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PRESENT ACTIVITIES BY U.S. GOVERNMENT AGENCIES TO EXPAND THE PRODUCTION AND UTILIZATION OF PROTEIN FOODS

Office of Nutrition
Agency for International Development
U.S. Department of State
Washington, D. C.

PREFACE

In 1968, the Secretary General of the United Nations asked the member nations to report on activities by their countries aimed at increasing the production and utilization of protein foods. This report is based upon the U.S. reply. A vast array of activities are being carried out by government departments, universities, and private industry. Collecting information on all of them - even if possible - would have taken years. This report is therefore illustrative, rather than comprehensive. It is hoped that this information will be of interest and use to those interested in this problem around the world.

The report was compiled with the generous assistance of the President's Scientific Advisory Committee, the U.S. Department of Agriculture, the U.S. Department of Health, Education and Welfare, the Bureau of Commercial Fisheries of the U.S. Department of the Interior. Compilation, drafting, and editing were provided by Dr. O.L. Kline, Dr. David Hand, Dr. Gerald Combs, Dr. Aaron Altschul, Dr. Nevin Scrimshaw, and Miss Jane Dietrick.

Martin J. Forman
Director, Office of Nutrition
Agency for International Development
U.S. Department of State
Washington, D.C.

June 1970

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PRESENT ACTIVITIES BY U.S. GOVERNMENT AGENCIES TO EXPAND THE PRODUCTION AND UTILIZATION OF PROTEIN FOODS.

Part I.

Introduction

This report deals with the world food problem, particularly the protein problem, in terms of what the United States is doing about it, and what it can do to deal effectively with it in the future. The world food problem has been defined in many ways. Demographers stress over-rapid population growth and suggest that birth control will mitigate the food shortage by reducing the rate of increase in numbers to be fed. Agrarians see the solution in terms of efficient use of arable land to produce larger and better crops. Fishery biologists believe that increased harvesting of food from the sea will reduce the gap between population and food supply to manageable proportions.

Obviously, the problem is multifaceted, and no single approach will provide a panacea. Also, much of the present malnutrition in the world is due to poverty and ignorance. This is a major problem in itself, and all the supplies, technology and good will available will count for very little if people do not understand or know how to cope with the social aspects of their food problems.

The United States can be of great help. Technical knowledge has greatly increased our own farming efficiency in a relatively short time. Industry has helped with chemical fertilizers, pesticides, and heavy machinery capable of doing, comparatively inexpensively and quickly, work that would otherwise require thousands of work animals weeks to do. Animals must be housed and fed; machines require less upkeep. Land grant colleges have educated farmers to use agricultural and animal husbandry techniques that have made modern farming attain levels of productivity undreamed of even twenty-five years ago. Transportation, distribution and marketing problems have also been solved to a remarkable extent, through cooperative efforts on the part of farmers, industrialists, railroad and trucking companies, and the federal government.

How can we educate people in areas of great poverty to attack their problems with multidisciplinary efforts? From our own experience, we know it will accomplish little to produce quantities of food in one locality unless it can be adequately stored and transported. How do we teach farmers in developing nations to increase their agricultural productivity, using less land than they now do, and how do we share our technical know-how with people whose farming habits have changed very little through the centuries? If the disease, poverty, and malnutrition problems, all of which interlock to create a destructive environment in developing nations, are not solved, and that rather soon, overcrowding and increasing misery will force insurrection by millions of people who are becoming aware that life does not have to be lived at that level. As travel and communications expand around the world, the realization of the gap between the haves and have-nots is also increasing. This is a good thing, because the contrasts become apparent and people see that something can be done. Although

education in overcoming these problems, to be most effective, must be sought rather than forced, we cannot, with the knowledge on hand, sit by and wait for non-technical societies to progress or fail according to how successful they are in coming of age in a competitive, modern world. If we and other industrialized nations do not make available the necessary education and training for developing countries, we can look forward to chaos by the end of the century when the population of the world will have doubled.

The United States, through programs of the U.S. Department of Agriculture, the Agency for International Development, and several universities, has taken steps to alleviate the problem in many parts of the world. Descriptions of some of these projects will follow later in this report. The focal point of most of them is the specific problem of the protein shortage. It cannot be separated from the world food problem, because mere supplying of calories will not suffice. Many developing areas have enough calories to avert hunger, but the protein content and quality of the legumes, pulses and starches on which most of these populations subsist are not sufficient to promote good growth and development of infants and preschool children.

It has become evident from laboratory experiments that severe malnutrition, and particularly insufficient protein, in young, growing animals not only stunts their physical growth and development, but impairs their central nervous system function as well. The implication is that such protein malnutrition in growing children may have a similar effect. Morbidity and mortality rates for malnourished children in developing countries are 30 to 40 times higher than those in industrialized ones. Malnourished and living in an unsanitary environment, these children have a greatly reduced resistance to diseases such as measles, chicken pox, and other common disorders of childhood, that cause only minor illness in most well nourished children. Infection and malnutrition interact, each worsening the effect of the other, so that in some places nearly half of the children die before they are five years old.

Women in developing countries, undergoing repeated cycles of child-bearing and lactation, are also depleted to the point that their borderline nutritional state is inadequate to provide the vitamin, mineral, and protein stores normally passed from mother to child during gestation, and the infants of these women start life with a nutritional disadvantage. Once breast milk ceases to be an adequate source of protein, after about four months, the child is in danger of suffering from an acute lack of protein, and the cycle of malnutrition and disease begins its downward spiral. If the malnutrition is early and severe, mental development, learning, and behavior are permanently affected.

These are the vulnerable groups towards which major efforts must be directed now by programs to solve the protein-food shortage. It is hoped that the following report will illustrate what steps the U.S. agencies are taking to alleviate the protein crisis, and what the United States hopes to do, in conjunction with the developing nations themselves, to remove this hazard from the world. If the future of developing countries is to depend on the health and well-being of its citizens, the children now alive must be given the chance to grow into adults capable of sharing the efforts and

progress of civilization. The United States has a stake in the peaceful and productive future of these countries. It cannot afford not to take part in helping them to help themselves achieve their birthright.

Part II.

Present and proposed activities in the United States to increase protein production and conventional livestock, fish, and plant sources.

Conventional sources of protein include meat, fish, dairy products, cereal grains and, in some countries, oilseeds. The largest volume of protein for the foreseeable future must come from conventional sources. The cost of protein per pound from animal products is prohibitive in developing countries; only where forages not suitable for human food are readily available for livestock husbandry, and where nitrogen may be supplied economically as urea for animal feeding, will there be a gain sufficient to contribute significantly to the supply of protein from animals. Although fish is an excellent source of protein, it is not universally available, both because its cost per pound of protein is out of reach for most populations in developing countries, and because lack of refrigeration, storage, and transportation facilities make it inaccessible to areas beyond immediate coastal regions.

animals and plants

Neither the quantity nor the quality of protein contained in cereal grains, by far the largest source of food for people in developing areas, is sufficient to avert protein malnutrition in young children. Because they are readily available, cereal grains, properly supplemented with pulses, oilseed meals, or fish, are among the most efficient sources of protein for populations in developing countries.

For fiscal year 1969, AID committed about 800 million dollars -- nearly half of all development assistance -- for direct aid to agriculture. Some of these proposals included loans to 1) finance imports of U.S. fertilizer; 2) to increase irrigation; 3) to provide transportation of foodstuffs; 4) to finance credit to help farmers invest in fertilizer, seeds, pesticides and storage facilities; and 5) to fund training in efficient agricultural methods.

The Agricultural Research Service (ARS) of the USDA currently has a number of active PL-480 grants at foreign institutions for increasing protein supplies from animal sources, and for chemical, biochemical, and related research on agricultural commodities that bears upon the production and use of edible proteins from conventional foods. The grants cover a variety of projects, such as evaluation of Indian feedstuffs for protein quality and energy value; development of rations for cattle and buffalo that permit maximum use of non-protein nitrogen; study of the effect of ration composition on rumen microflora; studies of the protein components of dry beans; separation of grain sorghum proteins; and distribution of rice proteins within subcellular particles.

Eighteen other PL-480 grants concerned with edible proteins have been made within the past few years, and the work supported has already been completed. These grants involved a total commitment of $1,254,000 equivalent in foreign currencies, for 83 man years of research. Other grants under consideration include production of edible protein from leafy plants, and fermentative conversion of cellulose into edible protein.

In addition to the activities of the United States government, reference should be made to the contribution of the land-grant universities to increased production of conventional foods. Participation by United States universities will be described in a later section of this report.

The Ford and Rockefeller Foundations have broad programs in agricultural development. For example, the International Institute of Tropical Agriculture in Ibadan, Nigeria is the newest of four research institutions in the tropics. The others are the International Maize and Wheat Improvement Center in Mexico City, the International Rice Institute in Los Banos, Philippine Islands, and the International Center for Tropical Agriculture in Cali, Colombia. Their primary objective is to improve the productive capacity and quality of food crops in the humid tropics, and to develop the conversion of low-quality feedstuffs into the high-quality protein from animals. Specific projects for leguminous crops are being developed in Latin America.

fish

Much emphasis has been placed upon food from the sea as a source of high-quality protein. Although estimates of the size of potential harvest from the oceans vary greatly, it is quite appropriate that fish be listed as one of the significant sources of protein needing further development. It is important to emphasize that problems lie ahead in marketing and in choosing methods of processing that will produce significant quantities of products of a quality and price that will gain wide acceptability.

The Bureau of Commercial Fisheries (BCF), Department of the Interior, is conducting an extensive program with the general objective of fisheries conservation and of increasing the efficiency of locating, catching, processing and marketing fish. This activity, which is primarily domestic, is described in the report, "Marine Science Affairs".[1]

The budget requested for this work is divided into the following broad categories:

1. resource development and management (63%)
2. processing and marketing of fish protein concentrate (FPC) (20%)
3. advanced technology (10%)
4. economic research (4%)
5. international activities (3%)

There are also other federal programs for vessel loans and subsidies. Reference should also be made to a number of university programs on marine science. These are mainly concerned with basic studies on oceanography and fisheries biology, with only minor work being directed specifically to increasing the catch and utilization of fish.

