AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 92 ARDA

1. SUBJECT CLASSIFICATION
A. PRIMARY
Food production and nutrition — AQ00-0000-0000
B. SECONDARY
Food science

2. TITLE AND SUBTITLE
The application of food technology to improve the nutritional status of rural poor in developing countries

3. AUTHOR(S)
(101) Fla.Univ. Inst.of Food and Agr.Sciences

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1978	72p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
AID/TA/N

8. SUPPLEMENTARY NOTES (Sponsoring Organization, Publishers, Availability)
(Prepared by Univ.of Fla. for Office of Nutrition, A.I.D.,under research agreement 12-17-07-8-2306,administered by U.S.Dept.of Agr.,International Development Staff)

9. ABSTRACT

Describes a study conducted by AID to identify factors contributing to rural malnutrition in less developed countries (LDC), and to propose AID-funded appropriate food technology (AFT) projects to alleviate the problem. The study presents six conclusions pinpointing causes of malnutrition and offers six accompanying recommendations for future AFT project planning. Working definitions of Appropriate Technology, Malnutrition, and Food Technology are provided, and specific Food Technology operations are outlined. The study also considers selection and delivery systems. Tables and an extensive bibliography are appended.

10. CONTROL NUMBER
PN-AAG-062

11. PRICE OF DOCUMENT

12. DESCRIPTORS
AID
Bibliographies
Food technology
Intermediate technology
Nutrition
Projects
Project planning
Rural areas
Technical assistance

13. PROJECT NUMBER

14. CONTRACT NUMBER
AID/TA/N

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Return

A-DTIN
PN-AAG-062

THE APPLICATION OF FOOD TECHNOLOGY TO IMPROVE THE NUTRITIONAL STATUS OF RURAL POOR IN DEVELOPING COUNTRIES

Report prepared by International Programs, University of Florida, IFAS, Gainesville, Florida 32611 for U. S. Agency for International Development, Office of Nutrition under Research Agreement 12-17-07-8-2306, administered by USDA International Development Staff, December 12, 1977 to April 8, 1978.

TABLE OF CONTENTS

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

General Conclusions: In response to a study objective, ". . . . to consider whether. . . . . an additional program activity (appropriate food technology (AFT) to improve the nutritional status of the rural poor in LDC's) should be undertaken by AID. . . . .", the answer is emphatic yes. Yes in so many ways that a major challenge has been how to limit the suggested interventions to a reasonable number and develop AFT ideas into viable high priority projects. This is the major theme of the report and the accompanying Project Identification Documents (PIDs)* represent the major recommendations.

General Recommendations: It is suggested that AID administrators responsible for program development carefully evaluate the following 5 PIDs and a sixth Project Description, the priorities represented and the background ideas from which they evolved with an end to designing the soundest possible AFT action programs out of these recommendations, their own experience and insights into AID's global role.

Conclusion 1: A major factor contributing to rural malnutrition is the low energy density of poor diets based on starch staples. Paradoxically, this often occurs in regions where oil crops grow, yet are shipped away for central processing. Oil crops represent an excellent source of calories and provide significant amounts of seed protein and pro-vitamin A, also deficient in many local diets. The refined oil is usually beyond the purchasing power of the rural poor.

*Available to authorized individuals through the USAID DSB Office of Nutrition.

Recommendation 1: Simple techniques for oil recovery at the village level could have a beneficial nutritional impact. PID No. 1 addresses the need for such technology.

Conclusion 2: In the process of producing polished rice, many decentralized (rural) rice mills build up appreciable quantities of rice bran containing valuable rice oil. However, the bran oil is destabilized during milling and the oil rapidly goes rancid, thus making it unfit for human consumption. This loss occurs in regions experiencing caloric deficits and the resulting shortfall of oil is either not made up or replaced by expensive edible oil imports - in either case to the disadvantage of the poor whose dietary energy intake is marginal at best.

Recommendation 2: PID No. 2 presents an appropriate means of stabilizing rice bran at the village mill prior to extraction of an edible grade oil at centralized locations.

Conclusion 3: Post-harvest losses of perishables and semi-perishable (PSP) reduce the availability and increase the cost of foods with considerable dietary potential. Useful examples of PSP preservation and utilization methods are found in some LDC's. However, these applications are not widespread and wet or dry preservation methods have not received adequate international attention.

Recommendation 3: PID No. 3 describes a survey of PSP preservation activities in order to establish the nutritional importance of promising systems and mechanism for encouraging incorporation of valuable processed PSP into rural diets.

Conclusion 4: The time and effort required for home food preparation in some rural circumstances conflicts with important nutrition-related tasks and may have undesirable repercussions for the most nutritionally vulnerable groups - mothers and children under five.

Recommendation 4: PID No. 4 addresses the need for reducing labor, time and resource waste by developing simple food preparation devices for home use.

Conclusion 5: The fuel and time expenditure in legume cooking can be an unacceptable economic burden to the poor and reduce the consumption of vegetable protein by those who need it most.

Recommendation 5: Several means of reducing the fuel required and the cooking time of legumes are proposed for study in PID No. 5.

Conclusion 6: AFT activities are becoming more popular as national and international organizations become involved in appropriate technology (AT). Despite the growth in interest in appropriate technology, very little information on low level food technology exists and there is no adequate mechanism now in effect for disseminating this information to end users. Actions identified in this study were not considered to be all inclusive but rather to represent what surfaced in the course of a rather brief effort.

Recommendation 6: A proposal is made in the support activity that further project identification be undertaken, emphasizing examination of the food chain in the field itself. Also recommended is a continuing process of collection of information on low level food technology and dissemination to end users. The support activity provides further for the managing of the projects, here proposed, and for furnishing technical assistance on village level technology to AID Missions.

Final Conclusions: The projects presented here only scratch the surface. The entire subject of AFT is so broad that in order to avoid duplication or dilution of efforts, project emphases are placed on applied activities which address the short-term nutritional needs of the rural poor, specifically in locations where solutions can be developed within the project life span. However, it is anticipated that many LDC locations and topics will be discovered requiring a much longer, interdisciplinary effort. In this category are: Small farm production systems (to provide raw material); challenging innovative design, engineering, and biological solutions relating to AFT under sub-industrial, rural conditions; needs for innovative extension, social and economic development programs; and coordination with other inter-related appropriate technologies in health, education, sanitation, energy, transportation, etc. In short, the development of successful AT interventions is related to a balanced consideration of human and technical factors.

Final Recommendation: A modest intra-AID project in AT addressing the long-term needs of the Agency to deal effectively with the evolving concept is suggested. One useful component should be an interdisciplinary analysis to determine other AT's and how disciplines as diverse as the physical sciences and behavioral sciences can most effectively be coordinated to strengthen AFT programs.

INTRODUCTION

Purpose: Determine existing or potential Food Technology (FT) interventions for improving the nutritional well-being of the poorest majority, particularly pregnant and lactating women, and preschool children, in rural areas. Suggest means (methods, hardware, delivery systems) by which appropriate food technology (AFT) interventions can have the most beneficial impact under existing economic, cultural and technical constraints. Recommend specific projects for AID consideration which address the most critical nutrition problems of the target group.

Objectives: Establish the feasibility of selected food technology approaches to help prevent rural malnutrition. Frame high priority recommendations in Project Identification Document (PID) form suitable for inclusion in AID Office of Nutrition planning program.

Strategy:

1. Obtain an indication of the magnitude and character of rural malnutrition in less developed countries (LDC's) where AID has an operational mandate and in the chain of events from food production to consumption, identify unmet nutritionally related needs amenable to FT intervention at the home and village level.

2. Survey the literature and organizations involved in nutrition intervention programs with FT components in order to establish the most viable tools (methodology and hardware) based upon past and current application or future promise.
3. Match critical nutrition needs with FT tools now available in use in LDC's or elsewhere or capable of development which can have the most beneficial impact in ameliorating rural malnutrition.
4. Develop FT based action programs based upon documents and feedback from experienced field and administrative personnel from private voluntary organizations (PVO's), U.S. and foreign government donor agencies, international and counterpart organizations in the LDC's.
5. Build upon the accumulated body of knowledge (including both successes and failures) in order to optimize the chance for participation of and acceptance by the beneficiaries and provide a mechanism for evaluating and improving both the FT and implementation system as appropriate to the needs and response of the target group.

Team Selection: With the advice of members of the food technology community, League of International Food Education (L.I.F.E.) and IFT and the guidance of the AID Office of Nutrition-supported USDA Office of International Cooperation and Development, several food technologists with international experience and interest in AFT were chosen to head up the study. To get a realistic assessment of the food/nutrition-related problems of LDC's in rural setting without the benefit of field trips it was deemed essential to include a strong emphasis on the social sciences as represented by team members with private voluntary organization (PVO) and consulting experience. Because of the short lead and execution time and the need to headquarter the study in Washington, consultant selection was limited to those qualified individuals in the D. C. area. Fortunately, the persons retained, their respective organizations and personal contacts covered the developing world quite well with on-site experience in Africa, Asia, Latin America, and the Mid-East. Thus, background information was obtained by the team via personal experience, supported by considerable literature review, interviews and/or correspondence with knowledgeable members of the international assistance community and, to a limited extent, with their counterparts in LDC's. This provided invaluable insights into actual field conditions under which an FT operation must eventually be tested.

Study Team:

R.P. Bates, Food Technologist, Food Science and Human Nutrition Department, University of Florida, Gainesville, FL.

T.S. DeBuckle, Food Scientist, Instituto de Investigaciones Tecnologias, Bogota, Colombia.

M.M. Sterner, Food Engineer, Nutrition Resource Bank International, Corona, CA.

R.P. Weil, Jr., Program Specialist and Contract Advisor, Nutrition and Agribusiness Group, International Development Staff, USDA, Washington, D.C.

Consultants:

R. Adams, International Nutrition Policy Planner, Washington, D.C.

M.L. Dulansey, President, Consultants in Development, Washington, D.C.

M. Fanning, Director, Inter-American Development Institute, Washington, D.C.

L. Mitchell, Senior Associate, New TransCentury Foundation, Washington, D.C.

Acknowledgment:

We would like to express our sincere appreciation to the consultants involved in this study. On quite short notice and at the expense of other duties they provided essential information and analyses in a very professional manner. Their experience and insight is a valuable resource and has made an important contribution to this report. We are also indebted to AID, Office of Nutrition and the USDA International Development Staff for necessary support services, useful advice and well placed encouragement. It has been a rewarding personal and professional experience to be associated with these capable individuals and their respective organizations.

BACKGROUND

Historical Perspective: Food Technology is the application of the basic and applied sciences to the conversion of raw material of plant or animal origin into safe, nutritious, acceptable human foods. Practices involve optimization of refining, preservation, formulation and consumption operations while minimizing resource depletion and safety hazards in a manner consistent with existing economic, cultural, logistic and environmental constraints. The field is highly interdisciplinary in scope, encompassing many interrelationships, including the behavioral sciences.

FT developed as a distinct discipline in the U.S. between the world wars with its roots in Chemistry, Engineering and Biology and is still evolving to fulfill the needs of a complex, industrialized society (125). The original emphasis on traditional food commodity processing has expanded to resource conservation, environmental quality maintenance, waste and byproduct utilization, nontraditional food resources and manufacture involving increasingly sophisticated hardware, complex technology and high throughputs. Coupled with advances in the food and production agriculture industries, Food Technology is promoting dramatic changes in the U.S. dietary and has resulted in a safe, economical national food supply. This has, however, not been accomplished without cost. Reliance upon resource-intensive technology in a resource-limited world is cause for concern.

Food industrialization, although labor sparing, utilizes a disproportionate amount of natural resources, energy, water, minerals, fiber, etc (56). Also, food related health problems due primarily to over nutrition are uncomfortably prevalent and a disconcerting indication that proper nutrition and food affluence are not necessarily synonimous (73).

