizer, "Time-series Studies in Epidemiology," 8th International Scientific Meeting of the International Epidemiological Association, Puerto Rico, September 1977.

Member, Uranium Epidemiology Study Advisory Group, Cancer Research and Treatment Center, The University of New Mexico, Albuquerque, 1978-

Organizer and Chairman, "Second Workshop on Health Surveillance around Point Sources of Pollution," Albuquerque, January 22-24, 1979. Sponsored by Health Research Division, Los Alamos Scientific Laboratory.

Invited contributor (1978), World Health Organization/International Epidemiological Association monograph "Epidemiological Methods for Environmental Health Studies." Assigned ANOVA, regression, covariance and multivariate analyses in Chapter 6, "Analysis, Interpretation, and Reporting."

Consultant, State of Montana, Department of Health and Environmental Sciences, Helena, 1979-

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Name: Jack Sheldon Mandel

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Education:

University of Manitoba - 1962-66
Major: Mathematics and Statistics
Minor: Psychology — B.Sc., 1966

University of Manitoba - Graduate School - 1966-6
Major: Psychology
Minor: Statistics

University of Minnesota - School of Public Health - 1972-73
Major: Epidemiology
Minor: Biometry — M.P.H., 1973

University of Minnesota - Graduate School, Ph.D. Program - 1973-
Major: Epidemiology
Minor: Supporting Program

Additional Courses:

MATOP (Matrix Operations Programming)
Statistics Canada, Ottawa, Canada — 1967

Computer Systems Fundamentals
I.B.M., Ottawa, Canada — 1967

Introduction to the System 360
I.B.M., Ottawa, Canada — 1968

Flowcharting
I.B.M., Ottawa, Canada — 1968

Introduction to Mental Health Statistics
Applied Statistics Training Institute
Durham, North Carolina — June, 1969

Introduction to Demographic Analysis
Applied Statistics Training Institute
Durham, North Carolina — February, 1972

Graduate Summer Session in Epidemiology
University of Minnesota — June-July, 1971

Graduate Summer Session in Epidemiology University of Minnesota	June-July, 1972
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Relevant Professional Experience:

Teaching Assistant in Statistics University of Winnipeg	1966-67
Teaching Assistant in Psychology University of Winnipeg	1966-67
Research Assistant in Psychology Graduate Department of Psychology University of Manitoba	1966-67
Statistician, Mental Health Section Health and Welfare Division Statistics Canada, Ottawa	1967-68
Acting Senior Analyst, Mental Health Section Health and Welfare Division Statistics Canada, Ottawa	1968-69
Instructor in Psychology, Adult Education Evening Program Collegiate Institute Board, Ottawa	1968-69
Instructor in Computer Programming (MATOP) Statistics Canada, Ottawa	1968-70
Lecturer, School of Medicine Department of Epidemiolgy and Community Medicine University of Ottawa, Ottawa (leave of absence 1972-75)	1969-74
Assistant Professor, School of Medicine Department of Epidemiology and Community Medicine University of Ottawa, Ottawa, Canada	1974-75
Teaching Assistant, Division of Epidemiology School of Public Health University of Minnesota	1973-74
Project Director, "Epidemiology Study of Prostatic Cancer" (funded by National Cancer Institute)	1975-79

Instructor, Division of Epidemiology School of Public Health University of Minnesota	1974-
Consultant, North Minneapolis Association for the Retarded, Minneapolis, Minnesota	1974-75
Co-Investigator, Department of Chronobiology, "Endocrine and Thermorhythmometry on Japanese and North American Female Volunteers with a View of Temporal and Other Patterns that May Differ in Relation to Mammary Carcinogenesis" (Funded by National Cancer Institute)	1975-78
Consultant, Minnesota State Health Department	1976-
Consultant, Department of Surgery, University of Minnesota, "Multi-Site Cancer Screening" (Funded by National Cancer Institute)	1975-76
Consultant, Department of Surgery, University of Minnesota, "The Use of a Screening Technique for Blood in the Stool as a Means of Detecting Early Cancer of the Bowel" (Funded by National Cancer Institute)	1975-
Consultant, Department of Pathology, University of Minnesota, "Epidemiologic Study of Cancer in Immunodeficiency Families" (Funded by National Cancer Institute)	1976-
Consultant, Fairview Hospital "High School Football Injuries" (Funded by Health Research Program, State of Minnesota)	1977-
Consultant, Minnesota Environmental Quality Council "Copper-Nickel Environmental Impact Study: Potential Health Effects" (Funded by State of Minnesota)	1976-78
Consultant, Veterans Administration Hospital "Epidemiology of Alzheimer's Disease"	1978-
Project Director, "EPA/NCI Special Skin Cancer Epidemiology Study" (Funded by National Cancer Institute)	1977-78
Co-Investigator, "Cancer Incidence in Northern Minnesota: Potential Effects of Asbestos" (Funded by Environmental Protection Agency)	1977-
Project Director, "Health Status of American Men Study" (Funded by NICHD)	1976-

Consultant, Los Alamos, New Mexico
"Health Study of Plutonium Workers" 1978-

Consultant, "Potential Health Risks Associated with Organic Contaminants in Great Lakes - Feasibility Study"
(Funded by Environmental Protection Agency) 1978-

Co-Investigator, "Minnesota Kidney Cancer Study"
(Funded by National Cancer Institute) 1979-82

Co-Investigator, "Long Term Mortality Study of Minnesota Iron Ore Miners"
(Funded by National Cancer Institute) 1979-81

Assistant Director, Division of Epidemiology
School of Public Health, University of Minnesota 1979-

Awards and Honors:

Health Scientist Fellowship from the Department of National Health and Welfare, Ottawa, Canada, 1972-75

Sigma Xi Society, 1978-

Membership in Professional Associations:

American Public Health Association
Society for Epidemiologic Research
American Statistical Association
Biometric Society

Committee Memberships:

Faculty Council School of Medicine,
University of Ottawa 1970-72

Epidemiology Committee, American Cancer Society 1974-

Committee on the Use of Human Subjects in Research,
University of Minnesota 1976-

Chairman, Breast Cancer Detection Task Force Committee,
Minnesota Health Department 1976-78

Design and Analysis Committee
National Study of Health Status of American Men
National Institute of Child Health and Development 1976-

Steering Committee
National Study of Health Status of American Men
National Institute of Child Health and Development 1976-

Space Planning Committee
School of Public Health, University of Minnesota 1977-

Research Committee
School of Public Health, University of Minnesota 1977-

Executive Subcommittee on Policy Use of Human Subjects in Research University of Minnesota	1977-
Grievance Committee School of Public Health, University of Minnesota	1977-
Planning Council School of Public Health, University of Minnesota	1978-

Publications:

Mandel, J.S., Notes on Methodology: Expectation of First Admission, Statistics Canada, April, 1969.

Johnson, G., Cooper, J. and Mandel, J.S., Expectation of admission to a Canadian psychiatric institution: Conditional expectancy measure, Can. Psychiat. Ass. J., 14, 295-298, 1969.

Neri, L. and Mandel, J.S., A household survey of chronic obstructive pulmonary disease in Ottawa: Methodological problems and results of pilot survey, Can. J. Pub. Hlth., 61, 407-412, 1970.

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Neri, L.C., Hewitt, D., Schreiber, G.B., Anderson, T.W., Mandel, J.S. and Zdrojewsky, A., Health aspects of hard and soft water. J.A.W.W.A., 67, 403-409, 1975.

Neri, L.C., Mandel, J.S., Hewitt, D. and Jurkowski, D., Chronic obstructive pulmonary disease in two cities of contrasting air quality. Can. Med. Ass. J., 113, 1043-1046, 1975.

Levy, B., Sigurdson, E., Mandel, J.S., Laudon, E. and Pearson, J., Investigating possible effects of asbestos in city water: Surveillance of gastrointestinal cancer incidence in Duluth, Minnesota. Am. J. Epid., 103, 362-368, 1976.

Boxtell, G., Mandel, J.S., Murray, S., Schuman, L.M. and Goltz, R.W., Incidence of skin carcinoma following renal transplantation, Arch. Derm., 113, 436-438, 1977.

Schuman, L.M., Mandel, J.S., Blackard, C., Bauer, J., Scarlett, J. and McHugh, R., Epidemiologic study of prostatic cancer: Preliminary Report. Cancer Treat. Rep., 61, 181-186, 1977.

Halberg, F., Cornelissen, R., Sothern, L., Wallach, E., Halberg, E., Ahlgren, A., Radke, A., Barbosa, F., Goetz., Buckley, J., Mandel, J.S., Schuman, L., Haus, E., et al. Rationalization of cost-effective sampling in oncology by pertinence rather than only by convenience. International studies of human host and tumor rythms with multiple frequencies. In: Comparative Pathology of Abnormal Growth. H. Kaiser, ed. (In press)

Mandel, J., Hollingsworth, C., Murray, S. and Lowry, P., Mortality among priests with special reference to cancer of the prostate. Submitted for publication.

McHugh, R., Church, T., Windler, C. and Mandel, J., Predictive value parameters in multi-site cancer screening. (In preparation.)

Glibertsen, V., Church, T., Grewe, F., Mandel, J., McHugh, R., Schuman, L. and Williams, S., The design of a study to assess occult-blood screening for colon cancer. (In press, J. Chron. Dis.)

Mandel, J.S. and Schuman, L.M., The Epidemiology of cancer of the prostate. (In preparation.)

Papers Presented at Professional Meetings:

Neri, L. and Mandel, J.S., The relationship between water hardness and cardiovascular mortality. The Canadian experience. Paper presented to the Society for Epidemiological Research, Minneapolis, Minnesota, 1970.

Neri, L. and Mandel, J.S., Epidemiological survey of respiratory disease in Ottawa. Paper presented to the Canadian Thoracic Society. Toronto, Ontario, 1970.

Neri, L., Mandel, J.S. and Davies, J., Household survey for chronic respiratory disease in Ottawa. Paper presented to the Canadian Thoracic Society. Toronto, Ontario, 1971.

Neri, L., Mandel, J.S., Hewitt, D. and Jurkowski, D., Chronic obstructive pulmonary disease in two Ontario communities. Paper presented to International Epidemiologic Association, Brighton, England, 1971.

Neri, L., Hewitt, D., Schreiber, G. and Mandel, J.S., Is there a water factor: A case for magnesium. Paper presented to Seventh International Water Quality Symposium, Washington, D.C., 1974.

Mandel, J.S., Epidemiologic study of etiologic factors in prostatic cancer. Paper presented to Society for Epidemiologic Research, Seattle, Washington, 1977.

Windler, C., Mandel, J. and McHugh, R., Test predictivity in multi-site cancer screening. Paper presented to the American Public Health Association, Washington, D.C., 1977.

Sigurdson, E., Mandel, J.S., McHugh, R.B., Michienzi, L., Levy, B. and Jagger, H., Investigating possible effects of amphibole fibers in city water: Surveillance of cancer incidence in Duluth. Paper presented to the American Public Health Association, Los Angeles, California, 1978.

Sigurdson, E., Levy, B., Mandel, J.S., et al. Cancer morbidity investigations: Lessons from the Duluth study of possible effects of asbestos in drinking water. Paper presented to the Second Workshop on Health Surveillance Around Point Sources of Pollution. Albuquerque, New Mexico, January 22-24, 1979.

CURRICULUM VITAE

Name:	Athena Linos, M.D.
Address:	[redacted]
Home Telephone:	[redacted]
Office Telephone:	507-288-4584
Date Of Birth:	[redacted]
Place of Birth:	[redacted]

Education:

School	Degree	Grade	Year
Athens Medical School	M.D.	Excellent	1975
Harvard School of Public Health	M.P.H.	-	1976
Athens University	Doctorate (Ph.D. equivalent)		1978
University of Minnesota, School of Public Health. Twelfth Graduate Summer Session in Epidemiology			1977

Positions:

Research Fellow, Mayo Graduate School of Medicine, Department of Epidemiology and Medical Statistics, 1976 to present

Assistant Professor, Division of Epidemiology, School of Public Health, University of Minnesota September 1979-

PUBLICATIONS

1. Linos, Athena, M.D., et al. Rheumatoid Arthritis and Oral Contraceptives. Lancet, 871, April 22, 1978.

2. Linos, Athena, M.D., et al. Effect of Aspirin on Prevention of Coronary and Cerebrovascular Disease in Patients with Rheumatoid Arthritis. A Long-Term Follow-Up Study. Mayo Clinic Proc. 53: 581-586, 1978.