The primary responsibility for programs to assist fisheries in the developing countries rests with the Agency for International Development. The goals of this agency are: to increase the numbers of fish harvested and brought to land, and to improve methods of processing fish in protein-deficient countries; to develop a competent FPC system in at least one protein-deficient country; and to encourage other nations and private interests to establish commercial fishing industries in appropriate developing nations. More detailed plans for fisheries programs in developing countries may be found in Chapter III of reference 1.

The Office of Agriculture and Fisheries of the Bureau of Technical Assistance is undertaking a considerable development program in fresh water fisheries in the Philippines and in Viet Nam. Plans are being made to extend this to the northeast areas of Thailand and to Indonesia. The latter programs are still in the formative stage. However, the value of fresh and brackish water fish farming is great and it can be expected that there will be increasing emphasis in this area in the future, if funds permit.

AID is looking carefully at the need for training in fisheries technology throughout the world. At the present time there are in the United States sufficient facilities for all aspects of training in fisheries. Also supported are certain regional fishing centers such as that proposed in Thailand. AID has also cooperated with the Food and Agriculture Organization of the United Nations (FAO) in establishing training centers for fishermen in Korea.

The following Rockefeller Foundation grants have as their objective various aspects of research and training in aquatic sciences. Five of them are concerned with discovering ways in which the aquatic environment may be more wisely used to provide increased supplies of protein to local populations by either increasing the quality and quantity of available food fishes, or by preventing the destruction of potentially productive waters by industrial or domestic pollution. While one project is related only to increasing the availability of trained manpower in applied aquatic science, all of the projects have significant elements of technical or academic training in aquatic resource utilization.

a. The Oceanic Foundation, Hawaii: studies on spawning and nutrition of tropical food fish larvae.
b. University of Washington, Seattle: education and training in cooperation with Catholic University of Valparaiso, Chile.
c. Joint Commission on Rural Reconstruction, Taipei: studies on genetics, nutrition, growth and production of tropical food fishes, oysters, and shrimp.
d. The Academy of Natural Sciences of Philadelphia: studies of pollution in fresh water.
e. Auburn University, Alabama: studies of warm-water fish culture.
f. New York Zoological Society, New York City: studies

of marine productivity.

Four major PL-480 research programs were conducted by the Department of the Interior during the past year on the degradation of fish muscle tissue through a study of the enzymatic constituents of the tissue and their cellular localization. The results of these studies will provide the fishing industries with ways to reduce the rate of fish muscle breakdown, thereby providing consumers with higher quality fish products and conserving valuable foodstuffs currently being wasted through lack of knowledge of proper preserv. ion techniques.

Two new PL-480-supported projects are now underway in Israel to identify and determine the properties of known fish enzymes causing rancidity in fish. Research has also been sponsored by AID on the construction of fishing ships that will be able to bring to shore, after long voyages, a high quality product suitable for human consumption.

Present and proposed activities by the United States to reduce the waste of conventional sources of protein.

In approaching the problem of increasing the amount of food, and hence protein, available for human use, the reduction of waste must be given a high priority. It has been estimated that 25% or more of the food in developing countries is lost through preventable wastage. A ready means of increasing available protein around the world would involve an educational program to reduce this waste. Losses of food may result from a wide variety of causes, including consumption by birds, insects, and rodents, spoilage due to inadequate harvesting, improper storage and processing due to primitive food-handling methods, further spoilage in the market place, and poor methods of food preparation. The solution of the problem of food waste will be complicated and difficult to achieve. The U.S. Department of Agriculture is supporting a research program on food waste. Of $30,400,000 spent for the conduct of research in foreign countries under PL-480 $6,300,000 was directed toward reduction of food waste, as of December, 1967.

Of primary importance in developing countries is the use of insecticides and control of rodents and other animals that consume foods in ever increasing amounts, further reducing the quantity available for human consumption. Active steps are being taken in this area.

Research has been sponsored by the USDA on finding natural enemies of various insects that attack food plants in countries throughout the world. The use of natural enemies is appropriate for prevention of crop damage by insects, and will increase the yield of products being grown under adverse agricultural conditions. The technical programs in the agricultural sector of the USDA's interests are numerous, particularly from a standpoint of their effectiveness in reduction of waste and preservation of foods. Much work has been done on food quality and research, particularly on the resistance of food plants to rust, wilt, or mildew, and to attack by ants or other pests that reduce

production quantity. In addition to pest control through the use of natural enemies, other attacks have been made through development of plants or seeds resistant to insects, and through improved methods of storage to avert damage after the plant or food product has been removed from the field.

A further extension of natural enemies research has been a study of bacteria and heat-killed bacterial cells injected into the leaves of plants to decrease the lesions produced by virus infections. Virus diseases of plants have been resistant to all chemical means of control. The identification and isolation of the active antiviral substances is incomplete, but the research could lead to a means of controlling virus diseases of food plants and to a significant reduction of waste in the field.

A research program of AID in collaboration with the Bureau of Sports Fisheries and Wildlife is in progress on improved methods for control of vertebrate pests. AID is currently sponsoring a multiphased program of research which includes screening attractants for rats which can be added to baits, and an evaluation of various methods of rodent control. A Johns Hopkins University study of small mammals in India has concentrated on parasites of rats that might be usable in controlling the rodent population.

One study deals with the vampire bat largely indigenous to Latin America, and found to be a vector of rabies causing large livestock losses. Another concerns the grain-eating weaver bird (Quelea) of Africa which consumes large quantities of grain each year. These, in addition to rodents, are the principal targets of efforts to develop suitable chemo-sterilants, chemo-attractants, and types of poisons that will be effective in the natural habitats of these species.

storage

The problem of food spoilage during storage may be attacked in many ways: through technical research to determine the deterioration occurring under certain environmental conditions; through studies of food packaging methods which will preserve the natural taste and nutritional qualities; the rapid distribution of foods to insure their use before spoilage sets in; and even the general logistic considerations of food distribution, such as the building of roads from farms to markets and the handling of foods under acceptable sanitary conditions.

Proper food storage has been recognized by AID as being a major factor in reducing food losses. Under its sponsorship, food storage facilities have been provided in various parts of the world to enable the local governments or the voluntary agencies to store food products under suitable conditions for the preservation of both quality and nutritional properties. Over the past several years AID and the USDA have sponsored considerable work on the studies pertaining to warehousing of foods. Of particular significance was the research on soybean oil indicating that the vegetable oils destined for long storage periods should not be refined prior to storage. Fundamental studies have been sponsored in Japan by the USDA on oilseeds and particularly, the deterioration occurring in stored oilseeds over longer periods of time.

Many oils used in the food industry deteriorate rapidly and sometimes become unsuitable for human use owing to excessive oxidation. Research was sponsored by the USDA on removal of residual trace metals left after processing, largely responsible for flavor changes in soybean and other oils. This technique proved to enhance the keeping quality and shelf-life of the product.

Other research projects on storage problems have concentrated on: biochemical studies of changes occurring during cold storage; basic studies of aging milled rice and its application to quality factors; isolation and structure of germination inhibitors in seeds; a study of stored-grain pests throughout the world, and also a study of the resistance of various types of grains to these pests; investigation on the physiology of various beetles in hopes of establishing practical methods for control; and studies on the effect of pesticides on the storage life, chemical composition, food quality, and nutritive value of plant commodities.

During the last several years, the USDA has sponsored research on addition of anti-oxidative improvers to meat to insure preservation, and a grant in Poland has been used to study the chemical compounds in wood smoke which retard oxidative deterioration and rancidity in smoked meats.

It has been found that the natural components of some foods possess antioxidant properties. Research has been sponsored by the USDA to determine the effect of these components on maintaining nutritive value of other foods when used in a formulated product. By taking advantage of such natural anti-oxidants, the shelf-life of various foods can be extended with the assurance that they will not decline in nutritive value.

The control of food spoilage has been attempted in all phases of food production and distribution, both technical and general, in the less developed countries. Numerous consulting personnel have been retained to work in various areas of the world. Their research efforts will continue to be a major part of the interest of the sponsoring agencies.

Through 1966, 257 grants and contracts were executed under which foreign scientific institutions conducted research aimed at expanding markets for farm products and controlling deterioration. Twenty-one countries were included in the study, representing a total combined value of 15 7 million dollars.

distribution

The improvement of food distribution is accomplished largely through self-help work programs to build roads from farm to market in the less developed countries. Approximately 14 million people benefited in 1966 from Food for Work projects aimed at eliminating a need for food aid, compared with 12.5 million in 1965. Most of the work projects were aimed at increasing agricultural production, clearing land, or construction of access roads. Farmers and their families received food aid while they were bringing new land into use or chaning the existing land use, or building roads for the transportation of food to the markets. These projects were in all major regions of the world. In India, 48,000 recipients have become workers on a five-year plan to assist in agricultural sufficiency and preservation of food. In the Philippines, over 300 kilometers of feeder roads and 167 kilometers of foot paths between

villages and mountain regions have been prepared.

Food Handlers

Another effort of AID to reduce the waste in the food program has been in education of food handlers. Representatives of the American School of Food Service Association have traveled throughout the world, discussing food preparation and preservation with those who handle donated foods and supervise the child-feeding programs in the less developed countries. They have visited many countries to examine school kitchens and instruct kitchen personnel in methods of food preparation, food handling, and basic principles of nutrition education and food conservation.

The results of a multiphasic program such as AID has carried on to reduce food waste cannot be calculated in dollars or tons of food saved in such a short time after its inception. AID is convinced, however, of the importance of food preservation to its objectives, and will continue to assist in any way it can to prevent the loss of foods so greatly needed throughout the world.

Conventional Improvement of Protein Quality of Cereals, Grains, and Legumes.

genetic

Without question, it is essential that special consideration be given to the enhancement of the effectiveness of cereal proteins, since 40 million of the 82 million tons of protein annually consumed by man are derived from cereals. Although 25 million tons of animal protein are consumed, most of this reaches only one-sixth of the world population. In view of the low levels and relatively poor quality of cereal grain proteins, there is an urgent need for special priority to be given to programs designed to improve the quality of cereal proteins and to increase the direct consumption by man of other plant proteins. This may be done by conventional or unconventional means.