Malnutrition: In contrast to the character and extent of malnutrition in the U.S., the situation in the developing world is extremely serious. The number of people suffering from malnutrition is estimated to exceed 500,000,000 in the LDC's at the lower economic strata (82, 100). A major difficulty in looking at the global picture of rural malnutrition is that it encompasses hundreds of millions of individuals in scores of countries under a variety of cultural and political systems.

A prime determinant of malnutrition is poverty. Except in situations approaching famine, a marginal national food supply is available but beyond the economic means of the mostneedy (89). In addition, those residing in remote rural areas are unreached by normal distribution systems, relying mainly on their own production efforts for subsistence. The misery, compounded by increasing population and decreasing natural resources, is prevalent among pregnant and lactating women whose nutrient demands are poorly met by marginal diets with resulting morbidity, mortality or irreversible physiological and/or psycological damage to the newborn (84).

The most vulnerable group are preschool children, particularly during the weaning process (87). At that time they lose access to the reasonably adequate nourishment and protective effect of breast milk and are subject to the dual risk of inadequate quantity and quality of food in a highly infectious environment (81). Under these circumstances child mortality peaks around 2 years of age and in the extreme can exceed 250/1000 of the afflicted population (26). Higher child mortality is believed to lead in turn to the incentive for more children and the stress on family resources is further aggravated.

On an absolute basis total energy and/or protein represent the greatest need (80). However, even when quantity and quality of the staple is adequate, trace nutrients (vitamins and minerals), particularly vitamin A and iron can represent significant deficiencies (84,109). Supplementation of diets with oil and modest amount of local fruits, vegetables and legumes and fish, if available (animal products usually are economically impractical) can have dramatic benefits. This holds especially for children being weaned on thin gruels, a further dilution of an already poor diet (76).

An additional, less well recognized deterrent to adequate nutrition is the strenuous, time-consuming nature of the many daily rural tasks i.e., farming, food preparation, water/fuel collection, plus other domestic and occupational duties (e.g. petty trading). These tasks compete with essential child care requirements and are a particularly serious stress to pregnant and lactating women (224).

Thus, life at the subsistence level demands the maximum human output from those who can least afford it. These generalizations suggest nutrition needs amenable to Appropriate Food Technology (AFT) approaches which constitute the major portion of this report.

Why the emphasis on rural malnutrition? Although the explosive growth of cities has been accompanied by a dramatic increase in urban malnutrition, the majority of the victims of malnutrition (greater than 70%) still live in rural areas (102). In fact, it is often rural poverty which compels people to leave a hopeless rural situation in exchange for the remote but perceivable opportunity offered in the city. If the well-being of rural poor, including their nutritional status, could be improved, the flow to the cities might be slowed and perhaps reversed to the ultimate benefit of the nation. Despite abject poverty, the malnourished in urban areas are reasonably centralized and within reach of programs (physically, if not economically or culturally). In contrast, the rural poor are spread over a wide area and present a vastly different logistic and political problem.

<u>Appropriate Technology</u>: In response to the suffering of a third of the world's population, there has been a growing interest in Appropriate Technology (AT) in a number of fields affecting nutrition and national development (5,12,14,15,40,49). These are: energy, water resources, health care, education, housing, small industry, transporation, sanitation, agriculture, and as part of

agriculture (and often lost in the shuffle) food technology. The accompanying philosophy of self-help and "small is beautiful" has much intuitive appeal for the LDC's and represents a logical reaction (and sometimes an overreaction) to the past theme of rapid industrialization (44,19,52). The proliferation of AT centers in both the developed and developing countries is an encouraging sign. AT is a promising tool (not solution) to help alleviate malnutrition and poverty/underdevelopment (14, 49). Nevertheless, as global experience with AT is accumulated there may be a traumatic "shakedown" period during which organizations addressing the subject in name only will falter, providing all too visible examples of "inappropriate technology", while those with sound approaches will survive and continue to make valuable contributions to the field (25,250). This is not an easy task. The apparent simplicity of AT belies the complexity of dealing with that elusive trait - human behavior, often under severe economic, environmental, social or political constraints. Fortunately, a number of organizations with considerable experience and insight are providing good working examples. Recently the majority of the more prominent AT involved organizations met as a loose consortum and discussed mechanisms for coordinating programs and AT information (3, 57).

In the U.S. an organization destined to play a major role is A.T. International. ATI is a non-profit organization authorized by Congress in the International Food and Assistance

Act of 1975 to "promote the dissemination of technology appropriate for developing countries and help them strengthen their own capabilities to develop, adapt and utilize appropriate technologies"(2). The list of AT centers continues to grow along with the amount of published information about systems and programs which address key nutrition and/or development problems in LDC's (1, 3, 8, 11, 15, 19 20, 29, 32, 35, 38, 54, 60, 61).

We have, therefore, devoted a major effort to becoming familiar with global activities in AT, particularly relating to AFT in the scope of this study. After perusing the literature and contacting knowledgeable sources of AT information, we have come to the following conclusions: 1) There are few concrete examples of ongoing field operations which directly involve the rural poor, although they may be potential beneficiaries of some programs, 2) Numerous examples are cited where encouraging field demonstrations of AFT devices/methods are in the developmental or field testing stage, again without hands-on involvement of the beneficiaries and 3) There are numerous accounts of promising ideas involving research and laboratory studies of AFT topics. In short, there seems to be an impressive amount of AFT (hardware, methods, ideas) in the "pipeline" and relatively little issuing from the "tap", i.e., being applied <u>by</u> the rural poor. Hopefully, this situation reflects either the imperfections of a U.S. - based survey of LDC field activities or the existence of a lag phase (incubation period) to be followed by a log (rapid growth) phase of AFT with documented success stories and widespread applications. To extend this analogy, the pipeline is long and the flow is slow. It is hoped that the recommendations presented here can perhaps increase the diameter of the pipe (238) or increase the flow rate.

AN INVENTORY OF FOOD TECHNOLOGY

Table 1 illustrates the wide scope of FT unit operations and techniques and Appendix A describes how some of them are applicable to the needs of the rural poor, while others are clearly inappropriate. Several of the more relevant operations, those with nutritional implications are dealt with in the PID's. In addition to type of operation, there are a number of levels at which Food Technology can be appropriate. Table 2 shows a very generalized hierarchy of operations which can range from primative to advanced. However, even the simplest technology, although it developed empirically, might be based upon quite sophisticated principles and require considerable basic research to gain a scientific understanding of the traditional operation (i.e., development of doughs by kneading staples, indigenous fermentations). Insights so gained can then serve to improve the traditional operation, still in its original setting. Or, the tradition operation could be scaled up for an expanded market or institutional use. As long as changes make economic and cultural sense to the people involved and do not cause disruptive effects, they can be appropriate.

As a rule, the range of our concern will be at the first three levels (Table 2). Traditional, improved traditional and intermediate. However, the distinction should ultimately be based upon nutritional impact on the beneficiaries. For example, production of a nutritive food by U.S. industry, combined with airlift delivery might be appropriate in a famine or natural disaster situation, but highly inappropriate and counter-productive under normal circumstances. "Appropriate", which describes the forms of Food Technology in this report, is amply defined in the burgeoning literature on AT (16, 62) i.e., inexpensive, simple, capital sparing, labor intensive, culturally compatable, etc. We are more concerned with "inappropriate" as that application of FT which does not fit the situation, is not adopted by the potential beneficiaries or results in undesirable consequences which outweigh the perceived benefits.

To have direct nutritional impact, a food technology intervention should help accomplish one or more of the following:

1. Preserve nutritive value in foods by stabilizing nutrients or preventing their loss (food spoilage).
2. Improve nutritive value by removing or inactivating deleterious components, making nutrients present more available or introducing additional nutrients by processing and formulation.
3. Enhance the consumption of key nutrients by providing them in a more concentrated form or removing less valuable components.
4. Facilitate consumption of desirable nutrients by improving the availability, acceptability, economy and safety of foods.
5. Assure that maximum food in optimum condition reaches and is consumed by those most in need of the provided nourishment.

6. Reduce cost, time, labor and energy associated with food handling, processing, storage and consumption.

Although Food Technology operations can have other indirect benefits which can favorably influence nutritional well being (i.e., providing foods for cash or barter, incentives for increased food production and activities which increase family incomes); the foregoing are deemed the major operational criteria of this study.

EVOLUTION OF THE PID's

As an indication of how the major AFT recommendations were arrived at, it is useful to follow their evolution. In the course of the work, the scope of food technology to be considered was defined as limited primarily to village and home level processes.

As discussed above, the study focused on both need and areas amenable to food technology intervention and food technology techniques or tools.

To help identify points of possible food technology intervention, the rural life consultants were asked to prepare detailed information on the food chain for particular regions. Approximately two areas in each continent were selected, each representing consumption of a particular major staple. The core team reviewed these presentations and, through dialogue with the consultants, sought to identify points amenable to intervention.

In addition to this approach, identification of both need for intervention and available food technology tools was sought through review of the literature and through contact with knowledgeable individuals.

These individuals included voluntary agency personnel, personnel of other donor agencies involved in food technology or nutrition, food technologist from the academic sector, and, to a more limited extent, LDC personnel involved in village level food technology work. Table 1 provides an inventory of FT methods and operations that were included for consideration as part of the review.

The ideas emerging from the above process are listed in Table 3. Table 3 also notes several areas that were considered for possible project development, but where it was decided not to develop a recommendation for various reasons as indicated. Ten ideas were refined and developed into pre-PID summaries which were presented written and orally to representatives of AID Regional Bureaus and a PVO administrator. Based on feedback from this meeting the 6 PID's as presented here were developed and are submitted for AID programming consideration in this report.

A summary of the ideas identified and also of areas considered but not pursued are as follows:

A. Flour and millfeed production and utilization. Although recognized as quite important nutritionally, it was concluded that durables (cereals, legumes and oilseeds) are being covered as part of the global effort on post-harvest food loss prevention, funded by AID, DS/AGR, DS/N), FAO and other Donor Agencies (136, 147, 148, 154, 155).

B. Vegetable oil extraction and utilization. The need for increased energy density in poor rural diets was seen as a serious global problem worth food technology intervention (80) and a pre-PID entitled "Use of small oil presses as a means of improving some calorie, protein and vitamin A deficient diets among rural village people" was developed and subsequently refined into PID No. 1, "Rural Village Oil Extraction". In addition, another oil-related pre-PID "Stabilization of rice-bran oil at the village rice mill to increase its value and provide edible oil from an untapped source" was felt important enough to warrant a separate project and was developed as PID No. 2, "Rice Bran Stabilization."

C. Drying of perishables and semi-perishables was suggested as an important topic due to the need to extend the seasonal availability of these foods (fruits, vegetables, fish, roots, tubers - generally high moisture foods). They receive relatively little attention in post-harvest loss prevention programs which stress durables. A pre-PID, "Dehydration of nutritious perishables and means of optimizing their contribution to rural diets," was developed.

D. A companion Pre-PID, "Wet preservation of nutritious perishables and semi-perishables and means of increasing their contribution to poor rural diets", developed to address a similar problem where dehydration is impractical, was combined with the preceeding pre-PID into PID No. 3, "An assessment of simple techniques for preserving perishables and semi-perishables and optimizing their nutritional contribution to poor rural diets".

E. Handling, packaging and storage were recognized as severe limitations to rural food availability (166), but werenot developed due to global attention to general post-harvest loss prevention.

F. Dough preparation was deemed important in view of the inordinate amount of time and effort devoted to this activity at the expense of other nutritionally-related tasks (13, 43). The topic was framed as pre-PID "Labor reduction in food processing at the village and rural home level" and after review, developed as PID No. 4, "Home processing to reduce labor required for food preparation".

G. Small-scale extrusion processing which addresses the need for efficient manufacture of indigenous weaning food (122) in rural areas was presented as pre-PID "The application of texturization techniques to the production of protein and fat rich foods at the village level". The reviewers felt that the process was perhaps too industrial or premature and it was not developed further, although elements of extrusion technology are contained in PID's No. 2 and No. 5.

