AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523

BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 37

1. SUBJECT CLASSIFICATION

A. PRIMARY: Agriculture — AA50-0000-0000

B. SECONDARY: Research

2. TITLE AND SUBTITLE

The international maize research network,case study

3. AUTHOR(S)

Levick,K.S.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1973	30p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS

AID/TA/AGR

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

(In Dept.of State. Senior Sem.in Foreign Policy case studies)

9. ABSTRACT

10. CONTROL NUMBER

PN-AAC-327

11. PRICE OF DOCUMENT

12. DESCRIPTORS

Information systems
Maize
Networks

13. PROJECT NUMBER

14. CONTRACT NUMBER

AID/TA/AGR

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

THE INTERNATIONAL MAIZE RESEARCH NETWORK

Case Study by KENNETH S. LEVICK

FIFTEENTH SESSION

SENIOR SEMINAR IN FOREIGN POLICY

DEPARTMENT OF STATE

1972–73

THIS IS AN EDUCATIONAL EXERCISE AND DOES NOT NECESSARILY REPRESENT THE VIEWPOINT OF THE SENIOR SEMINAR IN FOREIGN POLICY OR OF THE DEPARTMENT OF STATE

TABLE OF CONTENTS

Page

Introduction

I Summary. 1

II The Network Concept. 3

III The Maize Network. 6

IV How Effective Is Network Collaboration?. 10

Zaire
Planning and Program Design
Exchange of Materials
Training
Information Exchange and Dissemination
Professional Collaboration

V Limitations and Opportunities. 19

VI Conclusions. 21

Footnotes

Personnel Contacted

Bibliography

INTRODUCTION

In the interest of making my Senior Seminar Case Study useful to my Agency, I approached several colleagues in A.I.D. to see if their offices might have an unfilled analysis requirement which would coincide with my abilities and interests and the time available. Sam Butterfield, Associate Assistant Administrator in the Technical Assistance Bureau, suggested that the Office of Agriculture might be interested in having me look at some aspect of agricultural research networks. This was a subject with which I had had some peripheral acquaintance and which appealed to my interest in the institutions which can strengthen and support the development assistance effort. Omer Kelley and Guy Baird in TAB/AGR welcomed the idea. We chose a segment of the cooperative system for maize improvement as an application of the network concept which could be examined as indicative of its actual and potential value. I subsequently reviewed a selection of available documents on the network approach and its implementation in the international centers and a series of programs in Africa. Three and one-half weeks were devoted to visits to Mexico, Nigeria, Kenya, Tanzania, and Zaire. A cancelled airline flight made it impossible, given a tight schedule, to visit the CIMMYT team in Zaire. Government officials whom I should have interviewed in Tanzania and Zaire were not available. All those contacted, who are listed in an attachment, were uniformly helpful and extremely tolerant of my questions. Particular appreciation must be expressed for the opportunity to participate in CIMMYT's "Presentation Week", organized for the benefit of donors, the TAC, and Trustees. I acknowledge with thanks the cooperation of all those from whom information or opinions were sought. They made the study possible, pleasant, and, at least for me, interesting.

I. SUMMARY

A.I.D. since the early 1960s has financed a program of research on specific problems of the developing countries. The Rockefeller and Ford Foundations had even earlier devoted substantial resources and management attention to research, primarily in agriculture. Now the international donors in general increasingly see problem-oriented research as a promising form of development assistance. The impact of the Green Revolution's high yielding varieties of wheat and rice and the award of a Nobel Prize to Norman Borlaug for development of the Mexican wheats have stimulated this trend. Donors have formed a Consultative Group on Agricultural Research (CG), supported by a Technical Advisory Committee (TAC), to undertake coordinated planning and financing of a series of international research institutes and centers. The CG and TAC have attempted to assure optimum application of limited resources of funds and scientific personnel in determining the nature and direction of each center's program, to avoid duplication and to assure coverage of the most important problems. An integrated network of research endeavors thus is emerging.

A.I.D. is giving particular attention to research and to the development of research capability in the developing countries as a priority form of technical assistance. It has formulated policy and procedural guidance statements which seek more precisely to achieve detailed network effectiveness through systems of mutually reinforcing cooperation and coordination between all those working on or potentially able to contribute to the improvement and application of technology and methodology in specific crop or problem areas of special significance for development. These networks can include the new international institutes, regional and national centers in Asia, Africa, and Latin America, and university and other research operations in the developed countries. Forms of interrelationship can include coordinated programming and task assignment; exchange of materials, information, and personnel; collaborative training to expand the pool of qualified scientists and technicians; and cooperative use of personnel and facilities to accelerate research progress.