One conventional approach to the problem is the use of genetically improved varieties of rice, wheat and corn, in which the protein is increased in either quantity or quality. These varieties, grown indigenously, will be able to raise the protein content of human diets with no need to alter the food habits of the people consuming them. Continued research and training directed to specific areas of the world will be necessary, so that appropriate plant production practices can be applied. Moreover, plant breeding research designed for the development and adaptation of improved varieties to local conditions must be done routinely. Further, it is recognized that with the use of genetically improved hybrids, a system of commercial distribution of such seeds is essential to increased agricultural production. Many of these new varieties will not do well unless appropriate fertilizers are used, so it is essential that this be taken into consideration wherever new varieties are introduced. Also, soil and water management, control of diseases, insect pests and wees must be considered if substantial increases in agricultural output are to be achieved. This can take place only within the framework of other socio-economic developments that must accompany a shift from subsistence to commercial agriculture and an increase in the consumer demand for foods.

Extensive work is underway by a number of experiment stations and by major seed companies to transfer opaque-2 and floury-2 genes into commercially usable inbred lines of corn. Either of these genes has the ability to change the amino acid profile of corn protein. The resulting strains have been called "high-lysine", but amino acids other than lysine are favorably affected - particularly tryptophan, and the leucine: isoleucine ratio. These changes increase the biological efficiency of the protein. Biological trials in experimental animals and man have established the effectiveness of this new material. Experimental hybrids are currently being tested, but additional breeding work may be required to make these new hybrids competitive for yield capacity and other important agronomic characteristics. Genetic stocks of this material have been distributed to many countries and are currently being incorporated into adapted native stocks.

An AID/Purdue University contract deals with the development, acceptability, and nutritional value of high-lysine corn in Brazil. The first stage of the project is concerned with the incorporation of the opaque-2 or floury-2 gene into locally adapted corn varieties. High-yielding varieties or hybrids will be developed. When such corn is available, area tests will be conducted on its acceptability to local populations. In some areas where corn constitutes an important element of the diet, strong preferences exist for both endosperm color and texture. Yellow corn is often quite unacceptable. Some localities prefer the softer floury types, while others prefer flints. Since these preferences are strongly based, the local breeders will have to satisfy such requirements during the incorporation of the high-lysine characteristic.

Another important program for the improvement of the major cereals in Africa - maize, sorghum and millet - is being conducted in Kenya. Financial support is being provided by AID/USDA contract and by a grant from the Rockefeller Foundation. The Kenya Ministry of Agriculture, the Kenya Maize Marketing Board, and the Ministry of Overseas Development (Great Britain) are participating.

Very significant progress is being obtained in the development of high-yielding, hybrid maize. A double-cross hybrid of Kenya flat-white gave crop increases of 25 per cent. Varieties have been introduced from the United States, Mexico, Central and South America and grown in observation plots. One of the varietal introductions from Ecuador gave yields as great or greater than the conventional double-cross. These hybrids are fully adapted to the high altitude conditions of Kenya. High yields from varietal hybrids are not unique to the Kenya program; comparable results have been reported from Mexico, Brazil, India, Thailand, and the Philippines. It should be noted that in many cases, improved farming practices contributed as much to higher yeilds as did the improved varieties.

Successful application of the genetic and agronomic research is being made in Kenya. A special training course was organized, with cooperation of farmers in each district solicited by the District Extension Officer. In actual operation the farmer bought the seed and fertilizer, prepared the land, and tended and harvested the crop, with only advice and guidance from the extension officer. As many as 5,000 community demonstrations have been held during planting, thinning, and harvesting of the crop.

Efforts of government departments to distribute the hybrid seed failed. The Kenya Seed Company was developed as a commercial venture to provide and distribute the hybrid seed to make this a successful practice. It proposes to add the production and sale of hybrid sorghum and hybrid millets when suitable varieties are developed. Facilities have been constructed in Kenya to provide storage for surplus maize, sufficient to contain approximately ten per cent of the annual production. The Maize Marketing Board has maintained a relatively high price to encourage production, and in only two instances has production regularly exceeded demand.

Varieties of bread wheats have been identified which average two to three per cent higher protein content than types commonly grown. This increased protein percentage is genetically determined and can be transferred to other breeding stocks. The gene or genes responsible, however, appear to have no appreciable effect on amino acid balance.

Milling and baking properties of wheat flour have always been an important aspect of the evaluation of new varieties of wheat. These properties are known to be related to both protein percentage and quality. This definition of quality, however, has no close relation to amino acid composition.

Work on protein quantity and quality of wheat is underway at the University of Nebrask under an AID contract. The first objective is to assay the World Wheat Collection, searching for types which possess either an increased protein percentage or an improved amino acid profile. In addition, the Rockefeller Foundation has established a wheat quality laboratory in Mexico City. As the objectives of the two groups are somewhat parallel, interests have been defined by mutual consent. The AID contract will specialize on winter wheats and the wheat relatives. The Rockefller Foundation will concentrate on the spring wheats. Other protein quality laboratories established by the Rockefeller Foundation to provide data on the protein content, amino acid, and nutritional characteristics of varieties of cereal grains are being developed at:

a) Universidad del Valle, Cali, Colombia;
b) Rockefeller Foundation Cooperative Agricultural Program, India;
c) Kasetsart University, Thailand;
d) International Rice Research Institute, Los Banos, Philippines.

The second objective is to distribute information and materials as soon as promising types have been identified. Advice will also be provided on the best manner in which to use new material in a breeding program.

Work on protein quality and quantity of sorghums is also underway at Purdue University under an AID contract. Items from the World Sorghum Collection are being assayed for both protein quantity and quality. Marked variation has been established for both characteristics. Variation in lysine percentage is two- to three-fold. The inheritance pattern of this modified protein has not yet been established. Studies are underway to establish the feasibility of genetic transfer.

Under PL-480, the USDA sponsors several projects in India concerned with characteristics and inheritance of sorghums and millets. It also sponsors a project on amino acid content of peanuts. Information on variation in protein quantity and quality has been widely disseminated through periodic progress reports. Seed of new materials will be distributed to interested workers as soon as its superiority has been established.

Some collections of wild oat species have been obtained by the USDA in the Near East and have been found to be high in protein. Some of these contain as much as 30 per cent protein in contrast to 18 or 19 per cent for the best of the U.S. varieties. Both Asian wild and U.S. domestic oats have a good amino acid balance. Some wild strains also possess a high degree of resistance to crown rust and other important oat diseases. These wild types, however, are heavily awned and the seed shatters. They will therefore be useful only as breeding stocks. Breeding work at several locations is aimed at combining the high protein and disease-resistant traits of the wild species with the desirable traits of our common cultivated oats. This breeding effort will require five to ten years.

The development of improved types of edible legumes continues to receive much attention in public institutions and private enterprises in the United States. Primary emphasis has been on yield, disease resistance and market quality, rather than on either protein quality or quantity. It has been established that variation exists for both of these protein attributes.

An extensive program on the edible legumes is being conducted in Iran and India, supported by an AID/USDA contract. This is a broad-based program concerned with the development of improved varieties, disease and insect control, and optimum cultural and fertilization practices. Some effort is also being directed toward the evaluation of nutritional and culinary characteristics of legumes.

Work is being conducted in several experimental stations in the United States to increase the protein content of soybeans and to screen for higher levels of methionine. Varieties possessing 48 per cent protein have been identified in contrast with the usual 40 per cent.

fortification of conventional foods

In addition to improving the quality of plant proteins genetically, the addition of synthetic amino acids and protein concentrates can also contribute to the nutritive value of cereal and other plant proteins. Present technology has established that the quality of cereal proteins can be improved materially by the addition of the first limiting amino acid, or acids, either directly or by supplementing cereals with appropriate natural proteins containing relatively high levels of the limiting amino acids.

Whether or not the cereal protein quality is to be improved by direct amino acid fortification, or by the use of suitable protein supplements, may be determined by a) the proportion of protein and calories derived from cereals; b) the approximate amino acid levels usually supplied by other proteins consumed by various population groups; and c) the relative costs of amino acids vs. available protein supplements.

The common occurrence of protein-calorie malnutrition in much of the world is well recognized, especially in the post-nursing child under six years of age. Less evident is the fact that such dietary deficiencies of protein and calories in young children and pregnant or lactating women are almost always associated with multiple deficiencies of essential vitamins and minerals. In countries where most of the population subsists largely on cereals and plant protein foods, dietary deficiencies in vitamin A, thiamine, riboflavin, niacin, calcium, iron and iodine are commonly found.

More emphasis should be placed, therefore, on the need for complete fortification with vitamins and minerals that also might be limiting in diets when considering amino acid or protein fortification. When amino acids such as lysine are used in the fortification of cereals, particular care should be given to ensure over-all nutritional adequacy of the diet, since this type of fortification does not add those supplemental quantities of other nutrients normally found when natural proteins are used as supplements. Moreover, caloric adequacy deserves special consideration. There is little point in supplementing poor-quality proteins if the total food intake supplies a sub-optimal amount of energy, because protein will be metabolized for energy under these circumstances.

A particular advantage of fortification of cereal products with chemically pure amino acids, minerals and vitamins is that no change in food habits is required. The fortification need not affect acceptability or use of the product. Its implementation can be rapid and widespread where well developed food industries, or at least centralized milling, are available. On the other hand, certain countries may not have sufficiently centralized milling or food processing facilities to permit fortification of major cereal foods. Under these conditions, it is necessary to design special foods for the nutritionally vulnerable population subgroups (preschool children and pregnant or lactating mothers) rather than use the broadcast approach which frequently is more costly and less effective in reaching the groups-at-risk in the population.

Methionine has been used economically for some time to improve the protein quality of animal diets. Although lysine is still somewhat costly as a direct supplement, the addition of 0.25% L-lysine to wheat flour increases its protein efficiency ratio (PER) for rats from 0.7 to 1.6 at a cost of appoximately $5 per ton. The second limiting amino acid in wheat and rice is threonine, while in corn it is tryptophan. The addition of lysine to corn, rice, millet, and sorghum also improves their protein quality.

Product and process development research in progress at the several Utilization and Research Development Divisions of USDA's Agricultural Research Service includes amino acid or protein fortification of cereal products with currently available supplements. High-protein flours from rice are prepared by controlled overgrinding of milled rice, and by solvent extraction and classification of rice polish. Protein-rich concentrates from wheat milling byproducts and rice bran are obtained by drying and/or solvent extraction, followed by remilling and sifting in conventional machinery.