H. Nutritional food product development was decided to be a rather diffuse subject and more closely associated with Home Science (231, 227), (i.e. requiring a concerted education effort to teach the rural poor to improve some of their food preparation and consumption habits.)

I. Rural food transportation, marketing and distribution are high priority needs involving some FT components (117, 242). However, these multidisciplinary activities must be integrated into national development programs and are too broad in scope for an AFT PID.

J. Home food preparation with the similar but broader rationale as item F - Dough preparation, and a quite evident high priority was addressed in part in PID No. 4 and also in PID No. 5, "Quick cooking beans" with a puffing device as developed in item G as one alternate method (259).

K. Therapeutic food technology as a means of making oral rehydration kits (97) available in remote areas and an investigation of indigenous anti-parasitic plant materials was considered to address an important area of concern (92) and developed as a pre-PID. However, this activity was evaluated as being more closely associated with appropriate Health Care or Preventive Medicine than AFT. Dispensing of therapeutic food agents without a thorough education effort or paramedical personnel would be a risky endeavor.

L. A support activity was recognized as necessary for the performance of several functions: 1) Management of projects recommended for implementation; 2) further project identification; 3) collection and dissemination of information re village food technology; and 4) provision of technical assistance. An activity encompassing these functions was provided in Project No. 6 "Village level food technology supporting activities."

M. An additional pre-PID entitled "A study to find a fail-safe method of staple food enrichment of village mills" prepared because of the potential nutritional benefit of such an intervention (76, 119, 122) was considered as very difficult to implement in view of the decentralized nature of rural mills and the logistics involved.

The ideas developed into projects were based, as previously discussed, on readily available information and do not purport to be all inclusive. At the same time, the process of PID development served to focus attention on areas of nutritional need amenable to food technology, and suggested a reasonable course of action - the attached PIDs.* Since nutritional impact and technical soundness of specific project must be integrated with AID policy and funding considerations, no PID priorities have been assigned. However, the six projects submitted have been carefully selected to address the Office of Nutrition's program in Food Technology.

*Available to authorized individuals through the USAID DSB Office of Nutrition.

O[redacted] CONSIDERATIONS

Related Activities: Within AID the Development Support Bureau (DS) Offices of Agriculture, Science and Technology, and Nutrition each have programs with potential AFT components. DS/AGR is supporting several specific post-harvest loss prevention activities with durable crops. DS/N through L.I.F.E. has addressed this critical need with a post-harvest loss methodology study (160). DS/AGR is preparing a PID on storage, marketing, processing and agribusiness development of vegetable and fruit crops. This will be a technical services contract providing policy analyses to AID Missions and host governments, assistance in building national infrastructures, and developing domestic and export markets for these fresh and processed crops. DS /OST is involved in evaluation and analyses of AT ideas and problems with emphasis on economic development, and any evolving AFT would not emphasize nutrition directly. Thus, other DSB projects would complement and not conflict with the proposed AFT PID's, stressing rural nutrition improvement.

Delivery and Implementation Systems: No matter how sound the technical concept nor how urgent the need, unless an intervention can be framed and delivered the activity will be simply a learning exercise. The criteria for success is straight-forward:acceptance (and perhaps improvement) of the intervention by those for whom it is intended with a resulting enhancement in their nutritional status. How best to accomplish this under the very severe constraints of rural poverty? One approach which has worked well in the U.S. over a period of a century is agricultural extension - i.e., extending the results of research and successful experience to a target group and assisting them in putting the information to beneficial use (34, 117). Many LDC's with the assistance of Donor Agencies have at least the embryo of an extension service. However, the programs are usually burdened with more responsibilities than the few over extended (and often undersupported) field agents can handle. Inadequate resources for transportation, program material and in-service training are sometimes supplemented by PVO's. Another useful complement to extension is provided by some PVO's which operate in remote regions supplying services which the host government cannot provide, i.e., maternity, child health care services, assistance to small farmers, rural education, health clinics, etc. (35, 57). Such programs are generally staffed by experienced, dedicated local personnel supported by PVO's. Such individuals possessing an empathetic understanding of the people, their culture and subsistence problems account for some of the relatively unpublicized examples of successful self-help programs (32, 61, 67, 243). These are often long-term with subtle benefits and not particularly newsworthy, although quite effective in view of the modest resources involved. Through their programs, PVO's can offer important technical inputs. However, in view of the critical need for extension services in most LDCs, the PVO efforts can be only catalytic.

Most of the insights into the rural nutrition and food-related situations upon which our recommendations are based came either directly or indirectly from the field experiences of PVO and Peace Corps personnel. These networks are an extremely valuable resource which can be used in attacking nutrition problems. For example, the field worker who spends a number of years in a region gains a remarkably comprehensive understanding of the people and their problems. Field workers with some grasp of AFT, although not technologists, are as well qualified to judge the feasibility of a technical intervention as the food technologist whose field exposure is much more limited. Most importantly, the ability of PVO field personnel to frame a technical idea so it has the best chance of success is the essence of an effective extension delivery system. Their ability to focus attention on the critical socio-economic fit (the human factor) is essential (21).

Food technologists recognize how critical it is to attend to all details in developing a food process. To do otherwise would permit or even encourage spoilage. In an analogous sense, to unwittingly violate basic social/cultural principles can result in just as dramatic a "spoilage" with the important difference that food is a more expendable resource than people and their society. Based on the past record, the major caveat expressed by the team members and other experienced persons whose views were solicited was that reaching the rural poor in any way is a very difficult task involving much more than a sound technical component (16). They stressed the need for time and patience in order to educate the target group, implementors and local counterparts - ultimate source of managerial talent to provide continuity.

In designing a potential AFT intervention, a given project should:1) provide inputs to the affected population (the rural poor) at little cost (i.e., within their limited means) and without the necessity of long-term subsidization by the national government beyond what is politically and economically feasible (assumed to be very little); 2) speak to the need for education, formal or non-formal, required for any attitude and/or life-style (behavioral) changes expected to result from the project; 3) establish simple, well-defined roles for any education/extension agents involved that are feasible, within the limited resources available to these agents and provide for their training; 4) take into account the lack or scarcity of efficient production/marketing/distribution systems in the host nations; 5) be alloted a usual minimum of five years before significant, national effects are expected to begin to appear; 6) allow for the possibility of a very low level of cost effectiveness during at least the first three years.

Site Selection: Table 4 outlines some constraints affecting selection of a site and choice of an AFT activity. It was originally hoped to include in the PID's a clear indication of the country or countries and perhaps even the specific setting where the recommended AFT activity would be most practical. However, since the decision for project initiation must come from country Missions through the AID Regional Bureaus, site selection is premature without a field survey and joint planning in order to integrate projects into on-going national/regional AID programs. In addition, the question of how best to involve PVO's, counterparts and host country in feasibility, planning, implementation and evaluation could not be adequately addressed from Washington in a 3 month study. Consequently, built into the PID's are modest preliminary activities designed to answer those important questions.

Another Approach: Since our mandate was to address the nutritional problems of the "poorest of the poor" in a rural setting, we have placed considerable emphasis upon Food Technology in a home or rural context, thereby ignoring the much broader areas of FT appropriate to urban or industrial settings. This greatly restricts the choice of interventions consistent with reality, but nonetheless yields several viable alternatives. A cause for amazement is not only the high LDC morbidity and mortality statistics but also the fact that some members of the most vulnerable group, survive tenaciously under such severe nutritional and environmental restraints (120, 126, 237, 269). Aside from the very complex etiology of malnutrition, complicated by individual biological variability and their interactions, there is evidence of a survival strategy which works remarkably well in severe circumstances, although subject to breakdown when the society is challenged by rapid change and diminishing resources.

Are there food-related practices which represent a sound response to malnutrition and when better understood in a technical and cultural sense could perhaps be optimized for local use or, more importantly, refined and applied to other regions of need? If the answer is yes, then this could represent technology transfer with important differences. It may be 1) horizontal--from one traditional setting where it evolved to another culture at about the same level of development or 2) vertical, from the bottom up--originating in a traditional setting and expanded to the intermediate or even industrial level - instead of top down--originating in a more developed context and applied to externally perceived needs of the rural poor. There is nothing profound about horizontal or vertical upward transfe[illegible] It is the way technology evolves, and attention to the concept can be valuable to AFT planning.

Therefore, any intervention should take maximum advantage of the possible survival value of traditional food refining, preserving, formulation and consumption patterns where these practices do, indeed, obtain the most nourishment from the limited resources available. Understanding under which circumstances those traditional or improved practices can be applied to other rural areas possessing similar nutritional problems can be a very important contribution to appropriate food technology programs - and to development in general. A useful approach to obtain insights into this phenomenon is suggested in a recent Tanzanian report (143). This is called a "village dialog" which consists of carefully obtaining the target group's perception of a problem and stimulating them to contribute to the solution - an admittedly slow and painstaking approach but worth more attention.

Table 1: An Overview of Food Technology Operations Deemed Appropriate in Preventing Rural Malnutrition (See Appendix A)

CATEGORY & OPERATIONS

A. Refine

1. Clean, wash
2. Thresh, dehull, shell, winnow, degerm
3. Mill, screen
4. Peel, deseed, core, slice
5. Grate, crush, grind
6. Press, expell
7. Extract, solubilize, digest, precipitate
8. Scale, pluck, skin, eviscerate, debone

B. Preserve

9. Dehydrate, concentrate
10. Salt, sugar
11. Smoke
12. Pasteurize, sterilize (canning)
13. Irradiate
14. Ferment
15. Pickle
16. Stabilize chemically
17. Package
18. Cool, refrigerate, freeze

C. Formulate

20. Mix, blend
21. Knead
22. Homogenize, emulsify
23. Extrude, puff
24. Coagulate, compact
25. Enrobe, wrap, coat
26. Sprout

D. Consume

27. Transport, market, distribute
28. Soak, reconstitute, precook
29. Cook - warm, boil, bake, fry, roast

E. Therapy

Table 2 Hierachy of Food Technology Operations in LDC's

Scale	Description	Example	Support Requirements[1]: Local Skills: Technical	Local Skills: Mechanical	Technology Base: Local	Technology Base: National	Technology Base: International	Logistics: Local	Logistics: National	Logistics: Imported
Traditional	Established foods and preparation methods on single or multi-family basis.	Household grinding, cookery	L	L	H	L	L	M	L	L
Improved Traditional	Some innovations in food type, preparation equipment or techniques, same group basis.	Fuel efficient cooking, simple mills, nutrient complimentation	L	M	H	M	L	H	L	L
Intermediate	Multihousehold, some community centralization, local equipment and methods combined with some external innovations.	Village milling, oil pressing, solar drying, local weaning foods	M	M	H	M	M	H	M	L-M
Industrial	Village level and above to serve rural or urban markets using a mixture of national and international methods on local raw materials.	Fruit preservation, commercial weaning foods	M	H	M	H	M	M	H	M-H
Advanced	Regional to national level with modern equipment and international technology.	Canning, oil processing for export	H	H	L	H	H	L	H	H

[1] High (H), Medium (M), Low (L)

TABLE 3

Possible Village and Home Level Food Technology Interventions Appropriate to Preventing Rural Malnutrition

