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REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

U.S. Participation In International Agricultural Research

The importance of research to aid developing countries in meeting their food needs is being emphasized increasingly. Much attention has focused on the international agricultural research centers as a result of the development of high-yield varieties of rice and wheat which created the hope of a "Green Revolution."

The Agency for International Development is a major contributor to the international agricultural research centers and also supports agricultural research of benefit to developing countries through U.S. universities and other institutions.

This report examines the Agency's support of international agricultural research centers and its research strategy and makes recommendations for improving management of the program.

ID-77-55

JANUARY 27, 1978

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report is part of our continuing effort to recommend ways U.S. agencies can better help developing countries to improve their food situation. Some of our previous reports focused on the need for such countries to increase food production and to reduce postharvest food losses. This report concentrates on the need to improve U.S. participation in international agricultural research, especially in the international centers.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget, and the Administrator, Agency for International Development.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

U.S. PARTICIPATION IN INTERNATIONAL AGRICULTURAL RESEARCH

D I G E S T

NEED FOR IMPROVED AGRICULTURAL RESEARCH STRATEGY

In the 1960s the development of high-yield varieties of rice and wheat--the promise of a "Green Revolution"--focused attention on agricultural research as a means of reducing the food shortages of developing countries. International agricultural research centers were expanded, and funds for research increased.

The Agency for International Development expanded its funding for its food and nutrition technical assistance and research programs from $25 million in 1974 to about $71 million for 1978. These programs are conducted by U.S. universities and other institutions and by international agricultural research centers. Some studies, such as one completed by the National Academy of Sciences in June 1977, recommended stronger Agency action in research.

GAO reviewed the Agency's support of the international agricultural research centers, examined its strategy and policies for agricultural research, and made a case study of a project begun in 1967 to control animal pest damage to foodstuffs.

GAO concluded that the Agency for International Development should make further improvements in its agricultural research plans and programs for food deficient countries. The Agency should

--identify specific problems for U.S. financing,

--establish the relative priority of the problems, and

--determine those problems that should be pursued through international agricultural research institutions or in similar ways.

The Agency for International Development needs to establish criteria for allocating its funds among international research centers because of sharply rising costs, and it needs to deal with issues that will determine the future of the centers and the contributions that will be required.

International agricultural research centers

The Consultative Group on International Agricultural Research, a consortium, finances international agricultural research centers. In 1972 there were five centers costing $20 million; by 1977 there were nine centers and two other programs costing $79 million. Costs are projected to exceed $130 million by 1980. The Agency has financed up to 25 percent of all Group-sponsored centers and programs.

Agency contributions of $18 million for 1977 were about the same as the U.S. contribution to the regular budget of the Food and Agriculture Organization which is administered through a complex interaction of several agencies. However, it has participated in the Consultative Group and contributed to international centers through a small staff without the benefit of specific overall objectives and priorities to guide its participation. It has contributed to every Group-sponsored international center and program--the only Group member to do so.

A specific statement of U.S. objectives and priorities is essential because emerging issues will affect the future of the centers and the Consultative Group's role. (See pp. 11 to 20.)

The unlimited potential for increasing agricultural research and related activities

poses questions for all donors as to how much and into what area international research centers should expand. Funding requirements spiral, and a high degree of coordination is required. (See pp. 11 and 16.)

Another issue is the extent that research centers help developing countries improve their capabilities in research. Generally developing countries lack the capability to adapt and apply results of international center research. The centers' efforts to help these countries improve their capabilities create a danger of diverting the centers from their basic research thrust. (See pp. 13 to 15.)

U.S. universities and other institutions

The Agency's approval processes appear to insure that research projects deal with important issues, but problems requiring research should be more sharply defined and relative priorities should be established.

Greater involvement by the Agency's missions in developing countries in setting research funding priorities should make research programs more responsive to the needs of these countries. (See pp. 5 and 6.)

GAO's case study of the Agency's 10-year research programs for controlling losses of foodstuffs because of rats, vampire bats, and noxious birds shows the need to obtain participation donors for some kinds of research projects. There was some coordination and collaboration with other countries and organizations, but international interest was not capitalized upon and a multidonor-supported effort promoted. The vertebrate pest problem has worldwide dimensions, similar characteristics unique to particular situations, political and cultural sensitivities, and environmental considerations, all of which limited the success of the Agency's program. (See ch. 5.)

MULTIPLE FINANCING

The Agency for International Development contributes up to 25 percent of the centers' regular budgets; its bureaus fund extra-budgetary special projects; and the Inter-American Development Bank contributes to the centers from the U.S.-owned Social Progress Trust Fund, which it administers.

Special projects with the International Rice Research Institute, for example, were 45 percent of the Agency's regular contribution for 1976. Combined Agency and Social Progress Trust Funds were 46 percent of the total amount contributed to the International Maize and Wheat Improvement Center in 1976.

Total U.S. funds going into the centers from these sources are obscure because there is no consolidated reporting, and there is little or no assurance that the various U.S. financing entities are unified in promoting U.S. objectives through the centers because there is no central monitoring of activities.

The Agency should establish a mechanism for coordinating and monitoring all U.S. participation in the international centers and should disclose the full extent of U.S. financing to give the Congress and Agency management a valid basis for evaluating U.S. participation. (See ch. 3.)

CENTERS WITHOUT INTERNATIONAL SUPPORT

The Agency for International Development is virtually the sole financial supporter of the core program of the International Fertilizer Development Center at Muscle Shoals, Alabama, and the only major external donor (37 percent in 1976) to the Asian Vegetable Research and Development Center in Taiwan. These research centers were established at the Agency's initiative with the hope of gaining international financial support. However, other major international donors are reluctant to support these institutions for political reasons, and

the Agency is in the position of having to bear most of their long-term costs. (See ch. 4.)

GAO's July 5, 1977, report, "Restrictions on Using More Fertilizer for Food Crops in Developing Countries" (ID-77-6), recommended that the Administrator of the Agency terminate support of the International Fertilizer Development Center and arrange the transfer of its programs and activities to existing international organizations. The Agency said it would be a mistake technologically and diplomatically to terminate support, but it agreed that there should be broadened international financial support.

GAO recommends that the Agency disclose more fully to the Congress the prospect of broadened international financial support and the likelihood that a long-term Agency commitment will be needed.

AGENCY COMMENTS

The Agency for International Development agreed largely with GAO's recommendations. It said, however, that the report did not give adequate consideration to the positive benefits of its research programs and the improvements it had already made.

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ABBREVIATIONS

AID	Agency for International Development
AVRDC	Asian Vegetable Research and Development Center
CGIAR	Consultative Group on International Agricultural Research
FAO	Food and Agriculture Organization
FDA	Food and Drug Administration
GAO	General Accounting Office

CHAPTER 1

NEED FOR MORE SPECIFIC STRATEGY AND PLANS FOR FUNDING AGRICULTURAL RESEARCH PROGRAMS

At the 1974 World Food Conference, Secretary of State Kissinger encouraged greater financial support of agricultural research for the developing world. He stated that

> "* * * on the international plane we must strengthen and expand the research network linking the less developed countries with research institutions in the industrialized countries and with the existing eight international agricultural research centers. We propose that resources for these centers be more than doubled by 1980. For its part, the United States will in the same period triple its own contribution for the international centers, for agricultural research efforts in the less developed countries, and for research by American universities on the agricultural problems of developing nations."

The Agency for International Development (AID) increased its centrally funded food and nutrition technical assistance and research programs from $24.6 million in 1974 to $71 million in 1978. These interregional programs were administered by the Technical Assistance Bureau. Agency officials estimated that an equivalent amount is funded by AID's regional bureaus for agricultural projects for specific countries that are in some way research related.

Centrally funded interregional activities by the Technical Assistance Bureau have been about equally divided between (1) international agricultural research centers, primarily those supported by the Consultative Group on International Agricultural Research (CGIAR), a consortium of multinational donors, and (2) research and technical assistance programs, primarily performed by U.S. universities, colleges, and government agencies.

The National Academy of Sciences in June 1977 released a major world food and nutrition study, undertaken at the request of President Ford, on the potential contributions of research. Among other things, this broad and encompassing study advocated stronger U.S. action, through AID, to help establish research and development capacity in the

developing countries, to support further development of international research centers and programs, and to support the involvement of U.S. scientific groups in research concerned with food and nutrition in developing countries.

SCOPE OF REVIEW

Our review concentrated on AID's support of the international agricultural research centers and was not a comprehensive review of AID's entire agricultural research program. Regional bureau programs were considered only to the extent of their activities with the international centers. We traced the development of CGIAR and examined some issues it now faces. We evaluated the management of U.S. participation in CGIAR and in the Asian Vegetable Research and Development Center (AVRDC) and the International Fertilizer Development Center which are not supported by CGIAR.

In addition to the international agricultural research centers, we examined to a limited extent the Technical Assistance Bureau's overall policies and strategy for other agricultural research and support activities, such as with U.S. universities and government agencies. We did a case study of one of these activities--the vertebrate pest control research project--to determine the efficacy and limits in solving an international research need. Although not indicative of AID's entire research program, observations on the project have broad program implications.

We reviewed records and had discussions with AID officials in Washington, D.C., and AID missions in the Philippines, Thailand, Panama, Colombia, and Peru, and at the Department of the Interior's Wildlife Research Center in Denver, Colorado, which was doing the vertebrate pest project for AID. We visited and obtained pertinent information from AVRDC in Taiwan, the International Rice Research Institute in the Philippines, the International Potato Center in Peru, and the International Center for Tropical Agriculture in Colombia.

This report was discussed with agency officials, and AID's written comments are included in appendix I. AID generally agreed with the thrust of the recommendations. Agency officials commented, however, that the underlying discussions and logic were misleading. The premises for this statement appear to be AID officials' feeling that the report did not give adequate considerations to the positive benefits of its research programs and the improvements it had already made in its research strategy for interregional programs.

We have revised the report and have included the Agency's comments to the extent that we considered appropriate.

As this report was being processed, AID announced that Technical Assistance Bureau activities were being consolidated with other activities into a new bureau. The observations and suggestions in this report are generally applicable to whatever organizational component is responsible for agricultural research activities.

INTERNATIONAL AGRICULTURAL RESEARCH CENTERS

AID has promoted the growth of international agricultural research centers and multidonor funding. It has been willing to fund up to 25 percent of total core costs of CGIAR-sponsored centers if others would share the other 75 percent. The growth of the CGIAR-sponsored research centers and the increase in the number of donors is discussed in the next chapter. AID's contributions to AVRDC and the International Fertilizer Development Center are discussed in chapter 4.

AID does not have an explicit, written strategy clearly delineating its perception of CGIAR's objectives and priorities and its own role in CGIAR. There is no readily available and concise statement of goals and objectives that AID wishes to achieve through the international research centers, nor plan for how its financing of research through the centers relates to other research it finances.

AID's allocation of funds among centers has been largely one of filling the gaps, and it has been the only donor to contribute to every CGIAR-sponsored international center and other activity. Other donors generally have made contributions to specific centers while AID has supplied the residual requirements for all centers. This policy has resulted in AID's contributions to individual centers varying somewhat above or below 25 percent of their core budget in any given year.

A recent AID funding memorandum recognized that this non-prioritized allocation process may lead to problems if AID's funds become limited.

> "Because many centers and programs may be short, hard decisions will probably have to be made by AID * * * as to who will receive their somewhat more flexible funds. To do this, AID will have to start thinking more deeply about criteria--such as the Congressional mandate and others. This

could be a new ball game and a difficult one. Should, of course, additional AID funds * * * become available, the size of the gap would be reduced and the allocation problem might be less severe."

AID's total contributions to the core budgets of CGIAR-sponsored centers have increased from $3.8 million in 1972 to $22 million proposed for 1978. Twenty-five percent of the projected costs of CGIAR-sponsored centers for 1980 would be about $32 million. The recently completed world food and nutrition study by the National Academy of Sciences recommended that AID continue to provide 25 percent of the funding for the centers and programs sponsored by CGIAR and join in supporting other high quality international centers, both those with which it is already involved and others for which it is not now a major supporter.

AID's contributions to CGIAR-sponsored centers now equal or surpass U.S. contributions to other well known international organizations. For example, the $18.4 million for 1977 for CGIAR centers is slightly less than the U.S. contribution to the Food and Agriculture Organization's 1977 regular program budget. However, in contrast with U.S. participation in CGIAR, which is managed by a small staff in AID's Technical Assistance Bureau, U.S. participation in the Food and Agriculture Organization is a complex interaction among several agencies, including the Departments of State and Agriculture as well as AID.

Although such a bureaucratic involvement in CGIAR is probably neither necessary nor desirable, the growing size and complexity of the system may dictate a more refined and deliberative, forward-looking approach than the practice of funding every CGIAR-sponsored activity. In the early formative years when AID's primary objective was to promote multidonor-supported research, perhaps it was less urgent to develop an explicit overall policy and strategy. But total costs for CGIAR-sponsored research centers are projected to exceed $130 million by 1980, and major issues resulting in part from this growth are facing the centers and CGIAR. The resolution of these issues will determine CGIAR's future.

These issues are further discussed in the next chapter which examines CGIAR and the international centers in greater depth.

AID officials suggested that along with our discussions of present and future costs of the international centers there should be a discussion of the high payoffs from investments in the international centers. We did not attempt to evaluate the payoffs from investments in the international centers, but as AID indicated, some authorities ascribe very high rates of returns to the centers and especially to the high-yielding varieties of rice and wheat resulting primarily from the International Rice Research Institute and the International Maize and Wheat Improvement Center. Most of the other centers are in relatively early stages of development and have yet to realize their potential. Some difficulties in evaluating cost benefits are summarized later.

Some recent studies, such as one by the National Academy of Sciences and another by the Office of Technology Assessment, recommend larger investment in agricultural research, including the international centers. This report does not assess the magnitude of present and future research costs, but it does suggest that the increasing magnitude of such costs deserves greater management attention and a refinement of overall strategies.

UNIVERSITIES AND OTHER RESEARCH ORGANIZATIONS

AID's screening and evaluative processes appear adequate to insure that approved projects deal with important issues, but problems requiring research should be more clearly defined and relative priorities should be established to enable a sharper concentration of limited research funding on specific problems.

Our May 5, 1976, report, "Strengthening and Using Universities as a Resource for Developing Countries"(ID-76-57), stated that almost all of the AID-financed research under the central research program is a result of unsolicited proposals from research organizations, including universities. Contracts are awarded to the institution making the proposal after the review committees have considered the scientific merits of and a need for the proposal.

Officials of the Technical Assistance Bureau confirmed that most agricultural research projects were initiated on the basis of unsolicited proposals received from the research community. In addition to personal contacts with Agency officials, the principal formal mechanism by which

researchers are made aware of AID's centrally funded research program is a 34-page brochure of January 1977 entitled "Contract Program in Centrally Funded Research." This brochure generally describes broad research and development problem areas rather than specific research needs.

Programs in the agricultural area are organized around activity clusters, which are identified problem areas requiring concentrated attention both in research and in field-support activities. Project proposals are accepted if they fall within a cluster and fill a need in that cluster. Clusters are either deleted or added in response to changing research needs.

The cluster concept is an improvement in defining the extent and interrelationship of the centrally funded projects, but more needs to be done in the development of a specific overall strategy. Relative priorities have not been established, and while some activity clusters such as biological nitrogen fixation are specific, others are still very broad. The majority of activity clusters, such as cereal grain improvement, pest and hazard management, international agricultural research centers, and livestock production systems, are broad enough to encompass a wide range or research efforts.

In late 1976 field missions were requested by the Technical Assistance Bureau to assess the importance of proposed research clusters on each country's development effort. Even though this represented an effective way of integrating mission input into AID's centrally funded research program there were no definite plans to repeat this assessment in the future.

Missions should have intimate knowledge of the major research needs of individual countries and regions as the missions are primarily responsible for programing assistance to meet those needs. Involvement of the missions should make research programs more responsive to developing countries' needs and should generate a responsive attitude by mission personnel in incorporating centrally funded research findings into their country's programs.

Title XII of the International Development and Food Assistance Act of 1975 recognized the need for a clearer statement of research needs when it authorized the Board for International Food and Agricultural Development. The title placed specific emphasis on the increased involvement

of qualified universities in the planning and execution of food, nutrition, and agricultural development programs.

Drawing its membership from universities, private foundations, and agribusiness, the Board, with subordinate committees and staff, is charged to participate actively with AID in formulating policy, defining problems, and carrying out the planning, design, implementation, and evaluation of activities coming within the scope of title XII.

Since the Board and AID are in the process of developing effective operational procedures, it is still too early to assess the impact the Board will have on the manner in which AID identifies research needs, establishes priorities, and initiates appropriate research projects.

CONCLUSIONS AND RECOMMENDATIONS

In order to utilize limited research funding most effectively and efficiently, AID needs to continue to improve its overall strategy and planning for its agricultural research activities. Such improvments are becoming more urgently needed because of the increasing emphasis on food and nutrition research, the increasing number of international centers, their broad range of activities, and their spiraling costs. AID should, among other things, identify by priority those specific agricultural problems of the developing world that are most receptive to solutions through research. Continuing efforts should be made to keep the missions actively involved in this process. It should determine the relative priority of the use of funds for international centers as compared to its other activities. It should also attempt to draw the complementary linkages among various bilateral and multilateral projects and insure that appropriate determinations are made as to whether programs should be done multilaterally or bilaterally.