3. Linos, Athena, M.D., et al. Leukemia in Olmsted County Minnesota. Mayo Clinic Proc. 53: 714-718, 1978.

4. Linos, Athena, M.D., et al. The Epidemiology of Rheumatoid Arthritis in Rochester, Minnesota. A Study of Incidence, Prevalence, and Mortality. Submitted for publication.

5. Linos, Athena, M.D., et al. Occurrence of Hashimoto's Thyroiditis and Diabetes Mellitus in Patients with Rheumatoid Arthritis. Submitted for publication.

6. Linos, Athena, M.D., et al. The Prognosis of Rheumatoid Arthritis. Manuscript in preparation.

7. Linos, Athena, M.D., et al. Effect of diagnostic and Therapeutic Radiation on Leukemia. A Case Control Study. Manuscript in preparation.

8. Linos, Athena, M.D., et al. Occupational Risk Factors and Leukemia. A Case Control Study. Manuscript in preparation.

RESEARCH PROJECTS CURRENTLY IN PROGRESS

STUDY	STATUS
(1) Rheumatoid Arthritis and Oral Contraceptives. A Case Control Study	Data collection
(2) Epidemiology of Malignant Lymphoma in Olmsted County, Minnesota	Data collection
(3) Epidemiology of Multiple Myeloma in Olmsted County, Minnesota	Analysis
(4) Epidemiology of Amyloidosis in Olmsted County, Minnesota	Analysis

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DEC 20 1979
School of Public Health
Epidemiology

CURRICULUM VITAE

John Fred Annegers

PERSONAL

Date of birth: [redacted] Married: [redacted]
Place of birth: [redacted] Children: Two

EDUCATION

1962 Graduated from Evanston Township High School (suburban Chicago). Entered Michigan State University in the fall of 1962.

1965 Graduated from Michigan State University with a Bachelor of Arts degree: Major - Geography; Minor - History

1965 Accepted three year National Defense Education Act Fellowship for graduate study in geography. Began graduate studies June, 1965.

1967 Received Master's degree in geography. Thesis: Agricultural Production and Population Pressure in El Salvador.

1972 Received Doctorate of Geography at Michigan State University. Dissertation: Geographic Patterns of Diet and Nutritional Status in West Africa.

1973 Additional course work in medical statistics and epidemiology at the Mayo Clinic and University of Minnesota.

RESEARCH POSITIONS

1. Research Assistant in African Studies, Michigan State University. January-September, 1969. Bibliographical research on the geography of diseases in tropical Africa for John Hunter (Geography Department) and Charles Hughes (Anthropology Department).

2. Research Assistant in Human Nutrition, Michigan State University. June, 1971, to March, 1973 (part time). Research conducted for the Salt Institute with Olaf Michelsen on iodized salt, iodine intake and thyroid disease.

3. Research Assistant in Epidemiology Department of the Mayo Clinic "Rochester Project," April, 1973 to April, 1977. Assistant on studies of the epidemiology of disease in the Rochester-Olmsted County population. Assigned to projects concerning the epidemiology of epilepsy, congenital malformations, and cancer.

4. Research Associate in Epidemiology Department of the Mayo Clinic "Rochester Project" and "Comprehensive Epilepsy Program," April, 1977 to March, 1979. Associate on studies of epilepsy, head trauma, and cancer.

5. Associate Consultant in Epidemiology Department of the Mayo Clinic "Rochester Project" and "Comprehensive Epilepsy Program," from April 1, 1979. Consultant for study design on epidemiology projects.

TEACHING EXPERIENCE

1967 Michigan State University, Spring Term—Teaching Assistant in Geography. Responsible for recitation section in introductory world regional geography.

1968 Spring Term: same as above.

1969 Fall Term: Same responsibilities as above plus assisting in an introductory course on statistical methods in geography.

1971 Western Michigan University, Winter Semester--Instructor. Taught two sections of geography of Middle and South Africa.

1975 Mayo Medical School Assistant in epidemiology course for medical students.

1977 Instructor, Mayo Medical School

DISSERTATION RESEARCH

Dissertation: Geographic Patterns of Diet and Nutritional Status in West Africa with Special Reference to Calorie and Protein Deficiencies. Committee: Borgstrom, Hunter, Michelsen, Sommers.

Research: An extensive survey of the geographical, nutritional, agricultural, anthropological and medical literature concerning diet and nutritional status in West Africa from English and French sources was undertaken. This research included six months abroad in London, Paris, Geneva, Rome, Accra, Abidjan, and Dakar to obtain information and to confer with experts in various fields.

Synopsis: The regional and ecological aspects of food consumption and nutritional status in West Africa were analyzed. The patterns of use of the major foods and, in turn, nutrient composition of diets were shown to be highly regional and strongly related to the physical conditions influencing food production and storage. Nevertheless, these distributions are dynamic with economic factors and diffusion contributing to alterations in traditional distributions. Particular emphasis is given to those processes which have made and are continuing to make significant changes in these patterns. The occurrence of protein and calorie deficiencies in West Africa were found to be regional and related to the patterns of food consumption. Shortages of calories occur as a seasonal phenomena in parts of the sudanic zone of West Africa.

BIBLIOGRAPHY

John F. Annegers, Ph.D.

Articles:

1. Borgstrom G, Annegers JF: Post-war developments of East European agriculture. Tijdschrift Voor Economishe en Sociale Geografie 62:114-125, 1971.

2. Annegers JF: Ecology of dietary patterns and nutritional status in West Africa. I. Distribution of starchy staples. Ecology of Food and Nutrition 2:107-119, 1973.

3. Annegers JF: The protein-calorie ratio of West African diets and their relationship to protein calorie malnutrition. Ecology of Food and Nutrition 2:225-235, 1973.

4. Annegers JF: Seasonal food shortages in West Africa. Ecology of Food and Nutrition 2:251-257, 1973.

5. Annegers JF: Protein quality of West African foods. Ecology of Food and Nutrition 3:1-6, 1974.

6. Annegers JF, Elveback LR, Hauser WA, Kurland LT: Do anticonvulsants have a teratogenic effect? Archives of Neurology 31:364-373, 1975.

7. Harris LE, Stayura LA, Ramirez-Talavera PF, Annegers JF: Congenital and acquired abnormalities observed in liveborn and stillborn neonates. Mayo Clinic Proc 50:85-90, 1975.

8. Annegers JF, Elveback LR, Hauser WA, Kurland LT: Epilepsy anticonvulsants and malformations. New chromosomal and malformation syndromes. The National Foundation, March of Dimes, 11(5):157-160, 1975.

9. Annegers JF, Hauser WA, Kurland LT: Seizure disorders in the offspring of parents witha history of seizures--a maternal-paternal difference" Epilepsia 17:1-9, 1976.

10. Annegers JF, Elveback LR, Labarthe DR, Hauser WA: Ischemic heart disease in patients with epilepsy. Epilepsia 17:11-14, 1976.

11. Maruchi N, Annegers JF, Kurland LT: Hashimoto's thyroiditis and breast cancer. Mayo Clin Proc 51:263-265, 1976.

12. McDonald TW, Annegers JF, O'Fallon WM, Dockerty MB, Malkasian GD, Kurland LT: Exogenous estrogen and endometrial carcinoma. Case-control and incidence study. American Journal of Obstetrics and Gynecology 127:572-580, 1977.

13. Annegers JF, Hauser WA, Elveback LR, Anderson VE, Kurland LT: Congenital malformations and seizure disorders in the offspring of parents with epilepsy. International Journal of Epidemiology 241-247, 1978.

Articles—continued.

14. Annegers JF, Carr DT, Woolner LB, Kurland LT: Incidence, trend, and outcome of bronchogenic carcinoma in Olmsted County, Minnesota, 1935-1974. Mayo Clin Proc 53:432-436, 1978.

15. Annegers JF, Coulam CB, Abboud CF, Laws, Jr. ER, Kurland LT: Pituitary adenoma in Olmsted County, Minnesota, 1935-1977: A report of an increasing incidence of diagnosis in women of child-bearing age. Mayo Clin Proc 53(10):641-643, 1978.

16. Annegers JF, Hauser WA, Elveback LR, Kurland LT: The risk of epilepsy following febrile convulsions. Neurology 29(3)297-303, 1979.

17. Annegers JF, Strom H, Decker DG, Dockerty MB, O'Fallon WM: Ovarian cancer: Incidence and case-control study. Cancer 43(2):723-729, 1979.

18. Coulam CB, Annegers JF, Abboud CF, Laws, Jr. ER, Kurland LT: Pituitary adenomas and oral contraceptives: A case-control study. Fertility and Sterility 31(1):25-28, 1979.

19. Annegers JF, Laws, Jr. ER, Kurland LT, Grabow JD: Head trauma and subsequent brain tumors. Neurosurgery 4:203-206, 1979.

20. Annegers JF, Kurland LT: The epidemiology of central nervous system trauma. IN: Central Nervous System Trauma. GL Odom, ed. National Institutes of Health, 1979, pp. 1-8.

21. Kurland LT, Annegers JF: The geochemical enviornment and cancer epidemiology. Comments on international diagnoses and study design. IN: Geochemistry and the Environment, Volume III. HC Hopps, ed. National Research Council, 1978, pp. 90-93.

22. Kurland LT, Annegers JF, O'Fallon WM: Utilization of Mayo Clinic records for population-based, long-term evaluations of drug exposure. IN: Computer Aid to Drug Therapy and Drug Monitoring. H Duncrot et al. eds. North Holland Pub. Co., 1978, pp. 69-76.

23. Kurland LT, Annegers JF: Medical records linkage system of the Mayo Clinic. Recent computer experience--Contributions to epidemiology and health care delivery. In: Proceedings of the International Symposium on Medical Information Systems. Osaka, Japan. October 2-6, 1978. (In Press).

24. Malkasian GD, Annegers JF, Fountain KS: Carcinoma of the endometrium: Stage I. Am J Obstet Gynecol. (In Press).

25. Annegers JF, Hauser WA, Elveback LR: Remission of seizures and relapse in patients with epilepsy. Epilepsia 70:729-737, 1979.

26. Evans AT, Gaffey TA, Malkasian GD, Annegers JF: Granulosa cell carcinoma and theca cell tumor: A clinico-pathologic review of 200 cases. Obstet Gynecol. (In Press).

27. Coulam CB, Annegers JF: Do anticonvulsants reduce the efficacy of oral contraceptives for contraception? Epilepsia 20:519-526, 1979.

Abstracts and Letters:

1. Kurland LT, Annegers JF: Breast cancer and Hashimoto's thyroiditis. Lancet 1(7963):808, 1976.

2. Annegers JF, Labarthe DR: Tschaemic heart disease in epileptics. Br Med J 1(6023):1470, 1976.

3. Hauser WA, Annegers JF, Kurland LT: Is the incidence of epilepsy declining? Am J of Epidemiol 106(3):246, 1977.

4. Annegers JF, O'Fallon WM, Kurland LT: Exogenous oestrogens and ovarian cancer. Lancet II(8043):869-870, 1977. (Editorial Corrections: December 3, 1977, page 1188).

5. Hauser WA, Annegers JF, Kurland LT: Febrile convulsions: Prognosis for subsequent seizure. Neurology 27(4):341, 1977.

6. Hauser WA, Annegers JF, Kurland LT: Mortality in patients with epilepsy--A benign disease? American Epilepsy Society 1977 Annual Meeting. November 30 - December 1, 1977. New York, New York. Epilepsia (In Press).

7. Annegers JF, Hauser WA, Kurland LT: Secular changes in the incidence of seizure disorders in Rochester, Minnesota, 1935-1974. American Epilepsy Society 1977 Annual Meeting. November 30 - December 1, 1977. New York, New York. Epilepsia (In Press).

8. Annegers JF, Grabow JD, Groover RV, Kurland LT: Epidemiology of head trauma in a pediatric population, with special emphasis on post-traumatic epilepsy. Child Neurology Society. September, 1978. Keystone, Colorado. Annals of Neurology 4:196-197, 1978.

9. Annegers JF, Hauser WA, Anderson VE, Kurland LT: Fertility in males and females before and after onset of epilepsy. American Epilepsy Society 1977 Annual Meeting. November 30 - December 1, 1977. New York, New York. Epilepsia (In Press).

10. Grabow JD, Annegers JF, Groover RV, Laws ER, Kurland LT: Head trauma in Olmsted County, Minnesota--Epidemiology, risks of post-traumatic epilepsy, and EEG findings. Methods and preliminary results. EEG Journal, June 1979.

