CASALS & ASSOCIATES

PN-ABK-416-C

Nutrition CRSP
Feasibility and Planning Activity

February 1992

This report was prepared by Casals & Associates, Inc. for the Office of Nutrition, Bureau for Research and Development, Agency for International Development, under PDC-5110-I-00-0070-00, Delivery Order No. 1, Project Number 936-5110. Sergio Diaz-Briquets, Ph.D., Charles C. Cheney, Ph.D. and Susan Germano prepared the report.

EXECUTIVE SUMMARY

In 1977, at the request of President Gerald Ford, the National Academy of Sciences (N.A.S.) undertook a review of the status of world food and nutrition. The resulting study identified chronic mild-to-moderate malnutrition as the highest priority area for research on world food and nutrition issues. An N.A.S. Food and Nutrition Board workshop concluded that such research was feasible and deserved high priority for funding under Title XII of the Foreign Assistance Act.

As a result, the Agency for International Development (A.I.D.), supported a multi-year, comprehensive Nutrition Collaborative Research Support Program (Nutrition CRSP), titled "The Functional Implications of Malnutrition."

It is therefore appropriate to review Nutrition CRSP methodology and findings, particularly with regard to the relationships between marginal food intake and human performance, to suggest possible areas for future nutrition research and programming. Under contract and in consultation with the Office of Nutrition, Bureau for Research and Development, Casals & Associates, Inc. conducted the "Nutrition CRSP Feasibility and Planning Activity" and produced this report.

The Nutrition CRSP was conceptualized as a naturalistic (associative) study intended to generate data on the presence or absence of relationships between food consumption (specifically, chronic mild-to-moderate malnutrition) and human function, as well as on the nature of these relationships. The study's research design was geared to establish associations, rather than to demonstrate causality.

The general objectives of the Nutrition CRSP were to:

- Use a multidisciplinary approach to study the etiology and consequences of marginal malnutrition in terms of reproduction, lactation, physical growth, cognitive development, morbidity, and activity in the context of the household and community.

- Develop and utilize similar research protocols in study communities in Egypt, Mexico, and Kenya so that the research findings could be compared across countries that differ in their staple foods, agricultural systems, physical environments, and cultures, and hence could be made generalizable.

- Estimate food intakes of individuals and households identifying foods and nutrients associated with functional outcomes.

- Conduct these measures and estimates on target individuals within family households: infants (0 to 6 months of age), toddlers (18 to 30 months), schoolers (8 to 9 years), lead females (pregnant or with the likelihood of becoming pregnant), and lead males.

Based on the analysis of Nutrition CRSP data and assessments provided by the principal investigators and expert consultants, several important findings are identified regarding the study's hypothesized relationships. These are:

- growth faltering (stunting) begins to occur very early in life, as early as three to four months of age (this observation focuses attention on the need for quantity and quality food intake in pregnant and lactating women to ensure appropriate lactation practices and optimal infant growth and development);

- chronic mild-to-moderate malnutrition is an impediment to proper psychomotor, cognitive and behavioral development; and

- quality foods such as those derived from animal sources have major importance for optimizing human performance in chronically mild-to-moderately malnourished populations.

In addition, a fully validated finding is that:

- mild-to-moderate malnourished populations do not change (adapt) resting metabolic rates in any significant way during periods of food deprivation.

The study's most significant policy implications follow from the finding that growth faltering (stunting) begins to occur very early in life, a finding since confirmed by other studies. Equally important are the policy implications drawn from the associations suggesting that positive human functional outcomes are dependent not only on overall energy intake, but on dietary quality as well. The Nutrition CRSP provides evidence that for favorable birth and growth outcomes, it is necessary to focus on the nutritional and health status of a child-bearing woman even before she becomes pregnant so as to reduce the risk of lactational failure.

The policy implications that follow from the identified relationships are significant for programmatic efforts in a number of areas, including nutrition, health, education, agriculture, and community development. Some of the findings are particularly relevant for efforts underway under A.I.D.'s Women in Development Program and the Family and Development Initiative.

This report suggests several possible follow-on research activities which would probe more deeply into the hypothetical findings of the Nutrition CRSP. These activities flow from the multisectoral significance of the Nutrition CRSP findings, and could involve collaborative and coordinated efforts of A.I.D.'s Office of Nutrition, other A.I.D./R&D offices (e.g., health, education, agriculture), additional U.S. government entities, as well as other bilateral and multilateral development agencies, and private foundations. Such follow-on studies fall into three categories:

- operational research;
- further analysis of existing Nutrition CRSP data; and
- new research on food intake and functional outcomes.

The proposed plan for carrying out this research strategy comprises three basic steps:

1. Assign high priority to pursuing operational research activities, taking into account the appropriateness of country settings and the availability of support mechanisms;

2. Complete the analysis of the Nutrition CRSP database, in conjunction with a thorough review of the project's findings in light of other relevant research conducted during the past decade (including the meta-analysis of non-Nutrition CRSP databases); and

3. On the basis of 1) and 2), explore with the U.S. and international scientific community, as well as with potential collaborative funding sources, the pursuit of new research on food intake and human function.

ACKNOWLEDGEMENTS

The Feasibility and Planning Activity - like the Nutrition CRSP itself - has been a collaborative effort. Casals & Associates, Inc. has been assisted in this endeavor by the contributions of many individuals, including the Nutrition CRSP investigators, expert consultants, Agriculture Commodity CRSP program directors, and A.I.D. staff.

Special recognition is due to certain individuals who have ensured the successful outcome of the Feasibility and Planning Activity. These include Dr. Samuel G. Kahn, Senior Nutrition Advisor, Office of Nutrition, Bureau for Research and Development (R&D/N), who has served as Project Officer; Dr. Norge W. Jerome, previous R&D/N Director, under whose guidance this effort was launched; and Mr. Richard M. Seifman, current R&D/N Director, who has seen the project through to completion. Further, we wish to thank Dr. Doris H. Calloway and Dr. Avanelle Kirksey, former and current Nutrition CRSP Directors, for their insightful input, as well as Dr. Suzanne P. Murphy for her patience and kindness in responding to our many queries. Ms. Judith Ricci, Research Associate, Johns Hopkins University School of Hygiene and Public Health, lent her expertise to the Casals & Associates project team.

While gratefully acknowledging the assistance of the many persons who have contributed to this effort, Casals & Associates, of course, takes responsibility for this project report.

TABLE OF CONTENTS

I. **INTRODUCTION** 1

A. Background: The Collaborative Research Support Programs 2

B. The Nutrition CRSP 3

C. The Nutrition CRSP Feasibility and Planning Activity 8

II. **PROCEDURES** 9

A. Document Review 9

B. Interviews 10

C. Methodological Consultations 10

D. Policy Workshop 12

III. **RESULTS** 13

A. Background: The Research Hypotheses 13

B. Review of Methodologies and Procedures 14

1. A Naturalistic (Associative) Research Design 14
2. Interpretive Issues: Food Intake Data 17
3. Associations Between Food Intake and Human Functions 18

C. Major Findings 20

D. Summary of Findings 31

E. Policy Implications of the Nutrition CRSP Findings 32

F. Sectoral Significance of the Nutrition CRSP Findings 36

1. Nutrition 36
2. Agriculture 37
3. Health 38
4. Education 39
5. Household/Community Development 40
6. Program Evaluation 41

G. Marginal Malnutrition Indices 41

IV. RECOMMENDED RESEARCH STRATEGY 44

A. Feasibility and Planning Considerations 44

1. Operation[illegible] research 49

2. Research Based on the Nutrition CRSP Database 51

3. New Research on Food Intake and Functional Outcomes 54

B. Summaries of Research Topics 55

V. BENEFIT CONSIDERATIONS 69

A. Benefit to LDCs 69

B. Benefit to Agriculture CRSPs 70

C. Benefit to A.I.D.: R&D Research and Other Programs 72

D. Benefit to A.I.D. Regional Bureaus/Missions 72

E. Feedback to U.S. Domestic Programs 73

Appendix A Nutrition CRSP Publications
Appendix B Documents Reviewed
Appendix C Interviewed Individuals and Interview Protocols
Appendix D Methodological Consultations Agenda and Participants
Appendix E Policy Workshop Agenda and Participants
Appendix F Nutrition CRSP Measurements

I. INTRODUCTION

The Agency for International Development's Office of Nutrition, within its Bureau for Research and Development (A.I.D./R&D/N), has provided support to the multi-year, comprehensive Nutrition Collaborative Research Support Program (CRSP), titled "The Functional Implications of Malnutrition." Through extensive research carried out in study communities in Egypt, Mexico, and Kenya, the Nutrition CRSP has obtained valid measures of food intake concurrently with outcomes on reproduction and lactation, physical growth, cognitive and behavioral development, morbidity, and activity, together with measures of a number of explanatory and potential intervening variables. The Nutrition CRSP database covers a broad range of information from which key dietary characteristics can be identified that can play a significant role in optimizing human performance. This uniquely comprehensive study has influenced and should continue to influence policy direction in nutrition programming.

The Nutrition CRSP is coming to a conclusion, and it is therefore now appropriate to review the lessons learned from the Nutrition CRSP about the relationship between marginal food intake and human performance, and to consider possible directions that Agency-supported nutrition research and programming should take in light of the CRSP findings. To that end, Casals & Associates has conducted the Nutrition CRSP Feasibility and Planning Activity under contract to and in consultation with the Office of Nutrition, Bureau for Research and Development. This report presents the processes and outcomes of the Nutrition CRSP Feasibility and Planning Activity.

A. Background: The Collaborative Research Support Programs

The Collaborative Research Support Programs (CRSPs) were created in response to Title XII of the Foreign Assistance Act legislated in 1975. The main thrust of Title XII is to strengthen the capacities of land-grant and other U.S. universities to participate in programs of sustainable agriculture and natural resources management that help developing countries to produce adequate food. A.I.D. funds the CRSPs. Participating U.S. and host-country institutions also provide support for these programs.

The CRSP model has received widespread commendation and is recognized for its success in developing mutually-beneficial collaborative research between U.S. and overseas institutions. The programs have been able to attract some of the most capable U.S. faculties to collaborate in development research because of the unique scientific challenge, mutual interests and global benefits derived through this model.

Important efforts are those which improve the sustainability of food production systems in the developing countries with an emphasis on enhancing the availability of food and the quality of life of their people. A.I.D.'s CRSPs represent a long-term, multidisciplinary research and training initiative that capitalizes on the vast U.S. land-grant university and college of agriculture system that works with developing country research programs. In the order of their years of inception, the currently functioning CRSPs are:

- the Small Ruminant CRSP (SR-CRSP) (1978)
- the Sorghum/Millet CRSP (INTSORMIL) (1979)
- the Bean/Cowpea CRSP (1980)
- the Nutrition CRSP (1981)
- the Soil Management CRSP (1981)
- the Peanut CRSP (1982)
- the Pond Dynamics/Aquaculture CRSP (1982)
- the Fisheries Stock Assessment CRSP (FSA-CRSP) (1985)

Each CRSP has created collaborative linkages between the United States and developing country research communities that foster institutional growth and encourage the education and training of scientists and technicians. CRSP innovations are being shared with international agriculture and nutrition research centers, private industry, private voluntary organizations, and other nations beyond the developing countries and regions directly involved in the original research, including the agriculture and nutrition communities in the United States.

The Missions and Regional Offices through which A.I.D. directly assists developing countries are vital partners in the generation and distribution of these technologies. By means of various collaborative arrangements, the A.I.D. Missions and Regional Offices involve themselves in the research, technical assistance, and educational activities of the CRSPs. This collaboration enhances the CRSPs efforts and gives them a broader base from which to share their findings and technical expertise.

In 1990, representatives of the CRSPs established a CRSP Council, which has increased their mutual ability to coordinate the activities of individual programs and to make the CRSPs accessible as a group. The CRSP Council has developed several inter-CRSP initiatives that will make available a greater breadth of scientific knowledge, combine and synergize new technology, and encourage the exchange of information, resources, and other inputs among the CRSPs and the countries in which they operate. Some inter-CRSP initiatives that are now in the process of development (in West Africa and Central America) include components to be provided through the Nutrition CRSP or other comparable nutrition program endeavors.

B. The Nutrition CRSP

Although it is well documented that severe malnutrition, especially when it takes place early in life, results in the impairment of human functions, the impact of chronic mild-to-moderate malnutrition on human functions has been less clear. This issue has tremendous potential importance for billions of people throughout the developing world who are affected by chronic mild-to-moderate malnutrition. In 1977, at the request of President Gerald Ford, the National Academy of Sciences (N.A.S.) undertook a review of the status of world food and nutrition. The resulting study identified chronic mild-to-moderate malnutrition as the highest priority area for research on world food and nutrition issues. [1] A.I.D. then sponsored an N.A.S. Food and Nutrition Board

[1] Steering Committee, National Research Council Study on World Food and Nutrition, **World Food and Nutrition Study: The Potential Contributions of Research**, Chapter 2, "High Priority Research," National Academy of Sciences, Washington, D.C., 1977; and Commission on International Relations, National Research Council, **Supporting Papers: World Food and Nutrition Study**, Volume IV, Study Team 9, Nutrition, National Academy of Sciences, Washington, D.C., 1977.

workshop, whose participants concluded that such research was feasible and deserved high priority for funding under Title XII of the Foreign Assistance Act. [2]

In 1978, A.I.D. awarded a CRSP planning grant to the University of California, Berkeley, on this topic. Based on the deliberations of a series of planning workshops held in the same year, it was determined that the goal of the Nutrition CRSP would be to test the hypothesis that marginal food intake is related to functional outcomes that are believed to have import for the development of individuals, households, and communities. A key design consideration was that this overall hypothesis, and its several sub-hypotheses, should be examined in different biological and cultural ecosystems so that the findings would be generalizable. The study was to be carried out in countries with prevailing conditions of chronic mild-to-moderate malnutrition which possess institutional infrastructures which are sufficiently developed to permit effective collaboration in the conduct of research and to follow up with continued studies and appropriate interventions. [3]

In 1981, A.I.D. funded the Nutrition CRSP. A grant was awarded to the University of California, Berkeley, to provide administrative support and technical oversight of the implementation of the CRSP research protocols. [4] The University of Connecticut, Purdue University, and the University of California, Los Angeles, were subgranted by the University of California, Berkeley, to conduct CRSP activities in Egypt, Mexico, and Kenya, respectively. Collaborating institutions were: The Egypt National Nutrition Institute, Cairo, with Purdue University, which further subgranted

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[2] Commission on International Nutrition Programs, Food and Nutrition Board, **Summary Reports: Workshop on the Need for Research on Nutrition and Function**, July 18-21, 1977, National Academy of Sciences, Washington, D.C., March 1978.

[3] Workshop reports on Nutrient Intake and Disease Response; Nutrient Intake and Reproductive Competence; Energy Intake, Performance and Work; Nutritional Status and Cognitive Functioning; and Malnutrition and Social Functioning. These workshops were held in 1978.

[4] The University of California, Berkeley, served as Management Entity for the Nutrition CRSP from September 1981 to May 1988. After a lapse of over a year, Purdue University was designated as the Management Entity for the project's continuation phase (September 1989 to May 1992). AID allocated $11.8 million for the first phase of the Nutrition CRSP, and will spend up to $1.3 million in the continuation phase, for a total cost of $13.1 million. In addition, the collaborating institutions have provided, as of mid-1991, $1.9 million for support of the Nutrition CRSP.

to the University of Arizona and the University of Kansas Medical Center; the Instituto Nacional de la Nutrición, Mexico City, with the University of Connecticut; and the University of Nairobi, Kenya, with the University of California, Los Angeles.

The general objectives of the Nutrition CRSP were to:

- Use a multidisciplinary approach to study the etiology and consequences of marginal malnutrition in terms of reproduction, lactation, physical growth, cognitive development, morbidity, and activity in the context of the household and community.

- Develop and utilize similar research protocols in study communities in Egypt, Mexico, and Kenya so that the research findings could be compared across countries that differ in their staple foods, agricultural systems, physical environments, and cultures, and hence could be made generalizable.

- Estimate food intakes of individuals and households identifying foods and nutrients associated with functional outcomes.

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Three research sites were selected for intensive study. Ethnographic studies and methodological pilot tests were conducted in 1982 and 1983; longitudinal data were collected in the three study communities from 1984 through 1986. Kalama, Egypt, is a village of about 1,500 households located in the Nile delta about 35 miles north of Cairo. The land is low-lying and flat, and the climate is hot and humid for most of the year. This peri-urban community is relatively well developed economically: the population has access to modern technology, public transportation, health services, and basic education. More than half of adult men, but less than one-fourth of adult women, are literate. Agriculture and animal husbandry are of major importance to the economy; however, fewer than one-fourth of the households depend on agriculture for their subsistence. The irrigation canal that courses through Kalama is both a focus of social activity and a source of infectious diseases. The diet, based on whole wheat bread, is varied with seasonal vegetables and fruits, fava beans, lentils, rice, macaroni, and animal products.

The Solis Valley is a predominantly rural area with a population of approximately 44,000 persons located in the central highlands of Mexico about three hours driving time northwest of Mexico City.

The elevation is approximately 7,000 feet resulting in moderate temperatures. As is typical of the Mexican highlands, the summers in the Solis Valley are wet while the winters are dry, with frost being common between November and March. The six target communities in the Solis Valley are less modernized than the Egyptian village of Kalama, but the area has nevertheless experienced important economic and infrastructure changes in recent decades. Most households are electrified and have access to piped water, although the safety of this water is often questionable. Most households have Tvs and radios, and some possess refrigerators and automobiles. The population has ready access to schools, health services, and a developed transportation system. Most adults are literate. Although many men participate in wage labor in urban Mexico, the Solis Valley remains heavily involved in subsistence maize agriculture. The staple food of Solis is maize tortillas supplemented with varying quantities of beans, potatoes, pasta, rice, vegetables, and animal products.

Embu, Kenya, is a district containing about 180,000 persons (with over 26,000 in the study area) that is located about 120 miles northeast of Nairobi on the slopes of Mount Kenya. The community lies at an altitude of approximately 3,000-4,500 feet, and its climate is fairly mild and dry for most of the year, with short rainy and long rainy seasons. Health facilities are present, but the people lack electricity and convenient access to safe water and transportation; and although schooling is available, much of the population has only limited reading ability. As a predominantly agricultural community, Embu is at the mercy of the rains. Maize meal and beans are the most common foods, but sorghum, potatoes, green banana, and cow peas are also staples of the diet.

Embu is the poorest and least developed of the three study sites. The residents of Kalama and the Solis Valley benefit to at least some degree from the subsidized food distribution programs sponsored by the Egyptian and Mexican governments. This is not so in Embu.

Participant households were chosen based on the presence of one or more of each target individual: a woman in the first trimester of pregnancy, an 18-month-old toddler, or a school-age child between seven and eight years. The goal was to collect twelve months of data on each target child and his or her parents (the lead female or lead male in the household). The mother-child pair was studied during at least four through nine months of pregnancy and the first six months of the infants's life, the toddlers from 18 to 30 months of age, and the schoolers for one year. Limited data were also collected on non-target individuals residing in the household.