Chapter 5 contains a case study of a vertebrate pest control research project. AID's experience on this project shows the need to make these determinations.

A precise, updated statement of U.S. interests and objectives in CGIAR and the international agricultural research centers should be developed. An expression of U.S. policy and objectives is particularly important now in formulating constructive responses to major issues which will determine CGIAR's future. AID must be prepared to identify and take a positive lead in dealing with issues that have

potentially unlimited funding requirements and that affect the future thrust of centers as new centers are established and older centers expand their areas of research and related activities.

We recognize that, as only one member of CGIAR, AID may be limited in the direct impact it may have in dealing with pertinent issues. However, AID is a major donor and as such should be an influential member. Through its participation in CGIAR, contacts with other donors, and its grants directly to the centers, AID can exercise a more positive influence on the evolution of the centers and the activities of CGIAR if it is prepared to do so.

To insure that its food and nutrition research program effectively addresses urgent food problems, we recommend that the Administrator of AID develop a more specific overall long-range strategy for carrying out its agricultural research activities. AID should

--work toward identifying more specifically the problems requiring urgent U.S. research financing and establish the relative priority of these problems;

--determine the relative priority of the use of funds for international centers as compared to its other activities;

--provide criteria for deciding whether research problems should be pursued through multilateral channels, such as international agricultural research centers, or through other channels, such as universities or other organizations;

--provide criteria for allocation of funds, if necessary, among centers and identify and take the lead in dealing with major issues affecting the international agricultural research centers and AID as a major donor.

CHAPTER 2

CGIAR AND SOME ISSUES IT FACES

CGIAR

In the late 1960s two international research centers established earlier by the Rockefeller and Ford Foundations achieved significant advances in the development of high-yield varieties of wheat and rice giving rise to the concept of the "Green Revolution."

CGIAR was formed in 1971 in recognition of this work and of the potential value of expanded research in agriculture. CGIAR is composed of representatives of donor countries, development banks, foundations, and agencies committed to providing funds to international agricultural research centers for programs to increase food production and train research scientists and production specialists in developing nations.

CGIAR, as a voluntary consortium, is not a formal international organization with assessments and a large bureaucratic organization. It is supported, however, by a Secretariat provided by the World Bank and is advised on scientific matters by a Technical Advisory Committee and its own Secretariat supported by the Food and Agriculture Organization (FAO).

The CGIAR Secretariat consists of several full-time professional employees whose responsibilities include reviewing the centers' budget submissions, annual reports, and annual independent audited reports; advising and assisting the centers in their programing and budgeting; preparing an annual integrated report outlining existing and proposed programs, projecting costs for several years, and identifying program and financial issues which should be addressed by CGIAR.

The Technical Advisory Committee consists of 13 consulting agricultural scientists or research administrators and was established to advise CGIAR on research proposals, priorities, and program effectiveness. It meets two or three times a year in up to 5-day sessions and presents its findings during CGIAR's two meetings each year. The Committee selects special teams to do "quinquennial" reviews, detailed technical reviews of each CGIAR-supported center once every 5 years, which were begun in 1975.

CGIAR-supported research centers are located in developing nations, but they are owned and governed by international boards of trustees. Their senior scientific staffs

are recruited without regard to nationality. Although they do not directly contribute financial support to the centers, host governments do provide the site for the center and its experimental farmlands.

These centers and other CGIAR activities are summarized as follows:

Center	Location	Founded	Research
International Rice Research Institute (IRRI)	Los Banos, Philippines	1960	Rice varieties and crop production systems
International Maize and Wheat Improvement Center (CIMMYT)	El Batan, Mexico	1966	Maize, wheat, barley, and triticale
International Center for Tropical Agriculture (CIAT)	Palmira, Colombia	1967	Various crops, livestock, and farming systems in lowland tropics
International Institute of Tropical Agriculture (IITA)	Ibadan, Nigeria	1968	Root and tuber crops, grain legumes, and farming systems in lowland tropics
International Potato Center (CIP)	Lima, Peru	1971	Potatoes
West Africa Rice Development Association (WARDA)	Monrovia, Liberia	1971	Field testing of new rice varieties
International Crops Research Institute for Semi-Arid Tropics (ICRISAT)	Hyderabad, India	1972	Various crops, farming systems, and water management is semi-arid tropics
International Laboratory for Research on Animal Diseases (ILRAD)	Nairobi, Kenya	1973	Two major cattle diseases--theileriosis and trypanosomiasis
International Livestock Center for Africa (ILCA)	Addis Ababa, Ethiopia	1974	Cattle production and range management systems
International Board for Plant Genetic Resources (IBPGR)	Rome, Italy	1974	Coordination, collection, and exchange of plant genetic materials
International Center for Agricultural Research in the Dry Areas (ICARDA)	Iran, Lebanon, Syria	1976	Various crops and farming systems in mediterranean and cold winter climates

CGIAR meets twice a year in 2- to 5-day sessions. Delegates appointed at FAO's biennial conferences and representing five major developing regions of the world also attend these meetings as rotating members. Decisions are made by consensus as summarized by the CGIAR Chairman.

At the first meeting, commonly referred to as "Centers Week," the centers discuss their activities and proposed programs and budgets for the coming calendar year. The donors give a preliminary indication of their financial support for the coming year; however, they support individual centers of their own choice through grants consummated directly between the donor and recipient.

Between Centers Week and the second meeting, donors, in consultation with the Secretariat, can reconsider the allocation of their contributions in relation to centers that are under or oversubscribed. Many donors are flexible in making such readjustments.

As CGIAR has developed, certain issues have emerged relating to the system's future size and responsibilities. Notwithstanding any consideration that CGIAR may be giving to these matters, as a major donor, AID must be prepared to deal with these issues within the context of its defined objectives and goals.

MAJOR ISSUES FACING CENTERS AND DONORS

Growth

Although there are indications that the rapid expansion of centers will stabilize, some growth is inevitable, partly because of inherent pressures of the system. Potential research areas are many, and as centers evolve, they tend to incorporate into their work other crops or activities which extend or complement their original research mandate. Furthermore, centers have undertaken cooperative research in similar crops but under differing ecological conditions. Rice cultivation, for example, is currently being studied by the three centers in the Philippines, Nigeria, and Colombia, and by the cooperative program in Liberia.

Since 1972, when the 16 original CGIAR donors contributed $20 million to 5 centers, donors have increased to about 29, and contributions have increased to about $79 million for 1977. In July 1977 the Secretariat projected that costs for 1980 may exceed $130 million.

The increasing number of research centers and their spiraling costs thus raises a real question about the future roles of CGIAR and individual donors in funding and coordinating such activities. This question becomes more acute when considered in the context of the many research possibilities and related activities and potentially heavy funding requirements.

Growth in contributions under the aegis of the CGIAR system is shown by the following schedule.

CGIAR CONTRIBUTIONS

	1972	1973	1974	1975	1976	1977 (estimated)
	(000 omitted)					
Arab Fund	$ -	$ -	$ -	$ -	$ -	$ 310
Asian Development Bank	-	-	-	300	-	500
Australia	-	5	1,015	1,214	1,747	1,705
Belgium	140	600	380	621	1,742	2,410
Canada	1,160	1,780	4,675	4,340	5,392	7,367
Denmark	250	225	370	400	456	616
European Economic Community	-	-	-	-	-	2,500
Ford Foundation	5,315	3,675	3,000	2,800	2,000	1,500
France	-	-	130	411	511	535
Germany	-	1,805	3,040	3,936	4,474	5,756
Inter-American Development Bank	-	-	2,030	4,122	5,000	5,700
International Development Research Center (Canada)	175	345	645	990	1,779	1,475
Iran	-	-	-	-	1,975	2,000
Italy	-	-	-	-	100	100
Japan	150	230	265	675	1,200	2,500
Kellogg Foundation	155	290	280	290	300	310
Netherlands	375	430	555	1,234	1,500	1,500
New Zealand	-	-	-	-	105	100
Nigeria	-	-	-	646	643	640
Norway	75	185	445	807	1,119	1,520
Rockefeller Foundation	3,990	4,545	3,500	2,885	2,165	1,600
Saudi Arabia	-	-	-	-	1,000	1,000
Sweden	1,000	150	1,490	2,290	2,256	2,490
Switzerland	-	410	140	460	855	1,213
United Kingdom	690	1,110	1,920	2,411	2,889	3,330
U.N. Development Program	850	1,000	1,465	2,164	1,929	3,880
U.N. Environmental Program	-	-	-	600	340	340
United States	3,770	5,390	6,805	10,756	14,870	18,350
World Bank	1,260	2,780	2,375	3,226	6,625	8,000
Kresge Foundation	750	-	-	-	-	-
Total	$20,060	$24,955	$34,525	$47,578	$62,972	$79,247

Assistance to national programs

In recognition of the importance of national research programs, international centers are expanding their operations through cooperation with and assistance to developing nations' agricultural research and development programs. Cooperation with national programs is reported to constitute an important component of all centers' programs. It extends the scope of the centers' own research programs and at the same time, through demonstrations and training, helps strengthen the nation's research capacity.

The agricultural research and developmental systems of developing nations play a crucial role in linking the research performed by the international centers and developed nations with the needs of indigenous farmers. Research breakthroughs by the international centers usually require further adaptive research for local conditions. The national systems are responsible for doing this adaptive research and for disseminating information to local farmers.

We were told by the AID missions and the centers that we visited that the developing nations need to strengthen their national research and development capabilities, especially their programs for helping farmers at the local level. Also our earlier report, "Disincentives to Agricultural Production in Developing Countries" (ID-76-2), noted that developing countries could help realize their potential for food production increases by improving their extension services programs and by devoting more resources to research on adapting new varieties and techniques to individual country conditions and needs.

CGIAR centers have established various cooperative efforts to strengthen and improve national agricultural research and developmental systems. The CGIAR Secretariat, in a July 1977 report, stated that initially the centers' efforts to strengthen national research were largely in the form of technical assistance provided by center staff under special arrangements outside a center's core program. The center acted as agent for a particular donor in carrying out a special assistance project as agreed between the donor and the country concerned. (The next section contains a discussion of special projects.) The Secretariat said that now there is a growing tendency for the centers to provide technical assistance as part of their core programs, as evidenced in the growth of regional programs or networks involving increasing numbers of outposted staff.

The International Rice Research Institute has been in the forefront of this cooperative movement and is currently involved in projects in Bangladesh, Indonesia, Sri Lanka, and the Philippines. New projects were being negotiated with Pakistan, Egypt, and Burma. Its general objectives are to (1) disseminate information and genetic materials, (2) strengthen national research and training capabilities, (3) collaborate with national and regional programs in research and training activities, and (4) establish and implement international networks to accelerate the exchange of research products.

Institute officials informed us that although support of national development and research programs may be outside their original research mandate, they believe such cooperation helps its own scientists to maintain their perspectives on the problems of rice production. They also felt that no other organization had the capability to help individual countries develop their own rice research capabilities.

The International Potato Center's regional research and training activities are the center's largest single program and represent 35 percent of its total 1976 core expenditures. It has seven worldwide regional headquarters sites and is involved in various national research programs, including

--formulating plans for Chile's national potato program,

--supplying two greenhouses to Peru and Bolivia to increase production of quality seed, and

--organizing and developing national potato programs in Tunisia and Honduras.

To be effective, research must be disseminated to and applied by local farmers, and the centers' cooperation with national agricultural programs to facilitate this process is a logical extension of their research mandates. However, in view of the general and pervasive weaknesses of developing nations' agricultural systems, the potential for expansion in this area is great. The issue, therefore, is the appropriate limits of center involvement in developmental activities.

In discussing this problem, a CGIAR review committee said that the dimensions of the problem throughout the developing world far exceeded the capacity of the centers to respond. And if they tried to respond they could readily be swamped with a volume of requests that would divert

them from their principal and essential mandate. The committee expressed the view that centers should be receptive and responsive to opportunities to assist with the task. The extent of their involvement, however, should be, among other things, determined by the need (1) to avoid distorting their central research thrust, (2) to maintain a balanced program, and (3) not to overreach their managerial capacity.

At its September 1977 meeting, CGIAR considered a proposal for a new entity coming under CGIAR, whose mandate would be to assist in strengthening national research systems in developing countries. CGIAR agreed that the chairman appoint a task force to study the proposal and to report on the study results at future CGIAR meetings.

Special projects

In addition to CGIAR-sponsored center research, donors independently finance special projects. Some special projects are in the area of the centers' research mandates, but many projects extend them into other areas. One of the most common uses of special projects, according to the CGIAR review committee, has been to finance cooperation with national programs in individual countries. Special project contributions for 1976 were $12.2 million compared with regular program contributions of $63 million, or a 19-percent expansion of the centers' activities.

The International Rice Research Institute received $2.8 million, in addition to its core budget of $8.9 million, in 1976 to conduct over 60 special projects. Of the 13 special projects in excess of $100,000, 8 involved national agricultural research and development programs in Indonesia, Thailand, Bangladesh, Pakistan, and the Philippines. Other projects involved such diverse areas as agricultural equipment for rice cultivation and training programs.

The International Potato Center's special projects increased from 1.4 percent of its regular budget in 1974, to 19 percent ($617,000) in 1976.

The International Center for Tropical Agriculture's special projects for 1976 amounted to $710,000, or 12 percent of its core budgets. A special project funded by AID since 1971 through Texas A&M University has provided senior staff and other support to animal health in hemoparasitology. The Ford Foundation has provided funds for regional research on the economic and policy aspects of the Latin American livestock sector. A cassava chipping and drying project,

funded by Great Britain, provides support for a processing engineer.

Special projects are valuable in supplementing a center's central research mandate in areas that might be complementary or potential new thrusts, but they can lead to work incompatible with the research mandates. Furthermore, as a CGIAR report pointed out, they take the time of supervisory staff in the core programs and employ staff with qualifications and experience that may be in short supply. Concerns have also been expressed that acceptance of a large number of special projects may unbalance a center's program, distort its emphasis, impose additional strain on the center's administration, and have long-term implications for expenditures on maintenance and personnel.

If the CGIAR network is to remain research-oriented and not drift into areas that might be more appropriately served by specialized developmental international organizations, future special projects must be assessed for compatibility to a center's primary research function.

Overlapping research

Expansion of research center activities has led to various centers doing research on the same commodities and in the same geographic areas. Although it would be very difficult to ascertain if these overlapping efforts are duplicative, they do create a need for a high degree of coordination.

For example, the Rice Research Institute, the Center for Tropical Agriculture, the Institute of Tropical Agriculture, and the West Africa Rice Development Association are doing rice research. The Maize and Wheat Inprovement Center, the Center for Tropical Agriculture, and the Institute of Tropical Agriculture are doing corn research. Similar overlapping work among several centers is being done for sorghum, cassava, and beef production.

Several centers are doing work in Kenya, even though on different crops. The Laboratory for Research on Animal Diseases is based there, the Maize and Wheat Improvement Center is working on wheat, the Potato Center on potatoes, and the Crops Research Institute for Semi-Arid Tropics is planning to undertake a project on millet and sorghum.

Nonproductive overlap among centers could be avoided by clearly delineating respective responsibilities, and some centers have coordinated their efforts to a degree. Officials

of the International Rice Research Institute felt that it would not be advisable to limit rice research to only one center, since rice is a worldwide commodity and regional problems would best be dealt with through a cooperative approach. The Institute has signed a memorandum of understanding with three other centers concerning the allocation of certain areas of rice research to each.

Officials of AVRDC said that their work on the potato overlaps but does not necessarily duplicate the work of the International Potato Center because they are working on different aspects of the potato. These centers said they avoid duplication through coordination and exchange of genetic materials.

Cooperation among centers and national research systems is essential to CGIAR's research role. As centers include more commodities and programs into their research activities and expand their geographic coverage, coordinating their diverse activities will become increasingly difficult.

Livestock research

The establishment in Africa of the International Laboratory for Research on Animal Diseases and the International Livestock Center for Africa, combined with the International Center for Tropical Agriculture's livestock research program, resulted in a sharp increase in the proportion of CGIAR resources allocated to livestock research. The two African centers are working to increase livestock production through improved systems of range management and on immunological methods for controlling two major diseases of cattle: theileriosis and trypanosomiasis. In Colombia the center's program, which accounts for about 34 percent of its direct research expenditures, is oriented toward improving production by developing forages which will grow in the infertile soils of tropical America.

Although livestock is an increasingly large research component, meat and milk represent a relatively small source of nourishment in food-deficient countries. According to a 1971 FAO report, only 1 to 14 percent of their total per capita caloric intake was derived from meat and milk products, while cereal products accounted for 30 to 70 percent of the calories consumed. On the other hand, these research programs could have broader effects, such as opening areas of Africa to more intensive agriculture by controlling the tsetse fly.

The issue is not whether livestock research is a legitimate pursuit of the CGIAR system, but rather the dimensions of that effort and the potential beneficiaries, especially in view of (1) the relative insignificance of meat and milk products in feeding the world's hungry and malnourished people and (2) the lost alternative research opportunities in other, perhaps more beneficial, food commodities.