11. Annegers JF, Coulam CB, Laws ER, Kurland LT: Pituitary adenomas and oral contraceptives. Lancet 2(8104):1384, 1978.

12. McDonald TW, Annegers JF, O'Fallon WM, Dockerty MB, Malkasian GD, Kurland LT: Exogenous estrogens and endometrial carcinoma: Case-control and incidence study. IN: Yearbook of Cancer. RL Clark, ed. 1978, pp. 133-134.

13. Annegers JF, Kurland LT, Grabow JD, Groover RV, Laws ER: The incidence of head trauma and subsequent risks of seizures and brain tumors. Neurology 29(4):578, 1979.

14. Annegers JF, Kurland LT, Hauser WA: Brain tumors in children exposed to barbiturates. JNCI 63:3, 1979.

15. Annegers JF, Kurland LT, Grabow JD: The incidence, causes and secular trends of head trauma in Olmsted County, 1935-1974. Am J Epidemiol 110:464, 1979.

Presentations:

1. Epilepsy anticonvulsants and congenital malformations. American Epidemiological Society. Nw York, New York. April, 1974.

2. Epilepsy anticonvulsants and malformations. 1974 Birth Defects Conference. Newport Beach, California. June, 1974.

3. Malformations and seizure disorders in the children of parents with epilepsy. Minnesota Neurologic Society. Minneapolis, Minnesota. October, 1974.

4. Incidence of endometrial cancer in Olmsted County. Obstetrics and Gynecologic Advisory Committee, DHEW, FDA. Rockville, Maryland. December 16, 1975.

5. Epidemiology of the epilepsies. Where are we? 5th National Conference on the Epilepsies. Washington, D.C. January 19, 1976.

6. Endometrial cancer: Case-control and incidence study. American Epidemiological Association. Baltimore, Maryland. April, 1976.

7. Teratogenicity of antiepileptic drugs. American Epilepsy Society. Dearborn, Michigan. October 2, 1976.

8. Endometrial carcinoma: A study of incidence trends and the role of exogenous estrogen and other risk factors. Central Association of Obstetricians and Gynecologists. Houston, Texas. October 14, 1976.

9. Exogenous estrogen and endometrial carcinoma. Minnesota Obstetrical and Gynecological Society. Minneapolis, Minnesota. December 4, 1976.

10. Is the incidence of epilepsy declining? Society for Epidemiological Research. Seattle, Washington. June, 1977.

11. Secular changes in the incidence of seizure disorders. American Epilepsy Society. New York, New York. December 1, 1977.

12. Ovarian cancer: A case-control and study of risk factors. Society of Preventive Oncology. Washington, D.C. March 10,1978.

13. Head trauma in Olmsted County, Minnesota--epidemiology, risks of post-traumatic epilepsy and EEG findings. Central Association for Electroencephalographers. Omaha, Nebraska. May 19, 1978.

14. Remission and relapse of seizures in epilepsy. International Epilepsy Symposium. Vancouver, Canada. September 14, 1978.

15. Epidemiology of head trauma and post-traumatic seizures in a pediatric population. Keystone, Colorado. September 30, 1978.

16. Epidemiology of cancer. Cancer in West Central Minnesota. Fergus Falls, Minnesota. April 21, 1979.

17. The incidence of head trauma and risks of subsequent seizures and brain tumors. Academy of Neurology. Chicago, IL. April 26, 1979.

18. Incidence, causes and secular trends of head trauma in Olmsted County. Society for Epid. Research. New Haven, CT. June 14, 1979.

CURRICULUM VITA

Name: Richard B. McHugh

Education:

B.A., magna cum laude, (Mathematics)	1944	The University of Minnesota
Graduate Study (Statistics)	1946-47	The University of California-Berkeley
Ph.D. (Statistics)	1954	The University of Minnesota

Professional Positions:

1. Professor of Biometry, School of Public Health, Health Sciences Center, University of Minnesota, 1972-present. (Also Professor of Statistics and of Operations Research, Graduate Faculty, University of Minnesota, 1973-present.)

2. Visiting Fellow, Wolfson College and Department of Biomathematics, University of Oxford, 1978-79.

   U.I.C.C. American Cancer Society - Eleanor Roosevelt International Cancer Fellow, Department of Biomathematics, University of Oxford, 1978-79.

3. Visiting Professor, Graduate Summer Session of Statistics in the Health Sciences, University of Texas, Houston, 1973.

4. Visiting Scholar, University of London, 1971-72.

5. Professor and Head, Biometry Division, School of Public Health, University of Minnesota, 1968-72.

6. Director of Graduate Study in Biometry, Graduate School of the University of Minnesota, 1968-72.

7. Director of the Biometry Consulting Laboratory, University of Minnesota, 1968-72.

8. Director of the Biometry Training Grant (awarded by the U.S. Public Health Service to the University of Minnesota), 1968-72.

9. Professor of Biometry, School of Public Health, College of Medical Sciences, University of Minnesota, 1961-62.

10. Visiting Professor, Graduate Summer Session of Statistics in the Health Sciences, Yale University, 1966.

11. Senior Post-doctoral Fellow, National Institute of General Medical Science, University of California, Berkeley, 1964-65.

12. Associate Professor of Biostatistics, School of Public Health, College of Medical Sciences, University of Minnesota, 1956-61.

13. Associate Professor (1954-56), Assistant Professor (1950-54) of Statistics and Psychology, Iowa State University.

14. Teaching Assistant, Biostatistics, School of Public Health, College of Medical Sciences, University of Minnesota, 1944-50.

15. Teaching Assistant, Mathematics, University of California, Berkeley, 1946-47.

Memberships in Technical Societies:

Biometric Society
American Statistical Association
American Public Health Association
American Association for the Advancement of Science
Population Association of America
Society for Epidemiological Research
Royal Statistical Society

Honorary Societies:

Phi Beta Kappa
Sigma Xi
American Men and Women of Science
Fellow of the American Association for the Advancement of Science
Fellow of the American Statistical Association
Fellow of the American Public Health Association
Fellow of the Royal Statistical Society

Other Professional Experience:

1. Regional Advisory Board Member of Biometric Society (ENAR), 1960-61.
2. Editorial Collaborator of Journal of the American Statistical Association, 1961, 1966.
3. Representative of Biometric Society (ENAR) at the Pan American Sanitary Conference, WHO, 1962.
4. Invited Lecturer, 8th International Congress on Biological Rhythm, Hamburg, 1963.
5. Methodology Advisor to the Surgeon General's Committee on Smoking and Health, 1963.
6. Member of Advisory Board of the Minnesota Center for the Philosophy of Science, 1962-68.
7. Consultant Editor to Psychophysiology, 1966-present.
8. Invited Lecturer, Workshop Conference on Statistics in Endocrinology, Boston, 1967.
9. Editorial Collaborator of Public Health Reports, 1967.
10. Discussion Group Coordinator and Panelist at the Twelfth National Meeting of the Public Health Conference on Records and Statistics, Washington, DC, 1968.
11. Consultant to the Council of Graduate Schools in the U.S. (site visit University of Alabama Medical School), 1969.
12. Invited Participant to the Gordon Research Conference on Statistics in Chemistry and Chemical Engineering (New Hampton, N.H., 1969).
13. Invited Participant to the Conference on the Mathematics of Population Berkeley and Asilomar, CA, 1969).
14. National Program Chairman of the Biometric Society (ENAR), Annual Meeting (New York, 1969).

15. Member of the Advisory Committee to the Center for Population Studies, University of Minnesota, 1969-71.
16. Member of the Student Personnel Council of the College of Liberal Arts, University of Minnesota, 1969-71, 1974-75.
17. Member of the Advisory Committee to the School of Statistics and the Statistical Center, University of Minnesota, 1969-61.
18. Consultant to the Multi-dimensional Clinical Trial of Anticoagulants (sponsored by the Veterans Administration), 1968-71.
19. Consultant to the Multi-institutional Clinical Trial of Tuberculosis Chemotherapy and Tuberculosis Prophylaxis (sponsored by the Veterans Administration), 1968-71.
20. Council Member of the American Statistical Association, 1971-72.
21. Editorial Collaborator of Biometrics, 1970-72, 1974-78.
22. Statistics Section Council Member of the American Public Health Association, 1971-73.
23. Regional Committee Member of the Biometric Society (ENAR), 1971-73.
24. Invited Participant, International Symposium on Statistical Problems in Population Research (East-West Center, Honolulu, Hawaii, 1971).
25. Adviser, WHO Expert Committee on Statistical Principles for Design and Analysis of Public Health Field Studies (Geneva, Switzerland, 21-27, March, 1972).
26. Chairman, American Statistical Association Section on Teaching of Statistics in the Health Sciences, 1972-73.
27. Consultant to the 1973 "Region D" Health Manpower Survey of the Central Minnesota Health Planning Council and the University of Minnesota Area Health Education Center, 1973.
28. Editorial Collaborator, Gerontology, 1974.
29. Consultant to the National Cancer Institute (site visit, University of Hawaii Cancer Center), 1974.
30. Professor, 9th Annual Graduate Summer Session in Epidemiology, University of Minnesota, Minneapolis, 1974.
31. Member of an American Joint Committee on Cancer Staging and End Results Reporting Task Force (on Cancer of the Salivary Gland), 1974-75.
32. Program Chairman, Twin City Chapter of the American Statistical Association, 1974.
33. Member of the National Cancer Institute's Working Cadre for the National Pancreatic Cancer Research Project, 1974-78.
34. Director of Undergraduate Studies in Biometry, 1974-78.
35. President, Twin Cities Chapter of the American Statistical Association, 1975.
36. Vice-Chairman of the Council of the American Statistical Association, 1975.
37. Co-Investigator of the National Cancer Institute's "Multi-site Cancer Screening" Study, 1975-76.
38. Consultant on the Design of a Survey of State Hospital Patients for the Office of Research and Evaluation, State of Minnesota, Department of Public Welfare, 1975.
39. Co-Investigator of the National Cancer Institute's "Epidemiologic Study of Etiologic Factors in Prostatic Cancer", 1975-78.
40. Co-Investigator of the National Cancer Institute's "Occult Blood Screening for Bowel Cancer" Study, 1975-85.
41. Member of the Board of Directors of the American Statistical Association, 1976-77.
42. Vice-Chairman of the Statistics Section, American Public Health Association, 1976.

43. Member of the Food and Drug Administration's Oncologic Drugs Advisory Committee, 1976-present.
44. Chairman of the Statistics Section, American Public Health Association, 1977-78.
45. Member of the Board of the Program on Human Issues and Values, Vice-President for Student Affairs Office, University of Minnesota, 1976-77.
46. Invited Lecturer, The Annual Princeton Conference on Applied Statistics, 1976.
47. External Consultant to the University of Michigan School of Public Health, Ann Arbor (site visit, review of the Department of Biostatistics graduate program), 1977.
48. Member of the Sigma Xi Program Committee, University of Minnesota Chapter, 1977-78.
49. Consultant to the National Cancer Institute's "Epidemiology of Cancer in Immuno-deficiency Families", 1976-present.
50. Editorial Collaborator, Analytical Biochemistry Journal of Laboratory and Clinical Medicine, 1976-77.
51. Member of the American Statistical Associations Committee on Privacy and Confidentiality, 1977-80.
52. Associate Editor, American Journal of Epidemiology, 1978-79.
53. Editor, American Journal of Epidemiology, 1979-present (with responsibility for biometric contributions)

Publications:

1. "The Comparison of Two Correlated Sample Variances", American Journal of Psychology. (1953)
2. "Age Changes in Mental Organization - a Longitudinal Study", Journal of Gerontology (with W.A. Owens). (1954)
3. "The 'Post-Mortem' Testing of Experimental Comparisons", Psychological Bulletin (with D. Ellis). (1955)
4. "A Predictive Confidence Interval for the Validity Coefficient", Journal of Experimental Education. (1956)
5. "Efficient Estimation and Local Identification in Latent Class Analysis", Psychometrika. (1956) (Largely republished as Chapter 4, "The Latent Class Model: Estimation of Parameters" in Latent Structure Analysis by Lazarsfeld and Henry, Houghton Mifflin Co.,1968).
6. "Determining Sample Size in Validation Research", Educational and Psychological Measurement. (1957)
7. "The Interval Estimation of a True Score", Psychological Bulletin. (1957)
8. "Significance Level in Factorial Design", Journal of Experimental Education. (1958)
9. "Methodology for the Comparison of Clinical with Actuarial Predictions", Psychological Bulletin, (with P. Apostolakis). (1959)
10. Review of "Safety in Numbers", Survey of Anesthesiology. (1959)
11. "Regressive Electroshock Therapy in Chronic Schizophrenia, A Controlled Study", Journal Lancet (with H.K. Graber). (1960)
12. "The Effect of Promazine (Sparine) on Patients with Chronic Schizophrenia", Minnesota Medicine, (with E.A. Krenaas). (1960)
13. "Statistical Problems in Personality Evaluation Scales", Report of Confere on Social Adjustment Rating Scales, Center for Continuation Study, University of Minnesota. Auspices of Department of Psychiatry, Medical School, University of Minnesota; Psychopharmacology, Service Center, National Institute of Mental Health. Edited by B.C. Glueck. (1960)
14. Discussant Contribution to "The Design and Analysis of Experiments", Chapter IV in Research Design and Analysis, edited by R.O. Collier and S.M. Elam, Phi Delta Kappa Publishers, Bloomington, IN. (1961)
15. "On Hellinger's Treatment of Change Scores", Journal of Clinical Psychology. (1961)
16. "Confidence Interval Inference and Sample Size Determination", The American Statistician. (1961)
17. "On the Evaluation of Personality Changes as Measured by Psychometric Task Profiles", Psychological Reports (with G. Sivanich and S. Geisser). (1961)
18. "Estimating the Precision of Time Period Effects in Longitudinal Models with Serially Correlated and Heterogeneous Errors", Biometrics, (with F.J. Wall). (1962)
19. "On the Statistical Analysis of Tumor Immunity Experiments", Biometrics, (with J.E. Faulkner) (Abstract). (1962)
20. "Assessing the Temporal Stability of Profile Groups in a Comparative Experiment or Survey", Psychological Reports, (with G. Sivanich). (1963)
21. "Comment on 'Scales and Statistics: Parametric and Non-Parametric'", Psychological Bulletin. (1963) [Republished as Chapter 10 in Readings in Statistics for the Behavioral Sciences, edited by Heermann and Braskamp, Prentice-Hall Publishers, 1970].
22. "A Multivariate Analysis of Some Experiments in Tumor Immunity", Folia Biologica, (with J.E. Faulkner and H.F. Hirsch). (1963)

23. "Contribution of Stereotyped and Individualized Information to Predictive Accuracy", Journal of Consulting Psychology, (with Z. Stelmachers). (1964)
24. "Need the Randomized Block Design be Replicated?", Journal of Experimental Education. (1964)
25. "The Effects of Two Ion Exchange Resins on the Inhibition of Calculus-like Deposits in Vitro", Journal of Periodontology, (with E. Schaffer and S. Schindler). (1964)
26. "A New Experimental Approach to the Evaluation of the Effect of Narcotic Analgesics Upon Respiratory Function", Journal of the Minnesota Academy of Science, (with C.H. Pierce and R.N. Bieter). (1965)
27. "An Experimental Assessment of Gingivectomy and Soft Tissue Curretage in Dogs", Journal of Periodontology, (with N. Korn and E. Schaffer). (1965)
28. "A Two-Year Study of Clinical Chemistry Determinations in Minnesota Hospitals", Minnesota Medicine, (with B. Merritt, A. Kimball, and H. Bauer). (1965)
29. "Non-Orthogonality in the Two-Way Classification for the Mixed Effects Finite Model", Biometrics, (with P.W. Mielke). (1965)
30. "The Detection of Acute Erythema in Pigmented and Non-pigmented Bovine Skin by Measurement of its Spectral Reflectance", Journal of Investigative Dermatology, (with W. Runge and L. Johnson). (1966).
31. "Validity and Efficiency in the Design of Transverse Physiologic Periodicity Experiments", Chapter 4, The Cellular Aspects of Biorhythms, edited by H. von Mayersbach, Springer-Verlag Publishers, New York. (1967)
32. "A Model for Isotope Displacement Immunoassays", Biometrics, (with C.L. Meinert). (Abstract) (1967)
33. "Carcass Transaldolase Activities in Vitro, and Rates of Creatine Synthesis, in Vivo in Normal and Protein-depleted Rats", Journal of Nutrition, (with J.F. Van Pilsum and R.H. Warhol). (1967)
34. "A Biometric Model for Immunological Experimentation on Spontaneous Mammary Tumors in Inbred Mice", Biometrics, (with J.E. Faulkner) (Abstract) (1967)
35. "Clustering of Serum Immunoglobulin Concentrations within Sibling Groups", Journal of Laboratory and Clinical Medicine, (with I.D. Wilson and R.C. Williams, Jr.) (1968)
36. "The Biometry of an Isotope Displacement Immunologic Micro Assay", Mathematical Biosciences, (with C.L. Meinert). (1968)
37. "Negative Variance Estimates and Statistical Dependence in Nested Sampling", Journal of the American Statistical Association, (with P.W. Mielke) (1968)
38. "Basic Demographic Data", Proceedings of the Public Health Conference on Records and Statistics, 17th Annual Meeting. (USDHEW) (1968)
39. Review of Mortimer Spiegelman's "Introduction to Demography", Journal of the American Public Health Association. (1969)
40. "Long-Term Anticoagulant Therapy After Myocardial Infarction", Journal of the American Medical Association, (with P. Ebert and others of the Veterans Administration Cooperative Committee). (1969)
41. "Contrast Estimation in Clinical Trials with Strata Heterogeneity", Biometrics, (with N. Nelson) (Abstract) (1969)
42. "Validation of an In Vitro Enzyme Assay Indirectly Measuring an In Vivo Biosynthesis", Biometrics, (with J.F. Van Pilsum and F.W. Briese). (1970)
43. "A Theoretical Model for Statistical Inference in Isotope Displacement Immunoassay", Chapter 22 in Statistics in Endocrinology, edited by J.W. McArthur and T. Colton, MIT Press (with C.L. Meinert). (1970)
44. "Radiation Dose-Independent Inactivation of Isologous Mouse Lymphoma Cells by Nonspecific Resistance", Cancer Research 10, #8 August. (with Y. Maruyama and C. Ceman). (1970)

45. "A Symmetrical Incomplete Block Design Arising in a Tuberculin Testing Experiment", Biometrics (with C.E. Carlson and J.E. Bearman) (Abstract) (1970)
46. Discussant Contribution to "Mathematical Models of Demography: Alternative Approaches", 13th Annual Proceedings of the Social Statistical Section of the American Statistical Association. (1970)
47. "Circadian Rhythm in Susceptibility to Methylprednisolone-Side-Effect Upon Weight Gain in Immature C-Mice", Federation Proceedings (Physiology) (with M.H. Smolensky, et al) (Abstract) (1971)
48. "Oral Contraceptives -- A Continuing Reappraisal", Postgraduate Medicine. (with G.E. Tagatz, M.D.) (1971)
49. "Two Models of 'Follow-up in the Clinical Trial: Life Table and Competing Risk Analysis", Biometrics. (with C. Yeh) (Abstract) (1971)
50. "Bias in Observable Cancer Age and Life-time of Mice Subject to Spontaneous Mammary Carcinomas", Biometrics. (with J.F. Faulkner) (1972)
51. Statistical Principles in Public Health Field Studies, WHO Technical Report No. 510, Fifteenth Report of the WHO Expert Committee on Health Statistics, Geneva (with W.G. Cochran, et al). (1972)
52. "Mathematics of Radioimmunoassay", Biometrics. (Abstract) (1972)
53. "Decimal Reduction Time ('D Value') Estimation in Thermal Microbial Sterilization: A Preliminary Report" in Environmental Microbiology as Related to Planetary Quarantine, Report #9, Division of Environmental Health, School of Public Health, University of Minnesota (with . . Sundararaj) (1972)
54. "The Use of Anticoagulants in Acute Myocardial Infarction and Results of a Cooperative Clinical Trial", Journal of the American Medical Association. (with R.V. Ebert, et al) (1973)
55. "Cromolyn in Extrinsic and Intrinsic Asthma", Journal of Allergy. (with M. Blumenthal, et al) (1973)
56. "The Chronotherapy of Hypertension", International Journal for Chronobiology. (Abstract) (with K. Shietsuke, et al) (1973)
57. "A Biological Rhythm Experiment: Design and Analysis", Biometrics (Abstract) (with F. Halberg and M.H. Smolensky) (1973)
58. "A Comparison of Relaxation and Verbal Desensitization in the Treatment of Bronchial Asthma", Journal of Psychosomatic Research. (with N. Yorkston, et al) (1974)
59. "Proposal for a Core Curriculum in Medical Biostatistics", Clinical Pharmacology and Therapeutics. (with A. Feinstein, et al) (1975)
60. "The Acceleration of Theophylline Half-life in Cigarette Smokers", Life Sciences. (with J. Jenne, et al) (1975)
61. "Biological Rhythm Experimentation: A Longitudinal Design and Analysis", Chronobiologia (with F. Halberg and M.H. Smolensky) (1975)
62. "Early Breast Cancer and Postoperative Irradiation", Lancet. (with S. Levitt) (1975)
63. "Epidemiologic Study of Prostatic Cancer", Cancer Chemotherapy Reports. (with L. Scherman, et al) (1976)
64. "The Role of Radiotherapy in the Treatment of Operable Cancer of the Breast", Chapter in Advances in Cancer Surgery, edited by J.S. Najarian, J.P. Delaney Intercontinental Medical Book Corporation, New York (with S. Levitt) (1976)
65. "Osmolality Changes During Hemodialysis. Natural History, Clinical Correlations, and Influence of Dialysate Glucose and Intravenous Mannitol", (with F. Rodrigo, et al) Annals Internal Medicine. (1977)

66. "Radiotherapy in the Postoperative Treatment of Operable Cancer of the Breast. Part I: A Critique of the Clinical and Biometric Aspects of the Trials". (with S. Levitt) Cancer. (1977)
67. "Radiotherapy in the Postoperative Treatment of Operable Cancer of the Breast. Part II: A Reexamination of Stjernswärd's Application of the Mantel-Haenszel Statistical Method. Evaluation of the Effect of Radiation on the Immune Response and Suggestion for Post Operative Radiation". (with S. Levitt and C. Song) Cancer. (1977)
68. "Intravenous Glucose Tolerance and Insulin Response to Glucose and Arginine Before and After Hypophysectomy in Patients with Advanced Breast Cancer", (with A. Theologides et al) Medical and Pediatric Oncology, (1977)
69. "On the Factorization of the Crude Relative Risk", (with A. Ejigou) American Journal of Epidemiology. (1977)
70. "Estimation of Relative Risk from Matched Pairs in Epidemiological Research", (with A. Ejigou) Biometrics. (1977)
71. "Electromyographic Feedback and Physical Therapy for Neuromuscular Re-training in Hemiplegia", (with R. Mroczek and D. Halpern) Archives of Physical Medicine and Rehabilitation. (1978)
72. Book Review of Medical Statistics in World War II, for Journal of History of Medicine. (1978)
73. "Seasonal Behavior of Human Menstrual Cycles: A Biometric Investigation", (with N. Sundararaj, et al). Human Biology. (1978)
74. "Analysis of Accrual Randomized Clinical Trials with Balanced Groups in Strata" (with John Matts). Journal of Chronic Diseases (1979).
75. "Bronchial Asthma: Improved Lung Function After Behavior Modification" (with Neil Yorkston et al). Psychosomatics (1979).
76. "The Estimation of Dental Caries Incidence in the Presence of Diagnostic Error" (with George Reed). Biometrics (1979).
77. "Adjusting for Losses to Follow-up in Sample Size Determination for Cohort Studies" (with Mari Palta). Journal of Chronic Diseases (1979).