This form of international cooperation is most advanced in agriculture. This paper examines the extent and effectiveness of network operations in a single field of agricultural research and application, on the important food crop of maize or corn. The segment of the maize network examined includes:

(a) national programs in Nigeria, Kenya, Tanzania, and Zaire;

(b) joint programs of groups of developing countries in East Africa and in West Africa;

(c) regional specialization and relay functions of the International Institute for Tropical Agriculture in Ibadan, Nigeria, the CG-sponsored center in Africa;

(d) the global research and leadership role of the International Center for Maize and Wheat Improvement (CIMMYT) in Mexico; and

(e) the supportive basic research of Purdue University on nutritional quality improvement through increased protein value and better amino acid balance.

This segment cannot be seen as typical of the state of international cooperation either in agricultural research in particular or in research generally. It is a highly developed area of such cooperation and thus suggests the potential for integration and coordination in other aspects of research, not only on problems of peculiar interest to the developing world but with benefit also to industrialized countries.

II THE NETWORK CONCEPT

The concept of a research network as an interlinked system of otherwise independent persons or institutions, seeking cooperatively to accomplish a shared research purpose, is manifested in at least three different forms. All have the common characteristic that sponsors and/or participants recognize that mutually reinforcing interaction and coordination can extend the impact of limited resources, improve and hasten positive achievement, and, in general, permit the network to produce more than the sum of the parts, if they operated independently.

It might be argued that the concept of coordinating multiple research endeavors is so entirely natural as not to deserve attention. On the contrary, there have been and still are instances of independent and isolated activity by research stations under the same management. The A.I.D. team that reviewed agricultural research in Tanzania in 1971 found stations working on common problems functioning "essentially as independent institutions." (1) One would not need to go to a developing country for examples. The effort to coordinate and integrate globally the work of institutions formally responsible to a variety of independent national and international entities is a novel and very progressive step.

First, because of its authoritative international status, is the planning and financing, by the Consultative Group for Agricultural Research (CG), of a network of international research centers or institutes working on different aspects of agriculture and rural development. Participants in the CG are the IBRD (Chairman), 13 developed country governments, UNDP, FAO, Rockefeller, Ford, and Kellogg Foundations, three regional Development Banks, Commission of the European Communities, the independent Canadian IDRC, and governmental representatives of the five major developing regions of the world. The other donors, in effect, were joining the Rockefeller and Ford Foundations to expand the international research effort launched by the foundations in establishing and financing the two original and outstandingly successful centers, for rice in the Philippines and for wheat and maize in Mexico. There now are six CG-supported centers:

International Maize and Wheat Improvement Center (CIMMYT), Mexico
International Rice Research Institute (IRRI), Philippines
International Institute for Tropical Agriculture (IITA), Nigeria
International Center for Tropical Agriculture (CIAT), Colombia
International Potato Center (CIP), Peru
International Crop Research Institute for the Semi-Arid Tropics (ICRISAT), India

With the Technical Advisory Committee (TAC) providing guidance on research problems and opportunities, the CG gives conscious attention to avoiding duplication and assuring cooperation in determining the research and outreach tasks assigned to each institute, by crop, by problem, or by region. The existence of the Consultative Group itself results from recognition by donors that (a) agricultural research can yield benefits with broad geographical applicability, spanning not only countries but continents, and (b) that coordination could make the funds available produce greater results than otherwise would be the case. The cooperation of multiple sovereign entities in this relatively informal but effective body is a substantial achievement by the development community.

The centers conduct "International Research", defined by the TAC as research which, although based in one country, is of wider concern, regionally or globally; is independent of national interest and government control; and retains appropriate links with national and regional research systems to insure the necessary testing of results and the feedback of both results and needs. Both the Boards of Trustees and the staffs of the CG-sponsored centers are international in composition. Fifteen countries are represented on IITA's professional staff of 44, nine on CIMMYT's staff of 38.