Methods have been worked out to infuse lightly scarified wheat kernels, milled rice, and bulgur with lysine and methionine. Grains thus fortified to a high level are then blended with untreated material to obtain the levels desired at point of use. Where necessary, rinse-protective coatings can be applied; new methods and materials for this purpose are being studied. Extension of these fortification methods to other grains such as barley, sorghums, and millets seems feasible.

Supplementation of rolled wheat and cornmeal with conventional fat-free soy flakes or flours, and of bulgur and "WURLD" wheat with fat-free soy grits is found quite feasible, but careful attention must be given to acceptability at point of use in different world target areas. Fortification of ordinary white wheat flour with the protein concentrate from commercial wheat bran and shorts provides improved flours for Indian chappatties, Arabic breads, and similar products commonly made from long-extraction wheat flours in certain areas of the world. Fortification of traditional cereal products with new and improved cottonseed, peanut, and full-fat soya flours will likewise be applicable in appropriate target areas. Studies are continuing with all of the commodities and their fractions.

Work is also in progress on development of practical methods to detoxify or remove mycotoxins or other deleterious materials from contaminated feedstuffs.

In addition to the domestic research program, the Department of Agriculture is administering a number of research grants financed in foreign laboratories with PL-480 funds, directed toward the use of protein concentrates and amino acids in the fortification of cereal products. Examples of research projects related to the development and use of protein supplements are listed on a following page.

A major objective in several PL-480 nutrition projects sponsored by USDA's Agricultural Research Service is to determine the composition and biological value of selected plant food sources of protein, and to evaluate their nutritional quality when used as supplements to low-protein diets or in formulated mixtures Of the funds committed to date, $1.1 million, or over one-third, have been on projects relating specifically to protein nutrition.

Two completed projects have dealt with the nutritive values of supplements, especially sweet potato, for the protein, mineral and vitamin improvement of the Formosan diet. Both college men and young women served as subjects after preliminary screening had been done by animal assay

Other current PL-480 nutrition projects deal with the composition of tempeh, the value of leaf proteins, the effect of protein on the nutritional status, growth, and learning process of institutionalized children, and on lipid metabolism in the rat and in the monkey.

In addition, the malnutrition research program of the U.S.-Japan Medical Sciences Program, administered by NIH, supports projects on amino acid fortification of cereals, the development of legumes and cereals with improved protein quality, the distribution of mycotoxins in the foods of Southeast Asia, and the effects of early malnutrition of children on subsequent learning and behavior.

The United States is making the fortification of cereals a keystone of its efforts to improve protein food supplies. At present, demonstrations are being planned on a large scale in various countries, including India, Thailand, and Tunisia, to determine the feasibility of fortification and the long-range effects of such procedures. These tests are funded by the local governments and AID, with the technical assistance of the U.S.D.A. Consideration is being given to fortification of Food-for-Freedom shipments with amino acids or protein concentrates.

At present, the milled cereal products distributed by Food-for-Freedom shipments are supplemented with vitamins and minerals that are commonly deficient in local diets. Non-fat dried milk is also fortified with vitamins A and D.

Additional activities which encourage amino acid fortification of cereal products for both adults and children include the following:

India

1. Modern Bread. In concert with the Australian, Canadian and Dutch governments, government-owned bakeries are producing bread containing the standard vitamin and mineral enrichment plus L-lysine under the name "Modern Bread". Lysine is currently being supplied without charge to the Indian government by The Netherlands. USDA is exploring, with local companies, the possibilities for lysine production in India.

2. Salt. The feasibility and practicality of fortification of table salt with lysine, iron and calcium is being investigated. AID has provided the services of a consultant who is an expert in salt production and use. Specific attention is being given to consumption patterns in order to determine the potential nutritional impact of fortified salt.

3. Bal-Ahar (Hindi for "nutritious children's food). Lysine-fortified Bal-Ahar is being subjected to tests of its protein efficiency for rats in order to define the potential benefits of fortifying a wheat-peanut mixture. This information is required by the Indian government before a decision can be made on the desirability of fortifying Bal-Ahar.

4. Atta (whole wheat flour) and rice. AID is financing lysine-fortified atta testing by the Indian Council of Medical Research in New Delhi, Calcutta, Hyderabad and Mysore. Laboratory testing of rice containing amino acids, vitamins and minerals is currently being carried out at Mysore.

5. Child-feeding experiments. Feeding trials of lysine-fortified wheat are underway at the Christian Medical College and Hospital in Vellore, under a PL-480 project sponsored by N.I.H.

Thailand

The Research Advisory Committee of AID has approved a research project involving animal and human feeding to determine market value and logistics of fortifying rice.

Tunisia

A team will develop the details of a large-scale fortification project in Tunisia. Wheat flour will be fortified with vitamins, minerals, and lysine. Nutritional effects and economic benefits will be experimentally evaluated under real-life conditions.

Peru

AID is supporting a research project at the British-American Hospital to determine the limiting amino acids of wheat with respect to the requirements of young children. The Peruvian government is being encouraged to implement a government decree requiring the fortification of wheat with lysine and of rice with lysine and threonine.

Pakistan

The government has requested assistance in developing a wheat fortification project. Under AID auspices, a consultant in milling and enrichment procedures visited West Pakistan to determine which product would be the best vehicle for fortified wheat. It appears that fortified bread would be the product of choice for the project.

Guatemala

A study by the Institute of Nutrition of Central America and Panama (INCAP) and Rutgers on the logistics and methodology of fortifying corn protein with lysine and tryptophan is being supported by AID. In addition, USDA has stimulated position papers from various scientific bodies concerning lysine fortification of cereal grain products. These include the Food and Nutrition Board (NRC), the Protein Advisory Group, and the Mysore Conference on Oil Seeds. At a joint meeting of American and Indonesian scientists, sponsored jointly by the National Academies, it was agreed to recommend that all wheat flour imported by Indonesia be fortified with lysine.

PL-480 Research Projects Related to Fortification with Protein

Completed

Development and biological evaluation of protein mixtures in foods formulated from vegetable sources. (Hebrew University of Jerusalem, Jerusalem, Israel).

Nutritional evaluation in infants of a protein mixture from vegetable sources. (Hebrew University of Jerusalem, Jerusalem, Israel).

Studies on the nutritive values of protein and availability of amino acids to human subjects on a low-protein diet. (National Defense Medical Center, Taipei, Taiwan).

Nutritional studies on rice and sweet potato supplementation for the improvement of Formosan diet. (National Taiwan University, Taipei, Taiwan).

Effects of protein malnutrition and of different sources of protein on learning performance. (University of Baroda, Baroda, India).

Biochemical and nutritional studies of leaf protein. (University of Calcutta, Calcutta, India).

Current

Formulation and evaluation of low-cost meals for children 2 - 6 years of age in India. (MS University of Baroda, Baroda, India)

Nutritional response of children to various types of enriched wheat bread. (Nutrition Institute, Ministry of Health, Cairo, U.A.R.).

Fortified Foods for Infants, Weanling and Preschool Children.

Infants over four months of age, weanling and preschool children are the most vulnerable segments of the world's population. For them, protein malnutrition is life-threatening for the reasons outlined in the Introduction to this report. A practical approach of immediate significance toward solution of this problem is to fortify cereal diets with amino acids and/or protein concentrates to increase the utilizable protein of foods normally given to young children in developing countries.

The PL-480 projects related to fortified foods for children in Israel, India, Egypt, and Peru are described in the previous section. Two other completed PL-480 projects dealt with the evaluation of vegetable protein for infant feeding. First, mixtures of foods formulated from vegetable sources of protein were developed and evaluated biologically, using the rat as the experimental test animal. The most promising mixtures were then fed to infants for nutritional evaluation, using nitrogen balance and growth as indices of quality of the mixtures. An acceptable formula, one developed in Israel, was successfully fed to larger groups of infants in a developing country known to have meager resources for infant feeding.

Current work includes development of blended protein food products (generally about 10% protein) designed specifically for preschool children in a continuing program to enlarge the usefulness of various commodities in meeting world food needs. Commodities include corn, wheat, rice, barley, peanuts, cottonseed, soybeans, and fish protein concentrate. Emphasis is being given to simplified, less costly processing as well as to palatability, nutritive value, and wholesomeness of the end products.

Blended food products in late stages of development include partly precooked barley and wheat meals mixed with soy flour and non-fat dry milk, plus supplementary vitamins, minerals,

and stabilized soy oil. These are counterparts of the present Blended Food Product, Formula No. 2 (CSM), based on processed cornmeal. A somewhat similar fortified mixture of soy flour, wheat protein concentrate, and either precooked flour or bulgur flour (Blended Food Product, Formula No. 3, WSB) has reached the stage of commercialization. New and/or more widely applicable ways to process cereal and oilseed components of present and new blends are under continuing study. As other protein sources such as peanut flour or gossypol-free cottonseed flour become available, they will be worked into palatable blends having the nutritional balance and end-use properties needed for specific target areas around the world.

Development of Unconventional Sources of Protein for Human Consumption.

Fish protein concentrate (FPC)

For millennia, a variety of ways of preserving fish has included drying, salting, and fermenting. Recognition of the nutritional value of fish protein has led to development of a new process whereby whole fish can be utilized to make a fish protein concentrate (FPC), in which the oil and water are almost completely removed from the fish by solvent extraction or other methods, resulting in a bland, stable, concentrated form of high-quality protein that may then be incorporated into other foods as a supplement.

The Bureau of Commercial Fisheries, U.S. Department of the Interior, is collaborating with AID to improve the utilization of marine resources in providing protein-rich foods. Primary emphasis is being placed on FPC. The Bureau is carrying out research to develop the product, the processes for its manufacture (concentrating its research on the isopropyl alcohol extraction method), and its use in foods. AID is responsible for stimulating the production and use of FPC in the less developed countries.

In 1967, a Food Additive Regulation was issued, permitting the use of FPC prepared by either of two methods from whole hake as an additive to food. Its use was subject to certain product requirements in terms of labeling, proximate analysis, specified maxima for solvent residues, and fluoride levels, and of having a protein efficiency ratio at least equal to that of casein. During 1968, work was continued on the properties of FPC and its incorporation into foods such as bread, cookies, soups and noodles, and including items and drinks that might be especially attractive to children. The Bureau of Commercial Fisheries has continued to cooperate with universities and the food industry in several studies relating to the use of FPC in food products. Successful, carefully controlled human feeding studies have been carried out in Guatemala and at The Massachusetts Institute of Technology.