BIOGRAPHICAL SKETCH

NAME	TITLE	BIRTHDATE
Johnson, Eugene A.	Professor	
PLACE OF BIRTH	**PRESENT NATIONALITY**	**SEX**
	U.S.A.	Male

COMPLETE MAILING ADDRESS

Eugene A. Johnson, Ph.D.
Biometry Division, School of Public Health
University of Minnesota
1220 Mayo, Box 197
412 Delaware S.E.
Minneapolis, MN 55455

TELEPHONE

(612) 373-8040

POSITIONS AND TITLES

Professor, Biometry Division, School of Public Health, 1969-present
Director of Graduate Studies, Graduate Program in Biometry and Health Information Systems, 1971-present
Director, Health Sciences Computer Services Center, 1978-present

EDUCATION

University of Minnesota, Minneapolis	BA	1949	Mathematics
University of Minnesota, Minneapolis	MA	1950	Mathematics
University of Minnesota, Minneapolis	Ph.D.	1956	Biostatistics

MEMBERSHIPS

American Public Health Association
American Statistical Association
Institute of Mathematical Statistics
Biometric Society
Sigma Xi
Gamma Alpha

SERVICE ACTIVITIES

Editorial board, Journal of Medical Systems
Operations Committees for VA Hospital Cooperative Studies Program
Review Committees for NIH

1. "The Age Distribution of Female Breast and Genital Cancers" (with Abraham M. Lilienfeld, M.D.). Cancer, Vol. 8, No. 5, Sept. - Oct., 1955.

2. "Effects of Roentgen Irradiation on the Tumor Bed, II, the Inhibiting Action of Different Dose Levels of Local Pretransplantation Roentgen Irradiation on the Growth of Mouse Mammary Carcinoma" (with H. Vermund; K. Stenstrom; and D. G. Mosser). Radiation Research, Vol. 5, pp. 354-364, October, 1956.

3. "Motivation for the Use of Controls in the Laboratory and Participation in Experiments Designed to Discover Sources of Error." Minnesota Medical Technologist, Vol. 20, pp. 4-11, January, 1957.

4. "The Role of the Splanchnic and Lumbar Sympathetic Nerves in the Physiological Response to Fever and Hypoxia in Dogs Either Anesthetized or Unanesthetized" (with W. G. Kubicek; W. F. Geber; and J. W. Geiger). 56-66 Air University School of Aviation Medicine, USAF, Randolph AFB, Texas, June, 1957.

5. "Transfer and Duration of Naturally-Occurring and Salk-Vaccine-Induces Maternal Antibodies in Newborns; Preliminary Observations on the Antigenic Potency of the Oral Attenuated Live-Virus Poliomyelitis Vaccine in Newborns" (with Mauricio Martins da Silva, M.D.; John L. McKelvey, M.D. and Ronald A. Prem, M.D.). Society Transactions, American Pediatric Society, Carmel, California, June 17-19, 1957.

6. "Studies of Orally Administered Attenuated Live Virus Poliomyelitis and Vaccine in Newborns and Infants Under Six Months" (with Mauricio Martins da Silva, M.D.; John L. McKelvey, M.D.; Henry Bauer, Ph.D.; Ronald A. Prem, M.D.; and Marion K. Cooney, M.S.). University of Minnesota Medical Bulletin, Vol. MMM, No. 5, December 15, 1957. 18 pages.

7. "Problems of Selection in Studies Based Upon Hospital and Autopsy Data." Minnesota Medicine, Vol. 41, pp. 13-15 and 20, January, 1958.

8. "Response of Pregnant Women and Their Infants to Poliomyelitis Vaccine" (with Mauricio Martins da Silva, M.D.; Ronald A. Prem, M.D.; John L. McKelvey, M.D.; and Jerome T. Syverton, M.D.). The Journal of the American Medical Association, Vol. 168, pp. 1-5, September 6, 1958.

9. "Role of Splanchnic and Lumbar Sympathetic Nerves in Physiologic Responses to Fever and Hypoxia in Dogs" (with W. G. Kubicek; W. F. Gaber; J. W. Geiger; and L. A. Johnson). The American Journal of Physiology, Vol. 196, No. 5, March, 1959.

10. "The Use of Orally Administered Live Attenuated Polio Viruses as a Vaccine in a Community Setting: A Controller Study" (with Robert N. Barr, M.D.; Henry Bauer, Ph.D.; Herman Kleinman, M.D.; Mauricio Martins da Silva, M.D.; Anne G. Kimball, Ph.D.; and Marion K. Cooney, M.S.). The Journal of the American Medical Association, June 22, 1959.

11. "Graphic Monitoring of Seizure Incidence Changes in Epileptic Patients" (with Erhard Haus, M.D.; Franz Halberg, M.D.; and George L. Wadsworth, M.D.). Minnesota Medicine, Vol. 42, Sept., 1959.

12. "Motivation for the Use of Controls in the Laboratory and Participation in Experiments Designed to Discover Sources of Error." American Journal of Medical Technology, Vol. 26, January, 1960. Reprinted from the Minnesota Medical Technologist Journal.

13. "Vacunacion con Virus Poliomielitico Atenuado en una Colectivadad." Boletin de la Oficina Sanitaria Panamerica, Vol. XLVII, No. 4, Octobre, 1959. Reprinted from the Journal of American Medical Association.

14. "The Relative Biological Effectiveness of Cobalt 60 Gamma Rays and 220 EVP X-Rays in the Viability of Chicken Eggs" (with Merle Loken; Arthur Deisarg; and Don G. Mosser). Radiation Research, Vol. 12, February, 1960.

15. "Susceptibility Rhythms to E. Coli Editoxin and Bioassay" (with Franz Halberg; Byron W. Brown; and John J. Bittner). Proceedings of the Society for Experimental Biology and Medicine, Vol. 103, 1960.

16. "The Spearman Estimator for Serial Dilution Assays" (with Byron W. Brown, Jr.). Biometrics, Vol. 17, March, 1961.

17. "Circadian Periodicity, Adrenal Corticosteroids, Sleep Deprivation and the EEG in Normal Men" (with G. Frank, F. Halberg, R. Harner, J. Matthews, M. Greven, and V. Andres). Journal of Psychiatric Research, 4:73-86, 1966.

18. "Circadian System Based on an Aspect of Temporal Morphology; Procedures and Illustrative Examples" (with F. Halberg, and Y. L. Tong). Proc. International Congress of Chronobiology. In: The Cellular Aspects of Rhythms, Symposium on Rhythms, Springer-Verlag, 1967, pp. 20-48. Book Chapter.

19. "Effects of Misclassification in Epidemiologic Studies" (with Warren H. Gullen, M.D., M.P.H., and Jacob Z. Bearman, Ph.D.) Public Health Reports November, 1968, Vol. 83, Number 11, pp. 914-918.

20. "Quantitative Study of Isologous Tumor Cell Inactivation and Effective Cell Fraction for the L5A Mouse Lymphoma" (with Yosh Maruyama, M.D.). Cancer, Vol. 23, No. 2, February, 1969.

21. "Cerebral Circulation Studies Using Inhaled 133-Xenon and the Gamma Camera" (with Arthur C. Klassen, M.D., Joseph A. Perch, M.D., and Merle K. Loken, M.D., Ph.D.). Stroke, Vol. 1, Jan.-Feb., 1970.

22. "Concepts of Definition and Discovery of Clusters or Taxa," 8th International Congress on Clinical Chemistry, Copenhagen, June, 1972, the Scand. J. of Clin. and Lab. Invest., Vol. 29, Suppl. 126, p. 20.1, 1972.

23. "Some Applications of Profile Analysis and Clustering Techniques Based on Clinical Chemistry Data," 8th International Congress on Clinical Chemistry, Copenhagen, June, 1972, the Scand. J. of Clin. and Lab. Invest., Vol. 29, Suppl. 126, p. 20.3, 1972.

24. "Some Distribution Free Properties of the Asymptotic Variance of the Spearman Estimator in Bioassays," (with Cheng, P.C.) Biometrics, Vol. 28, No. 3, p. 882, 1972.

25. "Laboratory Data Analysis System: Section I - Introduction and Over View (with Grass, Benson) Amer. J. Clin. Path., Vol. 58, No. 2, p. 177, 1972.

26. "Some Basic Considerations of the Needs for Improved Clinical Laboratory Data Analyses," Human Pathology, Vol. 4, No. 1, p. 5, 1973.

27. "Computer-Assisted Bacterial Identification Utilizing Antimicrobial Susceptibility Profiles Generated by Autobac 1", (with Bruce B. Sielaff and John M. Matsen), Journal of Clinical Microbiology, Feb., 1976, Vol. 3, No. 2, p. 105-109.

28. "Formation of Bile Acids in Man: Metabolism of 7α-Hydroxy-4-Cholesten-3-One in Normal Subjects with an Intact Enterohepatic Circulation," (with R. F. Hanson, P. A. Szczepanik, P. D. Klein, and G. C. Williams, Biochimica et Biophysica Acta, 431 (1976), 335-346.

29. "Studies on Streptococci Resembling Streptococcus Milleri and on an Associated Surface-Protein Antigen", (with R. Lütticken, Ursula Wendorff, Doris Lütticken, and L.W. Wannamaker,) J. Med. Microbiol., Vol. 11 (1978), p 419-431.

CURRICULUM VITAE

LEE D. STAUFFER

DATE OF BIRTH:

PLACE OF BIRTH:

CITIZENSHIP: United States

MARITAL STATUS: Married, four children

MILITARY SERVICE: United States Marine Corps, July 1946 - September 1947; Midshipman, United States Naval Reserve, September 1947 - October 1948. Commissioned as an Assistant Sanitarian, U.S. Public Health Service Reserve, July 1955 -- Present Rank: Sanitarian

PRESENT HOME ADDRESS: 3000 Croft Drive, Minneapolis, Minnesota 55418

PHONE: 612-789-6761

PRESENT BUSINESS ADDRESS: School of Public Health, 1360 Mayo, Box 197, University of Minnesota, 420 Delaware Street S.E., Minneapolis, Minnesota 55455

PHONE: 612-373-8060

EDUCATION

University of Nebraska, 1947-51	B.S. in English Education
University of Minnesota, 1953-56	Master of Public Health

EMPLOYMENT

Date	Location	Position
July 1970 - Present	School of Public Health, University of Minnesota	Associate Professor and Dean
January 1969 - July 1970	College of Medical Sciences, University of Minnesota	Assistant Professor of Public Health and Executive Director, Office of Postgraduate Educational Activities
January 1968 - December 1968	Medical School and School of Public Health, University of Minnesota	Assistant Professor of Public Health and Assistant Director of Continuation Medical Education
July 1966 - December 1968	American College Health Association, Coral Gables, Florida	Executive Secretary

EMPLOYMENT (Continued)

Date	Location	Position
January 1962 - July 1966	School of Public Health, University of Minnesota	Assistant Professor and Assistant Director
July 1958 - January 1, 1962	University Health Service & School of Public Health, University of Minnesota	Senior Sanitarian and Assistant Professor
October 1955 - July 1958	University Health Service & School of Public Health, University of Minnesota	Sanitarian and Instructor
October 1954 - October 1955	University Health Service & School of Public Health, University of Minnesota	Assistant to the Public Health Engineer and Instructor
September 1952 - October 1954	University Health Service University of Minnesota	Housing Inspector
August 1951 - September 1952	Lincoln City-Lancaster County Health Department, Nebraska	Sanitarian

PROFESSIONAL ASSOCIATIONS

American Public Health Association (Fellow)

Chairman, Food Protection Committee	1962 - 1964
Member, Engineering and Sanitation Section Council	1964 - 1966
Association Representative to the National Restaurant Association	1962 - 1966

Minnesota Public Health Association

Treasurer	1962 - 1965
Chairman, Resolutions Committee	1964 - 1965
Program Committee	1966, 1972
Chairman, Awards Committee	1966
Nominating Committee	1968

Campus Safety Association

Member	1955 - 1962

National Association of Sanitarians (now: National Environmental Health Association)

Registered Sanitarian	1956 - Present
Awarded Certificate of Merit	1971

Minnesota Society of Professional Sanitarians (now: Minnesota Environmental Health Association)

Chairman, Registration Committee	1962 - 1966
Board of Directors	1966
Awarded Sanitarian of the Year Award	1971

PROFESSIONAL ASSOCIATIONS (Continued)

American College Health Association

Chairman, Committee on Student Housing	1958 - 1960
Liaison Committee	1958 - 1960
Chairman, Publicity Committee	1966 - 1967
Editorial Committee	1966 - 1968
Received Distinguished Service Award	1976

Association of American Medical Colleges

Member	1968 - Present

Intersociety Board for the Certification of Sanitarians

Founder Diplomate	1969 - Present
Member: Board of Directors	1970 - 1973
Chairman, Nominating Committee	1973

Association of Schools of Public Health

Chairman, Task Force on Accreditation	1971 - Present
Appointed Councilor, Council on Education for Public Health	1974 - Present

Council on Education for Public Health

Councilor and Vice President	1974 - 1976
President	1977 - Present

Advisory Committee on Health Education, Minnesota Higher Education Coordinating Board

Chairman	1975 - Present

National Advisory Public Health Training Council Health Resources Administration, H.E.W.