Title	Purpose	Approach	Disposition & Rationale
A. Production and utilization of flour and millfeed from indigenous staples	Optimize nutrient contribution of available food resources	Study of equipment and techniques for improving grain, legume, oilseed flour and by-product recovery at the home and community level	Not developed in view of well supported post-harvest loss prevention activities
B. Extraction and utilization of oil and press cake from local oilseeds	Increase caloric density and dietary contribution of oilseeds	Develop simple oil expelling or pressing devices and means of incorporating the resulting oil and meal into local diets at the community level	High priority, a PID deloped on oil extraction and one on rice bran stabilization
C. Dehydration and incorporation of nutritious perishables into deficient diets	Increase the availability, stability and nutrient contribution of perishables	Survey simple solar and fuel energy conserving dehydration methods and intermediate moisture food manufacture appropriate to home and community	High priority, combined with no. 4 as a PID on wet and dry preservation of perishables and semi-perishables
D. Fermentation and stabilization of indigenous foods	Increase the availability, stability and nutrient value of staple and accessory food materials	Improve beneficial fermentation processes and apply them to other food resources and/or other regions with similar raw materials at the village level	Combined with C.
E. Optimize handling, packaging and storage of perishable and semi-perishable foods in adverse rural environments	Reduce waste, maintain quality and nutritional value of the local food supply	Establish methods and packaging materials based on local resources which combined with education efforts can lengthen the storage life of the available food supply	Not developed in view of global attention to post-harvest loss prevention
F. Formation and nutritional improvement of doughs from local staples	Reduce labor and time involved in household preparation of traditional foods. Provide a mechanism for nutritional fortification during kneading	Mechanical simplification of the dough formation step, study of the desirable rheological characteristics and feasibility of adding available nutritious ingredients to the doughs	High priority, developed into a PID on labor/time conserving home food processes

TABLE 3 (continued)

Title	Purpose	Approach	Disposition & Rationale
G. Low throughput extrusion for the production of traditional and improved foods and multi-mixes	Simplify cooking, drying, texturization and utilization of indigenous foods by extrusion methods	Scale down of extrusion devices and development of batch puffers. Application to common food stables and nutritionally complimentary ingredients at the village and industrial level	Not developed, felt too industrial for many rural situations. Some ideas used in PID's on rice bran stabilization and quick cooking beans
H. Nutritional food product development with traditional foods and improved preparation techniques	To optimize the consumption of available foodstuffs by improving the ease and form of preparation	Explore the use of culturally acceptable foods in desirable, convenient, stable, nutritionally complimentary combinations feasible at the home or village level	Not developed, felt more appropriate to home economics activities
I. A food transportation, marketing, and distribution system appropriate to remote rural circumstances	Improve the quality and quantity of food available to the most needy at minimum cost	Develop site specific systems based on global experience and apply to appropriate rural areas	Important, but too interdisciplinary for an AFT project
J. Equipment and methodology for improving the efficiency, economy and nutritive value of home prepared foods	Take maximum advantages of family food resources under existing socio-economic constraints	Evaluate existing food preparation steps and introduce labor saving, nutrient sparing and energy conserving interventions	High priority, developed into a PID on quick cooking beans
K. Application of local ingredients to combat malnutrition aggravated disease states	Reduce the antagonistic factors which decrease the assimilation of nutrients	Investigate simple means of improving food sanitation, manufacture and distribution of oral rehydrating agents and possible indigenous remedies for intestinal parasites	High priority, but felt more appropriate to health care/delivery activities
L. Project management and further study and dissemination of information	Manage existing projects and identify additional ones, collect and disseminate village food information, provide technical information to Missions	Examine food chain and nutritional needs in field to identify project ideas. Utilize field trips, seminars and workshops as AFT development tools	High priority, developed into a project. Information dissemination elements also included in individual PID's

Table 4: Selection Criteria for Appropriate Food Technology (AFT) Projects and Locations

INTERVENTION

1. Promises to have a beneficial nutritional impact.
2. Sound technical concept either proven or field tested - not just an experimental idea.
3. Practical in an economic/cultural sense - simple, inexpensive and not too foreign to local habits and customs.
4. Based on local resources and raw materials as much as possible with potential for hands-on involvement of the target group.
5. Potentially applicable in other rural regions and countries.
6. Capable of demonstrating a beneficial impact within the project lifetime.
7. Self sustaining - a strong possibility of continuing after the end of project.
8. Safe - not dangerous from a sanitary standpoint nor involve hazardous equipment or operations.

SITE

1. Should be located in a high priority AID country (s).
2. Nutrition need - the target group should have a well defined malnutrition problem.
3. Country should possess a good Peace Corps/PVO network and/or host government extension service in some form.
4. Possess adequate raw materials/resources required by the intervention or the capability for developing them.
5. Selected foods/resources should be affordable by the target group.
6. A modest national infrastructure (transportation, markets, etc.) desirable.
7. If appropriate technology activities planned or in progress, AFT project represents a desirable add-on and not a dilution of effort or conflict.
8. Good, cooperative relationship between AID mission and other donor agencies and counterparts.

BIBLIOGRAPHY

Reference numbers in parentheses ( ) are cited, * are particularly relevant and others provide background information.

Appropriate Technology:

(1) AID. 1976. Intermediate Technology (IT) Organizations in Africa and the Indian Sub-continent. (PN-AAE-699)+.

(2) AID. 1976. Proposal for a program in appropriate technology: transmitted pursuant to Section 107 of the Foreign Assistance Act. (PN-AAE-693).

(3) AID. 1972. Research Interest of Foreign Assistance Agencies Concerning Appropriate Technology. Presented at sym. on priorities on innovating and adapting technologies, Princeton University, 1972. (PN-AAC-407).

4* AID. 1978. Intermediate Technology, Query Report. DS/DIU/ Development Information Center.

(5) AFHA. 1977. The state of the art of deliverying low-cost health services in developing countries. American Publication Health Association.

6 Askin, P.W. 1976. Intermediate Technology, an Informal Survey. (PN-AAE-700).

7* Auciello, K.E. 1976. Bibliography of Intermediate Technology Materials Held at the International Development Data Center. (PN-AAC-069).

(8) Brace Research Institute 1977. Un manual de tecnologia apropiada. McGill Univ. and Canadian Hunger Foundation, 75 Sparks St. Ottawa, Canda.

9 Brown, N.L. and Howe, J.W. 1978. Solar energy for village development. Sci. 199:651.

10 Buflin, R.L. and Greenwell, J.R. 1977. The application of technology in developing countries. University of Arizona Interdisciplinary Seminars Series.

(+) DS/DIU Query Access No.

(11) Buflin, R.L. and Weaver, H.L. 1977. Appropriate technology for natural resources development: An overview, annotated bibliography and guide to sources of information. University of Arizona.

(12) Carr, M. 1976. Economically appropriate technologies for developing countries: An annotated bibliography. Intermediate Technology Publications, Ltd., London.

(13) Carr, M. 1977. Appropriate technology: Its importance for African women. Workshop on marketing foods for children through the public distribution system. Protein Food and Nutrition Development Association of India, New Delhi Workshop, July, 1977.

(14) Clark, W. 1976. Big and/or little? The search is on for the right technology. Smithsonian 7(4):43.

(15) Darrow, K. and Pam R. 1976. Appropriate Technology Sourcebook. Volunteers in Asia, Box 4543, Stanford, CA-94305-.

(16) Drissell, J.P. 1977. Why the world will shift to intermediate technology: An interview with George McRobie. The Futurist, April, 1977, p. 83.

17 Eckaus, R.S. 1977. Appropriate Technologies for Developing Countries. Nat. Acad. Sci. (PN-AAD-928).

18 Edwards, C. 1976. Appropriate Agricultural Technology: Assessment of Nonfarm Impacts. (PN-AAE-697).

(19) Ellis, W.N. Transnational Network for Appropriate/Alternative Technologies. TRANET Newsletter. 7410 Vernon Square Drive, Alexandria, VA. -22806-.

(20) FAO. 1977. Report of the AD HOC Working Group on Appropriate Technology. Geneva 7-18, November 1977.

(21) French, D. 1977. Appropriate Technology in Social Context: An Annotated Bibliography. AID.OTR-147-77-777.

22* Furst, B.B. 1974. Traditional Medicine and Indigenious Practices. APHA report for AID/CSD 3423.

23 Goodman, L.J. 1976. Appropriate Technology Study: Some Background Concepts, Issues, Examples, and Recommendations: A Working Paper. (PN-AAE-702).

24 Hanlon, J. 1977. Will Kargot try new technology again? New Scientist, 19 May, p. 386.

(25) Harrison, P. 1976. Inappropriate AT. New Scientist, July 29, p. 236.

(26) Hart, R.M. Maternal and child health services in Tanzania. Medical Doctor, p. 179, October 1977.

27 IIT Tecnologia. Bimonthly bulletin of the Institute of Technical Research, Bogota, Colombia.

28 Intermediate Technology - reports. 556 Santa Cruz Avenue. Menlo Park, CA.-94025-.

(29) Intermediate Technology Publications Ltd. Appropriate Technology (Quarterly Journal). 9 King St., London WC 2 EHN, England.

30 Kelly, H. 1978. Photovoltaic power system: A tour through the altenratives. Sci. 199:634.

31 Koppel, B. 1976. Appropriate Institutions for Appropriate Technology: A Framework for Analysis and Guidelines for AID Roles. (PN-AAE-696).

(32) L.I.F.E. Newsletter. Monthly, League for International Food Education, 1126 16th Street, N.W., Washington, D.C.-20036-.

33 Lipinsky, E.S. 1978. Fuels from biomass: Integrated with food and material systems. Sci. 199:644.

(34) McCabe, M.S. and Swanson, B.T. 1975. International directory of extension organizations and extension training institutions. University of Wisconsin - Madison.

(35) MUCIA. 1976. Private voluntary organizations and appropriate technology, a report prepared for the Agency for International Development. (PN-AAC-928).

36 Murray, G.T. 1977. Traditional and modern strategies of health care delivery among peasants of El Salvador. 3/77. AID/la-c-1186.

37* Nat. Acad. Publ. Admin. 1977. Energy Organization Options: Section 119, 1977 International Development and Food Assistance Act. Report, Dec. 30, 1977.

(38) Nat. Council for International Health. 1976. Appropriate technology in health in developing countries.

39 NRB Newsletter. The Nutrition Resource Ban, 1428 Kellogg Street, Corona, CA-91720-.

(40) NSF. 1977. Appropriate technology - A directory of activities and projects. NSF/RANN.

41 NSF. 1977. Appropriate technology in the United States - an exploratory study. NSF/RANN.

42 NSF. 1977. Appropriate technology and agriculture in the United States. NSF/RANN.

(43) O'Kelly, O. 1977. The use of appropriate technology to help rural women. Approp. Technol. 4(2):20.

(44) O'Kelly, E. 1977. Intermediate technology as an agent of change. World Food Conference Proceedings, Iowa State Univ. Press, Ames, IA-50010-.

45 Planning and Development Division. 1976. Appropriate technology development organization, 4th 6th month report. Government of Pakistan.

46 Rao, R. 1973. An Example for the Third World. New Scientist 59:451.

47* Rural Development Network Bulletin. Quarterly from Overseas Liason Committee, American Council on Education. 11 Dupont Circle, Washington, D.C.-20036-.

48 Salubritas - Health information exchange quarterly from the American Public Health Association and World Federation of Public Health Association APHA, International Health Programs, 1015 Eighteenth Circel, N.W., Washington, D.C. -20036-.

(49) Schacht, W.H. 1977. International technology transfer to the developing nations and the role of appropriate technology: A background paper. Congressional Research Service, Library of Congress. Aug. 22, 1977.

(50) Schille, T.W. 1977. The past and potential role of the United States in the transfers of agri-food technology to developing countries. DRI State Dept. Report. 1977.

51 Schroeder, D. 1976. In search of an "Appropriate Technology". International Development Review/Focus, 18(3):2.

52 Schumacher, E.F. 1973. Small is Beautiful. Harper and Row, New York.

53 Schumacher, E.F. 1973. Small is Still Beautiful. The Futurist 11:93.

(54) Small Industry Development Network (SIDN) Quarterly Newsletter. Georgia Institute of Technology. Office of International Programs, Atlanta, GA-30332-.

55 Spurgeon, D. 1973. The energy equations. Natural power for the Third World. New Scientist 60:694.

(56) Steinhart, J.S. and Steinhart, C.E. 1974. Energy Use in the U.S. Food System. Sci. 184:307.

(57) TAICH. A listing of U.S. non-profit organization in food production and agricultural assistance abroad. American Council of Voluntary Agencies for Foreign Service, Inc. Technical Assistance Information Clearing House, 200 Park Avenue, S. N.Y., N.Y. -10003-.