Long-range program planning

In view of the growth in size and complexity of center activities, a refined statement of longer term, priority objectives and goals will be required to assess adequately a center's progress. Only the International Potato Center has developed a similar document in the form of 5-year research plans. According to a CGIAR report on the Potato Center, "the research program is based on a long-term research plan devised with assistance of outside experts, and updated every three years. No other center has such a forward planning mechanism."

Potato Center officials told us that senior scientists from developed and developing countries meet in Peru for periodic planning conferences to assist and guide the Center in establishing, monitoring, and evaluating research priorities and programs. Plans for future research programs are also discussed. Eleven such planning conferences, involving 94 international experts from 23 countries, have been sponsored by the Center.

The Rice Research Institute, at the time of our visit, was in the process of developing a long-range plan for the period 1977-81, outlining 11 areas in need of greater research emphasis in the future.

Inherent in this issue is the ability of donor members to evaluate effectively a center's progress in achieving approved objectives as well as to assess the propriety of new program thrusts in relation to defined priorities. Without an adequate long-range planning document, this type of evaluation will become increasingly difficult to make.

Costs versus benefits

The growth of the international research network testifies to the general acceptance of its research value in improving food availability in the developing countries. No detailed analysis of farm-level applications of CGIAR research results has been made except for the improved varieties of rice and wheat, but there is an implicit assumption that the benefits derived from CGIAR-financed activities greatly outweigh their costs.

Donors can assess center operations through CGIAR's common review processes and through their own evaluatory mechanisms. The Secretariat reviews the adequacy of the information provided in center program budget submissions, annual reports, and annual independently audited reports. The Technical Advisory Committee performs scientific assessments of ongoing center research programs and proposed major changes in their mandates. Donors can attend the Technical Advisory Committee and CGIAR meetings, visit centers, have formal and informal discussions with center personnel, and review center publications.

Such internal and external processes provide much information on the international agricultural research centers' operations, but they do not necessarily provide a measurement of the actual or potential research benefits, especially in relation to the costs of such research.

Problems hindering an analysis of the costs and benefits of investments in international agricultural research, as summarized by CGIAR, are:

--The impossibility of predicting the nature, timing, and impact of major scientific breakthroughs.

--Negative research findings may have real, but obviously unquantifiable, value.

--Uncertainty governing the relationships between research results and increased food production.

--Identifying ultimate beneficiaries of the research as well as those who may be adversely affected.

--Data deficiencies which may be unduly costly or impossible to overcome.

--Deriving objective criteria for assessing the efficacy and "quality" of research.

--Estimating the opportunity costs of all resources allocated to international agricultural research and to adapting international research output to farmer needs.

A challenge for CGIAR is the development of effective methods to gauge the potential "payoff" of present and proposed research efforts.

Consolidation of administrative functions

Consideration should be given to further consolidation of certain administrative functions for each of the centers. Such a process could reduce some elements of duplication and reduce costs.

The international centers use the International Institute of Education and its Agricultural Institute Purchasing Suboffice in New York City as a central entity for such administrative functions as salary payments, insurance, retirement benefits, travel, shipping, and some purchases.

AVRDC and the Rice Research Institute officials indicated that other areas might be conducive to cooperative arrangements, especially recruitment of international staff and purchases of such items as automobiles, trucks, field equipment, laboratory glassware, chemicals, and fertilizers.

These centers purchased similar vehicles and automobile and lab supplies in 1976. For example, over $200,000 was spent for various vehicles, including similar models of Toyotas and Chevrolets. Savings through bulk or fleet purchases might have been realized had the two centers and other centers in need of similar items coordinated their purchasing arrangements.

As the centers grow in size and complexity, scientific programs and administrative support functions should be continuously assessed to identify areas where closer cooperation could result in improved operations.

CGIAR REVIEW COMMITTEE REPORT

In view of the rapid expansion of the system, CGIAR decided in 1975 to review the scope of its activities and programs to better plan its future role.

A review committee was established, consisting of 15 individuals primarily drawn from the centers and donor members. A four-man study team was appointed to serve the committee.

The committee examined many of the issues discussed above and others and presented its final report at the October 1976 CGIAR meeting. The 22 review committee recommendations were advisory in nature and were offered as guidance in future deliberations.

The report recommended, in part, that:

--The next 3 years be viewed as a period of consolidation and that caution be exercised in undertaking initiatives requiring more financial commitments.

--All center projects be regarded as components of the center's total integrated program regardless of sources of funds.

--Each center develop criteria for choosing each program and periodically reassess the balance of its program.

--Centers continue to develop and strengthen their cooperation with national programs insofar as this is essential to accomplish their research mandate.

--All centers develop more effective forward research program planning procedures and include as advisors international scientists with competence in the appropriate areas.

--Centers be encouraged to collaborate when working in the same region or with the same commodity. Agreements and arrangements between centers be formally recorded in writing and a copy provided the Secretariat.

Although CGIAR generally supported the thrust or spirit of the recommendations, it regarded the report essentially as a tool for the guidance of its members. The Secretariat provided general guidance to the centers for carrying out the consensus of CGIAR members. Many of the issues are broad and general, are not subject to immediate specific action, and require progressive action over an extended period. Thus the donors must be prepared to provide continuing guidance over an extended period if the desired evolution of the research network is to be realized.

CHAPTER 3

U.S. MULTIPLE FINANCING OF INTERNATIONAL CENTER ACTIVITIES

AID has no formal mechanism for coordinating and monitoring assistance to international centers nor for consolidated reporting of all assistance to the centers.

In addition to AID's contribution of up to 25 percent of the centers' regular operating and capital costs, several AID bureaus finance special projects, and the U.S.-owned Social Progress Trust Fund provides other assistance. In the absence of central monitoring and consolidated reporting, total AID financing is obscure, and there is little or no assurance that the various AID organizational units present a unified front in dealing with the international centers.

REGIONAL BUREAU FINANCING

Within AID there are several regional bureaus responsible for the developmental assistance projects in their geographic area. These bureaus have financed special center projects, such as those discussed in chapter 2, which are additional to the Technical Assistance Bureau's regular contribution pledged through CGIAR. The full extent of special project financing and regular contributions is not readily apparent because the regional bureau's special projects are presented separately in congressional presentations, and a central or consolidated record is not maintained.

Technical Assistance Bureau personnel responsible for the regular contribution told us that the easiest way to determine AID financing from all sources would be to review individual center budget documents. Consequently, we identified special project financing for 1976 totaling $2 million, as shown on the following page.

Center	Regular contribution	Special project funding		
		Bureau	Amount	Percent regular contribution
	(000 omitted)		(000 omitted)	
International Rice Research Institute	$2,150	Asian	$ 417	
		Technical Assistance	553	
			$ 970	45
International Maize and Wheat Improvement Center	2,550	Asian	$ 263	
		Latin American	61	
			$ 324	13
International Institute of Tropical Agriculture	2,500	African	$1,055	42

AID suggested that this report should note that special projects are carried out by the centers acting as executing agents for AID and host country projects. Special projects are not support to the centers themselves as is the case of core support. AID said it is a tribute to the strength of the centers that they can contract for assistance in common development problems.

The extent that centers should be doing such projects and the potential effect upon the thrust of their operations were discussed earlier. We believe the extent of AID's use of such projects should be more fully disclosed and coordinated with its regular contribution.

SOCIAL PROGRESS TRUST FUND

The Latin American centers are partially funded with U.S.-owned local currencies, which generally are not recognized nor reported as part of the U.S. contribution. U.S. financing, dollars and local currencies, accounted for almost half of the three Latin American centers' total financing for 1976.

Local currency funds are part of the U.S.-owned Social Progress Trust Fund administered by the Inter-American Development Bank and originate as repayments on dollar loans made from the Fund. In 1974 the Inter-American Development Bank joined CGIAR and has increased its annual contribution from $2.03 million to the equivalent of $5 million for 1976. The Bank contributes from the Trust Fund as its own contribution. Even though this fund is wholly U.S.-owned, its support is not identified as a U.S. contribution.

Combined AID and Social Progress Trust Fund financing of the three Latin American centers' regular budget for 1976 was as follows.

	Center total	Trust Fund	AID	Combined AID and Trust Fund Total	Percent
	(000 omitted)				
International Center for Tropical Agriculture	$ 8,930	$2,100	$1,700	$3,800	43
International Maize and Wheat Improvement Center	10,532	2,300	2,550	4,850	46
International Potato Center	4,368	600	1,000	1,600	37

The Bank's pledge of $5.7 million for 1977 makes it the fifth largest overall donor to CGIAR-sponsored international centers. This amount, combined with AID's pledge of $19 million, is 31 percent of the total committed by all CGIAR donors.

In 1976 the Department of State's Inspector General of Foreign Assistance reported that the combined AID and Social Progress Trust Fund contributions to the Center for Tropical Agriculture and the Maize and Wheat Improvement Center were more than 45 percent of their financing. The report stated that,

> "We believe that this dual method of U.S. financing contravenes the target of 25 percent U.S. support of international agricultural research centers to which AID has committed itself and which the Congress has endorsed."

The Inspector General did not accept AID's contention that the Social Progress Trust Fund financing was a Bank rather than a U.S. contribution "because the [Social Progress Trust Fund] funds are 100 percent U.S. owned and the U.S. at its option can terminate [Inter-American Development Bank's] trusteeship thereof." The report added that

> "AID and the House Foreign Affairs Committee have noted that in the case of [the Fund, the Bank] is an intermediary in a U.S. assistance program as distinguished from its normal operations in carrying out its own program to which the U.S. contributes."

AID has taken no action on the recommendation to reduce the combined support to the target level of 25 percent.

AID disagrees that it should take such action, but it does agree that it should clarify the various sources of U.S. financing. Mexican currencies that can be used for center financing through the Trust Fund may be exhausted within a year or two, AID said, and this would result in a reduction of the combined amount.

Since funds available to the Social Progress Trust Fund are local currencies of the individual countries, it would appear that, properly, emphasis should be on reducing the AID dollar contributions rather than through the Social Progress Trust Fund.

RECOMMENDATION

AID's objective is to promote wider participation in financing the international centers, and it cites the increase in donors as a measure of success. We question, however, whether AID's continued multiple financing of center costs is in harmony with this objective, especially when the U.S. goal is no more than 25 percent and when part of the U.S. contribution is provided under the guise of being the contribution of an international financial institution. We believe that there should be more full disclosure of all U.S. activities with the international research centers and greater assurance that all activities are unified in pursuing U.S. objectives.

We recommend, therefore, that the Administrator of AID:

--Disclose the full extent of U.S. financing of international centers' activities so that the Congress and Agency management will have a valid basis for evaluating U.S. participation.

--Establish a mechanism for coordinating and monitoring all U.S. participation in the international centers.

CHAPTER 4

RESEARCH CENTERS NOT INTERNATIONALLY SUPPORTED

AID is virtually the sole financial supporter of the International Fertilizer Development Center in Alabama and the only major external donor to AVRDC in Taiwan. These centers were established at AID's initiative and were intended to gain international recognition and financial support of their long-term activities. Because of political reasons, such international financial support has not materialized, and AID has had to bear their cost.

The failure of the international community to assume support for these two centers vividly demonstrates the need for assuring support before costly, long-term institutions are established. In the absence of such assurance, AID is faced with the perplexing problem of finding ways to reduce its commitments or of being the sole or primary long-term financial supporter.

ASIAN VEGETABLE RESEARCH AND DEVELOPMENT CENTER

Recognizing that vegetables could supplement the staple rice diet of tropical and subtropical Asians with vitamins, minerals, and plant proteins, AID in 1973 requested its Asian missions to explore the possibility of establishing a vegetable research center.

Congressional interest in the project was reflected by Congressman Passman's visit to Taiwan in 1968, during which the matter of a vegetable center was discussed with Chinese officials.

In May 1971 representatives from the United States, Taiwan, Japan, Korea, the Philippines, Thailand, South Vietnam, and the Asian Development Bank agreed to establish AVRDC in Taiwan. This site was selected due to the willingness of the Taiwan Government to provide financial support to the institution as well as to the belief that Taiwan's geography and climate were representative of most of the participating countries.

AVRDC's objective was to increase the yield and quality of vegetable crops in tropical and subtropical Asia through research and training programs, but much of the technology would be applicable to tropical and subtropical countries

in Africa and Latin America. Eventually, attention focused on mungbeans, soybeans, tomatoes, Chinese cabbage, sweet potatoes, and white potatoes.

Financial support

AID originally envisaged its support in terms of a "one-shot effort" to assist AVRDC and demonstrate its value, after which other support would be generated to help carry it forward. However, a 1974 AID memorandum stated that the world food crisis and changed conditions required a continuing long-term U.S. financial commitment to the center. It stated:

> "Political changes in the China/Taiwan situation have limited severely the possibilities of other international support, however valuable continuation of the center's work proves to be.
>
> "AVRDC is barred from inclusion in the CGIAR overall budget support program for political reasons * * *."

Except for the relatively limited support of other contributors, AVRDC has been primarily funded by Taiwan (47 percent in 1976) and AID (37 percent in 1976). Funding is set through 1980 with AID maintaining its $600,000 annual support unless AVRDC's core budget rises beyond $2.4 million, after which AID's support would be limited to 25 percent on condition that the remainder would be provided by other donors.

A June 1976 AID Project Appraisal Report states that:

> "The most persistent problem which AVRDC will continue to face is caused by international political realities; diplomatic recognition of the People's Republic of China by an increasing number of countries and the related severing of formal government ties with the Republic of China."

AID believed that a number of CGIAR donor members would be likely to support AVRDC if it were elsewhere than Taiwan.

CGIAR relationship

At the urging of the Rockefeller Foundation, the Technical Advisory Committee appointed a mission to assess the need for more internationally supported vegetable research.

The mission, composed of scientists from the United States, the Netherlands, Venezuela, Nigeria, and Thailand, started its survey in late 1975, visiting Senegal, Nigeria, India, Thailand, and Indonesia, but it did not visit Taiwan.

The mission recommended that a new international center be formed to increase vegetable production in the tropics. It recognized the contributions AVRDC had been making but noted that the center was not located in the true tropics and alluded to the political problems affecting its future. The Technical Advisory Committee rejected the recommendations for a new center. The Committee wished first to obtain further information on the priority species of vegetables and research problems in the main ecological regions of the developing world.

CGIAR agreed to consider further establishing a pilot vegetable research project for a period of 3 to 5 years to be possibly based at existing CGIAR institutions in Asia and Africa. The project would include (1) genetic evaluation and use of main vegetable species, (2) training, and (3) specific proposals for a long-term program. No mention was made of inviting the Taiwan vegetable center to participate in the project.

INTERNATIONAL FERTILIZER DEVELOPMENT CENTER

In recognition of the need to develop improved fertilizers and use practices for the tropics and subtropics of the developing world, Secretary of State Kissinger's address to the U.N. General Assembly on April 15, 1974, urged the

> "* * * establishment of an international action on two specific areas of research: improving the effectiveness of chemical fertilizers, especially in tropical agriculture, and new methods to produce fertilizers from non-petroleum resources. * * * The United States will contribute facilities, technology and expertise to such an undertaking."

In October 1974, within 6 months of this proposal, the International Fertilizer Development Center was established in Alabama, adjacent to the Tennessee Valley Authority's National Fertilizer Development Center, without assuring

international support for the project. The Center's objectives were to increase fertilizer production and technology, to develop new products designed for conditions in developing countries, and to provide technical assistance and training on the use of fertilizers.

Financial support

The goal was for the Center to work closely with CGIAR and eventually gain full acceptance and participation in the network of CGIAR-funded centers. However, this support has not materialized. The only support was a $55,000 grant made by Canada's International Development Research Center for initial planning activities.

During fiscal years 1975 and 1976, AID provided $5.1 million for construction of facilities and $4.1 million for operating costs. For 1977, $1.9 million was programed to complete the Center's capital development program, and $3.8 million was programed to finance its third-year operating budget. AID indicated that it may be necessary to provide support for at least 10 years.

At the time that AID established the fertilizer center without first obtaining financial support from the CGIAR donor membership, CGIAR had refused, for political reasons, to accept AVRDC for financing, and AID was bearing the burden of being the only major external donor to that center.

CGIAR relationship

The Technical Advisory Committee evaluated and generally endorsed the Center's program but noted that the Center is in a developed country (CGIAR-supported centers are located in developing countries). CGIAR discussed the Center's activities at its meetings during 1975 and 1976 but never accepted it into CGIAR's donor-supported system. The reasons for not supporting the Center have never been clearly articulated either at CGIAR open meetings or in published reports. An indication of CGIAR's perception of the Center as a U.S. Government project was, however, revealed at a February 1976 meeting of the Technical Advisory Committee where it was noted that the United States "has committed itself" to supporting the fertilizer center's primary research programs.

We have seen no indication that this perception will change. For example, at CGIAR's 1976 Centers Week, AID requested CGIAR to name three members to the Center's Board

of Directors as a step in the Center's qualifying for international status under U.S. laws. But AID emphasized there would be no presumption about CGIAR's assuming any financial responsibilities for the Center. Similarly, CGIAR's report of the meeting noted that AID's request

> "* * * implied no other changes in [the International Fertilizer Development Center's] relationship with the Group and certainly did not include the suggestions that the Group would take on financial or any other responsibilities for [the International Fertilizer Development Center]."