Council Member	1976 - 1977

Alumni Association Foundation (MHA)

Ex-Officio Member: Board of Directors	1977 - Present

Minnesota Hospital Research and Educational Trust

Consulting Panel	1978 - Present

American Heart Association

Member, Epidemiology Council	1977 - Present

OTHER UNIVERSITY PROFESSIONAL COMMITMENTS

Executive Secretary, Friday Hospital Staff Meeting Committee, Hospital Medical Council	1968 - 1970
Executive Secretary, Advisory Committee on Postgraduate Education and Regional Medical Programs	1968 - 1970

OTHER UNIVERSITY PROFESSIONAL COMMITMENTS (Continued)

Member, Administrative Board, Medical School	1968 - Present
Member, Steering Committee for Continuing Education Facilities Planning, All University	1969 - Present
Member, Search Committee for the Director of Conferences and Institutes	1969 - 1970
Member (and Chairman, 1970), Committee on Fees and Salaries, General Extension Division	1969 - 1970
Member, Committee on Research, General Extension Division	1970
Member, Rural Health Care Project Committee, Health Sciences	1969 - 1970
Vice Chairman, All University Consolidated Fund Drive	1969
University Council of Academic Officers	1970 - Present
Chairman, Task Force on Patent Policy	1972 - 1975
Chairman, University Search Committee for Director of Center for Urban and Regional Affairs	1977 - 1978
Health Sciences Council of Deans and Directors	1970 - Present
Health Sciences Planning Committee	1977 - Present
Health Sciences Committee to Update the Master Plan	1977 - Present
Advisory Board of the Health Services Research Center	1976 - Present
Member, Search Committee for the Director of Hubert H. Humphrey Institute	1979

OTHER PROFESSIONAL ACTIVITIES

U.S.P.H.S., Communicable Disease Center, Community Health Training Branch, Atlanta, Georgia

Consultant 1962 - 1967

U.S.P.H.S., Division of Environmental Engineering and Food Protection, Washington, D.C.

Consultant 1962 - 1964

U.S.P.H.S., Division of Hospitals and Medical Facilities, Washington, D.C.

Consultant 1962 - 1966

American Hospital Association, Plant Operations Committee, and Committee on Infections Within Hospitals

Consultant 1962 - 1964

State Training Committee of the Nebraska State Health Department

Consultant 1964

OTHER PROFESSIONAL ACTIVITIES (Continued)

New York State Health Department

Consultant	1964 - 1968

Bureau of Health, City of St. Paul

Consultant	1964

Miller Hospital, St. Paul

Consultant	1965 - 1966

U.S. Public Health Service Contract: "Survey of Attitudes, Behavior, and Beliefs on Smoking and Health Among Students of American Colleges and Universities"

Project Coordinator	1966 - 1968

Northlands Regional Medical Program, Minnesota

Vice Chairman: Ad Hoc Committee on Continuing Medical Education	1968
Acting Director, University of Minnesota Division	1968 - 1970
Member: Dial Access Advisory Committee	1969 - 1970
Alternate: Board of Trustees	1968 - 1970
Chairman: Education Committee	1969 - 1970
Member: Board of Trustees	1970 - 1978
President: Board of Trustees	1972 - 1978

School of Public Health, University of North Carolina

Guest Lecturer	1970

World Health Organization, South East Asia Regional Office, New Delhi, India

Consultant - 2 weeks, New Delhi, October	1978
Consultant - 1 week, Mahidol University School of Public Health, Bangkok, Thailand, November	1978

COMMUNITY ACTIVITIES

Coon Rapids, Minnesota

Deputy Health Officer	1960 - 1964

North Suburban Sanitary Sewer

Trustee: Deputy Chairman	1962, 1963, 1965, 1966
Chairman	1964
District Representative to the Metropolitan Planning Commission	1965 - 1966

Lutheran Deaconess Home and Hospital, Minnesota

Trustee	1963 - 1966
Chairman of the School of Nursing Committee	1964 - 1966

COMMUNITY ACTIVITIES (Continued)

St. Anthony Village, Minnesota

Second Vice President: Elementary PTA — 1968 - 1969

St. Anthony Community Health Board

Board Member — 1977 - Present

St. Anthony-New Brighton School District 282 — 1969 - 1973

School Board Director-Vice Chairman — 1970 - 1972
Chairman — 1972

State of Minnesota

Member: Environmental Health Planning Task Force, State Planning Agency — 1969 - 1970

Metropolitan Council

Member: Metropolitan Health Board, Metropolitan Council — 1970 - 1973

PUBLICATIONS

"Food Sanitation and/or the Infectious Process." (With Richard G. Bond) Journal of the American Dietetic Association 31: 993-996. October 1955.

"How to Control Food-Borne Disease in the Hospital." Hospitals 31: 80-88 November 1957.

"Food Service Equipment Considerations in the Prevention of Hospital Infections." Continuation Course in the Prevention and Control of Infections in Hospitals at University of Minnesota Center for Continuation Study. September 8-9, 1958.

"Recommended Minimum Health and Safety Standards for Off-Campus Student Housing." (With Richard G. Bond) Student Medicine 7: 33-44. September 1958.

"Environmental Health and Safety." Proceedings of the Five State College Health Conferences in Conjunction with the 21st Annual Meeting of the North Central College Health Association pp. 31-34. March 1959. Minnesota Tuberculosis and Health Association, St. Paul, Minnesota.

"How Linen Handling Methods Affect Cross-Infection Rate." Hospitals 33: 82-84. June 16, 1959.

"Environmental Health." (With Richard G. Bond) Report of Michigan College Health Association, 23rd Annual Conference pp. 23-28. May 19 20, 1960. Northern Michigan College, Marquette, Michigan.

"The Fire Problem in Student Residences." Safety Monograph No. 10, Seventh National Conference on Campus Safety pp. 78-85. National Safety Council, 425 North Michigan, Chicago 11, Illinois, 1960.

PUBLICATIONS (Continued)

"Standards for Student Housing - Realistic or Idealistic?" Safety Monograph No. 12, Eighth National Conference on Campus Safety pp. 61-66. National Safety Council, 425 North Michigan, Chicago 11, Illinois, 1961.

"Environmental Health Needs in Colleges and Universities." (With Richard G. Bond, George S. Michaelsen, Gustave L. Scheffler, and Ralph O. Wollan). American Journal of Public Health 51: 523-530, April 1961.

"Minimum Standards for Non-Institutionally Owned Student Housing." Proceedings of the Thirteenth Annual Conference, Association of College and University Housing Officers pp. 84-89. July 30-August 3, 1961. Columbia University, New York, New York.

"Foreword, Student Housing Standards." Student Medicine 10: 366-367, February 1962.

"How to Design Residence Halls for Safe Living." (With Gustave L. Scheffler) College and University Business 32: 58-61, June 1962.

"Sanitation in Hospital Food Service." Hospitals 38: 162-170, July 16, 1964.

"From Pots and Pans to Large Appliances: Equipment and Food Safety." Hospitals 38: 80-87. August 1, 1964.

"Food Preparation Techniques that Minimize Bacterial Contamination and Growth." Hospitals 38: 84-88. August 16, 1964.

"Protecting Food on Its Way to the Patient." Hospitals 38: 116-121, September 1, 1964.

"Safe Food Handling Requires Health-Conscious Food Handlers." Hospitals 38: 88-97, September 16, 1964.

"Operation Water Safety 4th Grade. Report of a Community Effort in Drowning Prevention." (With Theodore Pederson) Health Department Activities in Drowning Prevention. U.S. Department of Health, Education, and Welfare, Public Health Service, Division of Accident Prevention, Washington, D.C., 1966.

"Dietary Services." (With Winston M. Decker) Chapter IV in Environmental Aspects of the Hospital: Volume II: Supportive Departments. Public Health Service Publication No. 940-C-16. March 1967.

"Hospital Environment: Experts Explain Role of Dietary Service." (With Winston M. Decker) U.S. Medicine, Vol. 3, No. 19, 20-24. October 1, 1967.

Editor, "Newsletter of the American College Health Association," June 1967-March 1968.

Editor, "Proceedings of the International Infectious Mononucleosis Symposium, March 27-28, 1967." American College Health Association, 2807 Central Street, Evanston, Illinois 60201, 1968. 260 pp.

PUBLICATIONS (Continued)

"Sanitation and the Human Ingredient." Hospitals 45: 62-66. July 1, 1971.

"Impact-People in their Environment: A Challenge to College Health Services." Journal of the American College Health Association. October 1976. (also presented at the general session of the 54th Annual Meeting of the American College Health Association, April 29, 1976, Denver, Colorado).

APPENDIX V-4

University of California, Berkeley: Submission for Management

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Capabilities of the University of California, Berkeley, for the Operation of a Management Entity for the CRSP on Intake and Function

Contents

1. The Institution
2. The Institute for International Studies
3. Campus Administrative Framework
4. CRSP Management Structure

1. The Institution

The University of California, Berkeley, has the resources to provide excellent management of the Title XII Collaborative Research Support Program on intake and function. The faculty is internationally noted for distinguished academic achievements. The research quality and scope is supported by 150 statewide research facilities, by more than 5,000,000 library volumes, and by a variety of computer services. The organization and administration of the University is entrusted to a corporate body, providing strong executive management independent of other state agencies.

Because Berkeley is known for both biological and social science research and has outstanding faculty in both areas, any research questions arising from the projects can be readily answered locally. Methodological problems can also be handled on the campus. The Department of Nutritional Sciences is one of the foremost in the nation and will provide much scientific support for the CRSP.

The Computer Center contains a CDC 6400 and seven remote job-entry stations, an IBM 4341 with virtual memory and remote access, UNIX time-sharing systems on five PDP 11/70's (two are linked to the 6400), a DEC-2040, various graphic devices including two Tektronics 4027 terminals, and various other one-on-one personal computers. Software packages such as FORTRAN, BASIC, ALGOL, COBOL, GPSS, SPSS, BMD are available for use. The Center is in the process of adding facilities and has expressed interest in assisting the CRSP with any new software needed.

2. The Institute for International Studies

The Institute for International Studies on the Berkeley campus has agreed to support the Title XII Collaborative Research Support Program (CRSP) on Intake and Function. This CRSP is multi-disciplinary, combining the strengths of biological and social scientists here and abroad. Thus, the social science emphasis of the Institute will complement the biological science emphasis of the Department of Nutritional Sciences and the College of Natural Resources. The Institute, with established overseas linkages and expertise with overseas projects, will be able to strengthen the management of the collaborative research projects. The Institute will also provide a structure to maintain close interrelationships among institutional administration, CRSP scientific and technical management, and the individual projects.

In recognition of the intellectually nourishing interface between teaching and research, the University of California has long encouraged the development of research centers on its campuses. For more than half a century international and comparative studies on the Berkeley campus have clustered about a unit that is known today as the Institute of International Studies. Formerly called the Bureau of International Relations, this center was formally established as an organized research unit of the University with institute status in 1955. By then it had already been involved in overseas projects in Latin America and other areas, and was deeply involved in negotiating with the old International Cooperation Agency to establish a medical training center in Indonesia for the UC medical school.

During the following quarter of a century, the Institute has administered many overseas projects, such as a large three-year study of the State of Sao Paolo in Brazil, a public administration project in Indonesia, and a four-year cultural study in Taiwan in the fifties and sixties, all of which involved

supporting researchers and their families overseas, as well as overseas research center offices in most cases. The pattern continues into the seventies with research projects in Africa, France, Germany, Scandinavia, England, Japan, Indonesia, India, Pakistan, and the Middle East, all involving research field support over extended periods.

A number of these overseas research or training projects were contracts, i.e., the Indonesia medical training project and the Brazil Sao Paolo project in the sixties, and in the seventies a two-year State Department contract for developing academic skills for the University of Nairobi in Kenya, an Arms Control and Disarmament Agency (ACDA) contract, a Department of Transportation contract, and a large three-year contract with the Volkswagen Foundation in Germany which places four researchers in the field and pays their expenses in foreign currencies.