58* TAICH. 1973. A Listing of U.S. non-profit Organization, Medical and Public Health Assistance.

59 TAICH. 1975. Criteria for Evaluation of Development Projects Involving Women. Sub-committee on Women in Development of the Committee on Development Assistance, ACVAFS.

(60) UN University, UNU Newsletter. Toho Seimei Bldg. 15-1. Shibibutaku Tokyo, Japan.

(61) VITA NEWS. Quarterly Newsletter of Volunteers in Technical Assistance, 3706 Rhode Island Avenue, Mt. Rainer, MD -20822-.

(62) Wakefield, R.A. and Stafford, P. 1977. Appropriate Technology: What it is and where it is going. The Futurist 11:72.

Nutrition:

63 AID. Development Assistance Programs - background data on many countries of interest to AID.

64 AID. 1976. A Proposal to Conduct Community Experiments in the Reduction of Malnourishment in Colombia. AID/ta-C-1121. Project 931-17-560-558.

65 AID. Health Sector Assessments. On many countries of interest to AID.

66 AID. National Nutrition Surveys - on many countries of interest to AID, jointly with DHEW.

(67) AID. 1975. Reports of American voluntary agencies engaged in overseas relief and development registered with the advisory committee or voluntary foreign aid.

68* AID. 1977. Nutritional Strategy in the Sahel. INTECH. AID ta-C-1214.

69* Berg, A. 1970. Increased income and improved nutrition: A shibboleth examined. The Marketing Challenge. Foreign Econ. Dev. Rept. 7. p. 41.

70* Binns, C.W. 1976. Food, sickness and death in children of the highlands of Papua, New Guinea. Environmental Child Health 22(1):9.

71* Brown, G. Mayer, J. Paarlberg, Humphrey, H. 1975. Feeding the world in the year 2000. The Futurist 9(6):293.

72 Cameron, M. and Hofvander, Y. 1976. Manual on Feeding Infants and Young Children. 2nd Ed. PAG.

(73) Clydesdale, F.M. and Francis, F.J. 1977. Food,Nutrition and You. Prentice-Hall, Inc.

74 Cox, K.M., Geletkanyca, C. 1977. The Health Situation in Peru, DHEW 12/77.

75* CRS. 1975. South American Nutrition Policy and Planning Seminar: Final Report 6/3 - 13/75. Catholic Relief Services.

(76) Devadas, R.P., Murthy, N.K. 1977. Nutrition of the preschool child in India. World Rev. Nut. Diet 27:1.

77* DHEW. Syncrisis: An analytic series on the interactions of health and socioeconomic development. U.S. DHEW Office of International Health. Many countries covered.

78 FAO. 1965. Human nutrition in Tropical Africa.

79* Haverberg, L.N. 1976. Some observations of the Church World Service nutritional programs in Haiti and the Dominican Republic 10/76.

(80) Hegsted, D.M. 1978. Protein calorie malnutrition. American Scientist 66(1):61.

(81) Hornstein, I. 1977. Impact of infection on nutritional status: Introductory remarks. Am. J. Nutr. 30:1204.

(82) IDRC. 1976. Catastrophe or New Soceity: A Latin American World Model IDRC. 064.

83 Jelliffe, D.B. 1969. Child nutrition in developing countries. A handbook for field workers. AID.

(84) Jelliffe, D.B. 1973. Nutrition in early childhood. Food, Nutrition and Health. W. Rev. Nutr. Diet. 16:1.

85 Jelliffe, D.B. and E.F.P. 1973. Nutritional programs for pre-school children. Zagreb.

86 Jelliffe, D.B. and Bennett, F.S. 1974. Health Education of the tropical mothers in feeding her young child. USHEW.

(87) Jelliffe, D.G. and Jelliffe, E.F.P. 1978. The volume and composition of human milk in poorly noursihed communities: A review. Amer. J. Clin. Nutr. 31:492.

88* King, Morly, Burgess. 1972. Nutrition for Developing Countries. Chapt. 9, The Food Path. Oxford University Press.

(89) Lappe, F.M. and Collins, J. 1977. More food means more hunger. The Futurist 11 (2):90.

90 May, J.M. 1961-1973. The Ecology of Malnutrition. A series of books on malnutrition in various regions of the world. Hafner Publ. Co., N.Y.

91 Monckeberg, F. 1977. Food and Nutrition - Policy in Chile National Food and Nutrition Council, (CONPAN).

(92) Morley, D. 1973. Paediatric priorities in the developing world. Butterworth & Co. Ltd., London, UK.

93* Muller, M. 1974. Money, milk, and marasmus. New Scientist 61:530.

94 Nat. Nutr. Council. 1977. Philippines, Nutrition Program, 1978-1982.

95* PAG. 1977. Food Problems. PAG Bull., 7:(3-4):1-39.

96* Pekkarinen, M. 1973. World food consumption patterns. In Man, Food and Nutrition, CRC press.

(97) Pierce, N.F. and Hirschhorn, N. 1977. Oral Fluid - A simple weapon against dehydration in diarrhoea. How it works and how to use it. WHO Chronicle 31:87.

98 Pines, J.W. 1977. Evaluation of school feeding in Peru and programming for improved nutrition in Peru. USDA Contract TA-C-2217. 12/23/77.

99 Rawson, I.G., Valverde, V. 1976. The ecology of malnutrition among pre-school children in rural Costa Rica. Environmental Child Health. 22(1):12.

(100) Reutliner, S. and Selowsky, M. 1976. The anatomy of hunger: An overview of malnutrition and poverty. World Bank Publications Summary.

101 Tech. Secretariat of Superior Econ. Planning Council, 1975. Nutrition Assessment: Honduras, Vol. 1, Survey.

(102) Tinker, J. 1974. The hungry planet. New Scientist, 63:388.

103* UNICEF. 1977. Community Action - Family nutrition programs - Guidelines and policy procedures. Internat. Union of Nutrtional Sciences, Nat. Inst. Nutr. Hyderbad, India.

104 Vita. A. Consortium Group. Guidelines for the evaluation of vitamin A deficiency and exrophthalmia.

Nutritional Food Technology:

(105) ADM. 1977. The Growing Challenge. ADM Milling Co. Box 7007, Shawnee, Kansas=66207-. U.S.A.

(106) AID. 1976. Extrusion processed foods based on plant protein sources other than soybeans. TAIN-URI project 3/1/75.

107 AID. 1977. The commercial usability and acceptability of Belona (WSB) as a nutritional intervention into the diets of low income families, Anambia and Ino States of Nigeria, USAID 5/77.

108* Baker, R.C. and Robinson, W.B. 1975. Food science research for improving the utilization, processing, and nutritive value of food production. N.Y. State College of Agriculture and Life Sci. Cornell University, NSF, Contract No. STP-75-22533.

(109) Buchanan, B.F. and Stewart, G.F. 1977. Identifying solutions to malnutrition in Latin America. Food Technol. 9(60).

(110) Connor, M.A. Saunders, R.M. and Kohler, G.O. 1976. Rice bran protein concentrates obtained by wet alkaline extraction. Cer. Chem. 53:48.

(111) Farkas, D.F. 1977. Unit operations concepts optimize operations. Chemtech 7:428.

112 INCAP. 1974. Forification of sugar with vitamin A in Central America and Panama.

113 International - Ventures Res. 1973. The Technology for Vitamin A Forification of Tea in Pakistan. USDA Cont. No. 12-17-07-05-765.

(114) Jelliffe, D.B. and Jelliffe, E.E.P. 1973. The role of legumes and dark green leafy vegetables in domestic multimixes for the transitional. PAG Bull. 3(2):40.

115* LIFE. 1971. The Food Industry in Asia. Its potential for providing low cost nutritious foods. Summary report, Singapore Workshop. 11/71, AID TAIN and LIFE.

116 Monckeberg, F.M. and Chichester, C. 1978. Chilean experience with fortified children's formulas. Memo Report.

(117) NAS. 1977. World Food and Nutrition Study: The Potential Contributions of Research with Supporting Papers (5 Volumes). Nat. Res. Council.

118* Oke, O.L. 1975. A case for vegetable proteins in developing countries. W. Rev. Nutr. Diet. 23:259.

(119) Orr, E. 1977. The contributions of new food mixtures to relief of malnutrition. Chapter 5 in Marketing of foods for children through the public distribution system, New Delhi, Workshop , Protein Foods and Nutrition Development Association of India.

(120) Poleman, T.T. Comment in USDA For. Agr. Econ. Rept. No. 143.

121 Protein Food and Nutrition Development Association of India. 1976. Extruder-based foods in India, Report of the Anand Workshop. 1/17/76.

(122) Rajalaskshmi, R. and Ramakrishman, C.V. 1977. Formulation and evaluation of meals based on locally available foods for young children. W. Rev. Nutr. Diet. 27:34.

(123) Scrimshaw, N.S., Wang, D.I.C. and Milner, M. 1975. Protein resources and technology: Status and research needs. NSF-RA, T-75-037.

124 Sgarbieri, V.C. et al. 1978. Nutritional and sensory evaluation of soybean (Glycine max l) and common bean (Phaseolus vulgaris l) for direct use as human food. J. Food Sci. 43:208.

(125) Stewart, G.F. and Amerine, M.A. 1973. Introduction to Food Science and Technology. Academic Press.

(126) Timmer, C.P. 1977. Food aid and malnutrition. International food policy issues, a Proceedings. USDA For. Agr. Econ. Rept. No. 143.

(127) TPI. 1967. The production of protein products from oil seeds. Trop. Prod. Inst. Rept. No. 31.

128* UN. 1976. The United Nations University World Hunger Programme.

(129) USDA, ERS. 1972. Improving marketing systems in developing countries: an approach to identifying problems and strengthening technical assistance. For. Agr. Econ. Rept. No. 93.

130 USDA. 1975. Food supplements in the Philippines, USDA Contract 12-17-07-5-1251, 6/75.

131 USDA. 1977. Survey of commercial weaning food in LDC's. El Salvador and Costa Rica. USDA 12-17-07-2-1743 - x 6/7.

132 Willse, E. 1977. Salt ionization plant - Pakistan. TA/N Report 2/77.

Appropriate Food Technology, Post-Harvest:

(133) April, J.E., Hersh, G.N., Rogers D.J. and Slater, C.C. 1974. Cassava's role as a food staple. A cross disciplinary systems analysis of nutrition problem in a cassava dependent culture. AID/CM/TA-C-73-44. Univ. Colorado.

134 Allright, N. 1974. Everything you can do with tomatoes. Organic Gardening and Farming 20(8):34.

135* Anon. 1974. Tools and cookware for preserving foods. Organic Gardening and Farming 20(8):37.

(136) Bourne, M.C. 1976. Promising avenues for the reducting of post-harvest food losses in developing countries. A report to TAB/AID, June, 1976.

(137) Bourne, M.C. 1977. Post-harvest food losses - The neglected dimension in increasing the world food supply. Cornell Internal. Agri. Mimeograpn 53.

138* Bourne, M.C. 1977. The role of post-harvest food loss reduction in improving the economic and nutritional status of troptical populations. Seminar on reduction of post-harvest food losses in the Caribbean and Central America, Santo Domingo and the Dominican Republic.

139* Branch, D. 1978. Tools for small-scale grain raising. Organic Gardening and Farming 25(4):88.

(140) Caurie, M., Lee, T.C. and Chichester, C.O. 1977. Underutilization of food technology resulting in losses of available food in West Africa, AID/TAIN.

141* Cole, R.C. and Bartow, L.J. 1962. Problems associated with the development of fisheries in tropical countries. The preservation of the catch by simple processes. Trop. Sci. 7:165.

142 Collins, G.A., Coward, L.D.G. and Pinson, G.S. 1977. A feeder to improve the performance of a hand-operated groundnut sheller. Trop. Prod. Inst. Rural Technology Guide 4.

(143) Community Development Trust Fund of Tanzania. 1977. Apporpriate technology for grain storage.