Our July 5, 1977, report, "Restrictions on Using More Fertilizer for Food Crops in Developing Countries" (ID-77-6), discussed the failure of the international community to financially support the Fertilizer Center. The report also pointed out that the International Fertilizer Development Center was performing some functions, such as providing technical assistance similar to other organizations already involved in fertilizer activities, such as the United Nations Industrial Development Organization. In view of the Center's lack of international support and the overlap of functions, the report recommended that AID terminate support of the Center and make arrangements for transferring its programs and activities to existing international organizations.

AID's position was that it would be a mistake technologically and diplomatically to terminate support of the Center. AID agreed, however, that broadened international support for the Center should be forthcoming and indicated that if a reasonable level of international support cannot be obtained during the next several years, then its position should be reconsidered. AID said some international support for special project activities had been negotiated, but none has yet been received for its core research program. AID further stated that it was embarking upon a course of action to assure that the U.S. share of the Center's cost is reduced and that it will keep the Congress informed of its progress.

CONCLUSIONS AND RECOMMENDATIONS

No matter how important or valuable an institution and its work may be, international donors will not recognize it or offer financial support unless it is politically feasible to do so. Although AVRDC and the International Fertilizer Development Center may be performing research and development

work vital to developing countries, financial assistance from other donors has been extremely limited due to the political concerns. The failure of international financial support to be forthcoming for these two centers shows the need to obtain support before undertaking international endeavors.

Both centers were designed to do long-term research which requires a continuing and substantial financial commitment. We believe that AID should inform the Congress of the limited likelihood of international support for these centers. We recommend, therefore, that pending other action that AID may take regarding the financing of the centers, AID fully disclose to the Congress the limited prospects of gaining broadened international financial support, especially for the core programs, and the probability that a substantial and sustained long-term AID commitment may be required.

CHAPTER 5

INTERNATIONAL COOPERATION REQUIRED FOR SUSTAINED LONG-TERM RESEARCH ON COMPLEX DIVERSE PROBLEMS

AID's 10-year vertebrate pest control research project has had varying degrees of success. Of particular note have been the developed techniques for reducing livestock losses by controlling the vampire bat in Latin America and controlling rat damage to rice crops in the Philippines. Notwithstanding its accomplishments, the project shows the limitations of a relatively small unilateral or bilateral effort to cope with worldwide problems having multiple diverse characteristics and requiring long-term research efforts.

Protecting food supplies from vertebrate pest damage is a problem having worldwide dimensions and multiple characteristics unique to particular situations. The problem is fraught with political and cultural sensitivities because of the many nations involved, and it involves critical environmental considerations. Consequently, AID's vertebrate pest research programs encountered political, financial, and other limits that might have been minimized or avoided within a suitable multilateral framework.

The CGIAR research network growth demonstrates the broadening international recognition of the value of multilateral cooperation in research. Multidonor cooperation, as exemplified by CGIAR, embodies inherent structural advantages, enabling it to overcome the limits of national programs. The sharing of costs by various donors limits the financial burden of each donor and provides greater assurance, through a broader base of funding entities, for continuing support of long-term projects. The political sensitivities of donors or recipients can be minimized within a multilateral framework where projects are conducted under the aegis of an apolitical international organization. Multinational activities can draw qualified personnel from worldwide sources, and when these personnel return to their national programs, they facilitate the transfer of the knowledge and experience gained. Multinational cooperative efforts can combine disparate national efforts and reduce duplication.

The following case study of AID's vertebrate pest control programs shows the need for careful assessment of

all program implications to insure that a project is conducted in the most beneficial manner. The project documentation shows that there is a degree of coordination and collaboration with other countries and organizations, such as through training programs and seminars, but there is no record of a substantive effort to obtain the multidonor support required to sustain the rigors of finding a solution to the problem.

VERTEBRATE PESTS

Rats, noxious birds, and vampire bats have caused significant damage to crops and livestock. Although there are no precise statistics, worldwide losses are recognized to be of major proportions.

The disastrous effects that rats have on food supplies are felt to varying degrees in virtually every food-producing area. Estimates of food grains lost to rats in India range from 1 million to more than 12 million tons a year. In the Philippines, rats have caused damage to rice production estimated at $30 million annually. Similar rice crop losses have been experienced in Latin America. Rats have also severely infested the sugarcane fields in most of the Caribbean Islands, Mexico, Panama, and Guyana.

At least 18 species of rodents have been reported damaging crops in Africa. The Sahelian zone recently experienced a major infestation of rats, causing considerable crop losses in Senegal, Mauritania, and Mali.

Control methods used by farmers in the developing world have been largely ineffective, primarily due to the lack of the proper technology, knowledge of the particular rodent problem, and capital to implement effective controls.

Some species of birds likewise represent a threat to growing crops in the developing world. The Quelea, perhaps the most destructive, seriously damages millet, sorghum, rice, and wheat in 25 African nations, resulting in estimated losses of $8.5 million annually. Other noxious birds are a problem in parts of Latin America.

Unlike rats and noxious birds, vampire bats are limited to one geographic area--Latin America. Cattle losses from rabies transmitted by vampire bats are estimated at 2 million head annually. Daily loss of blood and secondary infections further aggravate the problem. Direct and associated losses are believed to amount to $250 million annually.

AID VERTEBRATE PEST CONTROL PROJECT

AID, through the Technical Assistance Bureau, in 1967 signed a 10-year agreement with the Department of the Interior's Fish and Wildlife Service to develop safe, effective, and economical vertebrate pest control methods applicable to the developing world.

Due to its experience in designing pest controls in the United States, research was to be undertaken by the Denver Wildlife Research Center. The project was divided into three components, each to concentrate on one of the vertebrate pests, as discussed in the following section.

Through fiscal year 1977, total project funding amounted to $4.6 million. The project's recent extension to fiscal year 1982 is anticipated to cost an additional $3.7 million.

RODENTS

Because rats have wide geographic dispersion, multiple species unique to various geographic areas, and phenomenally high reproductive rates leading to genetic resistance to rodenticides, rodent control requires a long-term, expensive, and continuous research effort.

To reduce rodent damage to agricultural production in the Philippines and other Southeast Asian countries, the Rodent Research Center was established in June 1968 as a joint undertaking between the Government of the Philippines and AID through the Department of the Interior's Denver Wildlife Research Center. The Center's objectives were to (1) develop new, safe, technically sound and economically feasible rodent control methods, (2) train Filipino scientists in rodent research methods to continue the research when U.S. support was terminated, and (3) disseminate research findings to farmers through extension workers, demonstrations, and training programs.

After more than 8 years of research, whatever success AID has experienced has been limited essentially to rice in the Philippines with only fringe benefits to other countries. Preliminary surveys in target areas are reported to indicate that farmers who followed the research recommendations were able to successfully protect their crops from serious rat damage. The Rodent Research Center has reported to AID, however, that careful study and adaptive research would be a prerequisite to applying the techniques in the Philippines to other countries.

The center facilities and personnel are being incorporated into a Philippine national crop protection project undertaken with the assistance of a $5 million AID loan.

International interest in rodent control

AID project documentation is replete with references to other countries' and organizations' interest and work in rodent control and the need to approach such control on a multidonor basis. FAO, various Asian countries, and personnel of a German rodent control project in the Philippines expressed interest at varous times during the early 1970s in developing cooperative regional pest control programs.

In 1972 the Inspector General of the Department of State recommended that AID administer its rodent control project in close collaboration with FAO or even through suitable FAO programs.

An AID intra-agency review committee in 1974 recommended that the project either be regionalized by involving other international entities or be suspended due to the perpetual nature of the problem.

We could not identify any substantive action by AID in Washington to capitalize on the interest in rodent control or to implement the recommendations.

NOXIOUS BIRDS

Many characteristics of the rodent problem are also common to noxious birds. There are many kinds of noxious birds dispersed over wide geographic areas, and their migratory habits complicate effective control because they range over many countries and even continents. It is not apparent that the complexities and lack of success of other control efforts were adequately considered by AID in undertaking and designing its research efforts.

The history of the noxious bird project, as pieced together from incomplete files and from discussions with project officials, shows that the project suffered from lack of management attention and nothing tangible was accomplished during its almost 10-year existence. From the beginning, the AID project has been a stop-and-go effort, suffering from the lack of a clearly defined plan and a critical evaluation of the feasibility of pursuing the project.

Initially, research was to concentrate on the quelea problem in East Africa, but because of the political situation, the project was not established. Since AID in Washington and the Department of the Interior had arranged for a staff, it was decided to start a project in Colombia which had requested AID to conduct research on a variety of bird damage problems that appeared serious. The project was started in 1970 with two researchers to conduct research on birds and other vertebrate pests.

In 1971 an external review committee questioned the advisability of continuing bird damage research and suggested that within a year a comprehensive work plan be developed for future consideration. The committee also recommended that preresearch and reconnaissance studies on birds in Africa be endorsed.

A 1974 review committee characterized the vertebrate pest project as a shotgun approach and recommended that AID carefully guide the project to enhance the probabilities of achieving "real world" damage control.

The project in Colombia was terminated in 1974 with less than expected results, and 4 years of work were summarized as follows.

> "Exploratory studies now being phased out in Colombia, where several species of birds are implicated in the same crops, have shown that bird damage is highly variable--show the impact of controls may be low, until more predictive methodologies or perhaps broad spectrum approaches can be developed. However, certain findings in the Colombia research program will be related to the quelea project in Africa."

Discussions about establishing a bird research project had been held since at least early 1973 with Tanzania. A new research unit was established in December 1975 at Arusha, Tanzania, in cooperation with the Tropical Pesticides Research Institute to serve the East African Community. Its primary objective was to protect small grain crops, such as wheat, rice, sorghum, and millet, from the devastation caused by African quelea birds--a sizable task for one researcher. It is not apparent what consideration was given to the Colombian experience when establishing this project.

The Tanzanian project was suspended in December 1976 because of difficulties in working with the Tanzanian counterpart, and the researcher was assigned temporary duty in Kenya while consideration was given to shifting the project to Sudan.

International support

The limited project documentation indicates that there was some knowledge of the work of others and a degree of cooperation and consultation with other countries and organizations.

For example, a Denver Wildlife Research Center 1975 annual report, in discussing the severity of quelea damage and the work of others stated that:

> "Presently, three international organizations--the UNDP/Food and Agriculture Organization, German Technical Assistance, and the Centre for Overseas Pest Research--have active quelea research programs in Africa. In addition, many African countries affected by quelea have operational control teams or organizations actively combating the problem. While considerable progress had been made by these different groups in some aspects of the basic biology of quelea and its roost-site control, large-scale campaigns to reduce the numbers of quelea in several African nations have provided only limited relief from bird depredations. The strategy furthermore is costly and potentially hazardous. To be useful, a control method must be economical as well as effective, available to and usable by the people affected, safe, and its value and methods of employment must be made known to the farmer."

With this recognition of the work of others and the complexity and elusive nature of a satisfactory solution to noxious bird control, apparently no effort was made to promote an international response which could sustain the rigors of finding a solution to a problem that encompasses multiple countries and continents.

VAMPIRE BATS

The vampire bat is found throughout Latin American from tropical Mexico to northern Argentina. Feeding exclusively

on the blood of live vertebrates, they are common ectoparasites of cattle and other livestock. They are the principal vectors of paralytic rabies, considered by some authorities to be the most serious animal health problem in Latin America. Livestock losses caused by the vampire bat in Latin America are estimated at $250 million annually.

The program to control damage has been cited by AID as one of its most successful research efforts. AID's control method, using the drug diphenadione, has demonstrated its effectiveness in controlling vampire bat damage to livestock, but questions concerning the drug's ultimate effect on humans have not been resolved. AID has not aggressively pursued the issue and has continued to sponsor the drug's use by national governments of affected areas without making the U.S. registration tests required to insure its safety when used on food-producing animals.

Vampire bat research was initiated in Mexico by Denver Wildlife Research Center personnel in cooperation with the Government of Mexico in 1968 to develop a safe, effective, and economical way of reducing vampire bat damage to livestock.

By 1973 two methods of control were developed, both using the blood anticoagulant diphenadione ordinarily used for human heart patients. Blood, the sole source of nourishment for vampire bats, contains no vitamin K necessary for blood clotting. By ingesting diphenadione the bat's own blood cannot clot, inducing internal hemorrhaging and death within a few days.

The diphenadione is passed to the bat in either of two ways. The topical method requires capture of the bat and application of toxic paste on its body. Following their release the bats return to their roosts, and other bats ingest lethal doses of the toxicant while grooming.

The systemic method requires injecting the toxicant into the rumen of cattle where it is absorbed into the bloodstream. Bats feeding on treated cattle within approximately 72 hours will receive a lethal dose of the control agent.

The systemic method has received wider acceptance because the topical method requires special training in the capture and identification of bats, working at night, and direct handling of possibly rabid bats. For example, under the Nicaraguan national vampire bat control program,

over 200,000 head of cattle have been treated systemically since 1976. The topical method has been used on about 2,000 bats.

Following the discovery of the diphenadione control method, further research was phased out, and project personnel have concentrated on disseminating the research results to affected areas through seminars, demonstration programs, and publications.

Drug safety question

Diphenadione, when injected into cattle, is viewed as an animal drug and as such must be approved by the U.S. Food and Drug Administration (FDA) before it can be used in animals destined for U.S. markets. Since diphenadione has not been used as an animal drug in the United States, it has not been subjected to the safety testing required for FDA registration. According to FDA personnel, registration involves (1) the drug's efficacy, (2) safety to the target animal, and (3) safety for humans eating the tissue of the target animal. It was reported that FDA representatives tended to accept the efficacy and relative safety for the target animal but did not feel that the safety for human consumption had been adequately demonstrated by the existing work. Previous tests had shown, for example, that residues of diphenadione in injected cattle remained in their livers and kidneys.

Additional research to compile the necessary information would include long-term chronic toxicity and metabolism studies to further identify the residue picture. The Denver Wildlife Research Center estimated that these investigations would require a minimum of 2 years' study and would cost $250,000.

Due to the cost and time required for FDA registration, AID has been reluctant to undertake the required testing program to assure the drug's safety and has continued to sponsor its use in bat control work.

In October 1976 the Denver Wildlife Research Center requested AID's determination on the drug's registration, pointing out that:

> "The systemic method involves direct application of a pesticide (diphenadione) to a food crop (cattle). The policy of the Fish and Wildlife Service relative to pesticide use states, in

essence, that whether we are applying and/or recommending the use of a pesticide in a foreign country, we should be consistent with our own Federal policies and the procedures acceptable in the U.S. The policy (of FWS) in the U.S. is that no unregistered uses of pesticides will be permitted in operational programs involving crops. Our involvement in training, extension and promotional efforts, and assistance and advice on establishment of vampire control programs in Latin America is, technically, a violation of this policy."

The Denver Wildlife Research Center also outlined two problems stemming from the unclear status of diphenadione. The first related to the hesitancy of Latin Americans to use the technology simply because they are fearful of it. The second problem related to environmentalists' and conservationists' criticisms of project personnel for promoting the use in foreign countries of a drug whose safety has not been established. The research center concluded that vampire bat control technology was now available but full use of the technology "appears to be somewhat dependent on whether or not FDA approval is achieved."

In February 1977 the research center again indicated that the questionable status of diphenadione was having an impact on the program. The Center said that it does not appear that an answer to the question of FDA registration on diphenadione as a veterinary drug for systemic use on cattle will be forthcoming in the near future. And, consequently, activities at the Denver Wildlife Research Center are lagging because of the delay in reaching a decision on the matter.

AID has not indicated that any additional testing will be undertaken. Annex A to AID's comments states that the Mission Director will be requested to consider making a decision, based on technical information provided to him, that procedures involved in the use of the chemical diphenadione may be for purposes of protecting humans and animals against rabies and possibly other diseases.

Annual reports on vertebrate pest research control show that vampire bat control programs are either underway or being considered in a number of countries with a significant reduction in livestock losses, and it is not entirely clear to what extent the drug question has affected implementation of control programs. But it seems a paradox that, after nearly 10 years of work in controlling vampire

bat damage, AID has neither taken measures required to assure the safety of its solution nor made a commitment to do so. If livestock losses are $250 million annually as estimated and if the questionable safety of the control agent is the primary constraint to alleviating such losses, then assuring that diphenadione can be safely used would appear to be logical.

CONCLUSIONS

Whether research projects such as the vertebrate pest one are carried out in conjunction with the international agricultural research institutes or through other appropriate multilateral approaches, AID's experience with the vertebrate pest control project suggests that a multilateral approach may be required to deal effectively with such problems. There was a degree of coordination and collaboration with other countries and organizations, but international interest in alleviating vertebrate pest damage to foodstuffs was not capitalized upon, and a multidonor-supported effort was not promoted. An effort supported by many donors and carried out through an appropriate multilateral mechanism could better finance the long-term effort and cope with the political realities of dealing with multiple countries.

Now, with the presence of the CGIAR network, another option for conducting long-term research efforts is available. AID's work on alleviating pest damage to foodstuffs would appear to be a logical extension of the work of these centers, either as part of their regular programs or through special projects.

The International Center for Tropical Agriculture operates on a farm-system approach, and livestock is one of its major research components. The Denver Wildlife Research Center's bird research project in Colombia, however, had little, if any, association with the Center, and the vampire bat project had no association with it, even though livestock research was one of the Center's primary components.