Second among the three relevant network approaches is that applied by a single donor in attempting to achieve optimum coordination and integration of all research in which it is involved or which it can influence. The Rockefeller Foundation accomplished much in this direction in the international agricultural research endeavors in which it has been involved since World War II. The volume and range of activities in which it is engaged and which it is attempting to interrelate make the more recent attention to the network idea by A.I.D. particularly noteworthy. A.I.D.'s networking impulse covers:

-- the CG-sponsored international institutes, for which A.I.D. provides approximately 25%, up to a ceiling currently set at $7.0 million annually, of core operating budgets and new capital requirements;

-- research contracted or commissioned by A.I.D. on specific development problems;

-- bilateral technical assistance projects, requested by developing country governments, designed to carry out research in host country institutions and/or to improve the host country's own research capability;

-- research carried out as part of an educational technical assistance process, whether the establishment or strengthening of a university in the host country or the M.Sc. or Ph.D. training in the United States of an LDC scientist; and

-- research by personnel of institutions benefitting from A.I.D. grants, under Section 211(d) of the Foreign Assistance Act, to develop domestic U.S. capacity in fields of anticipated future importance for the foreign aid program.

A.I.D. for many years has devoted substantial resources to activities of these types. A 1972 Policy Guideline issued by the A.I.D. Administrator called for an increased emphasis on innovation and research, "to help LDCs find better answers to their most important development problems while helping them hasten the development of their own capabilities to find such answers."(2) This policy statement gave special attention to the build-up of global networks of mutually supporting research, information and technical assistance activities in priority subject areas. A more detailed Agency statement on research networks was issued in November 1972.(3)

The third appearance of the network phenomenon, much less structured and formal but no less significant, is the spontaneous and natural set of linkages and cooperative arrangements which modern scientists engaged in research on common problems construct between and among themselves and their institutions, without external sponsorship or encouragement. This often is referred to as the "old boy network", using the term in an entirely positive sense to suggest informal connections between individuals known to each other, if only through correspondence or acquaintance with each other's publications, and mutually recognizing each other's competence and relevance to a shared, constructive objective. These contacts may be as direct and substantial as those between a scientist and the professor under whom he did his degree research, or between two students of the same professor. Members of the network may have worked together in some prior research endeavor. The maize research fraternity is being expanded rapidly as young technicians and scientists from many countries spend extended training periods at CIMMYT and IITA and become not only acquainted with the institutions and their personnel but imbued with the philosophy and methodology of the pragmatic, action-oriented international centers.

The "old boy network" in maize research existed before donors began to articulate their more sophisticated network ideas. It already had accomplished much of the potential coordination and mutual reinforcement. It probably was the necessary basis for effective functioning of the more structured network arrangements which the CG and A.I.D. now emphasize. It is an important conclusion of this study that an essential condition for continued coordination and integration of the diverse elements involved in agricultural research is to not only permit but to facilitate the free functioning of the unorganized and undirected but very effective system of scientist-to-scientist contacts among researchers. Opportunities for the national members of LDC research staffs to travel and participate in working conferences and professional society meetings particularly need to be supported and encouraged. For all those involved, travel opportunities are perhaps the key to effective scientist-to-scientist cooperation.

III THE MAIZE NETWORK

The international maize research network is examined here as an example of the structure of cooperation which it is feasible to erect among a variety of organizationally independent units.

The objectives of CIMMYT's maize program may be understood also as those of all who participate in the overall maize network:[4]

" (a) To assist in the development of national and regional maize improvement programs and to supply technology for those programs which will benefit the largest possible numbers of farmers, especially in developing countries.

(b) To increase the efficiency of maize yields, as measured by yield per land unit and by production costs per measure of grain.

(c) To improve the nutritional quality of maize, especially in protein quantity and quality."

Agricultural research absolutely requires sustained activity at multiple levels. The coordination problem arises more significantly than in many scientific and technological areas where a single researcher or laboratory can produce a breakthrough usable widely around the world. There is broader geographical applicability of improved varieties and related cultural practice packages than used to be thought, but they still must be tried locally and adapted to varying ecological, disease, and pest conditions before being made available to farmers. Further, each country needs a continuing capability for research of a sophisticated and demanding nature. There will be further need and opportunity for varietal improvement to increase yield. More importantly, each new variety eventually becomes vulnerable to insect and disease hazards that it has originally resisted. To avoid disastrous crop failures, it is imperative to have multiple varieties in use within countries, to be able to identify and determine appropriate countermeasures when problems arise, and to make periodic introductions of new or modified versions of established varieties to keep ahead of the process of adaptation by insects and plant diseases. The 1970 leaf blight epidemic in the U.S. showed how serious that problem may become.

The network for maize has the components listed below, shown graphically on page 7.[5]

THE MAIZE NETWORK

(Linkages are not shown, as lines of interrelationship are multiple and do not necessarily follow heirarchical or regional channels, i.e. CIMMYT has direct contact with many national programs and any researcher can request germ plasm or advice from Purdue or the USDA.)