(144) Connor, M.A., Saunders, R.M. and Kohler, G.O. 1976. Rice bran protein concentrates obtained by wet alkaline extraction. Cer. Chem. 53:48.

145* Cummings, R.W., Jr. Food crops in low-income countries: The state of present and expected agricultural research technology. Working Papers. The Rockefeller Foundation.

146 Disney, J.G., Cole, R.C. and Jones, N.R. 1973. Considerations in the Use of Tropical Fish Species. Technical Conference on Fishery Products, FAO.

147* FAO. 1977. Analysis of an FAO survey of post-harvest crop losses in developing countries. AGP Document. AGPP: MISC/27 3/77.

(148) FAO. 1977. Reducing post-harvest food losses. Committee on Agriculture. COAG/77/6.

149 GIDA/ALC. 1977. El Salvador project for the reduction of post-harvest losses of corn, beans, sorghum, and rice.

150* GIDA/ALC. 1977. Post-harvest Systems in Central America. 7/77.

(151) Harriss, B. 1976. Paddy processing in India and Sri Lanka: A review of the technological innovation. Trop. Sci. 18:161.

152* Hoffman, A., Disney, J.G., Pinegar, A. Cameron, J.D. 1974. The Preservation of some East African Freshwater Fish. African Journal of Tropical Hydrobiology and Fisheries 3(1).

153 Horter, J.L. 1971. How to store your food crops, Part I: Building the storage room. Part II: Building the storage room. Organic Gardening and Farming, 18(8): 42 and 18(9):84.

(154) IDRC. 1976. Rice: Post-harvest Technology. IDRC. P.O. Box 8500, Ottawa, Canada.

(155) IGAD/LAC. 1977. Post-harvest systems in Central America. IGAD/LAC Program Identification 7/77.

156 IRRI. 1976. Rice Machinery Development and Industrial Extension: Semi-Annual Progress Report, Jan-June, 1976. (PN-AAD-001).

157 James, D.G. 1976. The contribution of the fish technologist to improvement of fish products in developing fisheries. Food Technol. Aust. 27:324.

158 Jones and Disney. 1976. Technology in fisheries development in the tropics. Tropical Products Institute.

(159) LIFE. 1970. Meeting food packaging needs in developing countries. Report of Workshop, 20-30 April, 1970, Washington, D.C. League for International Food Education.

(160) LIFE. 1978. Post-harvest grain loss assessment methods. LIFE/TPI/FAO, Publ. AACC under AID contract.

(161) MacGarry, B. 1977. A ground nut shelling seive and a fan assisted forge design. Approp. Technol. 4(1):29.

(162) Mahadeviak, M. 1970. The Alternatives to Sanitary Cans for Packing Food. J. Food Sci. Technol. (Mysore) 7(1):3.

(163) Majumder, S.K. 1970. Protecting food from deterioration during storage handling and distribution in technologically less developed countries of the world. SOS Proc. p. 518.

(164) Mitsudo, H. and Nakajima, K. 1977. Storage of cooked rice. J. Food Sci. 42:1439.

165 Moran, M.J. 1977. Transfer of post-harvest technologies to small farmers prepared for the "Seminar on post harvest food losses in the Caribbean and Central America", August 8-11, 1977, Santo Domingo, Dominican Republic.

(166) NAS. 1977. Post-harvest food losses in developing countries. NAS Staff Summary Report 11/77. AID/CSD-2584.

(167) Reichert, R.D. and Youngs, C.B. 1976. Dehylling cereal grains and grain legumes for developing countries. L. Qualitative comparison between attrition and abrasive - type mills. Cer. Chem. 53:829.

(168) Reusse, E. 1974. A case for community based oil extraction in small farms and palm rehabilitation schemes versus the large-scale general milling approach in Nigeria. West African Seminar on Agricultural Planning. FAO/NORAD.

(169) Reusse, E. 1976. Economic and marketing aspects of post-harvest systems in small farm economies. Mo. Bull. Econ. and Sta. 25(9):1 and 25(1):8.

170 Rogers, J.F., Cole, R.C. and Smith, J.D. 1975. An illustrated guide to fish preparation. Tropical Products Institute. G83.

171* SEARCA. Post-harvest Digest - a publication of the cooperative post-harvest research and development programme in S.E. Aisa U.P. at Los Banso, College, Laguna, Philippines.

172 Stoner, C.H. 1974. Store your harvest this fall. Organic Gardening and Farming. 21(8):33.

(173) Stoner, M. 1974. Shortcut picling. Organic Gardening and Farming. 21(8):46.

(174) Tainsh, J.A.R. 1976. Farmers need "mini-mills". 2: for the rice grower. W. Crops 27:198.

(175) The Solvent Extractors Association of India. 1977. Survey of Edible rice bran oil 11/25/77.

176 TPI. 1976. TPI and tropical fisheries development. Post-harvest Leaflet No. 1.

177* TPI. 1976. Fish preservation in the tropics. Overseas Development. No. 58, May 1976 p. 6 and 7.

178 TPI. 1977. Mixing insecticide powders with grain for storage. Rural Technol. Guide 3.

(179) VITA. 1970. VITA Village Technology Handbook, 3706 Rhode Island Ave., Mt. Ranier, MD -20822-

(180) VITA. 1977. Small farm grain storage. Action/Peace Corps Program and Training Journal Manual, Series No. 2, 9/76 VITA Publications Manual Series No. 35 E, VITA.

181 Wells, J. 1974. Easy way with vegetables. Organic Gardening and Farming, 21(8):38.

Appropriate Food Technology, Dehydration:

182 Akyurt, M. and Selcuk, M.K. 1974. A solar device supplemented with auxillary heating systems for continuous operations. Solar Energy 15:309.

183* Annon. 1976. Aid for Bandladesh. Australian Fisheries 35(3):4.

184 Bortz. 1975. Build a low-cost indoor direr. Organic Gardening and Farming 22(8):52.

(185) Bialostocki, S.J. 1977. A low cost wood fired grain drier. Approp. Technol. 4(1):20.

186 Branch, P. 1976. Choosing the right food drier. Organic Gardening and Farming 23(8):66.

187 Brown, C.E. 1971. Sundrying foods with homemade equipment. Organic Gardening and Farming 8(7):56.

(188) Clark, C.S. 1976. Village Food Technology: Solar drying of vegetables. LIFE, Newsletter, April 1976.

189 Del Vallee, F.R. and Gonzalez - Indigo, J.L. 1968. A quick salting process for fish 2. Behavior of different species of fish with respect to process. Food Technol. 22:1135.

(190) Del Vallee, F.R. and Nickerson, J.T.R. 1968. A quick salting process for fish 1. Evolution of the process. Food Technol. 22:1036.

(191) Del Vallee, F.R., Padilla, M., Ruz, A. and Rodriguez, R. 1973. Pilot plant production of and large scale acceptance trials with quick salted fish cakes. J. Food Sci. 38:246.

192 Disney, D.J. and Hoffman, A. 1976. A dried fish silage product. Proc. Torry Res. Stu. Symp. Aberdeen.

(193) Doe, P.E. et. al. 1977. A polyethene tent drier for improved sun drying of fish. Food Technol. Austr. 27:437.

194 Doe, P. 1977. Sun powered fish drying. Austr. Fisheries 36(5):24.

195 Dycus, R. 1973. Drying food in a cardboard box. Organic Gardening and Farming 20(11):92.

196 Feiger, J.B. 1974. How to dry beans. Organic Gardening and Farming 21(9):71.

197 Fisher, D. 1975. Easy dries it. Organic Gardening and Farming 22(8):54-58.

198* Flack, P.D. 1972. Fruit Leather - A natural for stockpiling the orchard suplus. Organic Gardening and Farming 19(8):114.

199 Guinn, R. Soybean drying using heat from solar energy. Teledyne Brown Engineering. Huntsville, Alabama. -35807-.

(200) Hoffman, A., Barranco, A., Francis, B.J., Disney, J.G. 1977. The effect of processing and storage upon the nutritive value of smoked fish from Africa. Trop. Sci. 19:41.

201 Kulser, E.A. 1968. A homemade dryer that save surplus fruit. Organic Gardening and Farming 15(11):62.

202 Lawand, T.A. 1966. A Solar Cabinet Drier. Solar Energy 10:158.

203* McBean, D. McG. 1975. Sun-drying of foods. Food Technology in Aust. 27:475.

(204) Moledina, K.H., Regenstein, J.M., Baker, R.C., Steinkrause, K.H. 1977. A process for the preparation of dehydrated salted fish-soy cakes. J. Food Sci. 42(3):765.

(205) Nat. Acad. Sci. 1976. Salt Production and Solar Crops Drying In Energy for Rural Development. p. 78 and 79.

206 Scott, E. 1974. Dried Sweet Corn - Nothing like it in the whole world. Organic Gardening and Farming. 21(8):52.

207 Smith, C. Solar Energy Applications Laboratory. Colorado State University.

(208) Srinivas, T. et al. 1976. Studies on the use of dry earth as a contact medium for absorbing mositure from paddy. J. Food Sci. and Technol. 3:142.

(209) Szulmayer, W. 1971. From sun-drying to solar dehydration Part L: Methods and equipment, and Part LL: Solar drying in Australia. Food Technol. in Aust. 23:440 and 494.

(210) Tan, T.H. et al. 1967. The manufacture of low-salt fish paste. Philippine Agriculturalist 51:626.

211* Thomas, P.L. 1975. Dried meat products. CSIRO Fd. Res. Q. 35:73.

212 TPI. 1976. TPI and tropical fisheries development. Post-harvest Leaflet L. June 1976.

213 USDA. 1958. Sun dry your fruits and vegetables. Extension Service.

(214) Watanabe, K. 1975. An experimental fish drying and smoking plant in Volta Lake,Ghana: Design construction and economic considerations. Trop. Sci. 17:75.

215 Weeks, L.E., Jr. 1977. An inexpensive evaporator for backyard syrup making. Organic Gardening and Farming 24(2): 138.

Appropriate Food Technology, Other:

(216) AID. 1977. Feasibility Study - Project bean CARE - Ecuador. 12/77.

(217) Anand, J.C. 1975. Development of appropriate technology for a breakthrough in fruit and vegetable processing industry Indian Fooc Packer. 29(6):31.

(218) AID. 1976. Extrusion processed foods based on plant protein sources other than soybeans. TAIN-URI Project 3/1/75.

219* Boulding, E. 1977. Women, peripheries and food production. Univ. of Colorado at Boulder.

220* Bressani, R., Elias, L.G. and Molina, M.R. 1977. Algunos ejemplos de la industrialización de productos agricolas a traves de tecnologias intermedias. Interciencia 2:281.

221* Buchanan, B.F. 1978. Self-help for the alleviation of malnutrition problems in Latin America through utilization of local appropriate food technology. AAAS Meeting February 14, 1978. Washington, D.C.

222 Bushuk, W. 1976. More food through improvements in grain production and processing. Food Tech. Austr. 28:253.

223 Cahpel, C. 1972. The ingeneous homemade apples press. Organic Gardening and Farming 19(9):92.

(224) Cloud, K. Sex roles in food production and distribution systems of the Sahel. AID Afr/SFWA No. 125-11-625-0907.

(225) Dovlo, F.E., William, C.E. and Zoaka, L. 1976. Cowpeas: Home preparation and use in West Africa. IDRC, Box 8500 Ottawa, Canada.

(226) Evans, I. and Wharton, P. 1977. The Lorena Mudstove: A wood-conserving cookstove. Approp. Technol. 4(2):8.

(227) FAO/PAG. Family Resource Management Workshop, Mali, Cooperative with FAO PAG - Role of Women in Food Production and Processing.

228* FAO. 1969-72. Development of home economics programmes, West Malaysia.

(229) FAO. Food Preservation Series 1. Vol. 1 and Vol. 3.