Rodents have plagued the International Rice Research Institute's work in the Philippines, and it has installed electric fences around test plots as a control measure. Thus, controlling rodent damage is not only a logical extension but a necessary part of the Institute's work; however, collaboration between AID's bilateral rodent research project in the Philippines and the Institute has been essentially limited to some training programs.

An improved overall strategy for doing research, such as we have recommended in this report, should identify or provide for identifying problems that should be approached only on a multilateral basis. Such a strategy should also provide for positive efforts to promote international support of critical multinational problems, such as vertebrate pest damage to foodstuffs. The connecting links between AID's research programs and those of the international centers should be clearly established so that the programs supplement each other and are carried out in the most logical manner.

APPENDIX I

DEPARTMENT OF STATE
AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

Auditor General

NOV 7 1977

Mr. James A. Duff, Associate Director
International Division
U. S. General Accounting Office
441 G Street, N. W.
Washington, D. C. 20548

Dear Mr. Duff:

Enclosed are the Agency for International Development comments on the GAO draft report, "U. S. Participation in International Agricultural Research: Problems and Issues." While Agency written comments were not requested by your letter transmitting the draft, we would appreciate your consideration of these comments prepared by our Technical Assistance Bureau and other AID offices with responsibilities in this area. The comments should be of use in preparing your final report.

Sincerely,

Herbert L. Beckington

Agency for International Development Comment
on the GAO Draft Report--"U. S. Participation in International
Agricultural Research: Problems and Issues"

The draft report addresses an important topic for A.I.D. While the recommendations, per se, are generally well taken (See GAO note.) the discussion and the underlying logic are misleading.

The A.I.D. policy for agricultural research is clear. AID/Washington has attempted to assure the relevancy to LDC problems of centrally funded research by eliciting inputs from field missions. As one indication, a series of messages was sent to virtually all field missions stating explicitly that "field comments are earnestly solicited" on development problems, and requesting suggestions for interregional research and development activities to help solve the problems. (The messages were AIDTO CIRCULAR A-638, AIDTO CIRCULAR A-316, and STATE 256581.

(See GAO note.)

The Annual Budget Submission reviews of centrally funded activities reflect field and regional bureau considerations. Centrally funded research projects are reviewed both by an internal body--the Research and Development Committee, with representatives from all relevant bureaus--and an external group, the Administrator's Research Advisory Committee. These reviews strive for relevancy and technical soundness.

Need for an Overall Research Strategy

The report recommends that A.I.D. develop a more specific overall strategy for carrying out its agricultural research activities. We agree that we need to do a better job of articulating our strategy. However, the discussion in the report does not do justice to the several efforts that have taken place over the past few years, which do constitute a strategy.

(See GAO note.)

Agricultural research is an integral part of the Agency's overall agricultural development strategy. It is treated explicitly in an A.I.D. agricultural development policy paper which is now in final preparation after having been distributed for comment to USAID field missions. We expect this statement to help the Agency guide its efforts in agricultural development.

With regard to research programs of the international agricultural research Centers, the Technical Advisory Committee (TAC) of the Consultative Group

GAO note: Deleted comments pertain to matters omitted from or revised in the final report.

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for International Agricultural Research (CGIAR) prepared a priorities paper soon after its establishment in 1971 and has updated it as situations change. A.I.D. participates in forming and modifying that strategy and takes it into account as we develop our own portfolio of research and development activities.

Regarding centrally funded activities, this Agency concluded about two years ago that the "Key Problem Areas" were too broad to have maximum utility for planning and strategizing. For instance, the former Key Problem Area, Soil and Water, with a diverse portfolio of activities, has been replaced by four clusters, each with specified objectives and strategy and consisting of from two to six projects. The clusters are: (a) Tropical Soil Management, (b) On Farm Water Management, (c) Fertilizer Development, and (d) Biological Fixation of Nitrogen. A set of papers that more clearly describes the activity clusters concept and its utility in planning and strategizing for research was recently submitted to GAO staff informally. To summarize briefly, each of the clusters of activities has its own strategy statement. The intent is to maintain the integrity of the clusters by supporting only those research and development activities that are both necessary and consistent with strategies for the clusters.

Unsolicited Proposals

The report states that, "Most research other than through the international Centers is initiated through the receipt of unsolicited proposals rather than on the basis of specifically identified needs pursuant to an overall plan." It is true that most of the agricultural research projects that are centrally funded are unsolicited proposals. However, A.I.D.'s interests are generally well known through a continuing discussion with agricultural scientists, and many more proposals are turned down than are accepted. The following brief example will indicate that even though most proposals are unsolicited, they do conform to a plan and strategy.

With the advent of the energy crisis a few years ago, a group of highly qualified U.S. scientists was commissioned to work with A.I.D. to develop a strategy for research and development in biological fixation of nitrogen, in the belief that results of these efforts would materially benefit small farmers in developing countries who often have neither the access to nor the funds with which to buy commercial fertilizer. An activity cluster for Biological Fixation of Nitrogen was created. In the process of defining the strategy, scientists in the U.S. learned of A.I.D. interest in the area and began submitting unsolicited proposals for research on various aspects of Nitrogen Fixation. Only those proposals were accepted that closely fitted our needs as dictated by the strategy. Some of the proposals that were accepted as original hypotheses were then modified slightly in discussions with the proposers so that the proposed activity matched well with our needs.

Title XII

The draft report does not mention the Amendment of December 1975 to the Foreign Assistance Act, known as Title XII. Under this authority a Board for International Food and Agricultural Development (BIFAD) was established in October 1976 and two joint committees, one for research, were established. The Joint Research Committee, while it is a young institution, is deliberating about its role and is seeking a systematic approach to helping A.I.D. establish priorities for collaborative research. We believe it would be prudent for the report at least to mention the existence of this important new institution.

The International Fertilizer Development Center (IFDC)

(See GAO note.)

This issue is treated at length in Agency for International Development comments on the GAO draft report, "Constraints to Increasing Use of Fertilizers on Food Crops in Developing Countries," and need not be repeated here.

The Asian Vegetable Research and Development Center (AVRDC)

The draft report recommends that the Administrator disclose that AVRDC shows "no prospect of gaining international financial support and consequently is an A.I.D. project requiring a substantial and long-term commitment." It is true that AVRDC is constrained for political reasons from getting broad-based financial support, but it is incorrect to say there is "no prospect." In fact, other donor support has been growing so that the constant level of U.S. support has been a declining proportion of the total support.

International Centers

The draft report mentions several times the sharply rising "cost" of the international Centers. The issue is not so much the present or future "cost" of the international Centers as the rate of return on these investments, in relation to alternative investments. Several studies have shown that returns on investments in agricultural research are among the highest of any public sector investment. Most authorities would ascribe the returns on the investment in the international Centers as extremely high. We believe the statements about cost should be balanced with statements indicating that payoff from the investment is quite high.

Multiple Funding of International Centers

The draft report implies that special projects funded by A.I.D., when added to the U.S. core support of the Centers, totals considerably more

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than 25 percent of the "cost" of the Centers' activities. The report fails to note that special projects of the Centers are carried out by the Centers acting as executing agents for A.I.D. and host country projects. Special projects are not support to the Centers themselves as is the case of core support. It is a tribute to the strength of the Centers that field missions and host countries "contract" with the Centers for assistance in common development problems. A consequence of the implied desirable reduction of core support to offset special project funding would probably be reduced capability to respond to development needs. The report should describe the separate value of these special projects which are separately funded.

With respect to SPTF financing, the draft report implies that A.I.D. should act to reduce the combined A.I.D. dollar and SPTF local currency support level to 25 percent. We disagree with this implication. Instead, we believe the report should state that the SPTF is provided by the IDB as its own contribution. It uses the U.S.-owned SPTF rather than its own soft window, the Fund for Special Operations (FSO), because the purpose is one suitable for the SPTF which has a somewhat narrower definition of projects eligible for the funds. Since, in the main, FSO and SPTF are fungible, to shift the Bank's contribution to FSO would only release SPTF which could be then programmed for other social projects of high priority to the U.S. Government. In addition, there is a real possibility that SPTF currencies will not be available in the required amounts for all the Centers in the future, so that an IDB contribution, particularly to the Mexican-based CIMMYT, is likely to be funded from FSO within a year or two, with the result that there would be a reduction in the portion of international financial Centers funded from the U.S. trust fund.

The GAO could appropriately indicate awareness of problems of Latin American IDB Directors in reaching agreement to shift the traditional SPTF financing to FSO. The report could acknowledge that an effort to do so at this time could result in a cutback in total contributions to the Centers, and that time will gradually reduce the combined portion of the aggregate U.S. dollar and SPTF local currency contributions to the Centers' budgets, as other donors' contributions increase, and as the SPTF is exhausted in certain currencies.

A.I.D. will attempt to clarify the various sources of U.S. Government support for the Centers in future reporting. Meanwhile, the Agency is not willfully misleading in its reporting; all of the contributions and special projects are contained in the Congressional Presentations.

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(See GAO note.)

Assistance to National Programs

The draft report has a section on the issue of the need for strengthening national agricultural research systems in developing countries and suggests that the issue needs to be addressed. The issue is seriously being addressed. The CGIAR and the TAC have been concerned for at least three or four years about the need for strengthening national research systems. Several international conferences and meetings have been held on the subject. Much analysis has centered on the question of how the international Centers should be involved in strengthening national research systems. Evolving from all of these concerns was a proposal before the CGIAR meeting in September 1977 for a new entity coming under the CGIAR, called an International Service for National Agricultural Research, whose mandate would be to assist in strengthening national research systems in developing countries. A task force has been appointed by the chairman of the CGIAR to study this proposal and several sub-issues underlying it and to report to the CGIAR at its meeting in 1978.

A.I.D. is also placing heavy emphasis in its bilateral programs to strengthening national agricultural research systems. The A.I.D. agricultural development policy paper mentioned earlier emphasizes this point. Table I shows the magnitude of A.I.D. grants and loans to countries in the Asia region, for agricultural research and closely related activities.

Vertebrate Pest Control

Recognizing that this project has had certain problems and that portions of the project have been delayed, mostly for reasons beyond control of A.I.D., the record clearly indicates that statements such as "limited success" and "futility" are unwarranted. The vampire bat portion of the project, which was completed in 1976, has had a very high payoff

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already. According to FAO data, reduction of losses in livestock production in Latin America are already about $100 million per year. The potential annual reduction is estimated by FAO to be around $250 million. Application of the technology is spreading rapidly in several countries in Latin America. Annex A describes briefly the Agency's plans regarding environmental procedures related to the use of Diphacinone.

Results of the rodent research element of the project are also being applied. The Philippines alone estimates that their reduction in losses of rice due to the technology approximate $50 million per year. Bangladesh, Nepal and Indonesia are initiating projects based on the research. Several other countries are making plans. The regional value of the rodent research center is not being lost.

The noxious bird portion of the project is at a much earlier stage, partly because a conscious decision was made to put earlier emphasis on vampire bats and rodents and partly because of political disruptions that were beyond control of the project implementers.

The implication that A.I.D. has not attempted to internationalize the rodent research program or to involve specialized UN Agencies is incorrect. There is substantial correspondence involving suggested FAO input into conferences, seminars, and field programs in these areas.

If GAO wishes to discuss the issues in the report further, A.I.D. staff will be pleased to do so, and will be glad to supply further data and information.

Attachment: Annex A

Copies to:

DAA/IA, M. Butler
GC, M. Ball
AA/PPC, A. Shakow
AA/LA, A. Valdez
AA/ASIA, J. Sullivan
AA/NE, J. Wheeler
AA/AFR, G. Butcher
AA/TA, M. Belcher
AA/TA, E. J. Long
AA/TA, H. Fleming
TA/PPU, B. Rush
TA/N, M. Forman
TA/AGR, F. Williams
TA/AGR, D. Peterson
TA/AGR, N. Konnerup

TA/AGR:LFHesser:lb:meh:10/19/77
Revised TA/AGR:LFHesser:lb:meh:10/27/77

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SUPPORT TO NATIONAL AGRICULTURAL RESEARCH INSTITUTIONS

Asia Region

Fiscal Years	Country	Grant ($000)	Loan ($000)	Total Amount $000
1976-78	Bangladesh	$ 2,561	$ 4,000	$ 6,561
1971-78	Indonesia	1,540		1,540
(1978-82)	Indonesia	1,800	7,000	8,800
--	Korea	--	5,000	5,000
1975-81	Nepal	5,000		5,000
1969-79	Pakistan	2,696	7,600	10,296
1975-78	Philippines	806	5,000	5,806
1976-81	Sri Lanka		4,200	4,200
1979	Philippines		10,000	10,000
	TOTAL	$14,403	$42,800	$57,203

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ANNEX A.

ENVIRONMENTAL PROCEDURES

Related to Use of Diphacinone

In respect to the use of Diphacinone (Diphenadione) in cattle as a vampiracide, the process to comply with Environmental Procedures will be as follows:

1. The Mission Director will be requested to consider making a decision, based on technical information provided to him, that procedures involved in the use of the chemical Diphacinone may be for purposes of protecting human and animals against rabies and possibly other diseases. This chemical has been used in areas of Latin America where vampire bat transmitted rabies is endemic and it has been found to reduce vampire bat bites in cattle by 95-99 percent. In Nicaragua where the use of this material has been extensive, not a single case of vampire bat rabies in man or animals has been recorded in over a year; whereas hundreds of cases were reported annually prior to its use. It is suggested that if requests for advisory services on the use of this compound occur in Latin American countries, the Mission Director should be provided with information on the disease incidence and estimates in its reduction based on previous technical experiences as well as the available information on its efficacy, safety and residues in tissues of treated animals in order that he may make a decision on recommendations for its use. This will enable the Director to make a decision on the interim requirements that he state in writing that the pesticide will be used for health purposes (human and animal) and that significant health problems will occur without the use of the pesticide.

2. An Initial Environmental Examination (IEE) evaluating the economic, social, and environmental costs and benefits of the planned use of this pesticide will be prepared by the project manager and the staff of the Denver Wildlife Research Center.

TA/AGR:NKonnerup:meh:10/19/77

APPENDIX II

GAO REPORTS ON RELATED SUBJECTS

"U.S. Actions Needed to Cope with Commodity Shortages," ID-74-37, Apr. 29, 1974.

"Increasing World Food Supplies--Crisis and Challenge," ID-75-4, Sept. 6, 1974.

"The Agricultural Attache Role Overseas: What He Does and How He Can Be More Effective for the United States," ID-75-40, Apr. 11, 1975.

"The Overseas Food Donation Program--Its Constraints and Problems," ID-75-48, Apr. 21, 1975.

"Disincentives to Agricultural Production in Developing Countries," ID-76-2, Nov. 26, 1975.

"Grain Reserves: A Potential U.S. Food Policy Tool," OSP-76-16, Mar. 26, 1976.

"Agricultural Research--The Organization and Management," RED-76-92, Apr. 9, 1976.

"Need for an International Disaster Relief Agency," ID-76-15, May 5, 1976.

"Strengthening and Using Universities as a Resource for Developing Countries," ID-76-57, May 5, 1976.

"Providing Economic Incentive to Farmers Increases Food Production in Developing Countries," ID-76-34, May 13, 1976.

"U.S. Participation in International Food Organizations: Problems and Issues," ID-76-66, Aug. 6, 1976.

"Hungry Nations Need to Reduce Food Losses Caused by Storage, Spillage and Spoilage," ID-76-65, Nov. 1, 1976.

"The United States Should Play a Greater Role in the Food and Agriculture Organization of the United Nations," ID-77-13, May 16, 1977.

"The World Food Program--How the U.S. Can Help Improve It," ID-77-16, May 16, 1977.

"Restrictions on Using More Fertilizer for Food Crops in Developing Countries," ID-77-6, July 5, 1977.

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"Management of Agricultural Research: Need and Opportunities for Improvement," CED-77-121, Aug. 23, 1977.

"Credit Programs for Small Farmers in Latin America Can Be Improved," ID-77-1, Dec. 9, 1977.

APPENDIX III

PRINCIPAL OFFICIALS RESPONSIBLE FOR ACTIVITIES DISCUSSED IN THIS REPORT

	Appointed
DEPARTMENT OF STATE	
SECRETARY OF STATE:	
Cyrus R. Vance	Jan. 1977
AMBASSADOR TO COLOMBIA:	
Philip V. Sanchez	June 1976
AMBASSADOR TO PANAMA:	
William J. Jorden	Feb. 1974
AMBASSADOR TO PERU:	
Harry W. Shlaudeman	May 1977
AMBASSADOR TO THE PHILIPPINES:	
David D. Newsom	Oct. 1977
AMBASSADOR TO THE REPUBLIC OF CHINA:	
Leonard Unger	March 1974
AMBASSADOR TO THAILAND:	
Charles S. Whitehouse	May 1975
AGENCY FOR INTERNATIONAL DEVELOPMENT	
ADMINISTRATOR:	
John J. Gilligan	March 1977
DIRECTOR, MISSION TO COLOMBIA	
James Megellas	Nov. 1975
DIRECTOR, MISSION TO PANAMA:	
Irving G. Tragen	Dec. 1975
DIRECTOR, MISSION TO PERU:	
Leonard Yaeger	July 1977
DIRECTOR, MISSION TO THE PHILIPPINES:	
Peter M. Cody	Nov. 1976
DIRECTOR, MISSION TO THAILAND:	
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RECOMMENDATIONS

Collaborative Research Support Proposal Grain Sorghum And Pearl Millet

Part I of the Final Report
Work Order No. 4, Contract AID/AFR-C-1139
United States Agency for
International Development
and
University of Missouri

March 1978

PART I

PLAN FOR

GRAIN SORGHUM/PEARL MILLET
COLLABORATIVE RESEARCH SUPPORT PROGRAM

AID/AFR-C-1139 W/O #4

PREPARED BY

UNIVERSITY OF MISSOURI-COLUMBIA

FOR

JOINT RESEARCH COMMITTEE

BOARD FOR INTERNATIONAL FOOD AND AGRICULTURAL DEVELOPMENT

AGENCY FOR INTERNATIONAL DEVELOPMENT

DEPARTMENT OF STATE

WASHINGTON, D. C.