Donors

Consultative Group — Technical Advisory Committee

Global Leadership

CIMMYT

Tech Support/ Specialized Research and Training

U.S.D.A.

Purdue University

Regional Relay Adaptation, Specialized Research, and Training

IITA . | CIAT | IACP

Sub-regional Relay, Adaptation, Specialized Research

EAAFRO

Samaru

National Adaptive Research and Application (countries named are those most active or advanced)

Zaire Kenya Tanzania Nigeria	Mexico Colombia Argentina Brazil Chile Peru Venezuela Central America	India Pakistan The Philippines Thailand Indonesia

Global

INTERNATIONAL CENTER FOR MAIZE AND WHEAT IMPROVEMENT (CIMMYT)

Functions - Multi-disciplinary production-oriented research, including in-depth studies in such areas as physiology, biochemistry, genetics; provide leadership on a general strategy for the maize network; promotion of the world germ plasm collection; support to production programs; training; consultation.

Services - Provision of improved varieties, technical information, consultant services, and training. Advice on research and production programs. Conduct workshops and seminars.

Funding - Consultative Group; bilateral arrangements (currently involving IBRD, UNDP, Inter-Amer. Devel. Bank, Canada, U.S., West Germany, Rockefeller Foundation, Ford Foundation).

Technical Support and Specialized Research

PURDUE UNIVERSITY

Functions - Research directed toward increased level and improvement in quality of protein in the grain; nutritive evaluation of grain; training; consultation.

Services - Assistance in research and production as related to protein level and quality; provide improved germplasm, technical information, and advanced research training leading to Ph.D. degree.

Funding - Indiana state government; A.I.D.

U.S. DEPARTMENT OF AGRICULTURE, AGRICULTURAL RESEARCH SERVICE (USDA)

Functions - Maintenance of germplasm bank; multi-disciplinary research to meet U.S. needs; cooperation with state programs.

Services - For international network, USDA is a source of germplasm, technical information, and consultation services.

Funding - Federal and state appropriations; A.I.D. for international assistance activities.

Regional Relay and Adaptation

INTERNATIONAL INSTITUTE FOR TROPICAL AGRICULTURE (IITA), Ibadan, Nigeria
INTERNATIONAL CENTER FOR TROPICAL AGRICULTURE (CIAT), Cali, Colombia
INTER-ASIAN CORN PROGRAM (IACP), Bangkok, Thailand

Functions - Relay center from CIMMYT to countries of region; adapt improved varieties for regional conditions; research on problems peculiar to the region; training, consultative, and information support for national programs. (CIAT and IITA have other major and primary functions. Those cited relate specifically to their role in the maize network. CIAT has global responsibility for beef and cassava, IITA for cowpea, seet potato, yam, and farming systems for the lowland humid tropics, with functions as CIMMYT has for maize.)

Services - Basically as for CIMMYT but normally restricted to region.

Funding - Consultative Group; bilateral arrangements varying from center to center. IACP is financed by Rockefeller Foundation and countries of the region.

Sub-Regional Relay and Adaptation

EAST AFRICAN AGRICULTURAL AND FORESTRY RESEARCH ORGANIZATION (EAAFRO), Maguga, Kenya. An activity of the East African Community (Kenya, Tanzania, Uganda).

WEST AFRICAN MAJOR CEREALS IMPROVEMENT PROJECT, Samaru, Nigeria. An activity of the Organization for African Unity's Scientific and Technical Research Commission, for 16 West African countries.

(These examples of sub-regional activity are listed because they fall within the network segment reviewed for this study.)

National Programs

Almost all maize-growing countries in Asia, Africa, and Latin America have some organization for maize research and are encouraged to benefit from services available in the network. Particularly active and well-integrated in the collaborative program are India, Pakistan, The Philippines, Thailand, Indonesia, Egypt, Mexico, Colombia, Argentina, Brazil, Chile, Peru, Venezuela, the Central American countries, and those within Africa which were visited for this study, Zaire, Kenya, Tanzania, and Nigeria.

Functions - Adaptive research and testing for national conditions; research on specific local problems; release of varieties for national use; advice on cultural practices; support of production programs; diagnosis of insect and disease problems and determination of appropriate response.

Funding - National governments; assistance donors.

IV HOW EFFECTIVE IS NETWORK COLLABORATION?

The network concept requires effective integrative linkages to generate the synergistic force of synchronized effort, drawing on a wide variety of talents, situations, and experiences in a mutually reinforcing manner and bringing the power of the U.S. and other developed world scientific resources to bear on developing country problems. How well is this standard of effectiveness met in the maize network, as observed in the segment examined for this study?