230 FAO. 1975. The family in integrated rural development. Rome, 1975.

231 FAO. 1975. Report of expert consultation on home economics in rural development. Rome 7-10, April 1975.

232* Forsythe, D. J. C. 1977. Appropriate technology in sugar manufacturing. World Development 5:189.

233* Ghosh, B.N. 1976. A bicycle-operated PTO unit. Agri. Eng. 57(11):157.

234 Hammond, R.W. 1977. Appropriate technology aspects of solar energy, Pictorial monograph, No. 2, AID Grant 211 (d) GIT.

(235) Hessetine, C.W. and Wang, H.L. 1967. Traditional fermented foods. Biotech. Bio-Eng. 9:275.

(236) Honda, M.M. 1977. Solar cooker. Approp. Technol. 4(2):28.

(237) Hulse, J. 1978. Ten days for world development. J. Can. Inst. Fd. Technol. 11(1):8.

(238) IFT. 1978. Intermediate/Appropriate Food Technology. Food Technol. 32(4):75-92.

(239) INTEC. 1976. Principal projects on extrusion cooking done INTEC-Chile 11/76.

(240) LIFE. 1977. Food and feed from wastes and agricultural residues. USAID Grant ta-B-1235.

241* McCullough, J.C. 1977. Pedal power - the new revolution. Organic Gardening and Farming 24(6):82.

(242) McDowell, J. 1976. Village technology in Eastern Africa. UNICEF, Regional Seminar on simple technology for the rural family. 6/14-19/1976.

(243) McDowell, J. 1977. Appropriate technologies for tackling malnourishment. IUNS Working Conference India. UNICEF.

244 McReynolds, K. 1974. Its' (Herb) tea-picking time. Organic Gardening and Farming 21(9):75.

245* Moledina, K. 1974. Intermediate food technology in Tanzania. Approp. Technol. 1(1):9.

246* Mustakas, C.C., et.al. 1967. Full-Fat Soy Flour by a Simple Process for Villagers. (PNNAAE038).

247* Nat. Acad. Sci. 1974. Food science in developing countries. A slection of unsolved problems.

(248) Nelson, A.I. 1976. Soybean Processing Using Low Level Technology. Final Report. (PNAAC-999).

249* PAG. 1977. Women in food production, food handling and nutrition. PAG. Bull. 7(3-4):40, 1977, and final report, 6/77.

(250) Roberts, H.J. 1977. Technolgoical Approach to Human Needs. L.I.F.E. Internal memo, August, 1977.

(251) Robinson, R.J. and Kao, C. 1977. Tempeh and miso from chickpea, horsebean, and soybean. Cer. Chem. 54:1192.

252 Ruesse, E. 1968. Ghana's Food Industries. UNDP Project in Ghana.

253 Ruttle, J. 1976. Using pedal power in the harvest kitchen. Organic Gardening and Farming. 23(8):100.

(254) Simmons, E.B. 1975. The small-scale rural food-processing industry in Northern Nigeria. Fd. Res. Inst. 14:147.

255* Simmons, E.B. 1977. Economic research on women in rural development in Northern Nigeria. OLC#10, 9/77.

(256) Simon, E. and Solis, P. 1977. Economic stove that burns sawdust as fuel. Approp. Technol. 4(1):23.

257* Sison. 1975. Food technologist have much to contribute in solving food problems. The Searca Diary, November 1975. pg. 5.

(258) Steinkraus, K.H., van Veen, A.G. and Thiebeau, D.B. 1967. Studies on Idli-In Indian fermented black gram-rice food. Food technol. 21(6):110-113.

(259) Sterner, M.H., Sterner, M.M. and Zeidler, G. 1978. The hand texturizer - A high protein, quick cooking food producer. Approp. Technol. 4(4):20.

260 Sullivan, G. and J. 1974. Apples pressin' an annual affair. Organic Gardening and Farming 21(9):73.

(261) TPI. 1975-77. Tropical Products Institute Reports. 1972-1974 and 1974-1976.

262* UNICEF. 1976. Village Technology. UNICEF News, Issue 90/1976/4.

(263) Univ. of Ghana. 1975. Seminar on the food industry in West Africa.

264 van Veen, A.G. 1963. Fermented and dried seafood products in southeast Aisa in Fish as Food, ed. G. Borgsteam, Vol. 3, Processing, Part I, p. 227-250, New Tork: Academic Press.

(265) van Veen, A.G. et. al. 1967. Nutritive quality of Idli, a fermented food of India. J. Food Sci. 32:339.

(266) von Oppen, M. 1977. The sun basket. Approp. Technol. 4(3):8.

(267) Worgan, J.T. 1977. Canning and bottling as methods of food preservation in developing countries. Approp. Technol. 4(3):15.

(268) Zamora, A.F. and Fields, M.L. 1978. Production of corn and legume malts for use in home fermentation. J. Food Sci. 43:205.

<u>Anthropological/Cultural:</u>

(269) McDowell, J. 1976. In defence of African foods and food practices. Tropical Doctor, Jan. 1976. p. 37.

270 McKenzie, J.C. 1969. Overcoming resistance to new food products. Proc. Nutr. Soc. 28:103-109.

271 Pringle, L. 1976. Foraging for food provides rewards for a brave palate. Smithsonian 7(6):121.

272* Robinson, J. 1978. Contribution of Anthropolgy to the Assessment of nutritional status. Fed. Proc. 37-47.

273* Todhunter, E.N. 1973. Food habits, food faddism and nutrition. W. Rev. Nutr. Diet. 16:286.

274* Uchendu, V.C. 1970. Cultural and economic factors influencing food habit patterns in Sub-Saharan Africa. SOS 70, Proc. 3rd Int. Cong. Food Sci. and Technol.

275 Wilson, C.S. 1978. Contribution of nutrition science to anthropolical research. Fed. Proc. 37:73.

APPENDIX A

Key: (D) Description and References (   ) (Ex) Example (V) Value

(N) Development need (P) Priority

<u>Value Key</u>:

(P) Preserve nutritive value

(I) Improve nutritive value

(E) Enchance nutrient ingestion

(F) Facilitate consumption

APPENDIX A

AN OVERVIEW OF FOOD TECHNOLOGY OPERATIONS DEEMED APPROPRIATE IN PREVENTING RURAL MALNUTRITION

A. <u>Refine</u>

D Separate edible components, eliminate inedible or contaminating substances.

Ex As presented in 1-8.

1. Clean, wash

D Physical or aqueous removal of extraneous material. Facilitated by minimizing contact with dirty, unsanitary surroundings. (180)

Ex Dry cleaning of grains and legumes, washing of tubers and vegetables.

V (F) Increases storage life and asthetic and sanitary quality.

N Mechanics of dirt and debris removal while preventing recontamination. Minimize or exclude use of water (if limited or contaminated). Cleaning and sanitation training programs.

P Medium - important in combination with other FT interventions and education efforts.

2. Thresh, dehull, shell, husk, winnow, degerm (142,151,156,161,167, 180)

D Physical rupture followed by removal of inedible or morphologically distinct portions from grains, legumes, oilseeds and nuts.

Ex Peanut shelling and blanching, grain dehulling.

V (E,F) Removes refractory substances for subsequent use as fuel or feed, improves quality and functionality of edible fractions, provides nutrient rich components - bran, germ.

N Simple economical labor saving devices which reduce wastage and produce quality edible fractions. Avoidance of overrefining, subsequent utilization schemes. Machines sufficiently versatile to refine a variety of foods depending upon region and specific preferences.

P High where post harvest losses are serious.

3. Mill, screen

D Size reduction, separations for dried grains, legumes, oilseeds. Selective processes can classify fractions with varying nutritional, functional properties. (174,180,261)

Ex Manufacture of flours and millfeed byproducts.

V (E,F) Inexpensive, quality flours from staples prepared with minimum effort and loss. Nutritive ingredients for formulation.

N Simple, versatile milling/screening devices from family to village in scale based upon indigenous construction materials. Assessment of social implications of efficient milling (labor saved and how utilized).

P High, scale of application unsure.

4. Peel, deseed, core, slice

D Removal of inedible portions from fruits and vegetables and subsequent preparation.

Ex Tuber peeling, fruit slice preparation.

V (F) Less preparation waste, improved sanitation.

N Study of the need for and development of simple machinery.

P Low - probably not a serious barrier in food refinement operations.

5. Grate, crush, grind

D Often tedious size reduction steps in refinement of root or cereal staples. Analogous to milling but with moisture naturally present or added.

Ex Tuber or cereal gruel preparation.

V (E) Simplifies preparation, conserves raw material.

N Versatile machines for home and/or small industry. Information on nutritionally beneficial consequences of improving the operations.

P High - where time saved is profitably utilized.

6. Press, expell

D Application of pressure to remove fluid (juice or oil) from crushed plant material.(127,133,168,223)

Ex Oil recovery from oilseeds, fruit or cane juice production.

V (E,F) Nutrient rich juices, edible oil and/or high protein partially defatted meal for human or animal use.

N Simple mechanical presses and pre-press treatments to make extraction more efficient. Improve existing expeller processes to upgrade meal/oil quality. Scale down of expeller operation.

P High - where oilseeds grow but aren't assimilated into energy deficient diets.

7. Extract, solubilize, digest, precipitate (110, 123, 144, 175).

D Means of either removing toxins or recovering useful constituents in a more concentrated or utilizable form.

Ex Cassava leaching, soymilk preparation, leaf protein manufacture.

V (I.E.F.) Ingredients so refined can upgrade the nutritional value, functional properties and acceptability of staples.

N Insights into the scale-down feasibility of recovery operations and nutritional applicability of resulting foods. (liquid cyclone processed cottonseed). Study of plant enzymes to perform useful digestions (starch, cellulose, protein).

P High at above village level, low at home level.

8. Scale, pluck, skin, eviscerate, debone

D Refinery steps with animal products.

Ex Butchering livestock, fish filleting.

V (F) Increases quality and safety of high protein foods.

N Sanitary procedures which reduce spoilage and increase recovery of edible material and byproducts.

P Low - expect where fish are plentiful.

B. <u>Preserve</u>

D Protect from intrinsic spoilage or hostile environments.

Ex As presented in 9-19.

9. Dehydrate, concentrate (15,180,185,188,193,208,209)

D Moisture removal to below levels where microbial and enzymic activity are storage limiting.

Ex Field (solar) drying of grains and legumes, solar drying of fish, hot air (mechanical) drying of cassava chips.

V (P,E) Some nutrients lost during dehydration, but overall nutrient and storage life extended. Bulk reduction with attendant ease of transportation and storage.

N Simple solar dehydration systems suitable to humid tropics, protection from pests, insects and spoilage microorganisms during drying. Effective supplementary systems to complement solar dehydration based upon efficient combustion of renewable energy resources (agricultural waste material or natural vegetation). Indirect dehydration tied into cooking procedures (fat frying, baking), or hot sand/soil, cooking fires, extrusion.

P High - at home, village and industry levels both for post harvest storage and preservation.

10. Salt, sugar

D Substances either naturally present or added to reduce water activity (effectively compete for water). Combined with partial dehydration result in stable "intermediate moisture" foods. Most commonly applied to animal foods or fruits.(191,204,205,210)

Ex Salted fish, fish cakes, cheese, raisins, figs, jellies.

V (P) Partial dehydration a milder process, less drying time and energy expended, stability achieved more rapidly.

N Processes for economically manufacturing reasonably pure salt and sugar. Search for indigenous water activity reducing substances (polyols?).
Synergistic combinations with other natural substances. Osmotic dehydration/regeneration systems using available energy sources.

P Medium, high - where fish are nutritionally important.

11. Smoke

D In conjunction with salting and drying imparts flavor, may discourage pests and insects and has modest preservative action. (140, 190, 200, 214).

Ex Animal/fish products.

V (P) Improve palatability and storage of salted/dehydrated foods.

N Simple energy efficient smokers/dryers. Effective use of smoke and heat generated during normal cooking procedures. Feasibility of smoking procedures with a range of perishable foods not traditionally smoked (animal flesh, vegetables).