The Nutrition CRSP study has created an enormous database. It has produced numerous reports and scientific publications, and ongoing analysis of the database continues to generate publication of important findings (see Appendix A: Nutrition CRSP Publications).

The Nutrition CRSP has also attained a number of other major accomplishments to the mutual advantage of the host countries and the participating United States institutions. The Nutrition CRSP multidisciplinary research approach has led to unprecedented collaboration among the host country scientists. Cooperation among host country ministries has been markedly enhanced as well.

Each of the host countries now has a clean database containing all of the Nutrition CRSP files for its own study location and for the other two sites. These can be used for both programming and training purposes. In each case, a national food composition database has been augmented and converted to electronic form for ease in application. Data management and analysis capabilities have been markedly improved in both the host countries and the participating U.S. institutions. Also, through the Nutrition CRSP, all of the host country institutions have received contributions of equipment (e.g., laboratory equipment, microcomputers, transportation vehicles) to facilitate their ongoing research activities. Moreover, the host countries are engaged in a varying number of follow-up and new research endeavors, together with intervention programs.

In Egypt, a model child survival unit is being developed in the study site, the National Nutrition Institute is following up on the anthropometry of infants and children in ex-CRSP households, and the U.S.-Egypt team continues to conduct research on vitamin B6 and other aspects of nutritional status. Policy developments at the national level have included increased awareness of malnutrition and cooperation among the Ministries of Health, Agriculture, and Education, which are now working on the formulation of a national nutrition policy. Other pilot programs include a vitamin C supplementation intervention program and school lunch programs.

In the Mexico field site, collaborative research addresses "technology for the surviving child," including effects of vitamin A and carotene, and United States-Mexico cooperation continues with a study of zinc and iron deficiency and supplementation. Further, based upon the outcomes of the Nutrition CRSP study, and with support and cooperation provided by a combination of Mexican government agencies, the Instituto Nacional de la Nutrición has initiated an intervention program directed toward the mother and child in 152 rural communities (including 150,000 infants and children) in two regions of Mexico. This intervention program provides primary health care and diet supplementation to children (three to sixteen months of age) and to pregnant and lactating women while conducting measures of health and nutritional status.

Ongoing United States-Kenya team collaboration involves study of ex-CRSP households, including anthropometry and cognitive development of infants and toddlers, as well as an applied nutrition program targeted to women and to children under the age of five through a local PVO. Further, partly as a result of the

important data gathered before, during, and after a drought-induced famine that took place while fieldwork was in progress, the national government has developed and implemented a food security program to help communities better cope with food shortages.

The Nutrition CRSP has provided and continues to provide training for individuals in the host countries and the United States. These include more than 20 Ph.D., 25 M.S., and 18 B.S. students, as well as non-degree training for approximately 530 persons, including a considerable number of health care professionals and paraprofessionals.

The Nutrition CRSP was conceived, designed, and implemented somewhat differently from the other CRSPs, in that its three-country operations were conducted under an integrated design with its product to be pertinent information for policy, whereas the other CRSPs were oriented toward improving food commodity production. Further, the Nutrition CRSP as originally conceptualized has had a finite life, whereas the other CRSPs are open-ended. The Nutrition CRSP experience and database form the potential foundation for both the planning of appropriate policy-guided intervention strategies and the identification of salient research needs.

C. The Nutrition CRSP Feasibility and Planning Activity

The purpose of the Nutrition CRSP Feasibility and Planning Activity has been to assist the Office of Nutrition in identifying and determining what is feasible for A.I.D. to do next based on the findings of the Nutrition CRSP, with attention to implications for the Agriculture Commodity CRSPs and other A.I.D. sectors, and how best to plan to address potential areas for policy-guided interventions and identified nutrition research needs.

This activity has comprised three basic components:

1. gathering information pertaining to the Nutrition CRSP, including research findings, related accomplishments, policy implications for the Agriculture Commodity CRSPs and other A.I.D. sectors, and identified research needs, through the procedures of document review, interviewing, methodological review, and policy analysis;

2. compiling and synthesizing the information gathered; and

3. developing recommendations for addressing policy implications and further program and research needs.

The data-gathering procedures are described in Section II, results are presented in Section III, and a research strategy is recommended in Section IV. Section V discusses benefit considerations of the proposed efforts. This report also includes several appendices.

II. PROCEDURES

From mid-June to mid-September of 1991, a wealth of data pertaining to the Nutrition CRSP was gathered. Procedures for collecting information encompassed a) review of relevant Nutrition CRSP-related documents; b) interviews with Nutrition CRSP investigators, Agriculture Commodity CRSPs program directors, nutrition research/international development policy consultants, and A.I.D. staff; c) a series of three one-day methodological consultations including Nutrition CRSP investigators and consultants; d) and a two-day policy workshop involving Nutrition CRSP investigators, nutrition research consultants, international development policy experts, and A.I.D. staff. In November 1991, a preliminary draft of this document was circulated to Nutrition CRSP principal investigators, Feasibility and Planning Activity consultants, and selected A.I.D. officials. This final report incorporates the recommendations of the reviewers.

A. Document Review

Included in the review of Nutrition CRSP-specific documents were the preparatory workshop summaries and the précis that preceded program implementation; the Egypt, Mexico, and Kenya country reports and follow-up in-country workshop proceedings; the overall Nutrition CRSP program management report; the 1988 cross-project report; subsequent interim, annual, and quarterly progress reports; and selected scholarly publications.

Review of related CRSPs documents encompassed the generic CRSPs guidelines and a summarized overview of the eight CRSPs, together with recent annual reports on the seven Agriculture Commodity CRSPs. Special attention was given to determining the role that nutrition and social science currently play in these CRSPs as an indication of potential useful collaboration that could be developed through follow-on activities. Further, a number of

documents were reviewed relating to A.I.D. policy on nutrition, food, agriculture, health, population, the Women in Development Program, and the Family and Development Initiative (see Appendix B: Documents Reviewed).

B. Interviews

Telephone interviews were conducted with 17 principal and other Nutrition CRSP investigators, including the three host country principal investigators. Most of these individuals completed protocols that contained a series of items relating to the outcomes of the Nutrition CRSP, recommendations for further basic and applied research, and areas for potentially fruitful collaboration between A.I.D.'s Office of Nutrition and the Agriculture Commodity CRSPs, as well as with various other A.I.D. sectors. In-person interviews dealing with the same issues were conducted with nine nutrition research/international development policy consultants.

A similar process was carried out with the program directors of Agriculture Commodity CRSPs and with staff representatives of the A.I.D. Office of Agriculture through the use of a protocol designed to address development agricultural issues. In parallel fashion, A.I.D. staff representing a range of development sectors and the Regional Bureaus responded to a protocol fashioned to capture their Agency-oriented views (see Appendix C: Interviewed Individuals and Interview Protocols).

C. Methodological Consultations

The Nutrition CRSP Methodological Consultations were held on August 12-14, 1991, at the Hotel Durant in Berkeley, California. The purpose of this series of three one-day consultations was to review and assess the methodological procedures and the research results of the Nutrition CRSP, to identify research needs, and to recommend follow-on research activities. Consultation participants comprised 11 principal and other Nutrition CRSP investigators, together with four nutrition research expert consultants who were familiar with but had not been directly involved in carrying out the Nutrition CRSP (see Appendix D; Methodological Consultations Participants).

Consultation I focused on Food Intake, Pregnancy, Reproduction, and Lactation; Consultation II on Food Intake, Physical Growth, and Cognitive and Behavioral Development; and Consultation III on Food Intake, Morbidity, and Activity Performance.

Salient research issues addressed over the course of the three days included the following:

- Conceptual and statistical issues that arise when researchers are faced with a large number of diet variables.

- Issues created by between-subject and within-subject variation in food intake.

- The impact of other variables (e.g., day of week, season, holidays) on food intake patterns.

- Degree to which food intake variables (e.g., measures of diet quality) are correlated with non-nutritional confounding variables.

- Complexities in constructing summary measures for behaviors and activities. Technical difficulties are involved in the use of factor analysis and other data reduction methods.

- Difficulties in assessing and quantifying morbidity experiences within and between subjects and populations. Response variability represents a problem in the assessment of the relative severity and duration of morbidity experiences.

Despite the difficulties posed by these complex methodological issues, the Consultations resulted in consensus on a number of important Nutrition CRSP findings, together with the delineation of certain salient research needs identified on the basis of the Nutrition CRSP experience which could be addressed through utilization of the existing database, together with new research activities. Further, it was noted that the food intake and functional associations observed in the Nutrition CRSP study could usefully inform the design and implementation of intervention strategies.

D. Policy Workshop

The Nutrition CRSP Policy Workshop was held on August 22-23, 1991, at the Rosslyn Westpark Hotel in Arlington, Virginia. The purpose of this workshop was to explore the implications of the Nutrition CRSP experience and outcomes, and on that basis to develop policy recommendations regarding the role of nutrition within A.I.D.'s overall international development mission, especially in regard to the Agriculture Commodity CRSPs and other programmatic sectors.

Workshop participants comprised 10 Nutrition CRSP principal investigators (including the three host country principal investigators); one Agriculture Commodity CRSP program director (representing the Agriculture Commodity CRSPs program directors as a whole); three of the nutrition research consultants who had taken part in the Methodological Consultations and who presented the outcomes of those sessions at the outset of the Policy Workshop; five international development policy consultants; and nine A.I.D. staff members representing the Bureau for Research and Development's Offices of Program, Nutrition, Agriculture, and Education, as well as the Bureau for International Food Aid and Development and Economic Cooperation, the Bureau for Food for Peace and Voluntary Assistance, and the Directorate for Policy (see Appendix E: Policy Workshop Agenda and Participants).

Major Policy Workshop components encompassed the following:

- Nutrition CRSP results-based Methodological Consultation reports on food intake, nutrition, physical growth, and psychological development; on food intake, nutrition, community development, and household management and food security; and on Nutrition CRSP policy significance.

- Significance of the Nutrition CRSP for the host countries of Egypt, Mexico, and Kenya in terms of institution building, policy formulation, and the implementation of both research and intervention programs.

- Observations of the international development consultants on the policy implications of the Nutrition CRSP and potential future follow-on activities regarding the Agriculture Commodity CRSPs and A.I.D. policy concerning agriculture, community development, health, and education.

- Concluding policy discussion and recommendations.

The extensive discussions involved the active participation of attendees. In the presentation of recommendations, considerable attention was given to potential inter-sectoral collaboration, as well as to the feasibility of nutrition playing a significant role in the planning of a range of interventions. Moreover, on the basis of the Nutrition CRSP study experience, it was suggested that a set of indicators could be developed that would have potentially broad inter-sectoral practical applicability for the measurement of physical and psychological development and nutritional and health status.

III. RESULTS

The above-noted data-gathering procedures provided the basis for the findings presented in this section.

A. Background: The Research Hypotheses

The research plan of the Nutrition CRSP was developed in order to test several sets of hypotheses. All six hypotheses pose relationships between the food intake of specific members of the household, or the household as a whole, and given human functional outcomes.[5] The hypotheses are as follows:

1. Maternal intake during pregnancy and lactation influences the infant's endowment at birth and her/his development during the first six months of breastfeeding. Thus, infant body size, psychological development, and morbidity are affected by maternal food intake.

2. Food intake of the child between 18 and 30 months affects his/her body size, morbidity, and psychological development.

3. Food intake of the child between seven and nine years affects his/her body weight, morbidity, and behavioral and cognitive performance.

4. Food intake of adults affects their morbidity, their care of and attention to children, and their performance of usual tasks; and this, in turn, affects the morbidity and the cognitive and behavioral performance of other household members.

[5] Nutrition Collaborative Research Support Program, **Food Intake and Human Function: A Cross-Project Perspective**, University of California, Berkeley, August 1988, pp. 11-12.

5. Household food intake affects household morbidity.

6. For adults, a reduction of resting metabolic rate provides a major path of adaptation to restore energy equilibrium.

B. Review of Methodologies and Procedures

1. A Naturalistic (Associative) Research Design

The research design of the Nutrition CRSP called for a multidisciplinary approach capable of addressing the many factors that aside from nutrition impinge upon human functional outcomes. This feature was central to a research design that gave special attention to the collection of adequately-measured food intake variables in order to assess the effects of chronic mild-to-moderate malnutrition independently from or in conjunction with the effects of other environmental variables. In this regard, the design of the Nutrition CRSP was unique. By collecting extensive first-hand quantitative information on food intake, the aim of the Nutrition CRSP was to overcome the limitations inherent in other studies that rely on anthropometric measures as proxies for nutritional status, despite the fact that these measures also capture the effects of a confounding assortment of disease experiences, genetics, and other factors. The focus of the Nutrition CRSP study was intended to be on the household, and individuals within it -- as well as in the community -- since food deprivation affecting one member of the household is likely to have an impact on others. In order to transcend country and cultural specificity, and thus generate results applicable to a wide variety of settings, the research design was conceptualized so that comparable data, generated by similar methods and at similar intervals, could be collected at roughly the same time in villages in Egypt (Kalama), Mexico (Solis Valley) and Kenya (Embu).

Data collection in all three research sites included the periodic measurement of food intake over a one-year period (two times per month on target individuals and households), and a host of other variables, ranging from climatic and household data, to functional outcome variables, including monthly individual anthropometry; weekly morbidity; metabolic

rate; physical examination and health evaluation; psychological measurements, such as semi-annual cognitive tests of children; social and economic measures, such as ethnographic information, housing, and education; sanitation and hygiene; selected activities of the lead female; and a number of other measures (See Appendix F). The information collected is unique in that it provides relatively comparable database for all three sites. In the interest of data comparability, efforts were made to coordinate individual country research protocols, but -- due to field condition differences and other factors -- comparability problems exist for some variables. Although such issues to some degree interfere with cross-country analyses, they pose no impediment to within-country studies.

The Nutrition CRSP was conceptualized as a naturalistic (associative) study intended to generate data on the presence or absence of relationships between food consumption patterns associated with chronic mild-to-moderate malnutrition and human functions, as well as on the nature of these relationships. This approach was dictated "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 judgement of causality." [6] The decision to use this approach was based on the premise that the human functions in question are interrelated and that individual food intake changes are likely to have indirect effects on other family members, as well as by the recognition that the connection between chronic mild-to-moderate malnutrition and human functional outcomes operates through various links and governing mechanisms that need to be understood.

Since the study did not use an experimental design, the results do not establish causation. The expectation was, however, that by taking advantage of the research plan's quasi-longitudinal design, it would be possible to strengthen inferences about likely causation by incorporating time-sequencing into the analyses. The power of these inferences was to have been further enhanced by an important feature built into the research design - comparative analyses of data from the three study sites. Further evaluation of associations identified by the Nutrition CRSP was anticipated through the modelling and testing of alternative hypotheses,

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[6] Doris H. Calloway, "Précis: Guidelines for Research on Intake and Function," Planning Document for the Nutrition CRSP, University of California, Berkeley, 1981, p.30.

and by their evaluation in light of existing theory and accumulated evidence. Yet, due to the timing of this activity in relation to work still in progress, many of the most powerful analytical features built into the original research design have yet to be fully utilized: time-sequencing has been used sparingly; only selected databases have been subjected to cross-country study; and model building is barely under way.

The intended analytical focus on household relationships was substantially modified on the basis of the recommendations of the External Evaluation Panel (EEP), which was established during the Nutrition CRSP Research Design and Review Phase (in late 1982) to provide research advice and oversight. The EEP concluded that the research design was already too ambitious, and that the funding allocated for the study was insufficient to address all of the initial research objectives. Therefore, A.I.D. accepted the EEP recommendation to concentrate instead on fewer research questions. As a result of this decision, the Nutrition CRSP was unable to collect the data required to adequately assess all the important household level relationships, in particular activity patterns, relevant to the fourth hypothesis linking adult food intake to functional performance, and hence to the functional outcomes of other family members. Also deleted from the core design were immunology (functional intermediate to morbidity) and most assessments of micronutrient status which later proved to be critical.

Despite these limitations, and pending further analysis, the nature of the associations and other supporting evidence is in many cases strong enough to draw credible inferences. As one of the principal investigators noted, some of these inferences (and by extension, some of the study's policy implications) are based on reasonable and well thought-out suppositions that at least minimize the potential confounding effects of other associated variables. These inferences led the Nutrition CRSP researchers to suggest that, in the populations they studied, there are strong linkages (not previously appreciated) between food intake measures and selected functional outcomes, and that the hypothesized relationships are worthy of further investigation.

2. Interpretative Issues: Food Intake Data

It is widely recognized that the food consumption data collected by the Nutrition CRSP (under field conditions found in three developing countries) are the most complete and reliable gathered to date, a view shared by the international nutrition consultants who were involved in the Nutrition CRSP Feasibility and Planning Activity. This feature is one of the study's most notable characteristics. Despite the many

efforts made to accurately report food intake, field experience and subsequent analysis revealed that quality of food intake measures for different target individuals was prone to vary as a function of several factors. Food intake measures for lead females and toddlers tended to accurately reflect intake, mostly because foods consumed by these individuals could be observed directly, or because recall on food intake by the respondent (usually the lead female mother) was more reliable (since she was reporting her own intake and that of her dependent children). Some limitations are apparent concerning infant intake data. None of the country studies recorded volume of breastmilk intake (a highly intrusive and difficult procedure in cultures where sleeping mothers breastfeed their infants on demand), although some analyses were made of the nutritional composition of mother's breastmilk. Breastfeeding frequency was recorded in Egypt and Kenya, but not in Mexico. There are also questions about the nature and level of infant breastmilk supplementation, which may not have been completely reported.

Food intake was less completely recorded for lead males. In some instances, food intake information could not be obtained from lead males directly, or there was incomplete reporting of foods consumed away from the home. Also, foods not eaten at home were apparently under-reported by school-age children. Further, there are questions about the accuracy of reported alcoholic beverage intake by lead adults, especially males, and also about the accuracy of food intake measurements when different household members eat from a common pot.

In general, the teams in the study sites of Egypt, Mexico, and Kenya reported that they obtained fairly accurate measures of food intake quantity (total grams), and that they achieved relatively good measurement of nutrient quality in foods consumed. Measurements of total energy, carbohydrates, protein and fat, vitamins, minerals, and non-nutritive components were adequate, although some field studies expressed concern about the lack of data on nutrient bioavailability (e.g., the absorbability of certain trace minerals). Measurements of animal source energy and protein were consistently reported to be of relatively high accuracy. Reliable measures of water intake (including in cooked food) were available only for Kenya.