Plans have been approved for the construction of a large-scale research and demonstration plant in the Pacific Northwest. This would have a fish-handling capacity of 50 tons of Pacific hake per 24 hours. This size plant is considered to be below optimum for a commercial operation, which should probably have

from two to ten times this capacity. However, it should be sufficiently large to demonstrate the commercial feasibility, to work out the operating problems that will arise from such a scale-up, and to provide construction, operation and cost data on which reasonably precise estimates of commercial operation can be based. This demonstration plant would also be able to supply significant amounts of FPC for large-scale feeding and acceptance programs required for market development.

To provide a stimulus to commercial production of FPC and to provide a substantial quantity of FPC for use in foods distributed by the voluntary agencies such as Church World Service, Catholic Relief, etc., AID has contracted for approximately 450 tons of FPC. This is being supplied by a commercial plant in New Bedford, Massachusetts, which uses the ethylene dichloride process.

Studies of the potential market for FPC are being carried out in Chile and Korea through AID contracts. Three pilot plants for the manufacture of FPC are proposed for Chile, Pakistan, and India, and a smaller scale plant for the Lake Victoria region in Africa. These plants would be primarily used for adaptive research to modify the process to the use of locally available fish. In the case of Pakistan, the plant would also be used to further the development of FPC made from shark. This work has been initiated by Pakistani scientists and holds promise as a means of utilizing an otherwise poorly utilized protein source. The small-bench scale plant is for preliminary work on the manufacture of FPC from fresh water fish stocks in Lake Victoria and other African lakes. The plants would also provide adequate amounts of FPC for marketing and acceptability studies.

Expanded use of oilseed meals as direct sources of protein.

Oilseeds have long been used as protein supplements in animal feeding. Added to corn and cereal grains, they raise the protein value to adequate levels without further addition of animal protein. Many developing countries have been processing oilseeds for animal feeding for some time, but few have exploited this source to raise the quality of human diets. Almost no developing country is without some type of oilseed, and there is no cheaper, more adaptable source of protein available today than oilseed meals. Considerable progress could be made on closing the protein gap if more extensive use were made of oilseeds and oilseed products. The support is fully warranted not only for development of such products to assure the fullest degree of acceptability, but also for their market testing and introduction.

The USDA has an extensive research program in progress at the Utilization and Research Development Divisions of its Agricultural Research Service, directed toward the development of high-protein products from oilseeds such as peanuts, soybeans, and cottonseed. Primary attention is devoted to simple, low-cost processing and to availability and quantity of source material. Significant accomplishments include solvent extraction and comminution of cottonseed meats, followed by removal of toxic gossypol-containing glands by use of liquid cyclone separators to obtain a bland, light-colored high-protein powder. The recent development of glandless varieties of cottonseed will make their processing even simpler. Also, a simplified, low-cost method has been developed to prepare full-fat

soy flours for ready use as dietary supplements.

In addition to the domestic research program, the Department of Agriculture is administering a number of research grants to foreign laboratories, financed with PL-480 funds and directed toward expanded use of oilseed meals as sources of protein for human diets.

The United States is the world leader in certain aspects of soybean technology. Industrial concerns have developed efficient processes for toasting and extruding the soybeans and for manufacturing a number of protein concentrates and protein isolates, including textured products. Although these products and the processes for their manufacture are primarily suited to the U.S. economy, some could be readily adapted to fit the needs and conditions in developing countries. This work could best be undertaken by those commercial concerns that already have extensive knowledge of soybean technology and a first-hand acquaintance with marketing conditions abroad.

This knowledge complements the equally untapped resources of Japanese technology for processing soy. U S. experience is limited to the development of ingredients for use in foods, whereas in Japan a large number of interesting and nutritious soybean foods have been developed for direct human consumption. Research is now going on in U.S. laboratories on oriental foods made from soybeans, and a body of knowledge is being built up to help extend these foods to countries where protein is in short supply. Exciting developments have also occurred in the U.S in the production of foods simulating those of animal origin using various ways of introducing texture into soy protein isolates. However, these products are considered too expensive at the present time for mass use in developing countries.

Single-cell proteins for animal and human consumption.

The United Nations Report No. E/4343 states that research to develop feasible means of producing and utilizing, on a large scale, protein from single-cells offers the best hope for major new protein supplies independent of agricultural land. There are various inexpensive substrates suitable for growth of bacteria and yeasts to form single-cell proteins. Among them are petroleum, and sulfite liquor waste from paper production, and molasses. The wholesomeness and palatability of such sources of protein are receiving major attention.

Yeast is one form of SCP that has been used in human diets, including foods for infants, for many decades. However, the quantity of yeast introduced into these formulas is relatively small. Single-cells are rich in nucleic acids which are metabolized to uric acid and excreted as such by man. High levels of uric acid in the blood can result in gout, and can give rise to uric acid kidney stones. Therefore, procedures which will lower the nucleic acid content of such materials will increase the quantities that can be safely fed to man. Quite apart from the nucleic acid problem, the safety of each new type of single-cell proposed for human feeding needs to be demonstrated by appropriate toxicological screening. In the United States, torula yeast for human feeding has largely been produced on the sulfite liquor of the paper industry. There is much interest, however, in the production of yeast and other single-cell sources of protein on other types of agricultural and industrial waste materials.

efforts for development

The effort in the United States to develop new single-cell protein sources involves government, corporate and university components. These are discussed separately.

government

The government is supporting work on single-cell proteins in two areas: space research (both in-house at NASA and through university contracts), and waste processing and water pollution abatement. The NASA efforts are at present limited and involve an attempt to utilize microorganisms, principally bacteria, as part of a life-support system for space missions. In the past, much NASA and Air Force-supported work involved algal systems.

In the case of pollution, the government is supporting research dealing with the conversion of cellulosic wastes into fermentable substances, and then into yeast or other SCP products. It has also supported research concerned with the use of algae for waste-water purification and the recovery of the algae for animal feeds.

corporate

Most of the large chemical, petroleum and fermentation companies have at least considered SCP production. Some of them have active research and development teams involving from two to ten professional workers. Among the companies known to be conducting active programs on SCP are Standard Oil of New Jersey, Standard Oil of Indiana, Gulf Oil, the Nestlé Company, Continental Oil Company, Corn Products Company and Mobil Oil Company. Furthermore, many companies involved in classical yeast production and processing sell their products for food, feeds, and flavoring, and are interested in expanding their production and marketing.

Little concrete information is available concerning the details of the companies' programs, but there is no reason to believe that an economical process is yet at hand.

university

Many investigators are working in university laboratories on problems connected with SCP. These include groups at the University of Wisconsin, University of Pennsylvania, University of California at Berkeley, University of Southern Illinois, University of Minnesota, and the Massachusetts Institute of Technology. At M.I.T. about twenty faculty and graduate students in the Department of Nutrition and Food Science are working on basic aspects of SCP. This major, integrated university effort is supported by grants from the Sloan Foundation, the Hartford Foundation, Corn Products Company, and Nestlé Alimentana.

The research area covered by the M.I.T. group includes clinical nutrition, animal nutrition, food processing, microbiology, and biochemical and food engineering. The work in clinical nutrition has been pointed mainly toward problems in nucleic acid metabolism, but has also included observations on possible intestinal upsets from yeast and the biological evaluation of yeast protein in man. The work in animal nutrition has been concerned with testing and evaluation of the digestibility and biological value of protein from various microorganisms, as well as evaluation of the effect of methods of processing of cells to improve their food value. The processing aspects of these investigations have been in progress for several years and have dealt with cell fragmentation and

extraction of cell proteins.

In the area of microbiology, investigations are in progress on isolation of thermophilic, hydrocarbon-utilizing organisms to reduce processing costs resulting from the need for mechanical refrigeration for mesophilic fermentation. A further subject of investigation is the effect of culture conditions on protein content and composition, particularly with respect to lysine and methionine.

In the area of biochemical and food engineering, major efforts are being devoted to continuous culture, studies on oxygen and hydrocarbon transfer, novel fermenter design, flocculation as a means of cell recovery, and studies on the drying of SCP and killing of living cells in SCP.

In Volume II of The World Food Problem; A Report of the President's Science Advisory Committee, Report of the Panel on the World Food Supply,[2] the following topics are listed to show some of the areas where research must be carried out with reference to nutrition and toxicology of single-cell proteins in regard to human consumption: "...utilization of protein under different physiological conditions, effects of ingestion of nucleic acids and other non-protein cell components, possible allergens in single-cell protein, effects of unusual amino acids, use of single-cell protein as the sole source of protein and as a protein supplement."

More work has been done on use of single-cell proteins for animal feeding. It would save time and money to direct more attention to their use for human diets, since the costs of development and production of processes for both human and animal foods are similar. The acute need for protein and energy call for this approach, but the problems to be solved, as outlined above, make it seem unlikely that single-cell proteins will be ready for human feeding in any appreciable amounts for several years.

Further information on single-cell proteins may be obtained from Single-Cell Protein,[3] based on the International Conference on Single-Cell Protein, held at M.I.T. in October, 1967.

Present and Proposed U.S. Activities to Support the Promotion and Distribution Overseas of Suitable Protein Foods for Human Consumption.

donations and sales

Overseas shipments of United States food commodities under Public Law 480 make a substantial contribution to the supply of protein and other nutrients in developing countries. These shipments are made according to three main categories:

1. Long-term credit sales
2. Sales for foreign currency
3. donations

From the standpoint of the production and use of edible protein, the shipments of non-fat dry milk and formulated child-food supplements (CSM and WSB) make the most direct contribution. The other commodities listed (wheat, flour, rolled wheat, and bulgur) all with 10-12% protein, rolled oats with 16-17% protein, corn and sorghum with 8-9% protein) also supply significant amounts of protein and make a major contribution to caloric requirements

which, of course, must be met if protein is to be utilized for its essential role in body growth and maintenance. The total value of such shipments was $1.7 billion during the fiscal year 1967 and $1.5 billion in 1968.