P Medium - in combination with intermediate moisture food process development.

12. Pasteurize, sterilize (canning)

D Application of sufficient heat for an adequate time to destroy microorganisms and enzymes in food packaged hermetically to prevent post process recontamination. (217, 229, 267).

Ex Home canning.

V (F,P) Thermally processed foods are stable, long lasting, convenient to use.

N Container cost and availability and logistic demands for pressure processing equipment are serious barriers. Investigation of re-usable glass jars, inexpensive flexible pouches and retorting systems. Development of simple sterilizable hermetic containers for acid and low acid processes. Solar and renewable energy based simple steam generating equipment.

P Low - except where community or home canning overcomes container logistic constraints.

13. Irradiate

D High energy irradiation at low dose rates can inhibit sprouting, destroy pests and insect contamination. High doses can sterilize foods.

Ex Sprout inhibition in tubers, grain deinfestation

V (P) Reduces post harvest losses.

N Feasibility of low dose irradiation integrated with other stabilization methods.

P Low - in current political climate but long term potential still exists.

14. Ferment

D Naturally present or innoculated microorganisms under the proper environmental conditions can either stabilize or upgrade food material by their metabolic activity. (235, 240, 251, 258, 265, 268).

Ex Lactic acid production - pickles; sauerkraut-type foods; mold fermentation-tempeh; vinegar production, yeast/alcohol manufacture.

V (P,I) Acid production facilitates stabilization, mold mycelia can improve nutritive value and texture. Low value waste material upgraded to food, feed or fuel (SCP,methane manufacture).

N Study of successful indigenous food fermentations in the Orient and feasibility of applying them to other foods and/or in other regions. Insights into cultural biasis to fermented foods. Village level fermentations based upon low cost or waste material and subsequent use of the biomass or end products in human foods.

P High - particularly where traditional fermentations are accepted.

15. Pickle

D Reduction of pH below 4.5 by naturally present, added or fermentation-generated acid to reduce the heating requirements for pasteurization. A less rugged container and simple heating system at <100°C are practical. (164, 173, 162).

Ex Pickled vegetable and specialty products (dill, ceviche).

V (P,F) Convenient, stable, improved or distinct flavor.

N Survey of plastic packaging materials and evaluation for pickled products. Investigation of local ceramic and wood material for pasteurization containers (probably hot fill).

P Medium - particularly for short term stabilization of perishables.

16. Stabilize Chemically

D A range of natural and synthetic compounds can act synergistically with acids, salt, smoke, heat, etc. in the right storage environment to effectively preserve foods. (136, 164, 166, 247).

Ex Sulfur dioxide, nitrites, benzoates, propionates, hydrogen peroxide, formaldehyde and simple natural compounds.

V (P) Small quantities judiciously used in combination with good processing, packaging and storage practices can dramatically increase storage life at minimum cost.

N Manufacture of simple natural preservatives from local plant matter. SO_2 generation from local sources of sulfur. Determination and maintenance of safe use levels. Emphasis upon good sanitary practices. Control of tendencies to chemically "resurrect" spoilt food or overdose chemically.

P Medium - except where chemicals are readily available.

17. Package

D From harvest to consumption foods must be protected from the environment. Methods include containers of indigenous plant and ceramic materials, well designed holes in the ground, discarded or adapted industrial materials (metal, glass, plastic). Scale from bulk handling of an entire harvest to portions for an individual serving. (159, 162, 163).

Ex Thatched silos for grain storage, plastic packaging of multimixes.

V (P,A) Sound packaging can dramatically reduce food losses and promote the development of effective processing and distribution schemes.

N Low cost packaging materials for bulk and hermetic storage at home village and small industry levels. Development of both indigenous and industrial (with reuse potential) materials,

P High - under most LDC circumstances.

18. Cool, refrigerate, freeze

D Either naturally or mechanically derived low temperatures slow down most food deterioration reactions and lengthen storage life. (137, 179).

Ex Below ground or high altitude storage of tubers or perishables, icing of fish, vegetables.

V (P) Food quality maintained, availability of perishables increased.

N Simple optimization of environmental factors - shade, natural insulation, cool breezes, water, high elevation, diurnal temperature cycles (cool nights - warm days). Evaporative cooling based on porous ceramics or moist cloth for arid regions where water is available. Mechanical refrigeration studies in conjunction with energy projects (solar, wind, methane geothermal, etc.)

P High - where climatically feasible.

19. Store

D Strategy which take optimum advantage of environmental factors combined with protective packaging and good sanitation is the first step in reducing food losses throughout the food chain and makes other preservation efforts more effective. (136, 143, 163, 180).

Ex Staple crop handling systems are recommended in Food Technology publications for LDC's.

V (P,A) Even slight reduction of food waste at all steps has beneficial additive effects.

N Extension strategies to disseminate food storage and handling information of practical value under the constraints of rural poverty.

P High - in conjunction with other education efforts.

C. <u>Formulate</u>

D Combine food ingredients, modify structure, improve form of presentation.

Ex As presented in 20-26.

20. Mix, blend

D Mechanical action to combine wet and/or dry food ingredients in desirable proportions. (105, 114, 119, 127).

Ex Combination of dry ingredients to form multimix flours, mixing flavorful nutrient rich ingredients with staples in stew, gruels, etc.

V (E,F) Judicious combination of ingredients possessing complimentary nutrients and functionality can enhance the nutritive value and acceptance of the resulting blend.

N A range of practical formulations based upon indigenous ingredients. Means of disseminating information regarding preparation and utilization of home, village and industry prepared multimixes. Data on socio-economic-nutritional impact.

P High - at all levels.

21. Knead

D Mechanical working of a moist or liquid food mass to develop a specific dough-like consistency or liquid slurry. Usually employs tedious handling of the local grain or tuber staple. (254, 263).

Ex Preparation of bread dough, corn masa, cassava, fufu, porridge, gruels (for infants).

V (F) Improves rheology and acceptance of basic staples, possibly amenable to nutritional enrichment.

N Simple mechanical devices to improving kneading/mixing efficiency at the home and village level based on local materials. Insight into how time and effort saved could be applied to improving family nutrition. Mechanics for fortification during kneading.

P High - if direct nutrition improvement can be demonstrated.

22. Homogenize, emulsify

D Mechanical action to disperse and stabilize phases - generally liquid/liquid or solid/liquid food systems. (248).

Ex Butter churning, soymilk manufacture, gruel from staples.

V (I.E.F) Food more palatable, digestible for infants, fortification opportunities.

N Effective low power homogenizer/emulsification equipment. Means of optimizing concentration of key nutrients (not too dilute for adequate nutrition not too concentrated for ingestion). Emulsification/stabilization systems based upon indigenous ingredients (oil, lecithin, starch, etc.).

P Low - unless important to efficient formulation of weaning food preparation.

23. Extrude, puff

D A mixing kneading action on semi-moist foods under conditions which generate heat and pressure followed by rapid release of pressure to flash off moisture and set the structure. (106, 121, 239, 259).

Ex Thermoplastic extrusion of snacks, multimixes or texture vegetable proteins. Batch puffing of cereal grains.

V (P,I,F) Can provide blending, stabilization, cooking, dehydration and texturization efficiently in one continuous step.

N Scale down of extrusion principle to village or even home level. Simple batch puffing devices for home use with indigenous foods. Investigation of food combinations and operating conditions for the production of inexpensive nutritious, acceptable extruded or puffed foods. Feasibility of rural applications for existing moderate throughput (∿300 Kg/hr) cooker extruders. Possibility of modifying industrial oil expellers to function as extruders or cookers for producing partially defatted meal for human consumption.

P High - if scale down and batch devices are practical.

24. Coagulate, compact

D Application of heat, acid, salts can coagulate fluids. Subsequent pressure treatment of the amorphous or particulate solids can form a coherent structure. (190).

Ex Tofu, yuba, cheese manufacture, cereal-oilseed wafer, salted fish cake.

V (E,F) Provides texture, reduces bulk, makes material less subject to spoilage or waste, concentrates nutritive value.

N Means of efficiently coagulating protein and other nutrients from dilute solutions (see item 6) i.e., whey, leaf juices, animal blood, oilseed milks, plus complimentary utilization with basic staples. Simple pressure devices to form texturized or pelletized foods or pharmaceuticals to meet specific nutritional or therapeutic needs.

P Medium - where raw material resources and processing economics are favorable.

25. Enrobe, coat, wrap

D Surrounding an amorphous or untextured food by a drier, flexible material to form an edible "package".

Ex Sandwich, tortilla with beans, chappatis with pulses.

V (I,F) Simplified handling and distribution, partially protective - improved sanitation, complimentary ingredients can provide improved nutrition. Useful presentation form for multimixes.

N Investigate familiar foods as carriers for nontraditional supplements - leaf, SCP, FPC, etc. Means of improving the protective effect and durability of the outer portion and palatability of the whole.

P Medium - where basic staples used as wraps and complimentary ingredients available.

26. Sprout

D Under proper moisture and temperature conditions viable seeds will germinate and change dramatically in structure and composition. (268).

Ex Soy, mung bean sprouts, germinated wheat.

V (I,F) Nutritive value, digestability and palatability of sprouts generally greater than the dormant seed.

N Storage methods which optimize retention of seed viability. Study of nutritive value and acceptance of sprouts from local seed stocks and means of incorporating into food supply.

P Medium - where seed quality and food habits are favorable.

D. Consume

D Prepare in convenient, palatable, ingestible form.

Ex As presented in 27-32.

27. Transport, market, distribute

D Getting proper food in adequate quantity in raw, refined, preserved or formulated form to the most vulnerable individuals on a regular basis. (129, 169).

Ex Distribution of multimixes in MCH Centers, promotion of home produced weaning foods.

V (F,A) Unless food can be afforded and is presented to and consumed by those in need, its nutritive value is zero.

N Means of putting food where it is most needed under the economic constraints of rural poverty. Avoidance of maldistribution between economic groups or among family members.

P High - in any nutrition related intervention program.

28. Soak, Reconstitute, Precook

D Dry, intermediate moisture or foods containing unpalatable or toxic substances require rehydration or leaching. (133, 216).

Ex Bean soaking, corn steaming, cassava leaching, fish cake rehydration.

V (E,F) Reduces cooking time, increased ease of preparation, improves palatability, stability, and/or ease or preparation.

P High - where legumes are important and cooking is a difficult operation.

29. Cooking - warm, boil, bake, fry, roast, etc.

D Food preparations requiring heating. Vary widely depending upon food, meal pattern (culture) and environment. Critical last step prior to immediate or delayed consumption. Present many opportunities to improve nutritional value, acceptability and convenience of foods. (225, 226, 236, 256, 266).

Ex Bean boiling, bread baking, tempeh frying, snack frying.

V (P I E F) Depending upon systems - inactivates antimetabolites, reduces microbial contamination, stabilizes biochemially, improves digestability and nutritive value, forms desired structure, increases calorie density and/or functionality. In general, transforms inedible or poorly accepted raw material into desirable dietary components.

N More efficient cooking devices and food preparation procedures to conserve fuel and reduce cooking time and expense. Solar heating systems to conserve or replace scarce fuel and heat exchange systems for indirect solar heating. Biomass conversion to generate methane. Methods of extending the versatility of food staples - economic substitution without nutritional penalties.

P High - with traditional and new food systems.

E. Therapy

D Food as a therapeutic vehicle for correction of disease states which aggravate malnutrition. (22, 92, 97).

Ex Fluid balance establishment during diarrheal diseases (oral rehydration). Use of pharmaceutical or natural plant medicinal materials combined with foods to combat intestinal parasites.

V (I.E.A) Provides physiological resistance to malnutrition.

N Simple, stable,convenient oral rehydrating formulations. Study of physiological needs amenable to preventative preparations. Knowledge of useful indigenous medicines and dangers associated with overdoses or accompanying toxins. Medical feasibility.

P High - with oral rehydration . low with other systems, unless reasonably safe dispensing can be assured.