Another large fund management responsibility appeared in the mid-sixties with the 1965 $5 million Ford Foundation grant to the University of California. The Institute of International Studies administered $4.5 million of this grant, which was reallocated by an interdisciplinary committee in the Institute and covered overseas projects as well as international studies based on the campus. Some of these have already been mentioned, such as the Taiwan project. By 1970, the capital account of $4.5 million had been reallocated to research projects, but the Institute continued to utilize the interest, which amounted to approximately $900,000 for seeding other extramural grants and for overseas travel, which was difficult for faculty to obtain from other sources.

Most recently, the Institute has entered into a Cooperative Agreement with USAID on a project entitled "Managing Decentralization," which undertakes a $4.5 million project over a four-year period, and embraces three UCB research institutes. Elements of the project include long-and short term advising in less developed countries, workshops and symposia held in the USA and overseas locations, the publication of research works and a textbook, the development of an information network concerning decentralization and development.

In summary, the Institute's infrastructure has developed over the years to accommodate increasingly complex international research needs on the Berkeley campus to include many overseas projects and international conferences. Several conferences are held under the Institute's sponsorship each year, most of which have involved bringing foreign scholars to the United States for varying lengths of time. A good example is the Soviet-American Conference on Contemporary Asia which brought together 40 American faculty members and scholars from all around the United States and 11 scholars from the Soviet Union for a week. In its daily operations, the Institute guides foreign scholars through immigration requirements and travel problems in bringing short-term visitors and lecturers to the Berkeley campus. Further, the Institute is recognized as having among the best staff resources on campus for managing conferences, colloquia, and workshops.

3. Administrative Framework

The Sponsored Projects Office on the campus would be the institutional representative for negotiation, acceptance and execution of the CRSP. The office oversees over 2,000 projects and $75,000,000 in sponsored research on

the Berkeley campus so provides much expertise and assistance in developing equitable agreements between the funding agency, the contracting institution, and the subcontract institutions. Several grants with USAID already are administered through the office (AID/DSPE-C-0021 and AID/ta-c-1195 as well as the CRSP Planning Grant) so established linkages exist.

With respect to other institutions, the University of California's indirect cost rate (31%) is low. Also, the University has decreased the amount of a subcontract subject to indirect cost, an advantage for this CRSP.

Since the University of California has had sponsored research for over 40 years and is a foremost research institution, resources exist as a matter of course that may not be available at other institutions. These include departmental staff trained in grant administration and campus administrators who support and understand the significance of this research.

4. Management Structure

Management of the CRSP would be housed in the Institute of International Studies. The Institute would provide space and staff support for managing the grant. Personnel hired by the management entity would include at the minimum:

Program Director (50%) - responsibility and final accountability for scientific management of CRSP;

Planning Coordinator (100%) - technical responsibility for project management;

Administrative Assistant II (100%) - clerical and financial responsibility for project management, including scheduling of meetings, maintenance of communication networks and legally qualified files, supervising clerical and data personnel, and keeping of financial records;

Bookkeeper and Statistical Clerk(100%)- accounting for all grant funds, statistical support;

Secretary (100%) - clerical support as well as support for the AA;

with additional data management and clerical support in subsequent years.

The choice of Dr. Doris Calloway as Program Director of this CRSP is logical since she generated the concept and fostered the idea of this research as a member of the NAS World Food and Nutrition Study Team 9. She is the principal investigator on the planning grant for this CRSP, and she knows all the principal scientists from all participating institutions in the U.S. and abroad.

She has a recognized international reputation in nutrition and has established relationships with international agencies. Thus, she can facilitate the coordination of the overseas research projects and the cooperation of additional experts, many of whom have already contributed to the CRSP.

She has an exceptional knowledge of the U.S. government system from ten years of federal service. She concluded her service to the government as the head of a twenty-person division. Her duties included administration of nutrition research contracts and grants for the Department of Army.

As former chairman of the Department of Food Science and Nutrition at the Stanford Research Institute, and chairman of the Department of Nutritional Sciences at the University of California, Berkeley, she has experience with research and academic administration.

Her research field is human nutrition, so she is familiar with the problems of human research. The type of research this CRSP addresses both a knowledge of humans as experimental subjects and a good idea of the inherent difficulties in experimental design and data collection when humans are the participants.

BIOGRAPHICAL SKETCH

NAME	TITLE	BIRTHDATE (Mo., Day, Yr.)
CALLOWAY, Doris Howes	Professor of Nutrition	February 14, 1923
PLACE OF BIRTH (City, State, Country)	**PRESENT NATIONALITY (If non-U.S. citizen, indicate kind of visa and expiration date)**	**SEX**
Canton, Ohio, USA	U.S.	☐ Male ☒ Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
Ohio State University, Columbus, Ohio	B.S.	1943	Nutrition & Dietetics
Johns Hopkins Hospital, Baltimore, MD	---	1944	Dietetics Internship
University of Chicago, Chicago, Illinois	Ph.D.	1947	Nutrition

HONORS

See "Professional Activities and Honors" - attached.

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
Human nutrition Protein, energy requirements Gastrointestinal studies	PRINCIPAL INVESTIGATOR

RESEARCH SUPPORT

1. USDA 12-14-5001-290: "Research Studies to Determine the Effects of Dry Bean Diets on the Function of the Human Intestinal Tract," 6/30/77-1/31/80; co-PI: G.W. Chang; $69,800.
2. NIH AM10202-13: "Studies in Human Nutrition," 12/1/78 - 11/30/79 (11/30/81), $467,233; Program Director is Dr. Sheldon Margen; DHC is co-PI.
3. US AID/DSAN/C-0002: "Functional Significance of Marginal Nutrient Deficiencies: Program-Project Planning," 4/1/78 - 6/30/79, $220,194. DHC is Principal Investigator.

RESEARCH AND/OR PROFESSIONAL EXPERIENCE

1963-present: Professor of Nutrition and Nutritionist in the Agricultural Experiment Station, Department of Nutritional Sciences, University of California, Berkeley

1976 - 1978 : Chairman, Department of Nutritional Sciences, University of California, Berkeley

1976-present: Professor of Nutrition, School of Public Health, University of California, Berkeley

1971 - 1974 : Senior Lecturer in Nutrition, Department of Community Medicine, University of California, San Diego

1962 - 1963 : Lecturer in Nutrition, Department of Nutritional Sciences, University of California, Berkeley

1961 - 1964 : Chairman, Department of Food Science and Nutrition, Stanford Research Institute, Menlo Park, California

1951 - 1961 : Nutritionist and Chief, Nutrition Branch, Armed Forces Food and Contair Institute, Chicago, Illinois

1948 - 1950 : Consultant, Medical Associates, Chicago, Illinois

1946 - 1947 : Research Assistant, University of Chicago, Illinois

1945 : Research Dietitian, University of Illinois, Chicago, Illinois

Professional Societies:

American Institute of Nutrition: Secretary, 1969-1972
Editorial Board, Journal of Nutrition, 1967-1972

American Dietetic Association : Editorial Board, J. Am. Diet. Assoc., 1974-1977

Professional Activities and Honors:

1959 - 1963: Member, Research Advisory Council, Institute of American Poultry Industries.
1959 : Meritorious Civilian Service Award, Department of the Army.
1962 - 1968: Associate Editor, Nutrition Reviews.
1965 - 1968: Member, Subcommittee on Pantothenic Acid and Ascorbic Acid, Committee on Dietary Allowances, Food and Nutrition Board, National Academy of Sciences, National Research Council.
1966 - 1969: Member, Ad Hoc Panel on Cabin Atmosphere Regeneration, Life Sciences Committee, Space Science Board, NAS-NRC.
1967 1972: Editorial Board, Journal of Nutrition.
1968 1971: Board of Directors, American Board of Nutrition.
1969 - 1971: Board, National Council on Hunger and Malnutrition in the United States.
1969 - 1971: Member, Committee to Evaluate National Nutrition Survey Data, Food and Nutrition Board, NAS-NRC.
1969 - 1974: Member, Committee on Dietary Allowances, Food and Nutrition Board, NAS-NRC.
1969 - : Editorial Board, Environmental Biology and Medicine.
1971 : Consultant to FAO on Report of Energy and Protein Requirements.
1972 - 1975: Member, Food and Nutrition Board, NAS-NRC; Executive Committee, 1974-1975.
1972 - 1973: Member, Program-Project Committee, NIAMD, NIH. USPHS.
1972 - : Member, WHO Expert Advisory Panel on Nutrition.
1972 - 1974: Visiting Committee, M.I.T.
1973 - : Member, Advisory Committee, Maternal Nutrition Education Project, California Association for Maternal and Child Health.
1974 - 1977: Member, Advisory Council, National Institute of Arthritis, Metabolism, and Digestive Diseases, National Institutes of Health.
1974 : Distinguished Alumna, Ohio State University.
1974 - 1977: Editorial Board, Journal of the American Dietetic Association.
1975 : Consultant, Nutrition Division, FAO (Headquarters program).
1975 - : Editorial Board, Interdisciplinary Science Reviews.
1976 : Group Achievement Award, National Aeronautics and Space Administration, U.S. Member of the Joint Editorial Board for Foundations of Space Biology and Medicine.
1976 - 1977: Member, NAS-NRC World Food and Nutrition Study Group 9 (Overview of Nutrition).
1976 - : Member, International Union of Nutritional Sciences Committee 7 (Evaluation of Protein Foods).
1977 - 1978: Member, Scientific Advisory Committee, XIth International Congress of Nutrition.
1977 - : Member, Editorial Advisory Board, International Journal of Abstracts in Nutrition Planning.
1977 - : Member, Committee on Food Consumption Patterns, Food and Nutrition Board, NAS-NRC.
1977 : Member, Competitive Grants Policy Group, USDA.
1977 : Advisor to the U.S. Delegation, Biennial Meeting of the Council of the Food and Agricultural Organization of the United Nations.
1978 - : Member, Joint Council on Food and Agricultural Sciences, USDA.
1978 - 1982: Member, National Advisory Council on Aging, National Institutes of

SELECTED PUBLICATIONS (1974 - 1979):

I. Books

Bogert, L.J., G.M. Briggs and D.H. Calloway. Nutrition and Physical Fitness, 10th ed. Philadelphia, Pa.: W.B. Saunders and Co., 1979. 604 pp.

II. Chapters

Calloway, D.H. Nitrogen Balance During Pregnancy, Chapter 5, pp. 79-94. In: Nutrition and Fetal Development (Myron Winick, ed.). New York: John Wiley and Sons, Inc., 1974.

Calloway, D.H. Basic Data for Planning Life-Support Systems, Chapter 1, pp. 3-21. In: Foundations of Space Biology and Medicine, vol. III (M. Calvin and O.G. Gazenko, eds.), 1975. (A joint publication of the USA-USSR Academies of Science.)

Calloway, D.H. Discussion - Biological Variables in Human Nutrition: Human Adaptability to Nutritional Variables, Section III, Chapter 14, pp. 157-158. In: Progress in Human Nutrition, Vol. 2 (S. Margen and R. Ogar, eds.). Westport, Connecticut: Avi Publishing Co., Inc., 1978.

III. Scientific Papers and Reviews

Calloway, D.H. Recommended dietary allowances for protein and energy, 1973. J. Am. Diet. Assoc. 64: 157-162, 1974.

Blackburn, M.L., and D.H. Calloway. Energy expenditure of pregnant adolescents. J. Am. Diet. Assoc. 65: 24-30, 1974.

Margen, S., J.-Y. Chu, N.A. Kaufmann, and D.H. Calloway. Studies in calcium metabolism. I. The calciuretic effect of dietary protein. Am. J. Clin. Nutr. 27: 584-589, 1974.

Calloway, D.H., R.D. Giauque, and F.M. Costa. The superior mineral content of some American Indian foods in comparison to federally donated counterpart commodities. Ecology of Food and Nutrition 3: 203-211, 1974.

Schraer, K.K., and D.H. Calloway. Zinc balance in pregnant teenagers. Nutr. Metab. 17: 205-212, 1974.

Calloway, D.H. Unresolved problems relating to the observed intake, nitrogen utilization, and predicted needs in pregnancy. In: Proceedings of the IXth International Congress of Nutrition (Mexico, 1972), Vol. I, pp. 49-52. Basel: Karger, 1975.

Crim, M., D.H. Calloway, and S. Margen. Creatine metabolism in men: Urinary creatine and creatinine excretions with creatine feeding. J. Nutr. 105: 428-438, 1975.

BIOGRAPHICAL SKETCH - Doris Howes Calloway (continued)

SELECTED PUBLICATIONS (1974 - 1979): (continued)

III. Scientific Papers and Reviews (continued)

Calloway, D.H. Nitrogen balance of men with marginal intakes of protein and energy. J. Nutr. 105: 914-923, 1975.