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PREFACE

These recommendations constitute Part I of a three part final report submitted by the University of Missouri on Work Order No. 4 of USAID Contract AID/afr-C-1139. This project was undertaken in response to a request from the Board for Food and Agricultural Development and the Agency for International Development.

Under provisions of Title XII of the Foreign Assistance Act of 1961 as enacted in Section 312 of the "International Development and Food Assistance Act of 1975," AID and BIFAD gave priority to Grain Sorghum/Pearl Millet for a collaborative Research Support Program (CRSP). The assignment to the University of Missouri was to recommend the major components of that CRSP and the universities to participate in it. The bases for these recommendations were the identification of the major constraints to increased availability and utilization of grain sorghum and pearl millet as a food source, the translation of those restraints into basic research needs, and the preliminary proposals from interested universities for research leading to the alleviation of those constraints. The proposals made should not dictate or circumscribe the program. A concerted effort to avoid such influence has been made and is urged upon all subsequent planning efforts.

A significant element in the project is that we turned to research scientists presently involved in grain sorghum/pearl millet research for the identification of the constraints.

This group of scientists, detailed elsewhere in the report by name, included those working in U.S. universities and in research institutions in other countries. Most of them were U.S. scientists, some working at home and some abroad, but a significant number of scientists from other countries were included.

Part II is largely supplementary information which supports the recommendations.

Part III is the Interim Report circulated to the interested institutions to invite their proposals, and detailing the identified constraints and research needs as well as the methodology used up to that point.

The proposals received from the universities were by direction presented in very general terms and broad outline. The recommendations in this report are intended only to identify the major components of the research project and the institutions best suited to carry out those component parts. The organization of the research program in detail is yet to be accomplished and will constitute another phase of the planning process. At the present time, Phase 2 is envisioned in two parts, Phase 2A as that of establishing an administrative and management entity and organizing the participating universities into a research unit, and Phase 2B as the development of the detailed research project and the beginning of its implementation. Considerable overlap of the two may be possible.

It is anticipated that the CRSP will include in-country collaborative research activities between U.S. and LDC

scientists, and provision for making available the results of the research in such a way that they ultimately affect production, storage and utilization methods in the developing countries. The difficulty of sharp delineation between JCAD and JRC programs is recognized. Certainly the building of irrigation systems, storage facilities, and roads will be left to country development programs. But provisions for training of scientists as a component part of the research project, and for extending the results of the research to the ultimate users should be integral parts of the research program.

A. THE STATE OF THE ARTS IN GRAIN SORGHUM AND PEARL MILLET

This grain sorghum/pearl millet collaborative research support program appears to have been conceived and the planning phase implemented on the supposition that the two crop species, Sorghum bicolor and Pennisetum americanum, can be lumped into a single program and researched as a single species. The two crops have many similarities. They are both drought and heat tolerant species and they are grown in geographic areas of close proximity. Perhaps, it is the drought and heat tolerance of the species that are their most significant characteristics. This tolerance adapts them to the harsh climates of the dry, semi-arid regions of the tropics and subtropics and enables them to produce food grain in areas of the world that are not suited to the production of wheat rice, or corn, because the rainfall is too sparse. Because of this tolerance they have emerged as the cereal grains most widely utilized for human consumption in the Sahel and Subsahelian region of Africa, and the central peninsular region of India.

Tolerance to moisture stress also constitutes a significant difference between the species, with pearl millet being able to tolerate greater moisture stress than sorghum. As one moves into the drought areas of Africa and India, sorghum is the first to replace the cereals with higher moisture requirements, and it is in turn replaced by millet. If one reverses this perspective, the first cereal to be cultivated as one moves from the arid deserts of Mali or Chad southward into the Sahel is millet, and as one continues, and rainfall increases, millet eventually gives way

to sorghum. Similar comparison may be made in the millet and sorghum growing areas of Maharashtra and other states of Central India. So while the crops are grown in the same general regions of Africa or Asia, the production areas are not exactly the same, only in close proximity to each other. And while the crops are similar they are also different. So in this program there are two crops, with research inextricably interwoven, yet blatantly different in many respects.

Why are sorghum and millet grown in these areas? The practical answer is simple. These are the only cereals that can be grown that will produce sufficient grain so that the people can subsist. So we are dealing with subsistence crops, produced in a subsistence agriculture, in a harsh climate, where irrigation water is largley unavailable, and the soil nutrients in short supply. This points clearly to where the focus of this project should be directed.

We have pointed to the similarities and the differences in the drought tolerance of these two species. Both are useful. The principles that are learned from this project that contribute to higher production of one of these crop species will almost certainly apply to the other. But the differences are important also. Why is pearl millet more drought tolerant than grain sorghum? Why are the centers of production of the two species in areas with different moisture supply? The real addition to the knowledge of these crops will come from understanding the differences. While the focus of this program must be to improve the lot of the subsistence farmer, and every effort should be made to make

rapid progress in this endeavor, yet the extent of the progress probably will be determined by the extent to which the basic problems can be understood and explained. This has been the contribution of the Land Grant Universities to American Agriculture.

Let us look at what has happened to the grain sorghum crop in the United States. It has been marked by two important advan Some of the earliest sorghum to be brought to the United States came on the slave ships. Other introductions followed. These e introductions were late maturing, tall, and unadapted to mechani harvesting. The first major advance came by overcoming these objectionable features. Selection of short, early mutants; cros ing of milo and kafir to obtain erect heads and stouter stalks; retaining the grain qualities of the milos; resistance to Perico circinata, the pathogen causing milo disease; all contributed to the final outcome. By identifying specific genes for height and maturity, these characteristic of the plant could be changed mor or less at will, making grain sorghum adapted to the high plains and more northerly latitudes. The second major improvement came with the development of hybrid sorghum. The identification of a usable form of cytoplasmic male sterility and restorer genes made possible the exploitation of hybrid vigor. These steps led to large scale commercial production, and has made grain sorghum the third most important cereal crop in the United States.

In the geographic areas in which this project is to be focused, we are dealing with the opposite end of the spectrum; subsistance farming, hoe culture, hand processing. This is not implying that the technology of the United States can be applied

to the subsistence areas. It is important though that science was utilized to develop the U. S. technology. Can science be applied to improve the technology of grain sorghum/pearl millet for the subsistence farmer in Africa or Asia? This is the challenge of the grain sorghum/pearl millet CRSP project; and a monumental one it is.

The "state of the arts" in all areas of the world have been reviewed thoroughly during the course of this project. They were presented in the Interim Report (included as part three of this report), so are not repeated here.

This project provides a modus operandi by which the Land Grant Universities can join hands with an International Research Center to contribute to the well-being of the grain sorghum/pearl millet subsistance farmer. It can add a new dimension to what either could do alone. The grain sorghum/pearl millet subsistence farmer will be the benefactor.

B. THE PROPOSED PROGRAM

In developing the proposed Grain Sorghum/Pearl Millet Collaborative Support Program, it appeared necessary to establish some guiding principles, which would delineate the magnitude or expanse of the program and permit a sharper focus on the most essential components, yet be compatible with the JRC guidelines and the assigned "Scope of Work" as fully as possible. While some of the guidelines were apparent at the beginning, others emerged as the planning process progressed, and as information was collected by interviews with scientists, both U. S. and foreign, knowledgeable about grain sorghum/pearl millet. The final workshop, in which invited biological and social scientists participated, many of whom had distinguished themselves in the international arena as well as in their professional disciplines, brought many of these guiding principles into clearer perspective.

SOME GUIDING PRINCIPLES

1. A mandate of Title XII is to "improve the participation of these (the agriculturally related) universities in U. S. governmental efforts internationally to apply agricultural sciences more effectively to increasing world food production and provide . . . support to the application of science to solving developing countries' food and nutrition problems."[1]

[1] Report 94-442 of the House of Representatives Committee on International Relations, "International Development and Food Assistance Act of 1975."

2. The Grain Sorghum/Pearl Millet CRSP is being developed as a research project which would contribute primarily to the improvement and utilization of grain sorghum/pearl millet in those areas of the developing world where traditionally they are the principal cereal grains being grown and consumed as human food.

3. While this plan is directed essentially toward sorghum/millet as grain crops (both sorghum/millet and grain sorghum/pearl millet are used in the language of the contract and scope of work), the fact that both crops may be used as forage is acknowledged, and it is recognized that in some geographic areas improvement in the potential of sorghum/millet as forage may be research goals to which components of this program may be usefully addressed either now or in the future. Likewise, use of sorghum/millet for brewing in Africa is recognized but not dealt with in this program.

4. The Grain Sorghum/Pearl Millet Research Program is planned as a long-term, comprehensive research program. It is assumed that over the life of the project funds will be available to research the urgent needs identified. It is also evident that over time the content and priority of the urgent needs will change requiring modifications in the program.

5. For greatest progress, the research needs should be attacked by multidisciplinary teams, according to the nature of the problem.

6. Recommendations of a university to implement research is based on the university's demonstrated competence to conduct grain sorghum/pearl millet research as well as the immediate proposals submitted.

7. Research recommended to be undertaken on the grain sorghum/pearl millet project has been coordinated closely with the research program of ICRISAT. The two programs should complement each other; duplication should be scrupulously avoided.

8. It is expected that research funded through this project shall be in addition to, and not a source of funds to continue, current university research programs. This will require additional staffing to carry out the research programs.

9. Trained manpower of the calibre needed for the additional staffing that this project will require is in short supply, or unavailable. This dictates that the project be implemented gradually, and that new research be started only as qualified personnel becomes available.

10. Due to the shortage of qualified manpower, both in the U. S. universities and abroad, training of scientists must receive the highest priority in all universities associated with this project.

11. Because much of the research is required to be site-specific, close cooperation must be developed with national programs and with ICRISAT. To the greatest extent

possible, this cooperation should be developed on a total project basis rather than an individual basis. Visits should be pooled and arranged in a manner to conserve the time of the ICRISAT staff and the time of the national grain sorghum/pearl millet program staff.

12. As a result of additional study and input into the final workshop, and also from the standpoint of closer coordination with ICRISAT, it was found desirable to redefine some of the "urgent research needs" as listed in the Interim Report, in order to focus more precisely on the problems. In other areas the final workshop group concluded that information now available does not address the most urgent research need, and that additional research input from multi-disciplinary teams is needed.

13. Grain sorghum and pearl millet have been grouped together in most of this planning effort due to the similarity of the two crops. Indeed, there are common problems of breeding, production practices, disease and insect pests, nutritional characteristics, marketing, as well as socio-economic related aspects. Yet, they are two different crops with production centered in different ecological areas. There are also problems in breeding, diseases, insects, and nutritive value that are crop-specific. This requires two separate and distinct breeding programs, and separate evaluation of the physiological, entomological, pathological, and nutritional problems of the two crops. This makes

it implicit that the manpower and financial resources allocated to this project will be spread more thinly, than if only a single crop were to be involved.

14. In planning this program, special attention has been given to those areas of research that have been demonstrated as being viable and that have high odds for contributing to production gains (plant breeding, disease control, improved nutritive value, etc.). It is believed that additional research in these areas, if carefully coordinated with research in the national programs, and at ICRISAT, can make the most rapid impact. This does not imply that the need for basic research has been overlooked. As this program moves forward, many gaps in basic knowledge will become evident which cannot now be foreseen. It is therefore a requisite that this program be flexible, innovative, and expansive, so that resources can be shifted to finding answers to problems which emerge and which restrict progress by the conventional research procedures. In the long run it may be in the area of solving problems through basic research that the greatest research contributions can be made by the U. S. universities.

STEPS IN PLANNING THE GRAIN SORGHUM/PEARL MILLET COLLABORATIVE RESEARCH SUPPORT PROGRAM

The methodology used in planning the Grain Sorghum/Pearl Millet Collaborative Research Support Program is described in part II, Section D, of this report, but will be listed here in summary form.

PHASE I.

1. An ad hoc committee composed of UMC staff, external experts, and a representative from ICRISAT, was convened to develop the planning process.

2. A questionaire was developed which would be the survey instrument, and which would make it possible to record and quantify information on the "constraints to production of grain sorghum/pearl millet". Persons interviewed were requested to fill in information on the questions insofar as they felt qualified to do so. In some instances the quesionaire was used as the basis of the interview in order to get appropriate responses.

3. Visits were made to U. S. Universities which had substantive research programs on grain sorghum/pearl millet, and to foreign institutions in Africa, Asia and Central and South America, insofar as time and resources permitted. All visits were made by teams which included both biological and social scientists. About 127 U. S. and 113 foreign scientists were contacted through these visits.

4. A two-day workshop was held, attended by UMC staff involved in the site visits, at which the summaries of the "constraints questionaires" were evaluated and discussed, and finally a list of production restraints and research needs were developed. The list was the collective judgements of the workshop group. It included inputs from the scientists who had made the site visits as well as the information obtained from the questionaires and interviews with knowledgeable persons.

5. An Interim Report was prepared, which included the list of constraints and research needs, and was distributed to the universities which had manifested an interest in participating in the project. The universities were invited to submit research proposals addressed to the research needs in which they had an interest and the capability to research.

PHASE II.

6. Internal research persons, or teams, representing eight areas of research were selected to review the proposals and develop preliminary recommendations for institutions to research the components in each research area.

7. A two-day workshop was held, including the internal research persons, other UMC staff who had actively participated in the project, seven external experts, and a representative from ICRISAT. During this workshop, recommendations to JRC and BIFAD on the comprehensive program of research and institutions to implement component parts of the program were finalized.

THE RESEARCH PROGRAM

The Grain Sorghum/Pearl Millet Collaborative Research Support Program proposed consists of eight multidisciplinary research areas which focus on the production constraints and the research needs identified in the Interim Report. The problems to be researched in each area will be approached by a team of scientists, who may or may not be located at the same institution.

This approach will be most effective in contributing to a total body of knowledge regarding these two crops, and should insure that needed gaps of knowledge will not be omitted from the final package of practices that may emerge from this program. To be successful, the program will require close coordination and cooperation among institutions involved, linkages with ICRISAT, linkages with national research programs in the grain sorghum/pearl millet production areas, and close monitoring by the administrative entity to insure that funds are judiciously and efficiently used for the objectives of the program.

The eight Research Areas are:

1. Crop Improvement
2. Cultural Practices
3. Storage
4. Nutrition
5. Technology communications
6. Socio-economic
7. Marketing
8. Data Systems

Training of foreign nationals and U. S. citizens for overseas work was considered to be an integral part of any research in the above eight areas.

I. CROP IMPROVEMENT

Developing a comprehensive research program in crop improvement will require the cooperation of a multidisciplinary team of scientists including Plant Breeders, Geneticists, Cytogeneticists, Plant Physiologists, Plant Pathologists, Entomologists, and Cereal Chemists.

A. Plant Breeding and Genetics

In the discussion on the most urgent research needs in the Interim Report, it was stated that "plant breeding may be the avenue through which more constraints can be addressed than any other single category of research." This, in part, is because there is the opportunity of effectively integrating research in plant breeding with research in crop physiology, plant pathology, entomology, cereal technology, human and animal nutrition, crop production, and sociological and economic factors. A central theme that emerged from visits to the areas where sorghum/millet are grown, or with research workers familiar to the problems of those areas, was the need to reduce risk in production of grain sorghum/pearl millet. This need is inherent in the production hazards associated with the harsh climatic areas where grain sorghum/pearl millet are the major cereals. This dictates that the central theme of all breeding programs must be breeding to reduce risk. Many of the risk factors are associated with physiological conditions, and coordinated research by the crop physiologist and the breeder is essential for their solution.

Risk is also reduced by breeding for disease and insect pest resistance.

(1). Productivity. Productivity implies that grain sorghum/pearl millet has both the potential for high yield and the stability to maintain satisfactory yields over a range of diverse environments. It has been repeatedly stressed to those planning this program that stable yields are more important to the subsistence farmer than high potential. Since stable yields often are achieved at a low production level, what needs to be strived for in this project is potential with stability.

(2). Efficient Nutrient Use. The traditional areas in which grain sorghum/pearl millet are grown are vastly different from the sorghum production areas in the U. S. The soils are poorer, the moisture is deficient, fertilizer is unavailable (or its use is prohibitive by cost); little is known about availability of trace elements. The physiological response of the genotypes in these environments, and why they respond as they do, is generally unknown. Research on efficient nutrient use would appear to be a productive field of study.