A major interpretative problem associated with the food intake data concerns the relation of the reported variances <u>within</u> an individual's intake pattern to the reported variance <u>between</u> respondents in study populations. A relatively large within-person variation in nutrient intake may mask existing relationships with outcome measures. Failure to find an association between two variables could result because there is no association, or because the association is clouded by

the variances in the two variables. Major implications follow from this statistical artifact for within-country and between-country interpretation of associations. These difficulties may be minimized through the derivation of best-estimate variables, as is being done by the Egypt study team (although this procedure may inject other interpretative issues by masking actual variances).

3. Associations Between Food Intake and Human Functions

It is difficult to provide succinct and unqualified statements on how well the Nutrition CRSP has established associations between food intake variables and human functional outcomes. This is largely due to the sheer size and complexity of the Nutrition CRSP database, the associative nature of the study, comparability issues among the study's three field sites, and the simultaneous influence of a multiplicity of variables involved in single functional outcomes. Moreover, data analysis has varied from country to country, and some country study teams have already analyzed databases yet to be examined by others. Except for a few definitive associations, the study results must, perforce, be presented as tentative and with numerous caveats.

Associations between food intake and reproductive outcomes are among the most consistent. A series of anthropometric measures correlate well with some aspects of food intake. Although the specific mechanisms through which growth outcomes are related to nutrition are not entirely clear, the Nutrition CRSP has been able to draw some inferences on the basis of the strengths of these associations. Some associations suggest that women make no concessions in diet and little in level of activity due to pregnancy. Likewise, there is evidence pointing to a close relationship between infant growth and the overall quality of maternal diets. The role of specific micronutrients is less well understood.

Many questions remain concerning the role of lactation on infant development. Some interpretative problems are related to how to explain early growth faltering, given that average birth weights are close to international norms. Some of the associations suggest that prepregnancy and pregnancy nutritional status are involved, since infants may be born with substandard nutritional endowments. Early disease experiences (some associated with supplementation of breastmilk) may also be implicated in infant growth failure.

In terms of food intake and physical growth, the associations suggest that once growth failure occurs, infants are unable to attain genetic growth potential. The associations are

particularly revealing with respect to length-for-age. A commonly-used growth measurement, the weight-for-length index, was found not to be a useful measure because it reflects current adequacy of energy intake rather than the multiple factors that affect longer term growth.

Measures of cognitive and behavioral development were found to correlate well with several indices of food intake for four target groups: mothers, infants, toddlers, and schoolers. Cognitive development appears to be related to diet quality, although many other influences (e.g., home environment, socioeconomic status, mother-child interactions) are intertwined in the relationship. Colinearity tends to disguise the strength of the associations, and questions can always be raised about the comparability of diagnostic psychological instruments when used in different cultural environments and for cross-country comparative purposes. It is possible that some of the associations between food intake and cognitive and behavioral development variables are mediated by biological factors not considered in the analysis. Further, there are some competing interpretations as to what is more important for cognitive and behavioral development: past or current food intake, or the nutritional endowment with which the child was born.

Lastly, the morbidity associations reported by the Nutrition CRSP are generally not strong and in most instances difficult to interpret. To begin with, there is a great deal of circularity, and many factors mediate in the food intake/morbidity relationship. Moreover, morbidity data are among the most difficult to collect accurately. Comparability problems are particularly difficult to overcome when attempts are made to collect morbidity data across different physical and cultural environments. Morbidity profiles vary significantly from locality to locality, and cultural perceptions have a major bearing on how diseases are recognized and defined.

Another complication -- present in the Nutrition CRSP data -- has to do with the skills and training that data gatherers/ evaluators bring to the data collection process. The fieldworkers that gathered the morbidity data in Egypt, for example, were trained physicians, whereas in Kenya they were high school graduates with little background (other than that provided by the project) on the identification and evaluation of disease. This difference may partly account for the high incidence of acute serious disease and the low incidence of minor illnesses reported in the Egypt site, in contrast to what was reported in Kenya. However, the Kenyan data collectors were closely supervised by physicians or nurses. Another important variable likely to have been implicated in the Egyptian morbidity profile was the presence in the field

site of numerous sources of contaminated water and very crowded housing.

In a few instances, there are associations linking food intake to morbidity outcomes. Among the most significant are those suggesting that chronic mild-to-moderate malnutrition is associated with more severe morbidity incidents, and that poor nutritional status of mothers is associated with a higher incidence of disease in children, possibly because malnutrition leads to unsatisfactory household management, including sanitation practices. Limited data on task performance have not been analyzed in detail.

C. Major Findings

Based on assessments provided by the researchers of results of data analysis conducted to date, it is possible to identify several findings - generally supported by the consultants involved in the Nutrition CRSP Feasibility and Planning Activity - regarding the study's hypothesized relationships. These findings are presented in the same order as they are shown above in Section III, Part A (pp. 13-14).

1. Maternal intake during pregnancy and lactation influences the infant's endowment at birth and her/his development during the first six months of breastfeeding. Thus, infant body size, psychological development, and morbidity are affected by maternal food intake.

The findings of the Nutrition CRSP in regard to this set of hypotheses have potentially major policy significance. **The most crucial finding -- established by analysis of data from the three study sites -- is that growth faltering (in weight and length) begins to occur very early in life, even as early as three to four months of age.** [7] Other studies have since

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[7] Early faltering (in terms of weight) at three to four months of age was known to occur before the Nutrition CRSP study. See J.C. Waterlow et. al., "Faltering in Infant Growth in Less-Developed Countries," **The Lancet**, November 29, 1980, pp. 1176-78; M.G.M. Rowland et. al., "Lactation and Infant Nutrition," **British Medical Bulletin**, Vol. 37, No. 1, 1981, pp. 77-82. What the Nutrition CRSP was able to establish on the basis of data from three different study populations was that faltering in terms of both weight and height/length [stunting] was also seen at those

confirmed this finding. This means that by three to four months of age, infants start to experience potentially unrecuperable losses in their potential for normal growth and development. What produces the faltering is not clear, and the researchers are divided in interpretation of the significance of the associations. In the view of some, the evidence is not convincing or is only moderately so in showing that maternal food intake is associated with birthweight or infant growth, although prepregnancy weight status and weight gain during pregnancy are modest predictors of the former. [8]

Other researchers feel that the evidence is rather convincing, stating (according to one of the principal investigators in the Egypt project) that "the quality of maternal diet during pregnancy and lactation is significantly related to infant behavior in the newborn period and to infant growth in the first six months." Some of the Mexico project investigators also think the evidence is convincing enough to postulate a strong relationship between food intake during pregnancy and subsequent infant growth, as well as between prepregnancy nutritional status and anthropometric outcomes. The Kenya project researchers express equally strong conclusions, noting that the relationship was strongly validated by less weight gain in pregnancy and lower birthweight during the drought-associated food shortage.

Another significant association is that the most important predictor of psychological development and other outcomes in the Egyptian infant is not the quantity of food consumed by the mother, but rather the quality of her food intake during pregnancy and lactation. Findings of the Egypt studies strongly suggest that **key predictors of behavioral competence**

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ages.

[8] These findings generally concur with the conclusions of a recent National Academy of Sciences report. Largely based on an exhaustive review of studies of well-nourished populations, the report found that "gestational weight gain is a determinant of fetal growth" and that "lower net gains [during pregnancy] are associated with an increased risk of IUGR [in uterus growth retardation]." Subcommittee on Nutritional Status and Weight Gain During Pregnancy, Committee on Nutritional Status During Pregnancy and Lactation, Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, **Nutrition During Pregnancy**, National Academy Press, Washington, D.C. 1990, p. 204. There is also evidence indicating that low gestational weight gain is associated with small head circumferences at birth, a marker for later cognitive and psychological development impairment (Ibid., p. 194). Some studies suggest that maternal anemia is harmful to the fetus and has a negative effect on birthweight (Ibid., pp. 274-276).

among infants are maternal intakes of food from animal sources. However, the relationship is not simple or direct, since the predictive value of diet quality can be enhanced by adding other psychosocial variables into the equation. Establishing the validity of these associations calls for the implementation of carefully-designed interventions with built-in experimental trials.

It is also important to note that some concern has been expressed about the potential impact of early malnutrition on brain development and the effect on cognitive and psychological development (the key stages for proper brain development being between the third trimester of pregnancy and 18 months of age). To what extent food intake is related to stunting and to brain development remains to be assessed, but the contents of the Nutrition CRSP database provide a golden opportunity to evaluate this relationship and its potential effect on several functional outcomes.

The Nutrition CRSP researchers believe that stunting may be associated with the adequacy of lactation, or at least so in Kenya, where mothers may not consume sufficient energy to produce as much breastmilk as infants require, and/or because the breastmilk that is provided may lack certain nutrients necessary for infant development.[9] Because the Nutrition CRSP did not directly measure breastmilk quantity and evaluated only selected quality features, these relationships cannot be established with any certainty. However, the Nutrition CRSP did measure food intake of mothers before and during pregnancy and lactation. The associations suggest that few women increase their food intake on account of their pregnancies, and even when they do while lactating, they may not do so by an amount sufficient to accommodate growing infant demand.

Evidence from the three study sites shows that during the first six months following childbirth, lactating mothers increased the amount of food they ate only slightly, if at

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[9] A recent National Academy of Sciences report notes that "the nutrients in human milk most likely to be present in lower than normal concentrations in response to chronically low maternal intakes are the vitamins, especially vitamins B6, B12, A, and D." Subcommittee on Nutrition During Lactation, Committee on Nutritional Status During Pregnancy and Lactation, Food and Nutrition Board, Institute of Medicine, National Academy of Sciences, **Nutrition During Lactation**, National Academy Press, Washington, D.C. 1991, p. 140. The lack of some of these vitamins has been connected with brain development failure.

all, and that energy intake equivalents were well below estimated energy requirements for lactating women. [10]

Mothers made up for the resulting lactating energy deficits by converting maternal body fat reserves into energy and/or by decreasing physical activity. The women in Embu lost 0.9 kilograms (two pounds) in the two months after birth, a sufficient conversion of fat into energy to release enough kilocalories to sustain maternal milk production in the first two to three months after birth but not thereafter. On the other hand, weight losses in the Solis Valley (0.9 kilograms or two pounds during the six months following childbirth), released insufficient kilocalories to meet infant energy requirements. [11] The situation in Kalama was more complex,

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[10] - The research literature suggests that women with limited daily mean calorie intakes (under 1,800 calories) may be unable to acquire the proper amount of nutrients required for adequate lactation. Ibid., pp. 13 and 50-152. Mean lactating energy intake for the Embu women was around 1,800 calories per day (at one to three months of lactation 1,822 +/- 623 calories, and at four to six months of lactation 1,771 +/- 453 calories). This suggests that a significant percentage of the women consumed less than 1,800 calories daily. Nutrition Collaborative Research Support Program, **Food Intake and Human Function**, p. 62.

[11] - In the United States, in contrast, well-fed lactating women lose on the average between 0.6 and 0.8 kilograms (1.3 to 1.6 pounds) per month during the first four to six months of lactation. Subcommittee on Nutrition During Lactation, **Nutrition During Lactation**, p. 164. There is no consensus, however, on the effects that maternal nutritional status has on milk volume. According to the NAS study:

> maternal nutritional status ... is not related to milk volume in studies conducted in industrialized countries such as the United States ... In less developed countries, the results are mixed; some studies show a positive association between maternal body composition (adiposity) and milk volume ... Average milk volumes of lactating women are comparable in industrialized and developing countries, despite substantial differences in energy and nutrient intake. This suggest that maternal energy intake is not strongly associated with milk volume." (p. 103).

It is well established that

> the major determinant of milk production is the infant's demand for milk, which in turn may be influenced by the size, age, health, and other characteristics of the infant as well as by his or her intake of supplemental foods. (p. 5).

for some women actually gained weight. These weight gains were consistent with the food energy intake of non-lactating women engaged in relatively light activities. Yet, when interpreted in the light of field observations that all infants in the Egypt site were fed sugar-water almost from birth, it would seem reasonable to infer that this supplementation reduced infant demand for breastmilk. Therefore, diminished infant suckling would have only partially stimulated lactation, and thus the amount of maternal fat energy expended through lactation would not have been enough to induce maternal weight loss.

These findings led the Nutrition CRSP researchers to postulate that if food intakes (plus any other adjustment) are inadequate to support lactation, then the mother requires supplementation, and last of all, the infant. In other words, in the populations they studied, food intakes of mothers before and during pregnancy, and during lactation, must be improved or else consideration must be given as to whether or not to complement the infant's diet.

In summary, the Nutrition CRSP researchers concluded that: [12]

> Infants as a group may have been food-deprived in all three locations. While there is no direct evidence of lactational failure, the indirect evidence is persuasive. Women's food intake did not increase during pregnancy and they gained much less weight during pregnancy than is customary in more privileged populations. While their infants were somewhat lighter than reference populations, the difference in pregnancy gain mainly reflects a deficit of maternal tissue reserves that otherwise could be drawn upon to support lactation. Women increased their energy intake during lactation, but not by enough to provide the amount of breastmilk needed for adequate infant growth ... We are persuaded that inadequate lactation was an important cause of early growth retardation in all projects, but the situation is complex in Egypt. Women in Egypt had more body fat than the others and, on average, they gained a small amount of weight during the first six months postpartum when they could have drawn on body tissue to support lactation. This suggests that lactation was diminished because infant demand for breastmilk was reduced. Two factors could have affected demand -- early supplementation with sugar-water and severe morbidity. Dilution of the quality of

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[12] - Nutrition Collaborative Research Support Program, **Food Intake and Human Function: A Cross Project Perspective**, University of California, Berkeley, August, 1988, pp. VII-VIII.

intake could limit growth. Infants who were ill are likely to have had reduced food demand.

These findings explain, according to the Nutrition CRSP investigators, why growth faltering is correlated with maternal food intake deficits, and why it might be necessary to:

a. improve the quantity and quality of food intake of women in the prepregnancy, pregnancy and lactating periods, and, failing that,

b. give consideration as to whether or not to complement infants' diets.

If the quantity and quality of the mothers' food intake is not addressed, then the less satisfactory alternative -- in terms of both the mothers' and infants' health and well-being -- must be considered. This is an issue that requires serious study. The conventional wisdom, supported by numerous field studies and programmatic intervention results, calls for exclusive breastfeeding from birth to at least four to six months of age, since:

- Breastmilk is ideal food for infants;
- Breastfeeding saves lives;
- Breastfeeding saves money;
- Breastfeeding prevents diarrhea;
- Breastfeeding confers immunity;
- Breastfeeding protects mothers' health; and
- Breastfeeding is effective family planning. [13]

While it would appear that inadequate maternal nutrition is partly involved in early infant growth failure, other variables are implicated as well. This is especially so with illnesses, and of repeated gastrointestinal infection episodes, as reported in the Egypt study site. One difficulty in disentangling the effects of lactation on infant and early childhood development is that supplements to breastmilk, often of low nutritional value, begin to be introduced. The supplements, if prepared with contaminated water or other undesirable ingredients, far too frequently produce infections of the gastrointestinal system.

Malnutrition and illness tend to operate in a synergistic fashion: their combined effect is greater than that of each acting independently on a variety of human functions. There are grounds for believing that the differing infant and

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[13] - Agency for International Development, **Breastfeeding for Child Survival Strategy,** Washington, D.C., May 1990, pp. iii.

children physical growth patterns observed in Kalama, on the one hand, and the Solis Valley and Embu, on the other, were related to not fully-understood morbidity/nutrition interactions. All three country study sites reported a significant relationship between diarrheal episodes and retarded physical growth. In Kalama, the introduction of pathogens with breastmilk supplements may explain the occurrence of early growth faltering in a context where food -- contrary to the situation in the Solis Valley and Embu -- was abundant.

Kalama infants were found to begin receiving sugar-water shortly after birth and throughout the first six months of life; and one-third were also fed rice-water. These breastmilk supplements were often diluted in unboiled water (in Kalama less than one-third of the households boiled water to prepare infant food). Use of contaminated water in the preparation of breastmilk supplements is a high-risk factor for gastrointestinal infections. Most supplementary feeding in the Solis Valley began after the infants were three months old, and in Embu it commenced when infants were between one and three months of age. Moreover, food supplements in the Solis Valley and Embu were reported to be of generally higher nutritional value than in Kalama. In addition, at least in the Solis Valley, such food supplements were often prepared with boiled water. These different practices probably account for the much higher incidence of infant diarrhea reported in Kalama, which was two-to-three times higher and more severe than in the Solis Valley or Embu.

Sanitary conditions, although wanting in the three study communities, appear to have been far more threatening in Kalama. The infected canal traversing the village is a source of many pathogens and parasites. On the basis of laboratory analyses, it was determined that 85 percent of all households in Kalama had at least one individual infected with parasites, and over 60 percent were infected by various organisms (e.g., schistosomos, amoebae, giardia, round worms). Heavy infestation with these parasites is known to produce signs of protein-energy malnutrition and vitamin and mineral inadequacies or even stunting. A prudent conclusion would be that although inadequate food consumption is implicated in early growth failure, food consumption effects are mediated to an important degree by the frequency and severity of infections.

Finally, it should also be recognized, as noted by the Nutrition CRSP researchers, that in the absence of adequate food intake, extensive breastfeeding draws on the mother's resources; and in the long run, together with the stresses of her many household activities, it exacts a toll on her health and well-being.

2. Food intake of the child between 18 and 30 months affects his/her body size, morbidity, and psychological development.

By and large, and with the exception of the relationship between toddler food intake and morbidity where findings are not consistent from country to country, this hypothesis appears to be supported by the associations, although questions can be raised regarding the interpretation of the data due to the effects of confounding variables. Each of the country projects reports an association between toddler food intake and growth, while body size appears to be related to cognitive and behavioral development. **That achieved size is a predictor of psychological performance is a finding of major policy significance.** These findings, in effect, seriously challenge the assumption that small body size is not a detriment to proper development, the "small but healthy" hypotheses.

Explanations of how food intake in toddlers is related to functional outcomes are not unambiguous, however. One interpretative issue is that the observed relationships may be mediated by growth faltering at an earlier age (before six months of age), rather than by current food intake. To satisfactorily address this question, it would be necessary to conduct a longitudinal analysis by taking advantage of the repeated measurements gathered by the Nutrition CRSP, or by following some of the children studied by the Nutrition CRSP as they age, as was done in Kenya with Ford Foundation funding. Some interpretative issues are also related to biologically-determined growth cycles, and by the assumption that catch-up growth to genetic potential is far more rapid among less well-nourished children earlier in life than for those who achieve greater growth at younger ages. It is always possible that environmental factors (e.g., child care, household management) can explain some of the associations, because these factors respond to the same set of variables that account for nutritional status.