The Food for Peace Act of 1966 spelled out for the first time the requirements for self-help by countries receiving United States food shipments. Agreements that have been signed to date reflect the many types of efforts essential for expanding food production, including plans to increase fertilizer utilization, or to establish more favorable price ratios. There are also proposals for improving storage facilities and for preventing soil erosion. The projections call for more farm-to-market roads or more farm credit. Strong emphasis has been placed on conditions for agri-business investment, especially in fertilizer plants.

Food donations provide the following benefits:

1. famine or other disaster relief;
2. amelioration of malnutrition, especially in children;
3. promotion of economic and community development;
4. assistance to impoverished persons and non-profit school lunch programs abroad.

During 1967, approximately 2.4 million tons of food valued at $548 million were donated. Some of the highlights of the 1967 program included:

More than 48 million children benefited from the food donated for school lunches and maternal/child feeding programs in 106 countries.

Approximately 12 million people benefited from the food utilized in Food-for-Work projects aimed at eliminating the need for food aid. In South Korea alone, almost 730 thousand workers were engaged in these projects

The United States government and voluntary agencies provided emergency disaster relief to an estimated 13 million victims of 51 major disasters in 39 countries.

The United States also contributed food to over 3.5 million refugees around the world, including 1 and 1/2 million war-displaced people in South Viet Nam.

There was further progress by the voluntary agencies in shifting from food relief to food-supported self-help activities directed toward community and economic development.

promotion and distribution of new foods

The U.S. is interested in the promotion and commercial distribution of protein foods. The development of viable new food programs that can eventually be self-sustaining with minimal or no subvention from government is needed. The food industry can make a major contribution toward developing new protein foods. This is the segment of the community that has been successful in designing, marketing and promoting new foods.

A major and continuing objective of the efforts of the U.S. government has been to interest the private sector in producing new protein foods that will be both acceptable and nutritionally effective. The assumption has been that for the initial efforts,

present technology is sufficient. The major problem is to develop the means of interesting the food industry and of bringing firms to the point where they can consider an investment in a new protein industry. The nature of the subventions and the conditions of investment and partnership with local enterprises or local governments will vary from location to location. Following are some examples of what has been done to stimulate the activities of the food industry:

A protein foods program has been inaugurated by the U.S. AID to provide grants to private companies to enable them to study markets in particular areas, to develop prototype foods that would be useful in a particular country and which could be the basis for a viable food industry, and to test prototypes so that the companies can choose whether or not to make further investments in their production. This program was begun in 1967 at an approximate annual cost of $400,000. During the first year, five American companies were given contracts: Pillsbury to develop a protein beverage in El Salvador; Swift & Company for soybean food products in Brazil; Monsanto Company for soybean beverages in Brazil and later in British Guiana; Krause Milling Company for work on fortified corn products in Brazil; and International Milling Company for a wheat product fortified with high-protein wheat fraction in Tunisia.

In the calendar year 1968, a contract was given to Dorr-Oliver Company to study cottonseed protein concentrates for human use in India, to Swift and Company for soybean work in India, to General Mills for exploration of textured food in Pakistan and in 1969 for fortified ready-mix tortilla flour in Guatemala. Several other contracts are now being negotiated.

Consideration is being given to providing conditions whereby American or foreign food companies, or combinations thereof, can be aided in the initial stages of their ventures in new foods. One possible way is to provide, on a sliding scale, institutional markets such as school lunch programs and child feeding programs for these new foods. Maximum help would be in the first of a several-year period, later declining to a low proportion of the total market. It is contemplated that, regardless of help given initially, no program shall be encouraged which requires permanent institutional support for the major portion of its sales.

An example of another approach is an effort to develop coconut protein products for such areas as the Philippines which have no other major protein concentrate. A search of available technology revealed that an American company had a process, not designed originally for coconuts, which enabled the drying of fat-containing aqueous mixtures. This process is applicable to handling of the whole coconut. Sufficient funds were provided to set up a plant to produce coconut oil and a good quality coconut concentrate with about 20% protein.

Through its participation in the financing of several international meetings on the subject of new protein foods, the U.S. government is stimulating interest and exchange of information about the latest protein foods. One such meeting was the Oilseed Protein Conference held in Mysore, India in June of 1967. Following this, with encouragement and initial support from the U.S. AID Mission in India, the food industry organized a Protein Foods Association to foster the development of new protein foods

in India.

There are already in existence some examples of new protein foods being produced and marketed by American companies. For instance, in Colombia the Quaker Oats Company is marketing Incaparina, a corn-cottonseed mixture with a protein of high biological value and added vitamins otherwise lacking in local diets, developed by the Institute of Nutrition of Central America and Panama. It was first distributed in Guatemala and is at various stages of commercial development in El Salvador, Honduras, Panama, Venezuela, Costa Rica, Nicaragua, and Brazil. Incaparina is low in cost and compatible with the eating habits of Central Americans.

Another product is a bottled, sterile, protein beverage being test-marketed in Brazil by the Coca Cola Company. This product, called Saci, contains about 3% soy protein. It is flavored with chocolate or caramel and is sold competitively with other soft drinks. It is relatively more expensive than other protein mixture beverages and may exceed the cost of milk products. One problem is that it is subject to the Brazilian government beverage tax imposed on all soft drinks.

An additional consideration important in the development of foods for humans is the question of aesthetics. These foods must not only be nutritious, but must contribute to the enjoyment of eating. Textured foods now being produced from soy protein are included in the possibilities under investigation because they can be made to simulate foods already considered desirable. It is too early to evaluate most of the existing projects for their efficacy in meeting specific problems of malnutrition or for broadening options for protein foods. It is clear, however, that there will be no single solution to the protein food problem; various solutions and a variety of foods will be needed to augment the present supply of conventional protein foods.

Present and proposed status of centers for the animal and clinical testing of new protein foods.

With the increasing use of protein-rich foods, there is an urgent need for well equipped and experienced centers to carry out the animal and clinical testing of new protein foods. These are essential to protect and serve the public and to facilitate the enforcement of established standards for such foods. Within the U.S. there are university, commercial, non-profit, and government laboratories which conduct testing of this kind.

AID is considering a proposal for establishing regional centers to provide technical guidance to local organizations developing high-protein formulated foods, to ensure nutritional adequacy and safety prior to tests in children and adults, and to develop guidelines for the incorporation of formulated foods into local diets. Such regional centers will have the following goals:

1. To determine the most practical way of incorporating a formula food into the diet of the target population.
2. To determine the adequacy of the formulation by field testing.
3. To determine the acceptability of the product in terms of the local diet.

4. To obtain information on the wholesomeness of the product during handling and storage within the country.

5. To develop information on the preparation of an acceptable product for use by organizations responsible for infant and child feeding programs; and for agencies developing new formulas.

Animal and clinical testing of new protein foods are to be carried out as a matter of routine in the programs of each institute. Through its research programs, the U.S. government is giving support to the centers already existing in Taiwan; Lima, Peru; and Santiago, Chile.

AID intends to support the creation of such a center in West Africa, either at Dakar or Accra, in close cooperation with the Regional Center for Research and Training proposed for West Africa. These projects would consist of three phases: developing a preliminary program, signing a contract with the local institution, and organizing the testing facility.

In addition, the United States has considered helping to establish a number of evaluation centers within already established institutions staffed with research personnel who will facilitate rapid development of action programs. The following have been mentioned as possible sites:

A. Latin America

1. Institute of Nutrition of Central America and Panama, Guatemala City;

2. National Institute of Nutrition, Bogotá, Colombia.

B. Africa and Near East

1. University of Ibadan, Nigeria;

2. O.R.A.N.A. Organization for Research on Food and Agriculture, Dakar, Senegal;

3. Department of Social and Preventive Medicine, University of Cairo, Egypt;

4. School of Preventive Medicine, Accra, Ghana.

C. Far East

1. Department of Biochemistry, United States Naval Medical Research Unit 2, Taipei, Taiwan;

2. University of Dacca, East Pakistan;

3. Food and Nutrition Research Center, National Institute of Science and Technology, Manila, Philippines;

4. The Central Food Technological Research Institute, Mysore, India.

Indirect support through the U.S. - Japan Cooperative Medical Science Program of the National Institutes of Health for evaluation of protein foods is also being given to the Food and Nutrition Center of the Philippines, to the Department of Biochemistry of the United States Naval and Medical Research Unit in Taipei, and to the Institute of Nutrition of Central America and Panama.

Additional centers are under consideration in other areas of Brazil, Chile, India and Peru, as well as in Indonesia, Iran, Jordan, Malaya, Sudan, Thailand, Turkey, and Uganda.

Present and proposed numbers and level of training of personnel in nutrition, food science and food technology, and other fields important to the production and consumption of protein foods.

The United States considers it essential to continue to emphasize and support training programs in nutrition, food sciences food technology, and other fields important to food production and consumption, in order to provide sufficient professional and technical personnel to ensure the training of indigenous persons needed for implementation of programs to overcome and prevent malnutrition. Among the more effective programs for training foreign students in the United States are those which require basic training at the graduate level followed by thesis work in the student's own country on a problem of practical importance. Since the problem of protein malnutrition is greatest in the preschool age child, the training of people for demonstration work and other public educational projects for mothers receives special consideration.

Agricultural development frequently is treated as the most important way of improving nutritional status. However, food alone, no matter how great the quantity available may be, does not provide a solution to nutrition problems, nor does it meet the continuous nutrient needs of the population unless factors of consumption are given due attention. These factors include a wide spectrum of aspects involving technology, from selection of crops to be cultivated, harvesting methods, storage, processing, distribution, marketing, and mode of presentation to the target population. Benefits to children, adults, and the labor force in general must be measured

Persons with various levels of basic education are involved in this spectrum of activities; they range from the village mother, through the middle-level technical and vocational worker, to the sophisticated scientist whose advice guides industry, the policy maker and the politician

The U.S. government provides support for this wide spectrum of training under the following categories:

A. Promoting, organizing, and holding conferences on nutrition, and preparing educational materials.

B. Supporting existing institutions dedicated to the training of high- and middle-level personnel, either through direct grants-in-aid of research and education, or by contributing to budgets of international organizations.