(3). Efficient Moisture Use. Moisture stress limits production in the traditional grain sorghum/pearl millet production areas. Genotypes need to be screened for tolerance to moisture stress, heat, and salt. This requires effective screening procedures. An understanding of the nature of tolerance to these stress conditions would be useful.

Selection procedures to develop populations with greater tolerance need attention.

(4). Emergence. Emergence is a problem that should receive careful attention in the breeding program. The small size of the seeds and the seedling plants, and the dry soil conditions are factors which reduce emergence. In most grain sorghum/pearl millet production areas, emergence occurs under warm conditions. Emergence under cool conditions is of lesser importance except at higher altitudes.

(5). Breeding Methodology. In the conduct of breeding research in this project, the opportunity to study new breeding procedures should be explored wherever possible. Can breeding procedures be developed that will be more efficient in development of varieties for the harsh climates where grain sorghum/pearl millet are grown?

(6). Germ Plasm Resources. Crop improvement by breeding is dependent upon genetic variability. Natural genetic variability is continually being eroded by introduction of improved genotypes. This project, if successful, will reduce natural variability still further. Steps need to be taken to sample, preserve, and characterize the native sorghums and millets and their wild relatives. This effort needs to be closely coordinated with ICRISAT and other institutions currently collecting and maintaining germ plasm collections.

(7). Seed Production and Distribution. Seed production and distribution has been given attention in the

planning but is given lower priority at the beginning of this project. As the project progresses, and new improved varieties are developed, a mechanism for maintaining pure seed stocks, and for increasing and distributing seed of the newly released varieties will become increasingly important. This aspect should be examined early in the project and developed to the extent that it may then appear necessary.

B. Plant Pathology, Breeding for Disease Resistance

As with all crops, grain sorghum/pearl millet are plagued with a wide spectrum of diseases. Diseases which infect sorghum or millet, or both, include downy mildew, head mold, smuts, various leaf diseases (particularly anthracnose), root and stalk rots, ergot, and others. Of these, downy mildew, the head molds, and anthracnose are perhaps the most devastating. Breeding for disease resistance is an important way to reduce risk. Although considerable information is available on the diseases, much additional information is needed from the traditional production areas on the extent of pathogen variability, host-genotype interactions, insect-disease interactions, nature of host resistance, techniques for screening for resistance, and other factors. This research will need to be cooperative with the breeders and entomologists on the program and with breeders and pathologists in the national programs and at ICRISAT.

The parasitic weed, striga, is a serious pest of grain sorghum/pearl millet in Africa. Because large research projects in Sudan and Upper Volta are working on this problem, and due to the difficulties inherent with conducting research on striga from the U. S., it is not recommended that research be started at the present time.

C. Entomology, Breeding for Host Plant Resistance

Serious insect pests of grain sorghum/pearl millet include midge, shoot fly, various stem borers, and others. Breeding for host plant resistance is an important way to reduce risk. Although information is available regarding some of the major insect pests, there are many insect pests in the traditional grain sorghum/pearl millet production areas which warrant additional study, particularly regarding their biology, level of injury, biotypes, host genotype reactions, inheritance, and nature of host resistance. The research will need to be cooperative with entomological research in the national programs and with ICRISAT. The midge is a major problem in all production areas. Shoot fly is not in the U. S. and research is being covered by ICRISAT, so its inclusion is not recommended here. Also, most of the important stem borers are not found in the U. S. Differences in insect problems among sorghum and millet need to be assessed and the problems identified brought into the CRSP.

Birds constitute another serious pest. Satisfactory resistance is not available. Timing of planting to avoid hesitation of migratory birds may deserve study.

D. Grain Quality, Breeding for Acceptable Quality

Grain quality involves both (1) consumer acceptance and (2) nutritive value.

(1). Consumer Acceptance. Consumer acceptance is determined by characteristics such as color and texture, and many unknown variables. To avoid development of varieties unacceptable in quality, the breeder needs to have specific physical-chemical characteristics identified which affect consumer acceptance, and simple tests devised by which he can screen genetic lines in the breeding nursery for these characteristics. The quality characteristics of grain sorghum and pearl millet will differ, so each of these grains needs to be researched to find applicable quality components. The consumer acceptance is complicated by the social and cultural differences of the people. This question is being addressed under the Socio-economic area of research.

(2). Nutritive Value. Research is well advanced on the nutritive value of grain sorghums and similar studies are needed with pearl millet. The nutritive value encompasses total protein, essential amino acids, especially lysine, and tannins. Information is needed on characterization of these properties in millet, and the screening of genotypes for improved nutritional value.

(3). Weathering. Factors associated with weathering of grain need to be given attention, and strains evaluated for genetic difference.

II. CULTURAL PRACTICES

Research that will develop new cultural practices or new techniques of culture that lead to increased yield or greater stability of yield should be a part of the project. Such research has special merit to the extent it may lead to useful technologies that require little capital investment or cash expenditure.

It appears that such objectives are receiving some attention in the Farming Systems Research section of SAFGRAD, and in the ICRISAT program. Because of the dominance of these two crops in subsistence systems, and the difficulty of adopting cash expenditure based, market oriented technology by many of the producers, inclusion of such research in the CRSP seems warranted.

Proposals under the Cultural Practices heading were received from Kansas, Texas A & M, and Nebraska. The Kansas proposal seems worthy, but is not judged to be one of cultural practices (more nearly crop improvement physiology). The Texas A & M proposal offers two objectives; one seems to be related to both nitrogen fixation and breeding, and the second relates to cultural practices through seeding depth investigation, but it too is heavily oriented toward crop improvement.

Nebraska offers 3 proposals which seem to relate directly to cultural practices, and suggest possible LDC collaborative contacts:

13. Influence of Residue Management and Tillage on Water Storage, Soil Temperature and Crop Yield

in Cooler Production Areas

15. Grain Legume Rotation With Sorghum

16. International Soil Fertility Studies in Relation to Soil Properties and Sorghum Genotypes.

It is the judgment that a comprehensive program in cultural practices has not been identified in the proposals, and that a further attempt to do so be a part of Phase 2 planning.

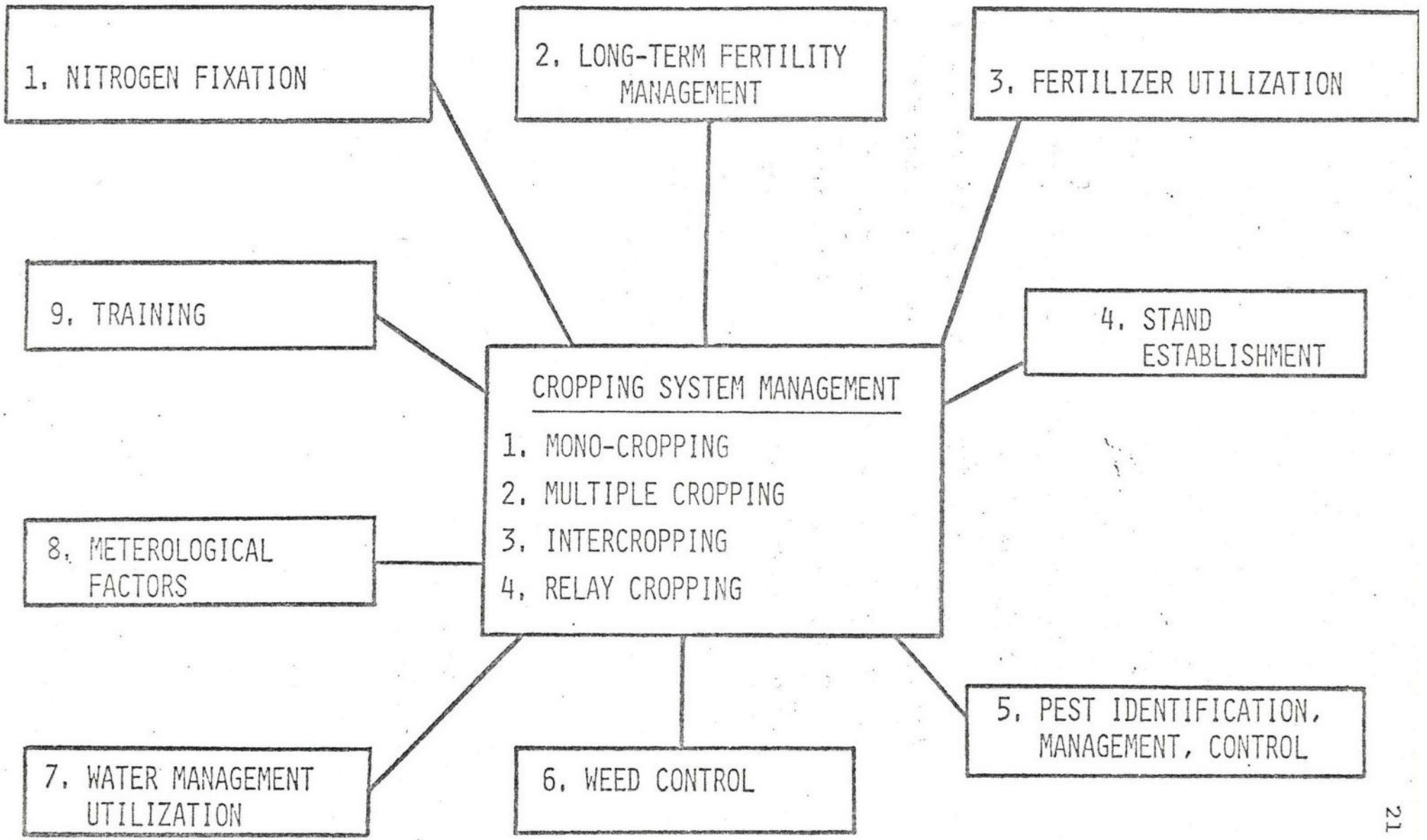
It is recommended that Nebraska take the lead in developing cultural practices research; that the program be further developed in cooperation with Kansas and Texas A & M, with assurance of coordination of appropriate aspects of any breeding or physiology research at those stations with the cultural practices research; and that consideration be given to inviting other institutions to join if such interest and strong capability are identified.

Cultural practices research likely should involve inputs from entomology, pathology, and physiology, especially in relation to research on cropping system management. Figure 1 is a graphic illustration of some major interrelationships in cropping system management research.

Nebraska, Texas A & M, and Kansas State propose research related to meterological factors that likely should be coordinated with cultural practices research, and are recommended for inclusion.

FIGURE 1.

TOTAL CULTURAL PRACTICES PROGRAM



Nitrogen Fixation is deemed to be an important focus within the CRSP. Although it is not a cultural practice per se, this seems an appropriate place to insert it for discussion. The existance of considerable research already underway, some of it financed by AID is recognized. But its importance in the grain sorghum/pearl millet production complex seems to warrant inclusion in this project. There is need for considerable replication in this area. Special efforts to coordinate new research in this area with that already underway seem especially important.

The work at the University of Florida may be the most advanced in the field related directly to these crops. In addition to that proposed, the proposals from Nebraska and from Texas A & M are recommended for inclusion and for development into a coordinated comprehensive project.

Manipulation of cultural practices may offer means for controlling diseases and for suppressing insect pests, offering opportunity for collaboration of plant pathology and entomology scientists in this research.

be addressed as part of the crop production program, but findings may not have immediate application possibilities in the LDC's. The value of this research needs to be assessed in LDC's before initiation.

III. STORAGE

Grain storage research problems may be focused on storage problems at the village level, or commercial storage. From the nature of the CRSP it seemed most appropriate to consider storage problems at the village level. These have been considered from the standpoint of (1) the grain quality factors that promote deterioriation in storage and (2) storage techniques. In considering research on storage cognizance should be taken of the large project on Post Harvest Losses being conducted by the Tropical Products Institute in Great Britain and the FAO project at IITA in Nigeria. Research undertaken should be coordinated with research of these two institutes.

1. Grain Quality Factors Affecting Storage. Information is needed on the physical, chemical, and structural characteristics of grain sorghum/pearl millet genotypes that contribute to their resistance to deterioration in storage. Storage mold resistant strains need to be identified, if they exist, and screening techniques developed that will aid in their identification. Similar information is needed on resistance to stored grain insects. Harvesting and handling techniques before storage may be applicable.

2. Storage Techniques. Storage facilities and techniques affect the deterioration and losses of grain in storage. Research on these problems in this CRSP did not seem appropriate until a better assessment is made of research in progress by the Grain Products Institute and other organizations.

IV. NUTRITION

Two areas of research in nutrition appear to deserve consideration in this project. The first area concerns genetic improvement in the nutritional characteristics of the grain sorghum/pearl millet grain, and the second area is concerned with the improvement in the nutritional value of sorghum and millet.

1. Genetic Improvement in the Nutritional Qualities of Grain Sorghum/Pearl Millet. This area of research has been taken up under the Crop Improvement section. Two needs were identified, (a) development of physical-chemical tests to measure the nutritional qualities which can be used by the breeder in screening breeding lines, and (b) improvement of nutritional value with consideration given to proteins, tannins, and other components.

2. Methods of Improving the Nutritional Quality of Grain Sorghum and Pearl Millet. Through various processes--germination, fermentation, blending, fortification--it may be possible to improve the nutritional quality of grain sorghum/pearl millet. Some of these processes are

adaptable at the village level, others are not. Research on these problems needs to be conceived and developed in the geographic areas where the breeding and cultural work on grain sorghum/pearl millet is being carried out, so that they will fit into the cultural acceptance patterns of the people. The research cannot be done in isolation, and wherever possible it should be coordinated with the nutrition projects at IITA.

V. THE TECHNOLOGY OF COMMUNICATING INFORMATION

The dissemination of innovations regarding sorghum/millet is essential if increased production and utilization is to occur. However, information on many of the questions needed to establish a program is not available. Some of the more important points to be considered are:

1. The adequacy of the information and technology available for delivery.

2. The organizational and functional adequacies of the systems used to develop, test and deliver the information--including local adaptive testing most often left out.

3. How correctly informational adequacy is determined before it is delivered to farmers.

4. The adequacies or inadequacies of subsystem linkages, particularly between the research and educational outreach activities.

5. How information development is articulated with outlet channels.

6. The credibility of both the information and delivery agents as seen by farmers.

VI. SOCIO-ECONOMIC COMPLEX SURROUNDING UTILIZATION OF SORGHUM/MILLET

Grain sorghum/pearl millet are grown and consumed primarily by small low income, subsistence farmers. Neither the production and utilization of sorghum/millet nor the total farming, marketing and utilization systems of the small farmers have been researched in sufficient detail and coverage to provide an adequate basis for the research in plant breeding, cultural practices, storage and nutrition.

Any adequate research program to access socio-cultural constraints and make prescriptions for alleviating them must first of all recognize the enormous complexity of the factors involved and secondarily how they interrelate and combine through time to condition the production, distribution and use of grain sorghum and millet as a food crop.

The Variables. As a minimum, the following variables must be considered:

1. Situational Variables. These include such things as farm size, land quality, land fragmentation, presence or absence of an assured water supply, plus the group related duties and obligations that accrue from family, kinship, locality and special group attachments, and the reference groups to which farmers and their families defer in the acceptance of production and utilization innovations.

2. Support System Infra-Structure Variables. These include the organization and operation of information, credit,

service and supply agencies upon which the farmers must depend for need inputs and the timeliness with which they are supplied; ultimately the market situation for the salable product (see marketing for more detail on this). There is also the additional matter of how all of the elements in the support system interrelate to service the needs of a farmer and his family.

3. Developmental Strategy Variables. In addition to the qualities of the change agent or agency to which potential adopters of production and utilization practices respond, there are also the educational methods and strategies used.

4. Technological Variables. These refer to the adequacy of the information and technology that is made available to the small farmer, i.e., the matter of an appropriate technology viewed mostly as the farmer sees it.

5. Behavioral Variables. These include what the farmer does, why he does what he does in trying to achieve goals for self and family.

VII. MARKETING DEVELOPMENT

The amount and proportion of sorghum/millet which passes through a market in the areas where these are important human foods is probably relatively small but varied. The availability and utilization of markets for any product by the small farmers who grow sorghum/millet is limited and limiting. If increased production does occur, then the probabilities

of more of the grain entering the markets is increased and if markets are not available, the possibilities of failure of the entire program is very high. Research on market organization, structure, and function at both the macro and micro levels is needed.

VIII. DATA BASE MANAGEMENT SYSTEM

A significant amount of information on grain sorghum/pearl millet is already being assembled, some in U. S. Institutions, some in the International Research Centers, and some in the LDC's, through both national and international research programs. Not all of this information gets published, or may be retrieved if needed. A system of collection, storage, and retrieval is needed that will assure all data is made available readily to research and extension personnel around the world. The important role that ICRISAT has initiated as an international center for grain sorghum and pearl millet research information is noted, and they are to be commended in this effort. The comprehensive and extensive nature of a collaborative research program such as is contemplated in this project offers the unique opportunity to create a truly international data base, and with a single or unified management system, make that data available to all scientists throughout the world. As with the germplasm resources, necessary safeguards should be taken against the destruction or loss of this resource from natural hazards, by parallel

storage, and linkages among U. S. institutions and between U. S. institutions and ICRISAT.

TRAINING OF SCIENTISTS

The importance of trained manpower, and how the lack of it can cause a significant constraint to the orderly and rapid implementation of the Grain Sorghum/Pearl Millet Collaborative Support Program, was pointed out in the Guidelines of this proposal. Because of its importance it is emphasized here once more.