A significant association was found between intakes of animal source foods and cognitive and behavioral development. **In some cases, it has been possible to tentatively identify the specific nutritional components that relate to specific aspects of development, and to postulate that not all behavioral parameters are influenced in the same way by nutritional variables.**

Across countries, the Nutrition CRSP found associations between food intake and morbidity, but the paths of causation

are not clear, and appear to vary from country to country. Severity of morbidity episodes seems to be influenced by food intake (as mediated by diarrhea in Kalama and the Solis Valley, for example), and has an impact on growth. In Embu, the better-fed children were more likely to experience less acute episodes of lower respiratory illness. The data on illness frequency also suggest that morbidity episodes have a negative effect on cognitive development. [14]

The Nutrition CRSP has shown that mild-to-moderate malnutrition plays an important role in cognitive development, a finding contrary to the earlier prevailing view that assumed no relationship. [15] Whether or not this effect is mediated by earlier nutritional failure (stunting earlier in life), or by later food intake, remains to be ascertained. Equally important is the finding that shows a strong association between quality of food intake and cognitive development. These associations are also mediated by non-nutritional variables which in turn have a synergistic effect on nutrition and cognitive variables. Both of these findings have significant policy implications.

3. Food intake of the child between seven and nine years affects his/her body weight, morbidity, and behavioral and cognitive performance.

The Nutrition CRSP investigators are still exploring the details of this set of hypotheses, although the Kenya project investigators who gathered additional longitudinal data with Ford Foundation support have already analyzed the longitudinal data. Preliminary findings indicate that relationships similar to those found with the toddlers are likely to emerge. The Embu study has shown that dietary quality (animal source foods), and in particular the availability of certain nutrients (e.g., iodine), is associated with cognitive outcomes. Also, dietary quality in Mexico was associated with

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[14] C. Neumann, M.A. McDonald, M. Sigman, N. Bwibo, and M. Marquardt. Relationships between morbidity and development in Kenyan toddlers. **Pediatrics** 1991, Vol. 32, pp. 307-21.

[15] Ernesto Pollit, "A Critical View of Three Decades of Research on the Effects of Chronic Energy Malnutrition on Behavioral Development." Paper presented at the meeting of the International Dietary Energy Consultative Group, Institute of Nutrition of Central America and Panama (INCAP), Guatemala City, Guatemala, 1987.

cognitive outcomes. It is anticipated that further analysis will permit the identification of nutrition components related to specific behavioral and cognitive outcomes. Total energy intakes were very important for the school-age children's activity level on the school playground in Kenya. Results available thus far seem to indicate that the associations between food intake and functional outcomes are mediated by a complex array of demographic and sociocultural variables. The relationship between food intake and morbidity among schoolers remains to be examined, but the data are available to do so.

4. Food intake of adults affects their morbidity, their care of and attention to children, and their performance of usual tasks; and this, in turn, affects the morbidity and the cognitive and behavioral performance of other household members.

Of all the hypotheses, this is the one that has been tested the least. This is due, in part, to changes in research design that resulted in the truncation of the data collection procedures originally envisioned, and in part to the higher analytical priority assigned to the testing of other hypotheses. Due to the EEP recommendations, the collection of measures on task performance and interactions were given less attention. In the absence of these data, it is not possible to build analytical models to assess the pathways of postulated relationships, particularly as they affect task performance and child caregiving. Some of the investigators find that the analysis conducted suggests the presence of causative paths linking mother's food intake and infant caregiving. They note, for example, that in Kalama, low hemoglobin levels (anemia) are partially determined by inadequate iron intake. Mothers' anemia, in turn, leads to lower levels of activity, which results in poor household management and sanitation, and hence in inadequate caregiving and malnutrition.

In the view of some Nutrition CRSP investigators, however, the morbidity components of this set of hypotheses could be assessed if an index were constructed of household morbidity derived from morbidity measures obtained from selected target members of the household. This could be done on a country-by-country basis. An important caveat to this view lies in the limitations of the Nutrition CRSP morbidity data; they are highly variable and tend to reflect different collection methodologies. The issue of morbidity data comparability across countries is especially daunting due to cultural differences and the various approaches to data collection

employed in each of the three countries. However, the morbidity data for Egypt and Kenya are reasonably comparable.

5. Household food intake affects household morbidity.

What seems clear is that the relationship of food intake to household morbidity is mediated by many other variables, such as structural features of the household (e.g., the presence of grandparents, number of individuals in the home), together with housing and environmental characteristics. Many analytical hurdles are related to changes in the Nutrition CRSP research design, as these modifications reoriented the focus of the study away from the dynamics of the household, as well as to the fact that morbidity itself affects food intake.

6. For adults, a reduction of resting metabolic rate provides a major path of adaptation to restore energy equilibrium.

This hypothesis is convincingly rejected by the Nutrition CRSP, in particular by the data collected before, during, and after the drought-induced famine in Kenya. Due to this natural intervention, it was possible to show that resting metabolic rates did not change in any significant way during the period of food deprivation, other than to the extent that resting metabolic rates are affected by changes in body weight. Thus, the only adaptation that occurs in resting metabolic rate is through reduced body weight, although individuals subjected to food scarcity also adapt by constraining physical activity. It was not possible to test this hypothesis with data from the Egyptian and Mexican sites, since in these sites adults did not experience marked food energy deficits. The finding based on the Embu data reinforces the point made above in reference to the lack of dietary concessions made by women during pregnancy and lactation.

D. Summary of Findings

In summary, there seems to be sufficient support for a number of findings regarding the associations identified by the Nutrition CRSP. While the validation of these findings must await further analyses and interpretation and the results of carefully conducted interventions, in some cases the associations are sufficiently suggestive to merit taking them into account when considering

policy initiatives. Particularly salient are the following findings:

1. Chronic mild-to-moderate malnutrition leads to growth faltering (stunting) very early in life. By three to four months of age, infants begin to suffer permanent losses in their potential for normal growth and development.

2. Stunted children are more prone to illness than bigger children, and diarrhea and respiratory episodes are more likely to progress in severity in stunted children.

3. Maternal prepregnancy body size, which reflects maternal prepregnancy nutritional status, is a strong predictor of such pregnancy outcomes as infant birthweight, infant growth, and maternal post-partum nutritional status.

4. Children's dietary intake influences their cognitive development. Dietary quality appears to be a very important link.

5. Length-for-age is a more accurate index of nutritional status in preschoolers than weight-for-age. Weight-for-height does not identify mild-to-moderately malnourished children.

6. In school-age children, both past and current quality food intake are important for cognitive performance.

7. In school age children, current food intake is associated with physical and social activity level.

8. High quality diets, sufficient not only in energy but also in micronutrients, are linked to positive health outcomes such as improved child growth. Dietary quality is characterized by the relative contribution of animal source foods to the diet.

In addition, two fully validated findings are that:

1. Maternal resting metabolic rate is not reduced in the face of inadequate dietary intake during pregnancy. Women compensate by losing body fat and by decreasing their level of physical activity.

2. Adults do not adapt to food deprivation through reduction of their resting metabolic rates.

E. Policy Implications of the Nutrition CRSP Findings

A number of the Nutrition CRSP findings underscore points that have been made by other investigators. Also, the findings of a single study -- even one of the magnitude of the Nutrition CRSP -- do not in themselves represent a sufficient basis for policy changes. Nonetheless, the Nutrition CRSP findings do bear potentially significant implications for policy in a number of areas.

The Nutrition CRSP found that in chronic mild-to-moderate malnourished populations, positive human functional outcomes are dependent not only on overall energy intake, but on dietary quality as well. This finding -- that energy is not the only limiting intake in the diets of malnourished people -- may be sufficient in itself to recast the intent of many agriculture development programs, including the Agriculture CRSPs -- whose main objective is to increase the output of given commodities. As some of the consultants to the Nutrition CRSP Feasibility and Planning Activity have indicated:

- If agriculture development programs are to attain the dual objectives of raising the level of commodity production and of improving the nutritional status of consumers, agricultural projects must reorient their efforts by approaching commodity production with a complementary perspective in which essential nutrients (e.g., micronutrients) not present in target crops must be introduced within the overall food system. Corollaries to this assertion are that:

  - agriculture development projects should promote varied production systems capable of providing micronutrients as well as energy/protein sources;

  - agriculture systems promoting the integrated production of crops and livestock (in particular small ruminants, fish, and poultry) should receive higher priority;

  - to enhance household food security, it is necessary to increase steady access to all essential nutrients; and

  - emphasis should be placed on food treatment or preparation methods that improve the bioavailability (absorbability) of micronutrients.

The Nutrition CRSP findings suggest that for favorable birth and growth outcomes in marginally malnourished populations, it is

necessary to focus on the nutritional and health status of the woman even before she becomes pregnant. Major implications follow from these findings, since the vast majority of Primary Health Care (PHC) and Maternal-Child Health/Family Planning (MCH/FP) programs intervene too late to have the most beneficial and cost-effective results. The targets of these programs -- for economic and other reasons -- mostly tend to be mothers, infants, and young children. These particular Nutrition CRSP findings suggest that:

- By design, PHC and MCH/FP programs may be neglecting a most critical segment of the population: the adolescent, prepregnant female. Failure to address the health and/or nutritional needs of these women may result in a higher than necessary number of functionally-deficient infants and children.

- Further emphasis on the monitoring and breastfeeding components of PHC and MCH/FP programs is warranted given their relationship to human functional outcomes; and

- PHC and MCH/FP programs should give more attention to the issue of wellness so that women remain healthy during the stress periods associated with pregnancy (as well as the intervals between pregnancies), childbirth, and lactation.

Significant policy implications follow from the finding that growth faltering (stunting) begins to occur very early in life. The Nutrition CRSP field studies confirmed earlier research that noted that weight growth failure occurs in the first three to four months of life under conditions of chronic marginal nutrition. [16] Moreover, the Nutrition CRSP also established that length/height growth failure (stunting) begins to occur at around the same age.

The ramifications of this finding are wide ranging, since it suggests that growth faltering produces individuals poorly equipped to function effectively in a range of human endeavors. Further, the Nutrition CRSP findings lend credence to the notion that once faltering occurs, catch-up may only be partial, and not sufficient to attain full genetic potential. Among the many policy implications that follow from the above are the following:

- Many supplementary nutrition interventions for children in developing countries are currently targeted exclusively to school age children, perhaps too late for the intervention to achieve maximum benefit;

- In the absence of complementary efforts to reduce the incidence of malnutrition, programs designed to bring

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[16] - Waterlow et. al., op. cit., and Rowland et. al., op. cit.

about marked infant mortality declines in poor countries (Child Survival Programs, for example) may have the long-term unintended consequence of promoting the survival of large birth cohorts with impaired capacities to thrive and to function effectively: survival without development. The ethical and economic implications of this trade-off are enormous (since they can undermine the achievement of many development objectives), and given their policy and programmatic importance, require careful reconsideration and study; and

- To the extent that growth stunting may be associated with lactational failure, in some instances, supplementation of either the mother or infant, or both, may be necessary. Since infant growth stunting may be associated with prepregnancy status and pregnancy endowment on the development of the fetus, a related issue deserving of close attention is the feasibility of food supplementation for adolescent prepregnant females.

Probably linked in yet-to-be fully understood ways to growth faltering and child-rearing practices are the associations suggesting that children's food intake affects physical growth and cognitive development. **This is a very crucial finding, since before the Nutrition CRSP findings it was not widely accepted that mild-to-moderate malnutrition had an effect on cognitive development.** However, despite the occurrence of growth stunting in infancy that may impair their ability to attain full genetic growth potential, children were found to manifest better physical growth and cognitive performance when animal source foods were included in their diets, and visa versa. Thus, the relationship between food intake and cognitive development is mediated by diet quality. Moreover, cognitive performance was found to be affected by both current and past animal food intake. Regardless of the paths through which the linkages operate and the synergism involved, it can be postulated that:

- Diet quality is critical for cognitive development;

- Diet quality is related to social behavior, the age at which children begin to go to school, school attendance, and school performance;

- Appropriate food supplementation programs can help ameliorate the deleterious effects of poor diets; and

- Food supplementation for children should start at an early age, well before they enter school.

Food intake is associated with a constellation of other household factors in which the role of adult women (and mothers) is central to the nutrition and health of all household members, especially

infants and children. This association, supported by some preliminary analysis of the Nutrition CRSP database, appears to be related to other indicators of household management and sanitation. The implication is that well-nourished women are capable of feeding and caring for their children more effectively, at least in part because they can manage their households more efficiently. It follows that:

- Reliable indices of household management can help identify families at risk for malnutrition; and
- Such indices could be used to formulate appropriate interventions.

Poorly-nourished populations do not adapt to reduced food intake by lowering their metabolic rates. What this means for food security concerns is clear and has already led to some interventions on the part of the Kenyan government. Similar interventions elsewhere can address the need to:

- Not assume that marginally-fed populations metabolically adapt to lower food intake, but instead assure that these populations receive adequate food assistance to sustain economic productivity and health standards;
- Introduce drought-resistant crops in areas where they were previously not used in order to minimize the danger of famine;
- Provide seed storage facilities as coping mechanisms to assure adequate supplies for the next crop's planting, since hard-pressed rural farming households are prone to consume reserve seed stocks in times of emergency;
- Educate the community in ways to deal with and overcome the medium-term effects of severe droughts; and
- Ensure that "Food for Work" programs provide diets which are adequate in quantity and quality.

F. Sectoral Significance of the Nutrition CRSP Findings

As can be ascertained from the above discussion, the Nutrition CRSP findings are relevant to the programmatic activities of a number of

development sectors and efforts, such as nutrition, agriculture (including the Agriculture Commodity CRSPs), health, education (including the Early Childhood Growth and Development Project), household/community development, and program evaluation, together with the Women in Development Program and the Family and Development Initiative.

1. Nutrition

Findings of the Nutrition CRSP have the potential to provide important feedback to nutrition programs, in particular to those sponsored by A.I.D.'s Office of Nutrition. **Perhaps the most salient lesson of the Nutrition CRSP is that the most effective approaches to nutrition interventions are those which are designed from a multisectoral perspective.** Likewise, the findings of the Nutrition CRSP can contribute to the efforts being conducted by the Office of Nutrition within A.I.D. to educate policy-makers about the importance of diet quality. In the future, some of the malnutrition indices identified by the Nutrition CRSP could find wide applicability in Office of Nutrition monitoring projects, as well as in similar efforts conducted under the auspices of other A.I.D. offices and the international development community at large. In general, and as they are validated, the findings of the Nutrition CRSP could be used increasingly in the development of nutrition programs by A.I.D. and other agencies.

2. Agriculture

The most obvious application of the Nutrition CRSP findings in the agriculture sector lies in the understanding gained regarding the correlates of improved nutrition in populations suffering from marginal malnutrition. This understanding bears considerable implications for programs aimed at increasing yields, improving the bioavailability of micronutrients, and assuring abundant food supplies for chronic mild-to-moderately malnourished populations. Of critical importance is the Nutrition CRSP finding that increasing the availability of energy intake (by improving the yields of basic staples) is not sufficient for optimal human functioning if other foods adequate in micronutrients (e.g., animal source foods) are not made available as well. A serious problem in implementing this recommendation is that while increasing the amount of animal source foods consumed is a desirable goal, it might be difficult (and expensive) to achieve in poor rural communities in which animal source foods are luxuries beyond the reach of most families. Nevertheless, the addition of nutrition components in agriculture projects, including fortification, or food preparation techniques that

improve micronutrient bioavailability, can be translated into potentially vast improvements in the performance of a range of human functions.

At a practical level, Nutrition CRSP findings and research can be used to complement agriculture initiatives by:

- Providing information on the adequacy of foods being consumed;
- Monitoring the nutrition outcome of Agriculture Commodity CRSPs and other agriculture programs.
- Monitoring nutritional status at the household and community levels; and
- Assessing the appropriate balance between food sources provided by cereal/legume and animal agriculture projects.

These objectives could be accomplished by:

- Expanding and making readily accessible the International (INT) Minilist Food Groups currently under development at the University of California, Berkeley. This instrument consist of "an abbreviated table of food composition in which foods of like nutrient content are represented by a single entry. The INT Minilist provides reasonable approximation of the content of 48 nutrients/food components in about 300 index or class representative foods, and allows calculation of the bioavailability of key nutrients as well as the total amount in diets"; [17]
- Developing statistical models to readily provide a snapshot of nutrient, especially micronutrient, bioavailability (partly based on the International Minilist Food Groups and the Nutrition CRSP findings) once basic information on the types and quantities of foods consumed are collected on a target community; and
- Assisting with the testing and evaluation of new varieties of agriculture food commodities in order to determine their nutritional merit and potential effect on child growth and cognitive performance.

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[17] Human Nutrition Collaborative Research Support Program, **Annual Report, 29 September 1989-28 September 1990**, University of California, Berkeley, p. 8.

3. Health

The saliency of the Nutrition CRSP for the health sector are multiple and essentially follow from three findings of the study:

- Growth faltering occurs during the first few months of life (suggesting that many infants may be born with low nutrient endowment);
- Stunted children experience more frequent and severe episodes of diarrhea and respiratory illness; and
- Maternal size (weight and height) has a powerful influence on child size and child functional outcomes.

Important implications that derive from these findings include:

- PHC and MCH/FP programs should incorporate a strong nutrition component to achieve positive child growth outcomes;
- Increasing attention to and resources should be provided for effective growth monitoring programs and promotion of breastfeeding and appropriate supplemental foods for mothers;
- Broadening the scope of oral rehydration therapy (ORT) to include appropriate nutrition supplementation (dietary management of diarrhea) would help sustain good health in children subjected to the ravages of repeated diarrheal events and subsequent diminished growth; and
- The purview of PHC and MCH/FP should be extended to improve the health and nutritional status of adolescent prepregnant females and maintain it during the stresses of pregnancy, childbirth, and lactation, as well as in between pregnancies.

4. Education

The Nutrition CRSP findings regarding the impact of chronic mild-to-moderate malnutrition on cognitive development, and hence on educational potential and outcome, are multiple and more often than not mediated by a host of other environmental psychosocial, and caregiving variables -- and vice versa. The

Nutrition CRSP has generated four tentative findings of particular relevance to the education sector:

- Maternal nutritional status affects child care, which in turn affects children's cognitive and behavioral development;
- Mild-to-moderate malnutrition bears important negative consequences for cognitive performance and social competence;
- Diet quality is critical for school performance; and
- Better-nourished children attend school earlier and make more regular progress through the educational system.

Potential education interventions that flow from these findings include:

- Promoting educational efforts directed toward both men and women to improve access to food for women;
- Devising socioculturally appropriate strategies for providing adult nutrition education for women;
- Introducing nutrition and household management education courses at all school levels, including primary education, and when available, in secondary schools;
- Designing educational interventions to enable parents to improve household management, time allocation, and sanitation strategies;
- Designing educational interventions to enable parents to improve household food and nutrition strategies;
- Developing education intervention programs to enhance child caregiving;
- Implementing school food supplementation programs; and
- Developing programs to maintain school attendance.

5. Household/Community Development

The household, as the primary production and consumption unit, has a central role in community and national development. Many of the Nutrition CRSP findings highlight the importance of household dynamics for:

- Proper nutrition;
- Adequate physical growth;
- Limiting the frequency and severity of disease; and
- Psychological development and educational success.