C. Training of foreign students in the United States. These students are sponsored either through broad contracts with U.S. universities or by individual recruiting. During 1965-1966 approximately 82,000 students from other countries were being trained in the United States. Of these only 3.6%, or 3.064 students, were registered in the fields of agriculture and veterinary medicine.

D. Laboratories of the Agricultural Research Service, USDA, the Department of Defense, and the National Institutes of Health, provide training for foreign students, often at the professional level, who are sponsored by international organizations or by their own countries. Also, foreign students are assisted in making tours, with prearranged contacts provided.

Of the academically trained students, 1,066 were undergraduates and 1,786 were graduate students. The academic range of the remaining 212 was not specified

The contracts with the United States universities which involve the building of institutions abroad result in the training of both undergraduates and graduates in the fields of agriculture, food science, and nutrition in various countries. The number of students participating approximates 3,000. In some of the larger countries, or in those with more critical problems, several U.S. institutions may be involved cooperatively In India, the University of Illinois, Kansas State University, the University of Missouri, Ohio State University, the University of Tennessee, and Pennsylvania State University are all working with at least one agricultural college. The several Indian colleges receiving assistance through these contracts are currently graduating more than 2,000 students each year, and ultimately expect 13,000 undergraduates and 1,400 graduate students. This represents the type of training accomplished through the agricultural colleges in host countries

It appears obvious that training of foreign students in these fields should receive a high priority in view of the current problem of protein malnutrition.

Latin America

A. Six regional conferences on nutrition have been held in Latin America under the sponsorship of the United States government. These were attended by a variety of people -- nutrition scientists, administrators, politicians, educators, engineers, and industrialists -- reflecting the multidisciplinary character of the nutrition field. In Latin America alone, in 1966, $200,000 was devoted to this kind of project; and in 1967, $120,000 was so used. Films, teacher-training manuals, student booklets, posters, flip charts, radio programs, tapes, outlines, and radio spot announcements were sponsored with funds partly contributed by the U.S. government.

B. The important contributions made by the Institute of Nutrition of Central America and Panama in the field of training personnel have already been mentioned. This kind of assistance is given to a number of universities, such as the Laolina National School of Agriculture in Peru and the School of Hygiene and Public Health of the University of Sao Paulo, Brazil. In addition to this most important activity, nutrition courses are supported in selected Brazilian universities.

Africa

A. The U.S. government has sponsored the first educational conference in West Africa to include both French and English-speaking countries of the region. The conference, held in Dakar in March, 1968, covered the following topics: nutrition and health,

nutrition and agriculture, nutrition and industrial development, child feeding, nutrition education, and nutrition and coordinated planning. Another conference for the English-speaking countries of East Africa was held in Nairobi in May, 1969. A similar conference is being organized for the countries of French-speaking Equatorial Africa and North Africa in Tunis in May, 1970.

B. The U.S. government supports a wide variety of training in the various countries. For example, in Kenya, educational grants have been made to about ten students in the fields of range development, poultry husbandry, home economics, food technology, animal husbandry, and fisheries.

The United States is supporting graduate training in fishery biology in Ghana. In addition, the University of Ghana offers degree courses in home economics, and the Teacher Training College at Winneba offers diplomas in domestic science.

In Guinea, students are being trained in animal science. In East Africa, there is a Regional Training Center at the Makerere Agricultural Faculty, with students training in dairy science, animal physiology, and livestock management. In Ethiopia support is given to training in veterinary medicine, range management, and animal science. In Somalia, degree training is given to students in range management and livestock extension. Non-degree training is given in range and livestock management. In Malawi, practical poultry husbandry is being taught.

In Sierra Leone, support is given to the Njala University College for the purpose of training an increasing number of students in agriculture and domestic science. In 1969, perhaps 200 students will receive degrees and 125 will receive certificates. Rural training institutes also give practical education to more than 300 students.

In Morocco, short courses are given in agricultural research, livestock development, and food processing. Middle-level training has been supported in 1965 and 1966 for the benefit of 474 students.

In Nigeria, educational support and training were given to animal husbandry, poultry husbandry, and veterinary medicine. Several middle-level farm institutes are also being given some support.

In cooperation with FAO, the United States has been collecting all available data on the composition of food consumed in Africa. Two expert observers have made visits to the African countries, spending considerable time in laboratories that conduct food analyses. A list of 1,300 foods important in the African diet has been prepared; in addition, over 3,000 other foods of lesser importance have been recorded for future study. The data collected indicate that complete nutrient analysis is available for less than 20 per cent of the foods on the major-use list. It is proposed to:

1. Establish two or three Regional Training Centers in Africa which would offer a six-month to one-year training course in food analysis for laboratory technicians.

2. Provide contacts with laboratories in 10 to 20 African universities, institutes, and agricultural training centers to carry out food analysis under a central coordinator, thus assuring salaried positions for personnel trained as outlined in previous paragraphs.

3. Provide equipment for these laboratories identical to that used in the training center, or contract for analytical data if no equipment is available. Countries able to purchase it would be encouraged to do so.

4. Provide technical assistance on expert level to contract laboratories with regard to specific analysis. Such expert assistance would be provided through one of the regional training centers.

5. Offer short-term (1-week to 3-month) training courses on new analytical methods to past participants in the Regional Analytical Training Center.

6. Provide short-course analytical training with regard to soil, fertilizer, pesticides, etc to experienced laboratory personnel, particularly during the latter stages of the program. Such training could be offered to the persons in the initial program of the Regional Center.

East Asia

A. Training activities are supported indirectly through the funding of evaluation and research projects at Taipei, through the program of NAMRU 2, and at Manila through the comprehensive program in combating malnutrition under Virginia Polytechnic Institute. Scholarships are granted to students in Thailand, South Korea, and Viet Nam.

Present and proposed support for training of personnel in the fields of marketing (including distribution and promotion); market research (including socio-cultural surveys of consumers), and systems analysis to assist the marketing and promotion of new protein foods.

The United States trains large numbers of people in the fields of marketing, market research, and systems analysis. Such training is valuable for the development of effective programs in commercial promotion and distribution of foods in the less developed countries. Economics experts who are knowledgeable in this field have prepared themselves through graduate studies in the fields of agricultural economics and business administration. The development of such expertise in the United States is extensive and subject to increase. Such increase can occur in a relatively short period, but only in response to more opportunities for young people trained in these areas. The U.N. effort to identify needs and to publicize opportunities will have an important effect upon supply of such assistance.

The training of persons in the United States in marketing, market research, and systems analysis is conducted in the schools of agricultural economics and business administration. A survey has been made of 13 major training centers across the United States. Reports of students in graduate training at the M.S.,

M.B.A., and Ph.D. levels were obtained. In these 13 centers, it was found that the annual average graduation of students with the Ph.D. degree is 175, and of M.S. or M.B.A. degrees 270. Those graduating with the B.S. degree have sufficient training to be of assistance in programs in marketing. However, it is difficult to estimate the numbers of students available, since an undetermined number continue in graduate studies, go on to other major subject areas, or discontinue their formal training.

The number of foreign students training for graduate degrees is approximately 12 per cent for the M.S. degree and 25 per cent for Ph.D. It has been estimated that these figures represent about two-thirds of the students receiving the Ph.D degree, and one-third of those receiving the M.S. degree in the total training programs of the United States.

The evaluation of training in systems analysis is most difficult because it is offered in many colleges, universities, and private corporations. However, to illustrate application in the field of protein food development and promotion, the following example may be of interest.

The Monsanto Company is a major producer of feed supplements for improved livestock production, as well as herbicides and pesticides for improving crop yields. This is a continually expanding part of its international business. Under the previously mentioned protein foods program of AID, Monsanto has developed a technical team to develop and introduce a low-priced protein beverage called Puma in two pilot countries. It is a descendent of the soybean beverage Vitasoy, pioneered in Hong Kong by Low. This task force is now focusing on systems solutions to some world food problems. The resources of the task force will be broadened to make available expertise in such disciplines as land development, agricultural efficiency, food preservation and distribution, business and agricultural development financing, community development, and computer technology for nutritional improvement as well as systems model building. Most of these resources are available within the Company and can be summoned on an assignment basis to provide technological research on contract. This should be a self-sustained program to generate locally owned and operated business and agricultural enterprises in pilot countries. Monsanto intends to direct such a coordinated effort to problems of protein foods, combining the resources of a scientifically-oriented company with the social science needed to identify and respond to consumer needs in the context of their own culture.

Present and proposed steps for government review and improvement of policies, legislation, and regulations regarding all aspects of food and protein production, processing and marketing so as to remove unnecessary obstacles and encourage appropriate activities:

The laws and regulations that pertain to all aspects of food production, distribution, and marketing are subject to continual review and modification to meet the changing needs of the people of the United States. The Food, Drug, and Cosmetic Act, the enforcement of which is assigned to the Food and Drug Administration, is such an administrative law. Under its provisions, false or incomplete labeling of foods is prohibited. Specific regula-

tions apply to foods for special dietary use, to substances added to foods and to staple foods for which standards are established to promote honesty and fair dealing in consumer relations. Further, the Food, Drug, and Cosmetic Act provides that all foods exported from the United States must meet the laws, regulations, and requirements of the country to which they are shipped. This is an important protection for all countries that have found it possible to establish meaningful and effective food and food additive laws.

Standards for staple foods established by the Food and Drug Administration make up a long list. Of significance here is not only the standardizing of the basic foodstuffs, but also the definition of added nutrients that may or shall be used to enrich the food with specific vitamins, minerals, or protein substances. Enriched wheat flour, bread, corn products, rice, macaroni, and other alimentary pastes are among the many foods that must meet specific formulas of enrichment specified in the standards. Dietary foods purporting to have special health or nutritional value are regulated under a particular section of the law that requires labeling to be informative as to the amounts of vitamins, minerals, or other nutrients listed on the label. Market quality standards for processed foods such as canned, frozen, and dried fruits and vegetables, and such other foods as olives, peanut butter, and honey, are promulgated by the Department of Agriculture under the Agricultural Marketing Act of 1946.