Calloway, D.H. Human nutrient requirements - An update. In: Proceedings of the Western Hemisphere Nutrition Congress IV (August 19-22, 1974), pp. 195-203. Action, Mass.: Publishing Science Group, 1975.

Livingston, R.B., D.H. Calloway, J.S. MacGregor, G.J. Fisher, and A.G. Hastings. U.S. poverty impact on brain development. In: Growth and Development of the Brain (M.A.B. Brazier, ed.), pp. 377-394. New York: Raven Press, 1975.

Zezulka, A.Y., and D.H. Calloway. Nitrogen retention in men fed varying levels of amino acids from soy protein with or without added L-methionine. J. Nutr. 106: 212-221, 1976.

Crim, M.C., D.H. Calloway, and S. Margen. Creatine metabolism in men: Creatine pool size and turnover in relation to creatine intake. J. Nutr. 106: 371-381, 1976.

Blackburn, M.W., and D.H. Calloway. Basal metabolic rate and work energy expenditure of mature, pregnant women. J. Am. Diet. Assoc. 69: 24-28, 1976.

Blackburn, M.W., and D.H. Calloway. Energy expenditure and consumption of mature, pregnant and lactating women. J. Am. Diet. Assoc. 69: 29-37, 1976.

Zezulka, A.Y., and D.H. Calloway. Nitrogen retention in men fed isolated soybean protein supplemented with L-methionine, D-methionine, N-acetyl-L-methionine, or inorganic sulfate. J. Nutr. 106: 1286-1291, 1976.

Calloway, D.H., and J.C. Gibbs. Food patterns and food assistance programs in the Cocopah Indian community. Ecology of Food and Nutrition 5: 183-196, 1976.

Meyer, S., and D.H. Calloway. Gastrointestinal response to oat and wheat milling fractions in older women. Cereal Chem. 54(1): 110-119, 1977.

Kuhnlein, H.V., and D.H. Calloway. Minerals in human teeth: Differences between preindustrial and contemporary Hopi Indians. Am. J. Clin. Nutr. 30(6): 883-886, 1977.

Butterfield-Hodgdon, G., D.H. Calloway, and F. Costa. Nitrogen requirement. Lancet I: 376-377, 1977. (letter to the editor)

Kuhnlein, H.V., and D.H. Calloway. Contemporary Hopi food intake patterns. Ecology of Food and Nutrition 6: 159-173, 1977.

Geissler, Catherine, D.H. Calloway, and S. Margen. Lactation and pregnancy in Iran. I. Social and economic aspects. Am. J. Clin. Nutr. 31: 160-168, 1978.

Calloway, D.H., and M.J. Kretsch. Protein and energy utilization men given a rural Guatemalan diet and egg formulas with and without added oat bran. Am. J. Clin. Nutr. 31: 1118-1126, 1978.

BIOGRAPHICAL SKETCH - Doris Howes Calloway (continued)

SELECTED PUBLICATIONS (1974 - 1979): (continued)

III. Scientific Papers and Reviews (continued)

Geissler, C., D.H. Calloway, and S. Margen. Lactation and pregnancy in Iran. II. Diet and nutritional status. Am. J. Clin. Nutr. 31: 341-354, 1978.

Kuhnlein, H.V., and D.H. Calloway. Adventitious mineral elements in Hopi Indian diets. J. Food Sci. 44: 282-285, 1979.

IV. Committee Reports

Recommended Dietary Allowances, 8th ed. Washington, D.C.: National Academy of Sciences, 1974. 128 pages. (Section author)

Guidance on the Application of the 1973 Energy and Protein Requirements. Report of Joint FAO/WHO Informal Gathering of Experts. WHO Miscellaneous Paper NUT/75.4; Food and Nutrition 1(2): 11, 1975. (Chairman and Rapporteur)

Food and Nutrition Strategies in National Development. Report of Joint FAO/WHO Expert Committee on Nutrition, 9th Session. FAO Nutr. Meetings Rept. Ser. No. 56; WHO Tech. Rept. Ser. No. 584, 1976. (FAO Consultant Editor)

Applied Nutrition Research. Report of an Interagency Meeting, FAO. Food and Nutrition 2(1): 5-8, 1976. (Editor)

Report of the First Joint FAO/WHO Expert Consultation on Energy Intake and Protein Requirements, (October 12-14, 1977; Rome, Italy). Danish Funds-in-Trust, TF/INT 297 (DEN). Rome: FAO, 1978. (Participant and Contributor)

V. Miscellaneous Technical Writings

Calloway, D.H. The role of nutritionists in food and nutrition planning. PAG Bulletin V(4): 26-27, 1975.

Calloway, D.H., S.M. Oace, and K.J. Carpenter. World Review of Nutrition and Dietetics, Volume 23. J. Am. Diet. Assoc. 68: 598, 1976. (book review)

Calloway, D.H. Working paper: Proposal for research. PAG Bulletin VII(3-4): 53-58, December 1977.

Calloway, D.H. Discussion: Nutrition and food science implications. Am. J. Agr. Economics 59(5): 849-850, 1977.

Wood, C., and D.H. Calloway. Nutrition, Immunity, and Infection, by R.K. Chandra and P.N. Newberne. New York: Plenum Press, 1977. 246 pp. (book review)

BIOGRAPHICAL SKETCH

NAME	TITLE	BIRTHDATE (Mo., Day, Yr.)
[redacted]ALL, Robin D.	Graduate Student	November 11, 1948
PLACE OF BIRTH (City, State, Country)	**PRESENT NATIONALITY** (If non-U.S. citizen, indicate kind of visa and expiration date)	**SEX**
Oakland, California, USA	US	☐ Male ☒ Female

EDUCATION (Begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
University of California, San Diego	B.A.	1969	Philosophy & Mathematics
University of Houston, Houston, Texas	M.B.A.	1975	Business Administration
University of California, Berkeley	Ph.D.	(1980)	Nutrition Policy

HONORS 1) Participant, USAID Workshop on Nutrition & Work Performance (La Jolla, 1978);
2) Discussion Leader, Teaching Asst. Training Conference, U. Calif., Berkeley, 1978;
3) Treasurer, Assoc. of Doctoral Students in Bus. Ad., U. Calif., Berkeley, 1976-77;
4) Fellowships: Amy Bowles Johnson & Genevieve McEnerney Fellowships, 1975-76. (contd below

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
Relationship of food intakes & activity patterns; quantitative methods applied to nutrition management methods	INVESTIGATOR

RESEARCH SUPPORT

NR-Res: Nutritional Sciences General Funds

7/1/78 - 3/30/79: 45% time
4/1/79 - 6/30/79 50% time NR - Teaching Nutritional Science

RESEARCH AND/OR PROFESSIONAL EXPERIENCE

Winter 1979, Summer 1978, Summer 1977: Research Assistant, Nutritional Sciences Department, University of California, Berkeley.

Fall 1978: Associate (full-time instructor of quantitative methods courses), Graduate School of Business, University of California, Berkeley.

1977 - 1978, 1976 - 1977: Teaching Associate, Graduate School of Business, University of California, Berkeley.

Spring 1978: Instructor, School of Business, San Francisco State University.

Spring 1977: Teaching Assistant, Conservation and Resource Studies Department, University of California, Berkeley.

1974 - 1975: Teaching Fellow (half-time instructor of quantitative methods courses) University of Houston.

Honors: (continued from above)

5) Student Representative, President's Advisory Committee on Instructional Improvement Programs, University of California, 1975-1976.
6) Honors at Entrance: University of California, San Diego, 1965.

BIOGRAPHICAL SKETCH

NAME	TITLE	BIRTHDATE (Mo., Day, Yr.)
C. West Churchman	Professor of Business Administration	August 29, 1913
PLACE OF BIRTH (City, State, Country)	**PRESENT NATIONALITY (If non-U.S. citizen, indicate kind of visa and expiration date)**	**SEX**
Philadelphia, Pennsylvania	U.S.	☒ Male ☐ Female

EDUCATION (begin with baccalaureate training and include postdoctoral)

INSTITUTION AND LOCATION	DEGREE	YEAR CONFERRED	SCIENTIFIC FIELD
University of Pennsylvania	Ph.D.	1938	Philosophy (symbolic logic)

HONORS Past editor-in-chief of Philosophy of Science, Management Science; editor of a number of journals in systems design; past officer of several associations (e.g., President of The Institute of Management Sciences); book and article awards and prizes; honorary degree (S.D. from Washington University.

MAJOR RESEARCH INTEREST	ROLE IN PROPOSED PROJECT
Philosophy, Planning	Co-PRINCIPAL INVESTIGATOR

RESEARCH SUPPORT

None.

RESEARCH AND/OR PROFESSIONAL EXPERIENCE

Basic Value Research, 1945-present;
Theory of Systems Science, 1945-present
City Planning, 1946-present
Industrial Operations Research, 1950-present
Space Science Research Policy, 1965-72
Wildlife Service, 1970-present
Licensing Policies in California, 1978

Publications

Theory of Experimental Inference, 1948
Introduction to Operations Research, with Ackoff & Arnoff, 1957
Prediction and Optimal Decision, 1962
Challenge to Reason, 1968
Systems Approach, 1968
Thinking for Decision, with Auerbach & Sadan, 1975
Systems Approach and its Enemies, 1979

C. WEST CHURCHMAN received his Ph.D. from the University of Pennsylvania in symbolic logic and after accepting the position of instructor in philosophy at the University, wrote a basic text called Elements of Logic. He also taught courses in the methodology of the formal and non-formal sciences, and translated Saccheri's Euclid Vindicated of Every Blemish. During World War II he was a mathematical statistician at the Frankford Arsenal and devised a powerful way of testing small arms ammunition and detonators based on the statistical methods of bioassay. He also investigated the explanation of why a detonation compound goes off when struck by a firing pin, being among the first to use high speed photography for this purpose. During and after the War, he became involved in city planning problems, first in Philadelphia and subsequently in Detroit and was a founder of the Institute of Experimental Method, which was dedicated to applying E. A. Singer's concept of experiment to real social problems. In order to form a sound intellectual basis for this effort, he and Russell Ackoff wrote a book, Psycholinguistics (1945), which provides a basic overall language for the social sciences based on Singer's theory of purposive behavior. He also wrote Theory of Experimental Inference (1948) to provide the basic methodology for this effort.

In 1950 he organized the first Operations Research Academic group at Case Institute of Technology, worked with a number of firms and helped in the design of the first masters and Ph.D. programs on operations research. This effort led to the first OR text, Introduction to Operations Research (1957), with Ackoff, Arnoff, et al. In 1957 he went to the School of Business Administration at the University of California, Berkeley, where he initiated a masters and Ph.D. program in operations research and helped found the Center for Research in Management Science. In coming to Berkeley he shifted his applied interest to non-military government agencies and has worked in and written about such diverse areas as R&D management,

health planning, K-12 education, the earth resource satellite, wildlife, the protein crisis, to mention some. During all of his career, the concept of human values seemed central and essentially elusive; in Prediction and Optimal Decision (1960) he tried to assess the current state of the art in measuring values, in utility theory, accounting and other efforts, and concluded that none of these captures the essence of value, especially ethical and moral values. A similar philosophical concern with the concept of "reason", which is central to all planning led to his writing Challenge to Reason (1968), which to some extent exhorts the world to reason better, but mostly calls for a much more sophisticated meaning of reason than one finds for example in the concept of rational man in economics. At the same time he felt that because OR had turned out to be so narrow in its perspective because of its emphasis on mathematical models, that a broader and plainer expression of social rationality was called for, which was tried in The Systems Approach (1968). The Design of Inquiring Systems (1971) is an attempt to go "beyond reason", by exploring all those aspects of inquiry which apparently cannot be incorporated into any known design of inquiry - or of social planning for that matter. His latest book, Systems Approach and its Enemies, is an attempt to understand how nonrationality combats the visionary ideals of the systems philosophers.

In his philosophical life in the Business School, he has written papers for accounting, marketing, economics, social and moral issues of the firm and behavioral science.

At present he is still exploring the problem of the morality of recognizing individual values vs. the ethics of whole systems as it arises in many specific social problems.

Honors and Services: Past editor-in-chief of Philosophy of Science, Management Science; editor of a number of journals in systems design; past officer of several associations (e.g., President of The Institute of Management Sciences); book and article awards and prizes; honorary degree (S.D.) from Washington University.