Utilizing and expanding on the considerable insights provided by the Nutrition CRSP on how nutrition and functional outcomes are related to household dynamics looms as a top programmatic area, a priority consistent with the importance accorded by A.I.D. to the household unit under the "Family and Development Initiative." Important issues underscored by the Nutrition CRSP findings that merit attention include:

- Determination of the ways in which better household management practices might improve the nutritional status and overall well-being of households, and thereby communities;
- Exploration of household data to analyze how poor families allocate scarce resources to maximize well-being and minimize risks;
- Utilization of the household unit to monitor program development and to evaluate the impact of development initiatives;
- Determination of the role of nurturing practices for improved nutrition and optimum physical and mental development; and
- Identification of viable approaches for the family/household to employ in order to effectively maximize its capacity to care for its members.

6. Program Evaluation

The Directorate for Policy's Center for Development Information and Evaluation (POL/CDIE) is now in the process of developing an agency-wide evaluation system called PRISM (Performance Indicators for Strategic Management). PRISM has

four major themes: 1) quality of life; 2) economic growth; 3) the environment; and 4) the democratic initiative. The quality of life theme contains a number of clusters, including MCH/Child Survival, which in turn has a subcluster that contains oral rehydration therapy, immunization, and nutrition.

Quality of life indicators for nutrition will be based on three child development measures: 1) weight-for-age; 2) length-for-age; and 3) weight-for-height. Although length-for-age is cited by some as being difficult to use in attaining accurate measures, the Nutrition CRSP study has demonstrated that this is the most appropriate and sensitive method to use in detecting chronic mild-to-moderate malnutrition. Based upon their extensive experience in this regard, the Nutrition CRSP investigators can provide a valuable informational resource for efforts to efficiently and accurately employ this measure.

G. Marginal Malnutrition Indicators

As a result of the analysis to which the Nutrition CRSP database has been subjected, it has been possible to identify a select number of indicators of practical utility to recognize individuals, households, and communities at risk due to chronic mild-to-moderate malnutrition, as well as for monitoring purposes. These indicators appear to be valid across the three study sites and seem to be capable of alerting program managers about potentially serious problems arising from nutritional deficiencies. The indicators are presented on Table 1 in terms of their assumed reliability and according to the individual or community targets for which they can be used as diagnostic tools. Also shown for each indicator is the problem area that it addresses. Conclusive validation of the usefulness of these indicators must await their use under field conditions.

It is also appropriate to mention that preliminary results from some of the field studies suggest other possible indicators, although the grounds for using them are weaker since they have yet to be evaluated with data from the three study sites. Some of these indicators (e.g., head circumference measures), in fact, are already being used in Mexico in some major field interventions. Additional indicators are likely to emerge as the investigators continue to analyze the Nutrition CRSP results. Examples of additional potential indicators that should be evaluated under field conditions include the head and arm circumference of women as proxies for body height and weight, respectively, and other more elaborate anthropometric measures.

TABLE 1

NUTRITION CRSP
MARGINAL MALNUTRITION INDICATORS

INDICATOR	LEVEL	PROBLEM INDICATED
No increase in body mass index* with age in women	Community	Inadequate food supply (insufficient quantity)
Low body mass index and low food energy intake during pregnancy	Mothers	Poor reproductive outcome
Lower length-for-age status at 6 months than at birth	Infant	Inadequate maternal diet and/or inadequate supplemental feeding and/or high morbidity burden
Diet low in animal-source foods	Household	Poor dietary quality
	Toddlers	Poor dietary quality and lower growth rate and impaired cognitive development
Diet very low in percentage of energy from fat	Household	Inadequate quantity of energy
	Toddlers	Inadequate quantity and probable quality, of energy

* Body Mass Index: Weight (kg) / Height in meters (squared)

IV. RECOMMENDED RESEARCH STRATEGY

A. Feasibility and Planning Considerations

As stated on page 8 of this report,

> The purpose of the Nutrition CRSP Feasibility and Planning Activity has been to assist the Office of Nutrition in identifying and determining what is feasible for A.I.D. to do next based on the findings of the Nutrition CRSP, with attention to implications for the Agriculture Commodity CRSPs and other A.I.D. sectors, and how best to plan to address potential areas for policy-guided interventions and identified nutrition research needs.

In keeping with this mandate, this report presents a research strategy which reflects considerations of the feasibility (e.g., state of scientific knowledge, relative significance, potential impact, and demand on resources) of conducting further research on food intake and human function together with policy implications. Further, attention has also been given to planning the research strategy. In keeping with the Feasibility and Planning Activity mandate, this report assigns the highest priority to operational research and then to further research needs.

The research topics identified by the Nutrition CRSP extend beyond narrowly circumscribed nutrition concerns since they encompass issues of potential policy significance for a number of (and combinations of) development sectors. They are also broad enough to embrace the programmatic priorities of funding agencies beyond A.I.D.. Thus, the research strategy proposed herein is predicated on collaborative and coordinated efforts among A.I.D.'s Office of Nutrition and other A.I.D./R&D offices (e.g., health, education, agriculture), as well as on collaboration between A.I.D. and other bilateral and multilateral international development agencies, and private foundations.

Within the proposed research strategy, the studies are ranked according to three categories:

- operational research;
- further analysis of existing Nutrition CRSP data; and
- new research on food intake and functional outcomes.

The proposed plan for carrying out this research strategy comprises three basic steps:

1. Assign high priority to pursuing operational research activities taking into account the appropriateness of country-settings and availability of support mechanisms;

2. Complete the analysis of the Nutrition CRSP database, in conjunction with a thorough review of the program's findings in light of other relevant research conducted during the past decade (including the meta-analysis of non-Nutrition CRSP databases); and

3. On the basis of 1) and 2), discuss with the U.S. and international scientific community, as well as with potential collaborative funding sources, new food intake and human function research.

Some of the proposed studies could be completed in a short time and at a relatively low cost (e.g., selected operational research-type studies and those resulting from the further analysis of the Nutrition CRSP data). Others may take far longer. Certain operational studies may involve assessing the effects of nutrition interventions over extended periods of time (for example, evaluating the effects of supplementation programs on the pre-pregnant adolescent woman through her early family formation years -- the woman and her children), and the design, execution and analysis of new research projects of ambitious scope could well occupy several years. Thus, as this discussion suggests, it is far from simple to determine in the abstract whether some of these

studies would be short- or long-term, or for that matter, to estimate with any degree of precision how much they would cost.

Within each of these three study categories, research priority is assigned according to the criterion that the principal investigators and consultants involved in the Feasibility and Planning Activity have judged to be the most significant preliminary finding of the Nutrition CRSP: the important role of diet quality in human functional outcomes.

1. Operational research to assess the applicability of selected Nutrition CRSP preliminary findings through field interventions to address the nutritional needs of populations subject to chronic mild-to-moderate malnutrition:

Within the study category of operational research, five proposed research initiatives (see below, section of Research Topics) follow from the important associations between food quality and human functional outcomes identified by the Nutrition CRSP. Moreover, in terms of priority, the five initiatives are based on the potential usefulness of the proposed activities and on the Nutrition CRSP premise that first priority should be accorded to improving the diets of pre-pregnant, pregnant and lactating women. Hence, the priority ranking of the five proposed operational research initiatives is as follows:

a. Identification of Nutritionally- and Culturally-Optimal Patterns of Food Intake in Different Settings;

b. Development and Testing of Malnutrition Indices;

c. Women- and Household-Focused Intervention;

d. Food Supplementation and Its Effects on Catch-up Growth; and

e. School-Based Interventions.

Some of these efforts could be conducted as part of the project "Women's and Infant's Nutrition (WIN): A Family Focus," which involves Mission buy-ins, or under a new project similarly funded by A.I.D./Washington and the Missions. It might also be possible to find funds for these projects under multi-sectoral A.I.D. programs and initiatives, such as "Women in Development" (WID), the R&D/E Early Childhood Growth and Development Project, and the "Family and Development Initiative." Many of these research efforts could be conducted as well in conjunction with, as a complement to, or

as part of the activities of the Office of Agriculture's Agriculture Commodity CRSPs. Particularly promising in this regard are the possibilities of collaborating with the Agriculture Commodity CRSPs that focus on staple foods (e.g., beans, cowpeas) and on foods of animal origin (e.g., small ruminants, fish). Further, the Missions could help support selected operational research endeavors through the resources made available by Title III of P.L. 480. The Office of Nutrition might also succeed in enlisting the collaboration of other development agencies in these efforts.

2. Completing the analysis of the rich Nutrition CRSP database.

Due to time and funding constraints, the Nutrition CRSP investigators have been unable to fully analyze this complex, enormous and unique database. Completing this analysis is important since it will provide guidance for the design of more focussed policy-oriented research efforts, in accordance with the Nutrition CRSP original intent (see Section B. 1, pages 14 to 16, "A Naturalistic (Associative) Research Design"). To not do so would be a waste of an invaluable scientific and policy relevant resource.

While it is difficult to rank the identified Nutrition CRSP data-based research issues (since all of the identified pending research issues are worthy of attention), it would seem most important to give precedence to the Nutrition CRSP studies having to do with food quality issues:

a. Food Intake Composition and Infant Growth Failure.

Secondarily, attention should be given to the important intervening variable of morbidity:

b. Food Intake, Morbidity and Functional Outcomes; and

c. Nutrition and Morbidity, and Household Management and Sanitation.

Thirdly, thorough analysis is required of Nutrition CRSP data focusing on the household as a unit of measure:

d. Food Intake, Time Allocation, and Outcomes; and

e. Implications of the Kenyan (Embu) Nutrition CRSP Database for Understanding Household Coping Mechanisms Under Drought Conditions.

The Nutrition CRSP researchers should also be encouraged to explore the data on:

f. Head Circumference, Brain Development, and Cognitive Outcomes.

The amount of funds needed to complete the analysis would be relatively modest. It is assumed, therefore, that R&D/N, perhaps with the help of other Washington-based A.I.D. offices, could underwrite the cost of the remaining analyses. R&D/H is already contributing to the analysis of some of the physical growth data, and R&D/E, R&D/A and other offices could contribute to the analysis of other subject areas as well. In addition, other funding sources could be approached to see if they would be willing to support the further analysis of the Nutrition CRSP data. The Ford Foundation has already invested some resources in data analysis, and the World Bank has indicated an interest in doing so.

3. New Research on Food Intake and Functional Outcomes

The importance of additional studies on food intake in populations subjected to chronic mild-to-moderate malnutrition and human functional outcomes can hardly be overemphasized.

Highest priority is assigned to studies focusing on:

a. Food Intake and Human Function From Two Months Gestation to Two Years of Age.

The Nutrition CRSP accomplished its objective of identifying associations between food intake variables in chronic mild-to-moderately malnourished populations and selected functional outcomes, especially in infancy and early childhood. This brought to light a host of interrelated questions regarding the nature of these associations. These questions can only be answered through elaborate and costly longitudinal field studies that follow mothers from early pregnancy, and their children from birth to two years of age. These studies should be designed to assess the effects of maternal nutrition and disease experience on early human growth during pregnancy and lactation, and what effects faltering has on physical and cognitive development up to two years of age. The Nutrition CRSP studied infants only from birth to six months of age, and toddlers from 18 to 30 months of age. It did not assess fetal development.

Second priority is assigned to studies targeting:

b. Food Intake and Household Dynamics.

While the first study proposed above is primarily biological in nature, this second study places a premium on the interactions between food intake and social relationships within the household and the family, and in particular within the mother-child dyad.

It would be difficult for A.I.D. -- given its action-oriented mission -- to justify being the sole source of support for such basic (although policy-oriented) research as represented by the first study described in this section. A.I.D., however, can act as a catalyst in attracting the interest and support of other organizations whose mandates include basic research such as the National Institutes of Health (especially the National Institute for Child Health and Development), the U. S. Department of Agriculture, and private foundations, such as Ford and Rockefeller. The Office of Nutrition has had success in leveraging its limited resources through this approach in other efforts (e.g., the Combatting Iron Deficiency Program). On the other hand, the "Food Intake and Household Dynamics" study(ies) could be conducted by interdisciplinary nutrition and social science research teams at considerably less cost. Co-sponsors for these efforts might include other R&D offices, as well as the Women in Development Program and the Family and Development Initiative.

1. Operational Research

a. Identification of Nutritionally- and Culturally-Optimal Patterns of Food Intake in Different Settings.

Since basic staples and other foods vary according to ecosystems, it would be useful to develop easily- applicable evaluative instruments to assess within different settings appropriate combinations of foods to maximize positive functional outcomes. The International Minilist Food Groups constitutes a potentially crucial building block for attaining this objective. A useful complement to the minilist would be a computer-driven model to assess the effects of micronutrient intake and bioavailability on target populations' functional outcomes given existing food patterns. Modelling results could be used to determine supplementation needs, and they should help in the assessment of different means through which missing micronutrients can be added to local diets. This complex and policy-significant model could draw substantially from Nutrition CRSP data and findings, but would also entail

additional research efforts, since the development of the model must rely on further fieldwork and biochemical assessments of nutritional status. Field-testing would be needed before such a model would be sufficiently fine-tuned for programmatic interventions. There would also be a need to field test data collection instruments (of wide applicability) for the rapid and inexpensive gathering of food intake patterns for input into the model.

b. Development and Testing of Malnutrition Indices.

As noted earlier, the Nutrition CRSP can make an important contribution to the well-being of families and international development in general if the study findings lead to the use of easy-to-use indicators of chronic mild-to-moderate malnutrition and its effects on functional outcomes. The Nutrition CRSP investigators feel that several such indicators are already available for field use (e.g., monitoring, surveys). Pending are some relatively minor efforts to operationalize the use of these indicators. In the case of other potentially useful indicators (e.g., head and arm circumference of women), much work remains to be done before they can be field-tested. Focused efforts should be made to identify additional potentially useful indicators and to test them under realistic field conditions, perhaps as an add-on to existing program activities.

c. Women and Household-Focused Interventions.

Given the importance of adequate maternal nutrition even before pregnancy occurs for children's (especially toddlers and preschoolers) functional outcome, and the advantages derived from more efficient household management by well-fed women, it is warranted to investigate the desirability of household supplementation programs, and what indices can be used to monitor and evaluate them. These efforts may include renewed interest in the promotion of household gardening (to increase the availability of selected micronutrients), the raising of small animals (for animal source foods), and food preparation techniques that increase micronutrient bioavailability. It should be noted, however, that such activities make additional claims on women's time and energy.

d. Food Supplementation and Its Effects on Catch-up Growth.

Since growth faltering begins three-to-four months after birth, it might be possible to forestall this occurrence through appropriate food or nutrient supplementation of mothers and/or infants. Food supplementation could include the nutritional evaluation of newly-introduced multi-mixes and animal source foods as weaning foods given in conjunction with breastmilk. These studies should carefully evaluate the extent of breastfeeding (full or partial) and the role of disease in early faltering.

e. School-Based Interventions.

Once nutritional shortcomings are identified, school-based interventions can be devised to assess the effects of food supplementation on cognitive and school performance outcomes. Intervention-related operational research can help determine which types of nutrient or food interventions are most appropriate, the extent to which household interventions are complementary, and at which stage (prepregnancy, pregnancy, infancy, and school ages) of the life-cycle household interventions are more effective. When and where appropriate, school-based interventions will have to be coordinated with women- and household-focused interventions as described in B.1 above. One critical element in school-based interventions is that children need to attend school regularly. School attendance itself is an indicator of program success.

2. Research Based on the Nutrition CRSP Database

a. Food Intake Composition and Infant Growth Failure.

Although the Nutrition CRSP was able to show relationships that suggest that early growth failure is associated with mild-to-moderate malnutrition, many questions remain regarding the specific nutritional components (and other factors) implicated in growth failure. Some of the data required for exploring these relationships are available in the Nutrition CRSP database, and can be explored further at a relatively low cost.

b. Food Intake, Morbidity and Functional Outcomes.

Only limited advances have been made in the analysis of the relationship between food intake and morbidity. For example, it was found that Kenyan females, toddlers and schoolers, who were sick more often and generally smaller, developed less well cognitively. Given the richness of the Nutrition CRSP database, the many variables affecting morbidity outcomes, and the potential significance of what may be gained from a better understanding of the morbidity/nutrition linkage, it seems warranted to further analyze these interactions. A decision as to how far to proceed should depend on a careful assessment of the feasibility, potential pay-off, and cost of the activity. The most crucial question is the interrelationship among food intake, morbidity and early growth failure.

c. Nutrition and Morbidity, and Household Management and Sanitation.

Preliminary analysis of the Nutrition CRSP database suggests that the nutritional status of mothers is associated with their ability to manage a household, which in turn is related to the sanitary conditions found therein. A cluster of variables (e.g., socioeconomic status, education, nutrition) can be grouped under the heading "household management." The purpose of additional analysis would be to try to better understand the factors governing this interrelationship, and ultimately to discern those markers that can accurately identify households with higher morbidity risks.

d. Food Intake, Time Allocation, and Functional Outcomes.

Related to point 2.c. above is the issue of how women utilize their time, and to what extent time allocation is related to the nourishment of different members of the household, and ultimately to functional outcomes. The Nutrition CRSP database contains some data on these topics, but until now this information remains largely untapped. Although the scope of the time allocation data is limited, analysis of the Nutrition CRSP data should suggest some important themes that could be explored in new studies.

e. Implications of the Kenyan (Embu) Nutrition CRSP Database for Understanding Household Coping Mechanisms Under Drought Conditions.

The unique database gathered when drought struck the Kenya field site constitutes a classical case of scientific serendipity. Investigators could develop a comprehensive understanding of how poor, rural communities adapt to famine conditions, since the database includes information on the study community before, during, and after the drought period. Preliminary data analysis has already assisted the Kenyan government to design and implement policies (i.e., how government agencies can intervene to assist households experiencing major reductions in food supplies) to reduce the impact, or to minimize the chances for the occurrence, of acute food shortages. Countries prone to suffer recurrent cycles of limited rainfall or other natural calamities affecting food production and distribution could benefit greatly from the lessons of the Kenyan drought captured in the Nutrition CRSP database. A related issue worthy of exploration is the identification of household-level indicators as predictors of food shortages.

f. Head Circumference, Brain Development, and Cognitive Outcomes.

An important scientific query that came to the fore during the Methodological Consultations is related to the mechanisms mediating chronic mild-to-moderate malnutrition and cognitive outcomes. This association appears to be influenced by early stunting. The suggestion was made by Dr. Frank Faulkner, a noted pediatrician and academic researcher as well as a consultant to the Nutrition CRSP Feasibility and Planning Activity, that growth failure may affect brain development, given that the most critical period for brain development is between the last trimester of pregnancy and 18 months of age. Brain development, of course, is also related to non-nutritional factors, including the level of stimulation and caregiving to which the growing infant is exposed. Since brain development may be related to head circumference, it was postulated that this relationship could be assessed through the Nutrition CRSP database. The Nutrition CRSP includes periodic measurements of head circumference, as well as a host of other measurements related to physical growth and cognitive development. When conducting this analysis, care should be taken to distinguish pre-term births from small-for-gestational-age infants, since the former did not achieve optimal growth in the protective uterine environment.