IT IS EXPECTED THAT TRAINING WILL BE INCLUDED AS AN INTEGRAL PART OF EVERY RESEARCH COMPONENT OF THIS PROGRAM. This approach will give a broader base to the training of scientists and avoid the stereotyped approach that might occur if localized at one institution.

A shortage of scientifically trained manpower to adequately cope with the research problems of this project will be found both on the U. S. university side and in the national programs. This shortage needs to be met by including training into all research segments of the project.

Training may be at five levels:

1. Undergraduate Level. Training at the undergraduate level can probably be met without a significant input from this project. From the U. S. side, researchers should seek out capable undergraduates and stimulate them to prepare for professional scientific careers.

From the foreign national side there are now agricultural universities in most, if not all, countries in which this project will be focusing. The undergraduate training received by these students may need to be strengthened, or supplemented, before they can pursue graduate study. It is important, however, that good students be identified for further study.

2. Training Programs. The training programs, such as offered by ICRISAT, can form an important supplement to strengthening the scientific background of the foreign national who may work on grain sorghum/pearl millet either in collaboration with an ICRISAT staff member or with a U. S. staff member. Through these programs, the techniques and procedures for conducting a field research program in his native country will be learned.

3. Graduate Training at the M. S. and Ph.D. Level. It is in the area of training graduate students that the U. S. universities have the unique opportunity to make an outstanding contribution to the training of scientists. The Grain Sorghum/Pearl Millet Collaborative Research Support Program provides a vehicle by which innovative approaches may be made. These include:

(a). Sending U. S. students overseas for graduate thesis research.

(b). Developing thesis research problems on grain sorghum/pearl millet for the foreign graduate student

that will be relevant to his national program. The research for the latter might be done in his country (a) under supervision of a U. S. professor working in that country, or (b) under supervision of an ICRISAT staff with whom he might be working. Another alternative for either the U. S. student or the foreign student would be to conduct his research at ICRISAT.

Other innovative procedures need to be sought out, and training incorporated into each research component.

4. Post-Doctoral. The Grain Sorghum/Pearl Millet CRSP offers unique opportunities for post-doctoral training. Again, this might be for the U. S. student on a foreign national program, or at ICRISAT, or for the foreign national student either at a U. S. institution or at ICRISAT.

5. Faculty Exchange and Sabbaticals. Another area for training is through faculty exchange between U. S. and foreign institutions, or sabbaticals of U. S. professors with ICRISAT either in research or training program teaching positions.

INSTITUTIONS RECOMMENDED FOR PARTICIPATION

The institutions recommended to initiate research on the grain sorghum/pearl millet program are identified in this section. Recommendations are based on research strengths observed on site visits, proposals submitted, and evaluations made at a workshop composed of University of Missouri project personnel and a panel of external experts.

I. CROP IMPROVEMENT

A. Plant Breeding and Genetics

1. Productivity. (Potential with stability.)

Texas A. and M. University. Comprehensive breeding program on grain sorghum.

University of Nebraska. Comprehensive breeding program on sorghum with emphasis on stress tolerance (collaborative with Texas A. & M.).

Kansas State University. Comprehensive breeding program on pearl millet.

2. Efficient Nutrient Use.

Texas Tech University. Nutrient extraction and efficiency of use.

University of Nebraska. Mineral efficiency and tolerance, N uptake and utilization.

Texas A. and M. University. Screening for efficient use.

3. Efficient Moisture Use.

University of Nebraska. Selection under water and temperature stress, sorghum.

Colorado State University. Water use efficiency and tolerance to moisture stress, millet.

University of Arizona. Development of germplasm for arid lands, sorghum and millet.

4. Emergence.

Mississippi State University. Characterization of stand establishment problems, sorghum and millet.

5. Breeding Methodology.

University of Georgia. Rapid method for gene incorporation in millet.

University of Nebraska. Comparison of recurrent selection methods in sorghum.

University of Florida. Pollen abortion vs. cytoplasmic sterility systems in sorghum and millet.

6. Germplasm Resources.

University of Arizona. Collection, characterization, and preservation of land races.

Texas A. and M. University. Introduction, quarantine, and day length conversion of exotic germplasm.

7. Seed Production and Distribution.

No recommendation.

B. Plant Pathology, Breeding for Disease Resistance

Texas A. and M. University. Identify and incorporate sources of resistance into sorghum breeding populations--downy mildew, head molds, smut, leaf diseases and stalk rots.

Mississippi State University. Identify and incorporate anthracnose and head molds resistance into breeding lines (cooperative with Texas A. and M.).

University of Nebraska. Methodology for using toxins in screening for resistance to head molds and leaf diseases.

C. Entomology, Breeding for Host Plant Resistance

Texas A. and M. University. Identify and incorporate sources of resistance to midge, panicle pests, and mites into sorghum breeding population (Texas will continue to collaborate with Mississippi State University).

Mississippi State University. Collaborative research program with Texas A. and M. is already existing.

D. Grain Quality

1. Consumer Acceptance.

Texas A. and M. University. Identification of quality characteristics of sorghum and development of screening tests for breeders.

Kansas State University. Identification of quality characteristics of millet and development of screening tests for breeders in conjunction with existing AID project.

2. Nutritive Value.

Purdue University. Nutritive value of sorghum and millet, including tannins, protein, and lysine.

3. Weathering.

No recommendation. This might be incorporated in No. 1 above, "consumer acceptance."

II. CULTURAL PRACTICES

A. Crop Improvement and Yield Stabilization

1. Nitrogen Fixation.

University of Nebraska. Symbiosis between nitrogen-fixing bacteria and sorghum roots.

Texas A. and M. Symbiosis between sorghum and millet roots and nitrogen-fixing bacteria.

University of Florida. Associative N_2 fixation in pearl millet and sorghum.

2. Nutrient Responsiveness.

No recommendation.

3. Stand Establishment.

No recommendation.

4. Cropping Systems.

No recommendation.

5. Meterological Factors.

University of Nebraska. Transfer of water harvesting techniques to LDC environment and economic conditions.

Texas A. and M. Screening for low moisture tolerance.

Kansas State University. Yield related processes affected by environmental stresses and developing models on environment/genotype response.

B. Plant Pathology

No recommendation.

C. Entomology

No recommendation.

III. STORAGE

1. Grain Factors Affecting Storage

TEXAS A AND M (Determine factors conferring resistance to deterioration from molds and techniques for identification.)

Kansas State University (Determine factors associated with susceptibility to stored grain pests and techniques for identification.)

2. Storage Techniques

No recommendations

IV. NUTRITION

1. Genetic Improvement in the Nutritional Qualities of Grain Sorghum/Pearl Millet. This portion has been included in the grain quality section of crop improvement.

2. Methods of Improving the Nutritional Quality of Grain Sorghum and Pearl Millet. Cornell and MIT offer proposals for modifying the grain (sorghum at Cornell, both at MIT) to increase its nutritive value, improve acceptability, and/or adapt it for use as a base in processed food. The question raised with these two projects is that of the relative importance of the use of these grains in a processed or amended form as compared to their use directly as grain. The panel workshop accepted these proposals as good, but did not formulate a recommendation on the inclusion of such research in the CRSP.

Missouri offered a proposal on improving the nutritive value through germination, fermentation, and blending. This too, was assessed by the workshop panel to be a useful proposal. It was criticized for the geographic area of proposed LDC linkage, and a reorientation toward Africa was suggested.

One suggestion for the resolution of these concerns and the further development of the research area was that a nutritionist be included in a proposed study of the social aspects of grain sorghum/pearl millet, acceptance and consumption and that a research strategy be designed that would pick up these pieces and integrate them into a comprehensive research program.

It is our recommendation that as the total research project is developed that a subcommittee be formed with membership from these institutions, augmented by other appropriate membership, to resolve the questions raised and make a recommendation.

Grain quality is closely related to nutritive value. Five states offered proposals in quality improvement and measurement as follows:

Flavor/ Taste	Cooking Quality	Texture	Digestability	Calorie Content
Texas A&M	Texas A&M	Texas A&M	Texas A&M	Texas A&M
Fla. A&M	Fla. A&M	Fla. A&M		Fla. A&M
Purdue	Purdue			
Colorado				
			Colorado	
			Kansas	

The work at Purdue was cited under the section on grain quality. The workshop panel was concerned that much of the research in these areas should be conducted in-country, and it should be integrated with field work in the socio-economic area where appropriate. It was suggested that Texas A & M and Kansas State should take the lead in further development and coordination of this area of research, and that the work group should include Dr. Futrell of Mississippi State.

V, VI,
VII. SOCIAL SCIENCE, PROJECTS INCLUDING COMMUNICATION OF INFORMATION SOCIO-ECONOMIC COMPLEX, MARKETING AND RELATED AREAS

The "Interim Report" which identified the principal constraints in production, marketing and utilization of grain sorghum and pearl millet listed seven most urgent research needs (#7 and 9-14) which included a major social science dimension. These are listed under V, VI and VIII in the research program section. Six institutions submitted projects which were categorized as including a significant social science aspect. As a result of this small number of project proposals, several constraints and research areas were not included in any proposal.

The panel discussed the entire social science area as one unit after first examining the individual proposals and made the following recommendations:

1. The social science area is important and needs to be fully integrated into the total project from the beginning. The panel emphasized the importance of this research and the need for cross communications of research including results. These recommendations should not be taken as decreased importance placed by the panel on the area or on any subparts of the area. The panel did think that because most social science research has not been oriented in the past to a specific crop or commodity, the projects were not as well coordinated as those from the biological sciences where communities of researchers work on specific crops. Also, the breadth of the area is considerable and includes several disciplines and sub-specialities.

2. The social science projects should be redesigned to be more inclusive of the world, more specific in purposes, and more efficient in use of resources, because, (a) some research areas were not covered, (b) it appeared that the proposed individual projects included in some ways unnecessary duplication (such as several proposed village level studies each for a different purpose when one study might collect the data for several researchers); and (c) major sorghum and millet growing regions of the world were not included in any project.

3. The proposed new structure necessitates that one or two institutions provide leadership and coordination in developing a program for social science area. It was recommended that the University of Missouri - Columbia and the University of Kentucky were the two institutions best suited for such a role because of personnel resources, especially in the area of rural sociology. Purdue, because of their strength in marketing, and Kansas State in the role of women were recommended as participants also. Mississippi State University was included in this group because of the social aspects included in their nutrition project and the experienced personnel available there.

4. The participation of institutions should not be limited to these listed above, but a team approach should be taken and new institutions and projects solicited as necessary. Examples of the area not covered by any proposals are "risk" (research need #12) and "farming systems" (research need#14).

VIII. DATA BASE MANAGEMENT SYSTEM

The reviewing panel of experts recognizes the need for a system to collect and disseminate research findings and information. Because the Canadian International Development Research Center (IDRC) is financing for sorghum and pearl millet the installation of an Information Center to collect, document and retrieve information for these two crops at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in Hyderbad, India, a definite commitment should not be made at this time. Coordination of plans for a cooperative data base should be established as the ICRISAT system develops. In the future, plans should be made to integrate a similar system into the U. S. Universities with two-way linkages for rapid exchange of information between the programs. To establish the cross linkages it is important that two systems do not emerge with different languages. The need for a coordinated data base management system will grow as the CRSP unfolds and should receive high priority.

COMMENTS ON "INSTITUTIONS RECOMMENDED FOR PARTICIPATION"

I. CROP IMPROVEMENT

A. Plant Breeding and Genetics

(1). Productivity. After discussing the plant breeding and genetics input, the panel recommended that a comprehensive breeding program should be mounted with cooperation from physiologists, pathologists, entomologists, and cereal chemists. Texas A. and M. University and the University of Nebraska have strong breeding programs on sorghum. The Texas program is coordinated more closely with pathology, entomology, and cereal chemistry; the Nebraska program with crop physiology. To utilize these strengths, the two universities are recommended to undertake a cooperative comprehensive program. With its USAID funded program, Kansas is developing strength in millets and is recommended for the development of a comprehensive program with millets.

B-C. Plant Pathology and Entomology

The proposals received dealt essentially with sorghum. The diseases and insect pests of millet were not adequately covered in the proposals and are deficient in the recommended program. These aspects of the millet breeding program should be looked at more carefully in the near future. Overseas research on pathogens and pests not found in the U. S. will be necessary.

D. Grain Quality

It was the opinion of the panel that the identification of physical and chemical characteristics affecting grain quality and the development of tests for evaluating these characteristics in the early breeding stages are research items of high priority. Further, the development of these evaluation tests should be tied closely with the breeding projects. These capabilities appear to exist for sorghum at Texas A. and M., and are being developed for millet at Kansas State University through their current AID program. It was also the recommendation of the panel that the nutritional aspects be examined at Purdue University, which has demonstrated capabilities in this area of research.

The question of weathering is important in both grain sorghum/pearl millet, but did not appear to the workshop panel to be adequately addressed in any of the proposals. This research problem needs to be considered again and put in sharp perspective, with inputs from plant pathology.

II. CULTURAL PRACTICES

It appears the recommendations are not complete, nor are they adequate in the area of cultural practices. There appears to be a grey area between what a grain sorghum/pearl millet crop oriented research project and a country development program directed toward a grain sorghum/pearl millet producing country should be doing. These concerns need to be sorted out and a more positive direction given to

institutions who would wish to make proposals in this research area. A logical dividing line might be that research to develop cultural practices related to grain sorghum/pearl millet should be a part of this project; the implementation of these practices a part of the country program. Yet such guidelines do not jibe with the directives to develop within this project recommendations on how to deliver the information and obtain acceptance.

It may also be noted that too many of the proposals in cultural practices were concerned with doing "research for" the LDC's rather than doing "research in" the LDC's. Cultural practices research designed and tested in U. S. Agriculture will have little chance of contributing to the success of grain sorghum/pearl millet production in the subsistence areas of Africa or Asia. Part of this problem stems from lack of experience of the institution making the proposal in the LDC's. Ways need to be found to get them experience so that proposals can be presented from the viewpoint of Africa or Asia rather than America. The problem is so large that assistance toward its solution needs to be solicited from all sources.

III. STORAGE

The grain quality factors affecting storage were considered important by the workshop panel and were recommended for funding. The question of storage techniques were also considered. This problem needs to be studied at the village level. There was some question by the panel whether proposals focused at the real problems. After the project is funded and

U. S. personnel have more experience in the grain sorghum/pearl millet production areas it seemed that the problems could be asessed more precisely. Knowledge of ICRISAT staff working with grain sorghum/pearl millet and the considerable experience of the Tropical Products Institute may also be brought into decisions on what can be done that will be most applicable.

IV. NUTRITION

Three aspects of the nutrition problems arose. The first related to grain quality and the development of simple tests that would enable the breeders to screen the genetic materials in the early stages of their development. This appears to have been adequately dealt with in the recommendation in the Crop Improvement section that Texas A and M look at the sorghum problem and Kansas State University look into the millet problem.

The second aspect related to the genetic improvement of the nutritional value of grain sorghum/pearl millet. The reflections of the panel were that the optimism for really significant gain for improvement in this area of research was not as bright as they had appeared earlier. However, the goals, if they can be achieved, are sufficiently great, that this area of research should continue to be pursued.

The third aspect related to improving the nutritional value and acceptance of grain sorghum/pearl millet. As with the cultural practices, it appeared to the panel that some of

the proposals do not sufficiently focus on the problems in these areas. The panel felt that probably sufficient information was not available to those making the proposals to view the problems in the proper perspective, and that a nutritionist with experience in Africa should accompany a social science team to assist in sorting out the bits and pieces, so that a more specific program may be developed.

V. THE COMMUNICATION OF TECHNOLOGY, VI, SOCIO-ECONOMIC COMPLEX SURROUNDING UTILIZATION OF SORGHUM/MILLET, AND VII MARKET DEVELOPMENT

The recommendations and the rationale for these recommendations are given on pages 38-39. Some additional comments may be useful here.

The recommendations of the workshop were clear that (a) the communication, socio-economic, and market aspects of grain sorghum/pearl millet are a part of this project and should be integrated into the project as early as possible, and (b) that information was not available in a form by which action programs presently could be undertaken except in an uncoordinated, piece meal fashion. Particularly significant was the fact that the information had never been collected or assembled on a crop situation base. Collecting and assembling the information with a grain sorghum/pearl millet perspective will add a new dimension from which an action program may be developed.

One of the most inefficient aspects of agricultural research worldwide has been the bottleneck encountered at the interface between the researcher and those charged with the responsibility of disseminating research results. Continual investigation into improved ways of communicating technology developed through research is needed. Research into the kind of questions raised in Section V on page 26 of this report need not be specific to any crop. However, if the research program related to grain sorghum/pearl millet is to be comprehensive, it should include that component.

Missouri has offered a proposal that is unique as an innovation in technique and methodology. It focuses on the adaptation of an information dissemination system, the University of Missouri Agricultural Guide which has received international recognition as a useful information dissemination vehicle. It proposes to translate research information, that presently available and that which may become available through the research project, into usable form for change agents worldwide, and to facilitate the development of similar national systems as the anticipated demand in other countries develops.

The workshop panel did not formulate a specific recommendation regarding this project, but recommended it for consideration by the group charged with further development of the socio-economic complex area, or some similar group in Phase 2.