All regulations dealing with specific products, particularly foods that involve special methods of processing, or products that require a showing of safety of food additives, are subject to revision and change whenever there is evidence that such change is in the interests of the consumer. At present, the important regulations which prescribe labeling of foods for special dietary use are undergoing modification and updating by orderly procedures established by law. In developing the scientific and technical basis for the promulgation of standards and regulations, the Food and Drug Administration is dependent upon the scientific community for pertinent facts. In the food enrichment area, such organizations as the National Academy of Sciences, the Food and Nutrition Board, the American Medical Association Council on Foods and Nutrition, the American Academy of Pediatrics Committee on Nutrition, and similar bodies are called upon for testimony on the scientific facts involved.

For those foods exported to foreign countries under Public Law 480, U.S. regulations are applicable with respect to quality, composition and conditions of shipping. Of particular concern are the regulations prescribing the specific vitamins, minerals, and other nutrient fortification which such foods as dried skim milk, wheat flour, or rice must meet when offered for PL-480 use.

Every country should enact and enforce regulations concerning food production, distribution, and marketing to ensure that the food supply is safe, sanitary, and free from adulteration. Advertizing claims for quality and nutritional values must not be misleading. This is especially important for foods claimed to be of special protein value, since the ordinary consumer is unable to determine for himself the importance of protein in his diet or the source of protein, excellent or poor, that may be used.

APPENDIX

MAJOR CONTRACTS OF MEMBER UNIVERSITIES WITH THE AGENCY FOR INTERNATIONAL DEVELOPMENT FOR AGRICULTURE OR AGRICULTURAL EDUCATION

I. Consortium of U.S. Universities for Rural Development in India

A.	AID/nesa - 149 University of Illinois 11/1/64 - 6/30/69 $904,167	Assist in the establishment of Madhya Pradesh Agricultural University
	AID - A.N. Renshaw-NESA/Tech	Ill. - R.W. Jugenheimer
B.	AID/nesa- 150 University of Illinois 11/1/64 - 6/30/69 $1,218,319	Assistant to Uttar Pradesh Agricultural University
	AID - A.N. Renshaw-NESA/TECH	Ill. - R.W. Jugenheimer
C.	AID/nesa - 146 Kansas State University 11/1/64 - 6/30/69 $972,095	Assistance to Andhra Pradesh University
	AID - A.N. Renshaw-NESA/TECH	KSU - R.A. Bohannon
D.	AID/nesa - 322 Kansas State University 11/1/66 - 6/30/69 $188,670	Assistance to Andhra Pradesh Agricultural University in connection with the Agricultural Production
	AID - A.N. Renshaw-NESA/TECH	Ill. - R.A. Bohannon
E.	AID/nesa - 144 University of Missouri 11/1/64 - 6/30/69 $824,186	Advice and assistance to the ORISSA University of Agriculture and Technology
	AID - A.N. Renshaw-NESA/TECH	UM - W.T. Wilkening
F.	AID/nesa - 320 University of Missouri 11/1/66 - 6/30/69 $216,921	Assistance in achieving a rapid increase in food grains production
	AID - A.N. Renshaw - NESA/TECH	UM - W.T. Wilkening

G.	AID/nesa - 321 University of Missouri 8/22/67 - 6/30/69 $154,400	Assistance in achieving a rapid increase in food grains production
	A.N. Renshaw	UM - W.T. Wilkening
H.	AID/nesa - 148 Ohio State University 11/1/64 - 6/30/69 $895,860	Assistance in establishment of Punjab Agricultural University
	A.N. Renshaw	OSU - Mervin G. Smith
I.	AID/nesa - 148 Ohio State University 11/1/64 - 6/30/69 $866,940	Assistance to Udaipur Agricultural University
	AID - A.N. Rensahw-NESA/TECH	OSU - Mervin G. Smith
J.	AID/nesa - 295 Pennsylvania State Univ. 2/1/67 - 8/25/68 $190,119	Technical advice and assistance to achieve a rapid increase in production of food-grains during years 1966-71. - Maharastra University and Research Institute.
	AID - A.N. Renshaw	PSU - R.H. McAlexander
K.	AID/nesa - 346 Pennsylvania State Univ. 10/1/67 - 6/30/69 $57,000	Technical advice and assistance to the Ministry of Food and Agriculture
	AID - A.N. Renshaw	PSU - R.H. McAlexander
L.	AID/nesa - 145 University of Tennessee 11/1/64 - 6/30/69 $$790, 805	Technical advice and assistance to the Mysore Agricultural University
	AID - A.N. Renshaw	UT - Lewis H. Dickson

M. AID/nesa - 318 University of Tennessee 6/1/67 - 6/30/69 $229,340	Technical advice and assistance to the Mysore University of Agricultural Sciences
AID - A.N. Renshaw	UT - Lewis H. Dickson
N. AID/nesa - 319 University of Tennessee 10/7/66 - 6/30/68 $170,850	Technical advice and assistance to the Madras Agricultural Research Institute
AID - A.N. Renshaw	UT - Lewis H. Dickson

Summary: 14 contracts with six United States universities for assistance to nine Indian institutions - a total of $7,679,672.

The data were taken from two publications of the Contract Services Division, AID as of December 31, 1967. The individuals named are the AID Action Officer & Campus Coordinator.

1. # W-442 AID-Financed University Contracts

2. # W-443 Current Technical Service Contracts

II. <u>Consortium for the Study of Nigerian Rural Development</u>

AID Action Officer in each contract is J. Emerson - AFR/ID

A. Colorado State University AID/afr - 447 11/24/64 - 9/30/69 $2,119,000	Ministry of Agriculture - AID in coordinating agricultural education and research.
Campus coordinator D.D. Johnson	
B. Kansas State University AID/afr - 295 10/1/63 - 6/30/69 $2,865,000	Advice and assistance in the establishment of colleges of agriculture and veterinary medicine at Ohmadu Bello University.
Campus coordinator R. Bohannon	

C. Michigan State University AID/afr - 264 4/1/65 - 8/31/68 $1,150,500 Campus coordinator - Thomas McGrain	Government of Nigeria - to evaluate program for agricultural development and effect of AID assistance to provide basis for future programs.
D. University of Wisconsin AID/afr - 450 12/15/64 - 12/31/69 $1,599,400 Campus coordinator - Edwin Heizer	Assistance in development of a land grant type of agricultural college - University of IFE

III. Western Nigeria

A. University of Wisconsin AID/afr - 350 10/1/65 - 9/30/69 $649,640 Campus coordinator - Edwin Heizer	Assistance to the Ibadan and Akure Schools of Agriculture

IV. Others in Africa

A. Oklahoma State University AID-W-629 5/16/52 - 9/30/68 $11,683,364 R. Ottley - AFR/ID	To improve agricultural education at the Imperial Ethiopian College C.C. William S Abbott
B. University of Wyoming AID/afr - 412 1/20/65 - 11/30/69 $1,680,000 W. Leake - AFR/ID	Technical assistance to the Ministry of Agriculture, Somali Republic C.C. G.W. Arnold

C. Texas A & M AID/afr - 291
10/26/62 - 12/31/69 $1,760,661

C. Ferguson - AFR/ID CC Paul Creech

Tunisia - advise and assist in strengthening the agricultural education, research and extension program by fostering establishment of land-grant types of college

D. University of Illinois AID/afr - 293
8/16/63 - 8/31/69 $1,921,000

AID W. Saunders CC O.N. Liming

Sierra Leone - Njala Teacher Training College, assist in establishment of a land-grant type college

V. Latin America

Brazil

A. AID/la - 165 Mississippi State Univ.
3/2/64 - 6/30/68 $776,500

AID/LA/ID J. Ford

Ministry of Agriculture - Training of personnel and passage of beneficial legislation in Brazilian seed program

C.C. Dean Bunch

B AID/W-639 Purdue University
7/27/51 - 12/31/68 $4,844,298

J. Ford - LA/ID

Rural University of the State of Minas Gerais: Advice and assistance in developing Brazilian agriculture

C.C. - D. Woods Thomas

Peru

C. AID/12-49 Iowa State University
10/2/62 - 12/31/69 $2,044,560

B. Pace - LA/ID

Instituto de Reforma y Colonización - Technical Assistance in development of an agrarian reform and credit program

C.C. - Floyd Andre

D. AID/la - 510 North Carolina State University 1/1/61 - 12/31/70 $5,412,180 B. Pace - LA/ID	Ministry of Agriculture - Advice and Assistance to improve agricultural production through educational research and extension programs C.C. - Arthur Coutu

VI. Near East and South Asia

Afghanistan

A. AID/nesa - 215 University of Wyoming 9/1/54 - 12/31/68 $7,068,424 Clyde Adams - AID/NESA/TECH	Technical advice and assistance to the Ministry of Agriculture and certain universities in the field of agriculture (Kabul Univ.) engineering and education C.C. - Gordon W. Arnold

Pakistan

B. AID/nesa - 184 Texas A & M System 6/24/54 - 6/31/68 $5,040,460 C. Adams NESA/TECH	East Pakistan Agricultural University - Assist Pakistani universities to develop and strengthen educational research and extension programs and activities. C.C. - J.D. Gray
C. AID/nesa - 178 Washington State University 6/24/64 - 6/30/69 $6,099,039 Clyde Adams - NESA/TECH	West Pakistan University and University of Peshawar - to assist universities in their agricultural educational programs C.C. - A. Spitz

COUNCIL OF U.S. UNIVERSITIES ON SOIL AND WATER DEVELOPMENT IN ARID AND SUB-HUMID AREAS (CUSUSWASH)

Members

University of California	(India)
Colorado State University	(West Pakistan)
Utah State University	(CIDIAT)*

Organized in 1967 for world-wide research in water management. Professor Charles Hardin, University of California at Davis, is President of the Council.

Each university has submitted an individual, but coordinated, proposal for water research to AID's Research Council. All the proposals were approved, but none as yet has been funded.

*CIDIAT is the Inter-American Center for the Development of Land and Water Resources of the Organization of American States at Merida, Venezuela. Utah State Has been involved there for some time.

REFERENCES

1. Marine Science Affairs - A Year of Plans and Progress, the Second Report of the President to the Congress on Marine Resources and Engineering Development. March, 1968, pages 39-41.

2. The World Food Problem. A Report of the President's Science Advisory Committee, Volume II, Report of the Panel on the World Food Supply, p. 368.
For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

3. Single-Cell Protein, R.I. Mateles and S.R. Tannenbaum, (Eds.). The M.I.T. Press, Cambridge, Massachusetts and London, England, 1968.