3. New Research on Food Intake and Functional Outcomes

a. Food Intake and Human Function From Two Months Gestation to Two Years of Age.

Since the original Nutrition CRSP research design did not include children six to 18 months of age, and because these children are in an age-range critical for functional development, in terms of both motor and cognitive development, it is crucial to augment the findings of the Nutrition CRSP with data from samples of children in these age categories. This study should give attention to the effects that chronic mild-to-moderate malnutrition has on the development of the fetus and adnexa (the extraembryonic membranes of the fetus, including the umbilical cord, amnion, and placenta) and on the nutrient stores with which a mother endows the newborn.

Another gap in our understanding of food intake and human function in chronically mild-to-moderately malnourished populations concerns the supply and nutritional content of mothers' milk. Growth failure in infants may be related to insufficiencies in the nutrient content of the breastmilk of poorly-fed women. Studies along these lines (e.g., collecting frequent samples of mother's milk, conducting laboratory analyses, measuring frequency and amount of intake) will require sophisticated research techniques. Yet they may provide valuable information to assess the causes of early stunting. Hence, priority should be accorded to the study of the nutritional content and quantity of the breastmilk of chronically mild-to-moderately malnourished mothers and the effects that breastfeeding has on the functional outcomes of their children.

Attention should be given to why normal birth-weight children experience rapid weight loss in early infancy. A related issue is why the Nutrition CRSP infants are not that far below reference standards for birth weight, yet drop dramatically in weight during the early post-natal period. Studies to address this set of questions demand research designs that are comprehensive in anatomical, physiological, nutritional, and clinical measurements. The nutritional status of women should be evaluated before, during, and after pregnancy, and cord blood should be analyzed as a potential indicator of fetal nourishment and stores.

b. Food Intake and Household Dynamics.

It is important to address in their full complexity the dynamics of food intake (including communal food intake) and functional outcomes within the household, the primary unit of production and consumption. Future studies on food intake and human functions should focus explicitly on the household, and more specifically on how households (and in particular, the women in the households) allocate their time. While time allocation studies are extremely difficult (and expensive) to do, they can provide unique insights for understanding how household management is tied into food intake and human functions.

An area of potentially great importance is the role of maternal nutrition in affecting care-giving behavior and household management. While the importance of maternal influences on infant nutrition through biological processes in pregnancy and lactation require further attention, the effects of poor maternal nutrition and poor health on women's abilities to provide adequate care also need to be systematically and rigorously examined.

B. Summaries of Research Topics

Following are a series of research issue summaries, each of which outlines the feasibility and constraints of conducting a proposed activity. In addition, each summary touches upon considerations regarding research design, research significance, and potential beneficiaries. The thirteen summaries are presented in the same order as they appear as topics in the preceding discussion of research needs: operational research (5 summaries), research based on the Nutrition CRSP database (6 summaries), and new research on food intake and functional outcomes (2 summaries).

Operational Research

Research Topic:

1.a. Identification of Nutritionally- and Culturally-Appropriate Patterns of Dietary Intake in Different Settings.

Feasibility and Constraints:

The usefulness of an internationally comparable food composition (in terms of energy and micronutrient characteristics) minilist is a priority concern if efforts to improve the food intake of chronic mild-to-moderately malnourished as well as severely malnourished populations are to succeed. Such a minilist, based on commonly available and easily identifiable foods, could be used as a proxy to evaluate energy, protein and micronutrient intake. When used in conjunction with statistical models (derived on the basis of associations identified by the Nutrition CRSP), the minilist can serve to determine how diets can be improved through the introduction of foods not eaten locally, or by the fortification of available foods. Since much work on the development of the minilist has been done by investigators at the University of California, Berkeley, and many Nutrition CRSP associations have been identified, this project is likely to provide a major new avenue for programmatic interventions.

Design:

It should incorporate field testing, ideally in conjunction with many of the Agriculture Commodity CRSPs projects being conducted around the world. This activity should also consider the use of rapid assessment methods to compile and evaluate information on local food patterns.

Significance:

It is difficult to exaggerate the practical significance of this effort if it succeeds in developing an easy and ready-to-use package to diagnose nutritional deficiencies on the basis of rapid assessments of food intake patterns in third world communities. Identifying appropriate country dietary patterns would help countries optimize their food resources.

Beneficiaries:

Development projects in general and Agriculture Commodity CRSPs in particular, since the package would provide the opportunity to assess at modest cost the adequacy of local diets. The package can also be used as an effective monitoring instrument, and will permit Agriculture and Planning Ministries to improve policies regarding allocation of food resources.

Operational Research

Research Topic:

1.b. Development and Testing of Malnutrition Indices.

Feasibility and Constraints:

The Nutrition CRSP investigators have given some thought to the development of malnutrition indices (see Table 1 in the text). They are at a point at which several of the indices are ready for introduction for monitoring and other purposes. All that remains to be done is to test these indices under field conditions. Other malnutrition indices have shown promise, but less progress has been made in evaluating their utility. In both instances, further research is warranted, since much of the analytical work essential for their development has been completed or is under way.

Design:

Field-testing should be conducted in conjunction with existing programs (e.g., R&D/N Food Nutrition Monitoring and Support Project), and with a view to testing comparable indices in different ecosystems. It would be desirable (and less costly) to devise testing protocols that can be applied by non-nutritionists and by developing country personnel with low-to-medium levels of skill. This feature of the study design should help ascertain the practical utility of each of the indices and under what field conditions.

Significance:

These indices could provide reliable and more sensitive indicators of the well-being of households and communities than other economic and social indices commonly in use. At this time, there is concern that many of the global indicators upon which the international development community has relied are ineffective, since they only capture gross relationships that say little about the well-being of families and communities.

Beneficiaries:

Program implementors and evaluators in general, including Ministries of Health and Agriculture in developing countries. These indices could be routinely incorporated into the design of programmatic interventions that depend on sensitive indicators for program monitoring and fine-tuning. The goals of the Agriculture Commodity CRSPs could be advanced by having access to dependable indicators of nutritional status for the populations they serve and among whom they conduct their fieldwork.

Operational Research

Research Topic:

1.c. Women-and Household-Focused Interventions

Feasibility and Constraints:

Given the importance of adequate maternal nutrition even before pregnancy occurs for children's functional outcomes, and the advantages for the family derived from more efficient household management by well-fed women, the nutritional and health status of women, before as well as during pregnancy, should be a priority focus for multi-sectoral interventions that combine elements of nutrition, health, population, education, agriculture, marketing, home economics, women in development, and the family. MCH/FP programs could be extended to include prepregnant adolescent females, who would also be provided with food supplementation through pregnancy and lactation, together with education on health, family planning, nutrition, and household management, to perhaps include the promotion of family gardening and the raising of small animals to improve family diets, and promotion of food preparation methods to improve the bioavailability of micronutrients. These programs should also devote special attention to the nutritional needs of children, including pre-schoolers and toddlers.

Design:

Operational research would conduct process evaluation and assess the outcomes of such a multi-faceted intervention program. Activities would include the monitoring of the health and nutritional status of women and infants, home economics and agricultural extension, together with time allocation studies and other measures of household management and sanitation, in three to four different ecosystems (for comparative purposes).

Significance:

This effort could provide useful answers on appropriate and effective (including cost-effective) approaches for integrating services in order to optimize the health and nutritional status of women, their children, and their households.

Beneficiaries:

The women and general populations of countries in the developing world. A.I.D., other international development organizations, and Agriculture and Health Ministries would directly gain from this operational research by learning how to design more focused, effective and sustainable nutrition intervention programs.

Operational Research

Research Topic:

1.d. Food Supplementation and Its Effects on Catch-up Growth

Feasibility and Constraints:

Malnutrition and morbidity seem to interact synergistically in causing stunting in infants at three to six months after birth, with the results that thereafter children may be unable to reach their genetic growth potential and are more likely to experience diarrheal and respiratory illnesses of increasing frequency, duration, and severity. Therefore, PHC programs that include a nutrition component should be able to enhance their capacity to help children to not just survive, but to thrive. The nutrition component would include infant growth monitoring, promotion of breastfeeding, and infant diet supplementation as necessary with nutrients, multi-mixes, or animal source foods. Care would be required to ensure that diet supplementation would not displace breastfeeding, would be conducted in sanitary fashion, and that the foods used would be locally available and culturally acceptable to respective populations.

Design:

Operational research would entail process evaluation, the monitoring of nutritional intake, physical growth, and morbidity experiences, and the assessment of the intervention program outcomes in communities in three to four different ecosystems (for purposes of comparison).

Significance:

This operational research effort could provide useful answers on appropriate and effective (including cost-effective) approaches for integrating health and nutrition services to prevent or reduce stunting, and to permit catch-up growth.

Beneficiaries:

The children of all countries in the developing world. A.I.D. and other international development agencies would gain directly from the lessons learned through this operational research endeavor.

Operational Research

Research Topic:

1.e. School-Based Interventions.

Feasibility and Constraints:

Diet quality is critical for cognitive development, and school-based food supplementation programs can at least help ameliorate the deleterious effects of poor diets. Multisectoral interventions (e.g., nutrition, agriculture, health, education) should address this important issue. Interdisciplinary operational research can assist school-based intervention efforts by identifying schoolers' nutritional shortcomings and by assessing the effects of supplementation on health status, physical growth, and cognitive and behavioral performance. Such operational research could include determining at what school ages interventions are most appropriate and effective, the extent to which household interventions may be warranted, and the most feasible manner for carrying out complementary school-based and household food supplementation interventions.

Design:

This operational research effort would entail process evaluation, monitoring of children's physical growth, nutritional and health status, and cognitive and behavioral performance, and the assessment of intervention program outcomes in communities in three to four different ecosystems (for comparative purposes).

Significance:

This operational research endeavor could provide useful answers on appropriate and effective (including cost-effective) multisectoral approaches for improving school children's cognitive and behavioral development and performance.

Beneficiaries:

The children and eventually the general populations of all counties in the developing world. Ministries of Education, A.I.D., and other international development organizations would gain directly from the lessons learned through this operational research effort.

Further Analysis of Nutrition CRSP Data

Research Topic:

2.a. Food Intake Composition and Infant Growth Failure.

Feasibility and Constraints:

While the Nutrition CRSP database is not sufficient for establishing unambiguous associations between food composition and infant growth failure (due to intervening factors such as morbidity and quantity and quality of breastmilk), its analysis might succeed in identifying selected micronutrients (before and during pregnancy, and after childbirth) in whose absence growth failure is observed. This research issue can be addressed since the food composition data are available and have been used for other analytical objectives.

Design:

The validity of the postulated relationship would be strengthened if databases from the three countries were to be examined according to a common analytical strategy.

Significance:

Inferences could be made for the development of nutrition interventions (in conjunction with other programs) to minimize the chances for early growth faltering and thus stunting in populations experiencing chronic mild-to-moderate malnutrition.

Beneficiaries:

Young children born in malnourished populations and the countries in which they reside.

Further Analysis of Nutrition CRSP Data

Research Topic:

2.b. Food Intake, Morbidity, and Functional Outcomes.

Feasibility and Constraints:

The importance of this issue can hardly be overemphasized. Morbidity is the most critical intervening variable in the relationship between food intake and human function. The circularity of the relationship between the two variables is inescapable. Morbidity has an effect on food intake, just as food intake has an effect on morbidity. Many associations between food intake and human functional outcomes correlate as well with morbidity measures. The Nutrition CRSP analysis has had only limited success in controlling for the effects of one variable when evaluating the effects of the other. Some of the difficulties are due to problems with the morbidity data, but some of the investigators feel that these problems can be overcome if dependable indices of household morbidity can be characterized.

Design:

It is recommended that this research issue be approached through a comparative strategy that carefully builds on the evaluation of gradually more complex research questions. The objective of the suggested strategy will be to cumulative identify associations and how they relate to each other. The study design will have to be tightly controlled by a coordinating university, and all participating institutions will have to adhere to a strict research plan.

Significance:

This effort will significantly enhance the value of the Nutrition CRSP findings, and in all likelihood will help guide future research agendas and the nature of multisectoral program interventions, particularly in health and child survival.

Beneficiaries:

The global community at large, and in particular programs in the health sector which could benefit from a closer understanding of the synergistic relationships between nutrition and morbidity.

Further Analysis of Nutrition CRSP Data

Research Topic:

2.c. Nutrition and Morbidity, and Household Management and Sanitation

Feasibility and Constraints:

Given the emphasis that A.I.D. is giving to the recently announced Family and Development Initiative, and the significance that the Nutrition CRSP investigators accord to household management as a key mediating variable in food intake and sanitation practices, this research topic deserves high priority. The Nutrition CRSP database includes information that could serve to identify household management practices associated with a lower morbidity incidence (despite the problems with the morbidity information) and favorable sanitation outcomes. Work in progress has already revealed some tantalizing relationships that could be further explored through a fairly limited research effort.

Design:

The significance of the relationships already identified (and others that can be postulated) could be assessed through a comparative analytical strategy in which relationships are systematically explored with data from all three countries.

Significance:

The findings related to how better household management contributes to better nutrition, sanitation, and less frequent and acute morbidity episodes have great implications for community level interventions and for health and education sector programs. They could also help advance the Women in Development and Family and Development Initiative programs being undertaken by A.I.D..

Beneficiaries:

Poor populations in developing countries generally, and more specifically populations served by Ministries of Health and A.I.D.-funded operational programs.

Further Analysis of Nutrition CRSP Data

Research Topic:

2.d. Food Intake, Time Allocation, and Outcomes.

Feasibility and Constraints:

This topic, related to how women manage their households can and has been approached partially with Nutrition CRSP data. The approach can only be partial, since the research design of the Nutrition CRSP did not include the collection of detailed time allocation data, although some of the data generated can be used to address this issue. Exploration of these relationships can suggest potential research strategies for studies designed to assess how time allocation is related to food intake, other intervening variables, and human functional outcomes.

Design:

The analytical approach should consist of a comparative and systematic strategy to assess data from all three study sites.

Significance:

The associational findings could contribute greatly to our general understanding of how the burdens of poor women can be lightened to facilitate their children's caregiving activities, including nutritional needs. The findings could assist in the design of more focused studies linking time allocation with food intake and human functional outcomes.

Beneficiaries:

Poor populations in developing countries generally, and more specifically populations served by A.I.D.-funded programs which focus on Women in Development and the Family and Development.

Further Analysis of Nutrition CRSP Data

Research Topic:

2.e. Implications of the Kenya Nutrition CRSP Database for Understanding Household Coping Mechanisms Under Drought and Other Conditions Leading to Acute Food Shortages:

Feasibility and Constraints:

Given the extensive and varied database collected by the Nutrition CRSP before, during, and after the drought episode, and the impact of the drought on selected socio-economic and nutrition parameters, it is entirely feasible to continue the analysis at relatively low cost. Several investigators are familiar with the database, and with some expert support, will be capable of identifying additional policy-relevant issues.

Design:

The design of the study should emphasize the assessment of food security issues and the extent to which households protect their most vulnerable members. The study should be designed to search for policy interventions to reduce the short-term impact of acute food shortages and to help identify policy actions to strengthen the economic and nutritional recovery of the household after the crisis is over.

Significance:

Further policy-oriented analysis of this unique database could help identify policy initiatives of relevance to nutrition and sectors such as agriculture, food security, health, and education. The findings could also provide formal support for the development of agency-wide policies for programs such as Women in Development and the Family and Development Initiative. They could also support the activities of several Agriculture CRSPs, in particular those involved with the production of commodities in drought-prone regions of the developing world, and to Food for Peace and PVO field activities. The findings should also be of interest to UNICEF and the World Food Program.

Beneficiaries:

Rural populations in some of the poorest regions of the world that experience frequent episodes of severe food shortages. Results will support the programmatic efforts of various A.I.D. offices, regional bureaus, and country missions. The study can provide essential social science, agriculture and food and nutrition information to agriculture activities focusing on drought-resistant crops in arid countries.

Further Analysis of Nutrition CRSP Data

Research Topic:

2.f. Infant Head Circumference, Brain Development, and Cognitive Outcomes.

Feasibility and Constraints:

The validity of the postulated mediating relationship between chronic mild-to-moderate malnutrition, other potentially associated variables (e.g., morbidity), and infant head circumference and cognitive outcomes can be assessed with data collected but not yet analyzed by the Nutrition CRSP. In the event that a strong association is found between infant head circumference and functional outcomes, further analytical work (of a very different nature) will be necessary to establish the biochemical and physiological bases (if any) of early brain development failure in infants, and the extent to which early faltering is related to food intake. A major problem with this issue is factoring in the role that morbidity incidents have in early faltering, and how morbidity incidents affect food intake. The Offices of Education and Health should consider supporting these efforts.

Design:

The strength of the postulated relationship would be strengthened if databases from the three study sites were to be examined according to a common analytical strategy.

Significance:

If strong associations are identified, and later validated by the scientific community, they will have unprecedented implications for global development strategies, mostly those defined in social and economic terms. These strategies will have to be reconsidered in light of potential biological underpinnings.

Beneficiaries:

The global community at large. There is a strong rationale for studying the reasons for growth faltering in infancy and childhood, whatever its cause.

New Research on Food Intake and Functional Outcomes

Research Topic:

3.a. Food Intake and Human Function From 2 Months Gestation to 24 Months of Age

Feasibility and Constraints:

To evaluate the relationship between food intake and functional outcomes in this age group would require new field studies in which many of the Nutrition CRSP data collection procedures are replicated. The age group from 6 to 18 months of age was excluded since the design of the Nutrition CRSP called for linking food intake and function, and intakes of children below 18 months of age could not be measured reliably in a field study with large numbers of subjects. This matter would require serious attention in developing future research designs. This age group of 0 to 24 months includes some of the most critical stages in human development, such as weaning, late brain development, and motor and cognitive development. Components of this study(ies) include assessing: a) the effects of chronic mild-to-moderate malnutrition on fetal development; b) the effects of chronic mild-to-moderate malnutrition on quantity and quality of maternal breastmilk; and c) why the children of chronic mild-to-moderately malnourished women have normal birth weights yet experience rapid weight loss in early infancy.

The obstacles facing a field study of fetal development are likely to be extremely difficult. Yet it is of crucial importance to determine what effect chronic mild-to-moderate malnutrition has on the development of the fetus and adnexa, and hence on the nutrient stores with which mothers endow their newborn. Studies to evaluate the effects of quantity and quality of breastmilk are also difficult to do and require a great deal of sensitivity. Such research deserves high priority due to lingering questions regarding the effects of chronic mild-to-moderate malnutrition on the quantity and quality of mother's milk and what effect mother's milk has on early growth faltering.

An important research question is why the near normalcy in infant birth weights in populations experiencing chronic mild-to-moderate malnutrition (having average birth weights not too different from those observed in developed countries). An associated issue is the post-natal growth trend (velocity), and how is this trend related to individual genetic target growth curves. Thus, as indicated by an expert consultant, " 'healthy' newborn infants ... may exhibit catch-up or catch-down [growth], or neither, as they shake off perinatal influence on growth" (maternal size, for example). One hypothesis worth exploring (according to this consultant) is that "inadequate maternal-fetal nutritional factors" are involved, since "in mild and not severe malnutrition fetal-newborn stores may have been inadequate and only appear as growth faltering early post-natally." Study in this area should include the evaluation of mothers' food intake on placental development under developing country conditions (chronic mild-to-moderate malnutrition) and how these factors relate to growth faltering. Research must also consider the effects of breastfeeding and of breastmilk supplements (as potential sources of infection, in terms of added nutrition, etc.).

Design:

This is a new research project that will require careful thought to design. A.I.D. should seek input from the research community and from a multiplicity of disciplines.

Significance:

Major, if the study illuminates the effects of chronic mild-to-moderate malnutrition on fetal and infant and early child development, and thus on a variety of functions.

Beneficiaries:

Infants in poor communities who survive past infancy but who grow to become stunted early in life.

New Research on Food Intake and Functional Outcomes

Research Topic:

3.b. Food Intake and Household Dynamics

Feasibility and Constraints:

With the Nutrition CRSP database, it is possible to do some preliminary exploration of these associations. Although the study was originally conceptualized to address household relationships from a holistic perspective, the study was not intended to narrowly focus on time allocation issues, although some data on this topic were collected. For various reasons, the household dynamics focus was modified, the study concentrating instead on the associations between food intake and functional outcomes among selected household members. The goal of the proposed research will be to close this gap by doing studies that concentrate on the role of household time allocation and management on food intake, child caregiving, and human functional outcomes.

Design:

This new activity should be designed on the basis of the Nutrition CRSP research results. Analysis of the Nutrition CRSP data pertinent to this topic should provide some guidelines for a concentrated effort. Long term multidisciplinary nutrition and social science field research will be required. At least two sites should be chosen for the studies in order to make the findings generalizable to more than one ecosystem.

Significance:

If it is proven correct that time household allocation is a key intervening variable in the food intake/human functional relationship, the project could provide valuable suggestions regarding how to promote the well-being of households, especially women and their children.

Beneficiaries:

Poor communities in developing countries generally. Findings will be of particular relevance to Agriculture Commodity CRSPs as they seek to translate food availability increases into improved human nutrition.

V. BENEFIT CONSIDERATIONS

A. Benefit to LDCs

The initiatives proposed herein can benefit developing countries since, by contributing to the improvement of the nutritional status of chronic mild-to-moderately malnourished populations, they may have a positive impact on the ability of individuals to live more fruitful lives. As the Nutrition CRSP findings suggest, populations subjected to the pernicious effects of chronic mild-to-moderate malnutrition may be incapable of achieving their potential in a range of human functions. In malnourished populations, infants become stunted at a very early age, are more susceptible to disease, pay a price in terms of cognitive development, do poorly in school, and ultimately must become less productive workers.

At a more immediate and practical level, many of the Nutrition CRSP preliminary findings and the recommended follow-on studies are apt to benefit developing countries by providing knowledge that can serve to formulate programmatic interventions. This knowledge can be used to **monitor the success** of many sectoral initiatives (e.g., in agriculture, health, the family) and to help design interventions to **strengthen the actions** of other sectoral interventions (e.g., in agriculture, health, community interventions, education). Among chronically malnourished populations, nutritional status can be regarded not only as the most dependable indicator of relative well-being, but also as the variable around which the success of many development initiatives can revolve.

Last but not least, the research efforts proposed under the follow-on activities can provide benefits to the host countries in the areas of institutional and human capital development. As stated earlier in this report, in Egypt, Mexico, and Kenya the Nutrition CRSP contributed markedly to institution building, and left as one of its major legacies a large number of professionals and technicians with newly-acquired state-of-the-art training on fieldwork procedures and nutritional analysis. The proposed follow-on activities would make similar contributions.

B. Benefit to Agriculture Commodity CRSPs

Several of the research projects proposed herein could be performed in close collaboration with the Agriculture Commodity CRSPs, or they could be done independently. Some priority research efforts that come to mind are the development of strategies to cope with seasonal food shortages and how to provide nutrients lacking in diets that are short on fruits and vegetables. A major role for the follow-on research activity will be to provide Agriculture Commodity CRSPs with basic information on how to complement deficient diets with locally-produced foods (local or introduced). These efforts will be centered, fundamentally, on the evaluation of diet quality in different ecocultural niches, and on ways to improve the micronutrient content, bioavailability, and cultural acceptability of foods. The same applies to the nutritional implications of food preparation. There is also considerable room for additional research on food intake and human functional outcomes, as described above in the preceding section.

Second, the Nutrition CRSP findings strongly support the notion that links between CRSP projects should be forged (interCRSPing). Promoting the development of food systems that integrate the production of agricultural commodities and animal source foods is necessary, since in many poor countries diet adequacy rests on a precarious balance between the two. Likewise, the findings of several CRSPs, including the Nutrition CRSP, suggest that it is critical to integrate food production with its many nutritional, sociocultural, and economic underpinnings.

Concern with integrating various CRSP activities is being translated into efforts to design collaborative projects in single sites in which the expertise of different CRSPs are brought together to bear on complex problems the solution of which lies beyond the purview of any single CRSP. Commodity production, for example, is directly linked to family welfare, not only through food consumption, but also by the surpluses generated and sold in

the market, which provide the means with which to supplement the diet with commercially-processed foods. Agricultural by-products are used as animal feed, while animals provide the manure used by farming households to fertilize their crops. These primary activities generally determine how household members allocate their time, which in turn is related to how much energy is consumed, and the type of caregiving mothers provide to their children. All of these relationships are partly determined by nutritional variables or have nutritional consequences for members of the household.

Finally, a technical assistance role for a follow-on activity could be built around the analytical capabilities that nutrition scientists bring to the qualitative assessment of food intake. While most Agriculture Commodity CRSPs contain selected nutritional features, by definition they concentrate on the food production side of the human nutrition equation. Yet, nutrition evaluation is of paramount importance in judging the appropriateness of composite flours, porridges, weaning foods, food preparation procedures, and food supplements with which most of the Agriculture Commodity CRSPs are concerned. Nutritional analysis is also of relevance when new higher-yielding or drought-resistant cultivar strains are introduced, or when there is concern about bioavailability and the digestibility of cereals, legumes and other foods.

The Nutrition CRSP has developed or is in the process of developing several instruments (such as the International Minilist Food Groups) that in conjunction with other methodologies (and additional developmental work) can contribute greatly to nutritional assessments. These activities, together with the basic biological analysis of nutrient composition, are some of the core activities around which the technical assistance component of a follow-on activity can be built. Other ancillary technical assistance activities could include providing support to Agriculture Commodity CRSPs through food status monitoring, evaluating field interventions, and assessing intricate food intake and household relationships that may have a bearing on family well-being. Nutrition CRSP insights can be equally well incorporated into the cross-CRSP efforts being performed by the Women in Development project component within the Bean/Cowpea CRSP. Noteworthy among these are educational activities and gender-related issues.

C. Benefit to A.I.D.: R&D Research and Other Programs

Overall, the follow-on research activities proposed in this document will dovetail with the research goals of various A.I.D./R&D offices. These potential benefits have been discussed throughout this document. Research programs that stand to benefit from the proposed activities of the follow-on activities include those of the Offices of Agriculture, Health, Education, and Economic and Institutional Development, to name those particular programs that stand to gain the most. Particularly noteworthy are the gains that will accrue to the Collaborative Research Support Programs. Moreover, benefits will flow as well to the research activities being conducted under the aegis of the Family and Development Initiative, the Women in Development Program, the Child Survival activities, the Center for Development Information and Evaluation's PRISM Initiative, and various Office of Nutrition activities.

D. Benefit to A.I.D. Regional Bureaus/Missions

The proposed research program can contribute to furthering the objectives of A.I.D. Missions through buy-ins and other means. Technical assistance and training support can be built into country-specific nutrition-related programs in health (MCH/FP, PHC, Child Survival), education, and rural development. Nutrition-related technical assistance can also be useful for program-monitoring purposes, given the current interest in employing nutrition indices as a primary means to assess program success in meeting the needs of poor households. The follow-on activities, of course, can also provide crucial input for the design of nutrition interventions, in collaboration with, or independently of, the Agriculture Commodity CRSPs.

E. Feedback to US Domestic Programs

Findings from the Nutrition CRSP project have already contributed to the scientific understanding of how chronic mild-to-moderate malnutrition is associated with impaired human function. This contribution has had an impact on the conceptualization of United States nutrition interventions geared to low-income populations. Domestic nutrition intervention policies and programs should be further enriched by the work done abroad by the nutrition scientists engaged in the follow-on activity.

Appendix A

Nutrition CRSP Publications

PUBLICATIONS, ABSTRACTS, PRESENTATIONS AND TECHNICAL REPORTS FROM THE NUTRITION CRSP

FINAL AND PROGRAM, USAID GRANT NO. DAN-1309-G-SS-1070-00

Egypt Project Final Report (A. Kirksey, G. Harrison, N. Jerome and O. Galal), submitted to University of California, Berkeley, November 1987.

Kenya Project Final Report (C. Neumann and N. Bwibo), submitted to the University of California, Berkeley, November 1987.

Mexico Project Final Report (L. Allen, G. Pelto and A. Chavez), submitted to the University of California, Berkeley, November 1987.

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78

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Dr. Sawsan Abdel-Ghany. Maternal nutrition and the outcome of pregnancy. Ph.D. dissertation.

19

Dr. Salwa Makeen. Effect of food intake on long-term lactation. Ph.D. dissertation.

Dr. Afaf Sobhy. Food intake and its effect on the child's social and behavioral parameters. Ph.D. dissertation

Dr. Emtisal Swafy. Effect of nutritional status on some psycho-social parameters in primary school children. Ph.D. dissertation.

Dr. Wagih Mawed. Pattern of disease in toddlers in rural Egypt. MSc thesis.

Dr Wael Mahmoud. Gestational age and its reflection on the pattern of growth in children in the first six months of life. MSc thesis.

Dr. Mohamed Zaazou. Morbidity burden on toddlers' growth as affected by the household conditions. MSc thesis.

MEXICO PROJECT

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Allen LH. "Diet Quality in Marginal Malnutrition." University of Rhode Island, 1990.

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45

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Murphy SP, SW Weinberg-Anderson, C Neumann, K Mulligan and DH Calloway. Development of research nutrient data bases: An example using foods consumed in rural Kenya. J Food Comp and Analysis; in Press.

Espinosa MP, MD Sigman, CG Neumann, NO Bwibo and MA McDonald. Playground behaviors of Kenyan children in relation to nutrition, family characteristics and schooling. Developmental Psychology; in Press.

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Thomas JC, D Cattle and CG Neumann. Physical contact as a protective factor against diarrhea among young children in rural Kenya. American Public Health Association, New Orleans, LA, October 18-22, 1987.

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91

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McDonald MA, M Espinosa and CG Neumann. Playground behaviors of mild-to-moderately malnourished Kenyan children. Society of Research in Child Development, Seattle, Washington, April 18-20, 1991.

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Neumann CG, AA Jansen, E Carter and NO Bwibo. Onset and determinants os stunting among young rural Kenyan children. International Congress of Auxology, Madrid, Spain, September 20-25, 1991.

"Morbidity and Cognitive Development in Marginally Malnourished Kenyan Children." UCLA School of Medicine, Department of Pediatrics, Grand Rounds, 1990.

"Energy Intake and Human Function." UCLA School of Medicine, Department of Pediatrics, Grand Rounds, 1989.

"Pregnancy Outcome in Rural Mildly Malnourished Women." UCLA School of Medicine, Department of Obstetrics, Perinatal Conference, 1990.

"Functional Outcomes of Chronic Energy Deficiency in Rural Kenyans." UCLA African Studies Center, 1990.

"Functional Effects of Marginal (Mild-Moderate) Malnutrition in School-Aged Children." State of California, Child Health Disability Program Update on Nutrition. Palm Springs, California, May 1990.

"Energy Intake and Human Function." UCLA School of Public Health. Lectures two to three times a year in courses, doctoral seminars, etc.

Invited Participants:

Neumann C. Mothercare Conference and WHO Workshop, April 1990.

Sigman M. Bellagio Meeting on Malnutrition and Cognitive Development, July 1990.

Espinosa M and M Sigman. Society for Cross-Cultural Research. Claremont, California, April 1990.

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Thomas JC. Risk factors for diarrhea among young children for diarrhea. Ph.D. dissertation, 1987, University of California, Los Angeles.

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81

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Appendix B

Documents Reviewed

DOCUMENTS REVIEWED

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Appendix C

Interviewed Individuals and Interview Protocols

INTERVIEWED INDIVIDUALS AND PROTOCOLS

I. Nutrition CRSP Investigators

Dr. Lindsey H. Allen, Department of Nutritional Sciences, University of Connecticut

Dr. George H. Beaton, Department of Nutritional Sciences, University of Toronto

Dr. Doris H. Calloway, Department of Nutritional Sciences, University of California, Berkeley

Ms. Ann Coulson, Department of Physchology, University of California, Los Angeles

Dr. Gail Harrison, School of Medicine, University of Arizona (Currently at the School of Public Health, University of California, Los Angeles)

Dr. Norge W. Jerome, University of Kansas Medical Center and Agency for International Development

Dr. Avanelle Kirksey, Department of Food and Nutrition, Purdue University

Dr. George McCabe, Department of Statistics, Purdue University

Dr. Suzanne Murphy, Department of Nutritional Sciences, University of California, Berkeley

Dr. Charlotte Neumann, School of Public Health, University of California, Los Angeles

Dr. Gretel Pelto, Department of Nutritional Sciences, University of Connecticut

Dr. Steven Selvin, School of Public Health, University of California, Berkeley

Dr. Marian Sigman, Department of Psychology, University of California, Los Angeles

Dr. Ted Wachs, Department of Psychology, Purdue University

II. Host Country Principal Investigators and Institute Directors

Dr. Nimrod Bwibo, African Medical Research Foundation (AMREF), Nairobi, Kenya

Dr. Adolfo Chavez, Instituto Nacional de la Nutricion, Mexico, D.F., Mexico

Dr. Osman Galal, Egypt National Institute of Nutrition, Cairo, Egypt

III. Nutrition Research/International Development Policy Consultants

Mr. Sol Chafkin, Community Development Consultant

Dr. Kathleen DeWalt, College of Medicine, University of Kentucky

Dr. Frank Falkner, School of Public Health, University of California, Berkeley

Dr. John Osgood Field, School of Nutrition, Tufts University

Dr. Bruce Johnston, Food Research Institute, Stanford University

Dr. Janet King, Department of Nutritional Sciences, University of California, Berkeley

Dr. Robert G. Myers, United Nations International Children and Education Fund, Early Childhood Development, New York

Dr. Marian Radke-Yarrow, National Institute of Mental Health, Developmental Psychology, Bethesda

Dr. Zak I. Sabry, School of Public Health, University of California, Berkeley

IV. Agriculture/Commodity CRSPs Program Directors

Dr. Pat Barnes-McConnell, Bean/Cowpea CRSP, Michigan State University

Dr. David Cummins, Peanut CRSP, University of Georgia

Dr. John Glenn, Small Ruminant (SR-CRSP), University of California, Davis

Dr. John Yohe, Sorghum/Millet CRSP (INTSORMIL), University of Nebraska

V. AID Staff

Bureau for Research and Development(R&D)

Program Office (PO)
Ms. Leola Thompson

Office of Nutrition (R&D/N)
Ms. Susan Anthony
Dr. Samuel G. Kahn
Mr. Richard Seifman

Office of Agriculture (R&D/AGR)
Dr. Harvey Hortik, Bean/Cowpea CRSP
Dr. John Malcolm, Soil Mangement CRSP (Tropsoils)
Dr. Robert Schaffert, Sorghum/Millet (INTSORMIL) & Peanut CRSPs
Ms. Joyce Turk, Small Ruminant (SR-CRSP)
Dr. Lamarr Trott, Fisheries Stock Assessment (FSA-CRSP) and Pond Dynamics/Aquaculture CRSP

Office of Economic and Institutional Development (R&D/EID)
Dr. Eric Chetwynd

Office of Education (R&D/ED)
Dr. Marilyn Merrit
Dr. Anthony Meyer
Dr. Richard Pelezar

Office of Health (R&D/H)
Dr. Mary Ann Anderson
Mr. Robert Clay
Dr. Pamela Johnson

Office of Women in Development (R&D/WID)
Dr. Chloe O'Gara

Board for International Food and Agricultural Development and Economic Cooperation (BIFADEC)
Mr. W. Frederick Johnson
Dr. William Miner
Dr. Ralph Smuckler

Bureau for Food for Peace and Voluntary Assistance
Ms. Silvia Graves
Dr. Thomas Marchione
Ms. Susan Park

Directorate for Policy (POL)
Dr. Gerald Britain
Dr. Steven Gale
Dr. Melanie Marlett

Regional Bureaus
Ms. Linda Lou Kelley, Europe and the Near East
Ms. Hope Sukin, Africa
Ms. Mellen Tanamly, Latin America and the Caribbean

99

N-CRSP INTERVIEWEE PROTOCOL

- **Name:** _____
- **Date:** _____
- **Method:** _____

Purpose of this project: to assist S&T/N in the process of determining the feasibility of addressing, and how best to plan to address, the research gaps identified by the Nutrition CRSP.

1. How successful has the N-CRSP been in testing the six main sets of hypotheses included in the research plan.

   - Food intake of the mother during pregnancy and lactation influences the infant's endowment at birth and his/her development during the first six months of breast feeding. Thus, infant body size, psychological development, and morbidity are affected by maternal food intake.

   - Food intake of the child between 18 and 30 months affects his/her body size, morbidity, and psychological development.

   - Food intake of the child between seven and nine years affects his/her body weight, morbidity, and behavioral and cognitive development.

   - Food intake of adults affects their morbidity, their care of attention to children, and their performance of usual tasks; and this, in turn, affects the morbidity and cognitive and behavioral performance of other household members.

   - Household food intake affects household morbidity.

   - For adults, a reduction of resting metabolism rate provides a major path of adaption to restore energy equilibrium.

   - What are the most significant findings of the N-CRSP.

2. Based upon the N-CRSP experience and findings, what efforts should S&T/N undertake in the future:

   - In terms of basic field research on food intake.

- In terms of the five functional areas of reproductive outcome and lactation; physical growth; cognition and behavior; morbidity; and resting metabolism rate.

- In terms of the potential applied research activities and the application of research findings.

3. What potential contribution can nutrition basic and applied research make to the Agricultural Commodity CRSPs:

   - General (e.g., CRSP Council, Cross-CRSPing, the relationship of production to food consumption).

   - Specific Agricultural CRSPs (e.g., Bean/Cowpea, Sorghum/Millet, Peanut, Small Ruminant, Soil Management, Fisheries Stock Assessment, Pond Dynamics).

4. What potential contributions can nutrition basic and applied research make to USAID and international development endeavors in general:

   - In terms of development sectors (e.g., health/population, especially "child survival"; family/household; small enterprise development/nutribusiness; women in development; environment).

   - In terms of specific functions and activities relating to food intake and nutritional status (e.g., use of measures and indicators, monitoring, rapid assessments).

5. Additional comments or recommendations.

AGRICULTURE CRSP INTERVIEWEE PROTOCOL

- **Name:** _____
- **Date:** _____
- **Method:** _____

Purpose of this project: to assist S&T/N in the process of determining the feasibility of addressing, and how best to plan to address, the research needs identified by the Nutrition CRSP.

Background:
The 1977 World Food and Nutrition Study of the US National Academy of Sciences gave its highest priority to determining the functional consequences of chronic mild-to-moderate undernutrition. In 1981, the US Agency for International Development, under the auspices of the board for Food And Agricultural Development (BIFAD), funded the Nutrition CRSP. The goal of the Nutrition CRSP was to test the hypothesis that food intake is causally related to functional outcomes that are believed to have import for the development of individuals, households, and communities. A key consideration was that this overall hypothesis, and its several specific sub-hypotheses, should be examined in different biological and cultural ecosystems so that the findings would be generalizable. Intensive field research as carried out between 1982 and 1988 in communities in Egypt, Kenya, and Mexico. Food intake as measured with sufficient frequency and over enough time to be a valid representation of individual and household intake, and body size and fatness were recorded in conjunction with food intake. Additional measures included morbidity, psychological development, and household sanitation and socioeconomic status.

Results:
The Nutrition CRSP's important outcomes included the following:

- Findings which show that chronic food restriction is not compensated for by decreased resting metabolic rate disprove the previous scientific opinion. Also, predictors were identified that show faltering heights in children at about three to four months which cannot be overcome later in their development. Further, results demonstrated that the quality (i.e., combinations including animal source foods, micronutrients) of food consumed is a much stronger determinant of nutritional status than is the quantity (e.g., total calories, proteins) of food consumed. These research findings are recognized as being on the cutting edge of modern nutrition science and technology.

- Identification of these and other nutrition predictors provide the base for nutrition interventions in the field mission programs through buy-ins. The experience of the nutrition CRSP will undoubtedly continue to yield fundamental lessons and knowledge.

- The results obtained thus far in Egypt, Kenya, and Mexico have provided a commonality for nutrition events which are believed to be generalizable when examined in different biological and cultural ecosystems.

- The Nutrition CRSP has generated a tremendous data base and has developed an excellent cadre of scientists who can provide input into a mechanism for integration into the other existing CRSPs and carry the message to developing countries. The findings have significant policy implications. The results have already impacted on food and education policy in Egypt.

* * *

1. Based upon the Nutrition CRSP experience and findings, how can nutrition input complement (e.g., through the CRSP Council, Cross-CRSPing, the relationship of production to food consumption) the Agricultural CRSPs in general?

2. How can nutrition input complement specific Agricultural CRSPs (e.g., Bean/Cowpea, Sorghum/Millet, Peanut, Small Ruminant, Soil Management, Fisheries Stock Assessment, Pond Dynamics)?

3. How can nutrition input complement Agricultural CRSP activities being carried out in specific developing countries?

4. Additional comments or recommendations.

USAID INTERVIEWEE PROTOCOL

- **Name:** _____
- **Date:** _____
- **Method:** _____

Purpose of this project: to assist S&T/N in the process of determining the feasibility of addressing, and how best to plan to address, the research needs identified by the Nutrition CRSP.

Background:
The 1977 World Food and Nutrition Study of the US National Academy of Sciences gave its highest priority to determining the functional consequences of chronic mild-to-moderate undernutrition. In 1981, the US Agency for International Development, under the auspices of the Board for Food And Agricultural Development (BIFAD), funded a Collaborative Research Support Program (CRSP) on this topic. The goal of the Nutrition CRSP was to test the hypothesis that food intake is causally related to functional outcomes that are believed to have import for the development of individuals, households, and communities. A key consideration was that this overall hypothesis, and its several specific sub-hypotheses, should be examined in different biological and cultural ecosystems so that the findings would be generalizable. Intensive field research was carried out between 1982 and 1988 in communities in Egypt, Kenya, and Mexico. Food intake was measured with sufficient frequency and over enough time to be a valid representation of individual and household intake, and body size and fatness were recorded in conjunction with food intake. Additional measures included morbidity, psychological development, and household sanitation and socioeconomic status.

Results:
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- The results obtained thus far in Egypt, Kenya, and Mexico have provided a commonality for nutrition events which are believed to be generalizable when examined in different biological and cultural ecosystems.

- The Nutrition CRSP has generated a tremendous data base and has developed an excellent cadre of scientists who can provide input into a mechanism for integration into the other existing CRSPs and carry the message to developing countries. The findings have significant policy implications. The results have already impacted on food and education policy in Egypt.

* * *

1. Based upon the Nutrition CRSP experience and findings, how can nutrition input complement USAID and international development efforts in general?

2. How can nutrition input complement activities in specific USAID sectors (e.g., health/population, especially " child survival "; family/household; small enterprises development/nutribusiness; women in development; environment)?

3. How can nutrition input complement USAID programs relating to food intake and nutritional status in terms of specific activities (e.g., use of measures and indicators, monitoring, rapid assessments)?

4. Additional comments or recommendations.

Appendix D

Methodological Consultations Agenda and Participants

Casals & Associates, Inc.

Crystal Plaza One, Suite 1010, Arlington, VA 22202, (703)415-1234

Nutrition CRSP Methodological Consultations

Agenda

August 12-14, 1991

Hotel Durant
2600 Durant Avenue
Berkeley, California

Executed under contract with the U.S. Agency for International Development, Nutrition CRSP Feasibility and Planning Activity (Contract No. PDC-5110-I-00-0070-00).

101

CONSULTATION I
Food Intake, Reproduction, and Lactation
Monday, August 12, 1991

9:00-9:30 a.m. **I. INTRODUCTION**

- Welcome and Introductions, Doris H. Calloway
- Objectives of the AID Office of Nutrition's Feasibility and Planning Activity, Norge W. Jerome
- Purpose and Format of the Nutrition CRSP Consultations, Sergio Diaz-Briquets, Moderator

II. FOOD INTAKE OF MOTHERS AND INFANTS

9:30-9:45 a.m.
- Conceptual Overview, Suzanne P. Murphy

9:45-12:30 a.m.
- Discussion: Validity of Food Intake Measures:
  - quantity
  - type
  - quality
  - distributional (gradient) effects
  - comparability across countries

12:30-1:30 p.m. **Lunch**

III. FOOD INTAKE, REPRODUCTION, AND LACTATION

1:30-1:45 p.m.
- Conceptual Overview, Avanelle Kirksey

FOOD INTAKE AND PREGNANCY

1:45-3:45 p.m.
- Discussion: Effects of Mothers' Food Intake Quantity and Quality on:
  - maternal body weight
  - newborn body weight

3:45-4:00 p.m. **Break**

FOOD INTAKE AND LACTATION

4:00-5:00 p.m.
- Discussion: Effects of Mothers' Food Intake Quantity and Quality on:
  - lactation
  - maternal body weight
  - infant growth

5:00-5:45 p.m.
- Discussion: Effects of Infant Food Supplementation Quantity and Quality on:
  - maternal body weight
  - infant body weight
  - infant growth
  - infant morbidity

5:45-6:00 p.m. **Break**

6:00-7:00 p.m. **IV. CONSULTATION RECOMMENDATIONS**

CONSULTATION II
Food Intake, Physical Growth, and Cognitive and Behavioral Development
Tuesday, August 13, 1991

9:00-11:00 a.m. **I. FOOD INTAKE OF TODDLERS AND SCHOOLERS**

- Discussion: Validity of Food Intake Measures:
  - quantity
  - type
  - quality
  - distributional (gradient) effects
  - comparability across countries
  - ranking of food intake measures

II. FOOD INTAKE, PHYSICAL GROWTH, AND COGNITIVE AND BEHAVIOR DEVELOPMENT OUTCOMES

11:00-11:15 a.m.
- Conceptual Overview, Lindsay Allen and Marian Sigman

FOOD INTAKE AND INFANT DEVELOPMENT

11:15-12:30 p.m.
- Discussion: Effects of Mothers' and Infants' Food Intake and Quality on:
  - infant physical growth
  - infant psychological development

12:30-1:30 p.m. **Lunch**

1:30-2:30 p.m.
- Discussion (Continuation)

FOOD INTAKE AND TODDLER AND SCHOOLER DEVELOPMENT

2:30-4:00 p.m.
- Discussion: Effects of Toddler Food Intake Quantity and Quality on:
  - physical growth
  - cognitive development
  - behavioral development

4:00-5:45 p.m.
- Discussion: Effects of Schooler Food Intake Quantity and Quality on:
  - physical growth
  - cognitive development
  - behavioral development

5:45 - 6:00 p.m. **Break**

6:00 - 7:00 p.m. **III. CONSULTATION RECOMMENDATIONS**

CONSULTATION III
Food Intake, Morbidity, and Task Performance
Wednesday, August 14, 1991

9:00-11:00 a.m. **I. FOOD INTAKE OF TARGET INDIVIDUALS: HOUSEHOLD IMPLICATIONS**

- Discussion: Validity of Food Intake Measures Not Covered in Earlier Consultations (lead females and males, household implications):
  - quantity
  - type
  - quality
  - distributional (gradient) effects
  - household implications
  - comparability across countries
  - ranking of food intake measures

II. FOOD INTAKE AND MORBIDITY AND TASK PERFORMANCE OUTCOMES

11:00-11:15 a.m.
- Conceptual Overview, Gail Harrison and Charlotte Neumann

11:15-12:30 p.m.
- Discussion: Effects of Food Intake and Morbidity on:
  - incidence
  - duration
  - severity

12:30-1:30 p.m. **Lunch**

1:30-3:00 p.m.
- Discussion (Continuation)

FOOD INTAKE AND TASK PERFORMANCE

3:00-4:00 p.m.
- Discussion: Effects of Food Intake Quantity and Quality on Task performance of:
  - lead females
  - lead males
  - households

4:00-6:30 p.m. **III. CONSULTATION RECOMMENDATIONS**

NUTRITION CRSP METHODOLOGICAL CONSULTATIONS PARTICIPANTS
AUGUST 12-14, 1991 BERKELEY, CALIFORNIA

Nutrition CRSP Investigators

Dr. Lindsay H. Allen
Department of Nutritional Sciences, University of Connecticut

Dr. Doris H. Calloway
Department of Nutritional Sciences, University of California, Berkeley

Dr. Osman Galal
School of Medicine, University of Arizona

Dr. Gail Harrison
School of Medicine, University of Arizona

Dr. Norge W. Jerome
Office of Nutrition, Research and Development, U.S. Agency for International Development

Dr. Avanelle Kirksey
Department of Foods and Nutrition, Purdue University

Dr. George McCabe
Department of Statistics, Purdue University

Dr. Suzanne Murphy
Department of Nutritional Sciences, University of California, Berkeley

Dr. Charlotte Neumann
School of Public Health, University of California, Los Angeles

Dr. Gretel Pelto
Department of Nutritional Sciences, University of Connecticut

Dr. Marian Sigman
Department of Psychology, University of California, Los Angeles

Consultants

Dr. Kathleen DeWalt
College of Medicine, University of Kentucky

Dr. Frank Falkner
School of Public Health, University of California, Berkeley

Dr. Janet King
Department of Nutritional Sciences, University of California, Berkeley

Dr. Zak I. Sabry
School of Public Health, University of California, Berkeley

Appendix E

Policy Workshop Agenda and Participants

Casals & Associates Inc.

Crystal Plaza One/Suite 1010/Arlington, VA 22202

Nutrition CRSP Policy Workshop

AGENDA

August 22-23, 1991

The Rosslyn Westpark Hotel
1900 N. Fort Meyer Drive
Arlington, VA 22209

Executed under contract with the U.S.AID Nutrition CRSP Feasibility and Planning Activity, Contract No. PDC-5110-I-00-0070-00.

113

AGENDA

Thursday, August 22, 1991

9:00 a.m.	**OPENING REMARKS** Samuel G. Kahn, Office of Nutrition, U.S. Agency for International Development (A.I.D.)
9:25 a.m.	**GOALS OF THE NUTRITION CRSP POLICY WORKSHOP** Sergio Diaz-Briquets, Casals & Associates
9:30 a.m.	**I. CONSULTATION REPORTS**
	Food Intake, Nutrition, Physical Growth, and Psychological Development Frank Falkner, University of California, Berkeley
	Food Intake, Nutrition, Community Development, and Household Management and Food Security Kathleen M. DeWalt, University of Kentucky
10:30 a.m.	**Coffee Break**
10:45 a.m.	**NUTRITION CRSP POLICY SIGNIFICANCE** Zak I. Sabry, University of California, Berkeley
11:15 a.m.	**DISCUSSION**
12:00 p.m.	**Buffet Lunch**
1:30 p.m.	**II. SIGNIFICANCE OF THE NUTRITION CRSP FOR HOST COUNTRIES** Moderator: Sol H. Chafkin, Consultant
	Osman Galal, Former Director, The Nutrition Institute, Cairo, Egypt, and University of California, Los Angeles
	Nimrod O. Bwibo, Director of Training, African Medical Research Foundation (AMREF), Nairobi, Kenya
	Adolfo Chavez, Director, Division of Community Nutrition, Instituto Nacional de la Nutricion, Mexico City, Mexico
3:00 p.m.	**Coffee Break**
3:20 p.m.	**DISCUSSION**
5:00 p.m.	**WORKSHOP FORMAT FOR FRIDAY AUGUST 23**

AGENDA

Friday, August 23, 1991

9:00 a.m.	**III. COMMENTS OF WORKSHOP CONSULTANT PARTICIPANTS** Moderator: Samuel G. Kahn
9:05 a.m.	**AGRICULTURE CRSPs:** Pat Barnes-McConnell, Program Director, Bean/Cowpea CRSP, Michigan State University
9:20 a.m.	**AGRICULTURE POLICY** Bruce F. Johnston, Food Research Institute, Stanford University
9:35 a.m.	**COMMUNITY DEVELOPMENT POLICY** Sol H. Chafkin, Community Development Consultant
9:50 a.m.	**Coffee Break**
10:05 a.m.	**HEALTH POLICY** John Osgood Field, Tufts University
10:20 a.m.	**EDUCATION POLICY** Robert G. Myers, UNICEF
11:05 a.m.	**DISCUSSION**
12:00 p.m.	**Buffet Lunch**
1:00 p.m.	**IV. POLICY DISCUSSION AND RECOMMENDATIONS** Moderator: Zak I. Sabry
3:00 p.m.	**Coffee Break**
3:15 p.m.	**SUMMATION** Kathleen M. DeWalt
3:30 p.m.	**CLOSING REMARKS** Samuel G. Kahn

NUTRITION CRSP POLICY WORKSHOP PARTICIPANTS
AUGUST 22-23, 1991 ROSSLYN, VIRGINIA

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Director for Training
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10

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119

Appendix F

Nutrition CRSP Measurements

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BASIC VARIABLES LIST (October, 1991)

Community description

Based on Phase I data collections. Reviewed and updated to reflect significant community changes at approximately one year intervals.

Climatic data

Average rainfall	Monthly
Average noon temperature, or daily maximum and minimum	Monthly
Barometric pressure, each research site	Once only

Household data

Household entry data	At entry
Household demography	At entry + 6 month updates
Household social and economic measures	Twice
Disabilities and chronic illnesses in household	At entry + 3 month updates
Anthropometry (nontarget): Height	Once
Weight	Twice, by seaso
Household food use	2 days/month
Household morbidity, 7-day recall	Weekly

Lead female (P=target pregnancy; L=target lactation; N=all others)

Reproductive history	At entry
Physical assessment of nutrition and pregnancy related variables	N: every 6 mo; P: every 5th,8th mo; L: 6 months
Pregnancy outcome	At delivery
Pregnancy /lactation survey	Monthly
Anthropometry: Weight	Monthly
Height	Once when not pregnant
Food intake	2 days/month
Morbidity, 7-day recall	Weekly
Illness disability and task assignment subroutine	As indicated
Resting metabolic rate	N: every 3 mo; P: 5th,8th mo; L: 1st,3rd & 6th months
Sanitation and child care activities	Every 2 months
Blood analyses, albumin, hemoglobin	P: 8th mo
Milk analyses	L: day 1-3, 1st, 3rd, 6th mo.
Time allocation/activity pattern	Monthly
Psychology: Ravens matrices	Once
WAIS (Subscales)	Once

Lead male

Food intake: use of household food on same days as other individuals (not necessarily total intake)	2 days/month
Anthropometry: Weight	Monthly
Height (in duplicate)	Once
Morbidity, 7-day recall	Weekly
Resting metabolic rate	Every 3 months
Time allocation/activity pattern	Monthly
Psychology: Ravens matrices	Once
WAIS (subscales)	Once
Illness disability and task assignment subroutine	As indicated

Infant (from target pregnancy)

Food intake (if breast fed, quantitative estimate of supplementary food intake; otherwise estimate of total intake)	2 days/month
Anthropometry: length, weight, arm & head circumference	Monthly
Morbidity, 7-day recall	Weekly
Dubowitz Scale (first edition)	Within 3 days of birth
Physical assessment: birth condition	At birth
nutrition related variables	6 months
Psychology: Brazelton	1-7 days old
Bayley Motor Scale	6 months
Infant Behavior Record	6 months
Observation of caretaker and child	2, 4, 6, months

Target toddler - 18 to 30 months

Food intake (by observation or combination of observation and reporting)	2 days/month
Anthropometry - length, weight, arm & head circumference	Monthly
Physical assessment of nutrition related variables	Every 6 months
Physical Assessment of vision and hearing	Once
Morbidity, 7-day recall	Weekly
Illness subroutine	As indicated
Psychology: Bayley Mental Scale	18,24,30 months
Bayley Motor Scale	18,24,30 months
Bayley Infant Behavior Record	18,24,30 months
Observation of caretaker and child	18,24,30 months

Target schooler - 7 to 9 years

Food intake	2 days/month
Anthropometry: Height, head circumference	Entry and exit
Weight, arm circumference	Every 3 months
Morbidity, 7-day recall	Weekly
School attendance (days present/ days of school)	Monthly
Psychology: WISC-R (Subscales)	Entry and exit
Ravens Matrices	Entry and exit
Barrett-Yarrow-Klein classroom observation	Twice during school year
Playground observation	Twice during school year
Physical assessment of vision and hearing	Once
Physical assessment of nutrition-related variables	Every six months