By any appropriate definition of such a standard, considering the relative newness of the effort to coordinate independent research activities on a global scale, the network functions with a surprizing degree of integration and collaboration, in both depth and breadth. One should expect not only that programs of the international centers are coordinated but that donors significantly committed to the CG system are not concurrently financing and or operating, individually or collectively, duplicative and unrelated research and technical assistance efforts. Comprehensive linkages should be operating between and among all relevant activities under their control.

These conditions seem to be satisfied. The full array of collaborative relationships within the network segment studied is too extensive to report totally. A selection of the most typical and important linkages is described below. In general, one can affirm with confidence that there is full coordination of functions and a thorough exchange and cooperation among the six CG-sponsored institutions. Further, judging on the basis of work in maize, substantial donors to the CG-supported system (Canada, Ford Foundation, Germany, IDRC, Netherlands, Rockefeller Foundation, Sweden, U.K., UNDP, U.S., World Bank Group) correlate their other foreign assistance research activities with those of the international institutions. Finally, A.I.D., which finances more agricultural research and research capability development than any other donor, assures a very thorough integration both:

-- between its activities and those of the international network and

-- internally within the large range of endeavors it organizes, finances, or is in a position to influence.

The network thus seems relatively fully developed and operational, unless judged by a more demanding standard than seems logical for this stage in the growth of international cooperation. The limitations it encounters and the further opportunities for its extension and refinement are discussed in the following section, after examination of the evidence for the preceding general conclusions.

The Zaire national maize program provides a comprehensive example of the integrated functioning of the network, where the various types of interaction can be seen as they apply together in a single geographical situation. We subsequently will look at examples of collaboration by type.

Zaire

The Government of Zaire in 1971 requested the A.I.D. Mission in Kinshasa to provide technical assistance for improvement of maize research and production. A.I.D./Kinshasa obtained the temporary services of the Assistant Agricultural

Officer in Tunis, J. Gerard Neptune, a corn breeder and agricultural educator. He had been manager of a project in Tunis under which A.I.D. financed the services of CIMMYT in assisting the Tunisian wheat program. IITA, to which the CG has assigned regional responsibility for maize in Africa, was then still in the process of assembling its staff and completing its physical facilities. It accordingly was agreed that CIMMYT would take the lead in the Zaire program. CIMMYT's maize program director, Ernest W. Sprague, and Keith W. Finlay, Deputy Director for Outreach and Special Programs, were joined for the initial survey by Michael N. Harrison, an experienced maize breeder and Leader of the Cereal Improvement Program at IITA.

The composition of this team itself underlines the integrated international nature of the maize network. Ernest Sprague before joining CIMMYT had worked for many years in Asia as head of the Rockefeller Foundation's regional corn program. Keith Finlay is an Australian. Michael Harrison is British and had joined IITA after many years in East Africa. He had been Maize Breeder at the National Agricultural Research Station at Kitale, Kenya before independence, had worked there for the East African Agricultural and Forestry Research Organization under Rockefeller Foundation financing, and then had been East African Regional Coordinator for CIMMYT, making his headquarters still at Kitale.

During much of this period, Harrison cooperated closely with a team of cereals research scientists from the USDA who were carrying out research on breeding methodology for developing countries at Kitale under an A.I.D. central research project. Their cooperation produced a new comprehensive breeding system and high yielding new maize varieties, both composites and hybrids. Latin American strains obtained in 1959 from the Rockefeller program in Mexico (predecessor to CIMMYT) were an important component of the new Kenya maize varieties. Kenyan farmers, small as well as large, had adopted the new varieties and the related cultural practices recommended by the researchers and had seen their yields go up until Kenya now is not only self-sufficient in maize for food but is using increasing amounts for poultry and animal feeding, has filled its emergency carryover storage capacity, and is exporting limited amounts.

The intimate professional collaboration which yielded these valuable results was exemplified by the publication in 1967 of an article describing the new breeding system. It was jointly authored by Harrison, S.A. Eberhart, the research geneticist who headed the USDA team in Kenya, and Festus Ogada, the Kenyan Senior Maize Research Officer at Kitale.(6) Michael Harrison, as indicated, had become chief of the crop improvement program at IITA. Eberhart, after four years in Kenya, had returned to the USDA's Agricultural Research Service and was technical coordinator for the USDA research teams on A.I.D. regional projects in East Africa and West Africa. Festus Ogada had remained at Kitale as Chief Maize Breeder for the Kenya national program. Harrison and Eberhart have continued their close personal and professional relationship, which assures collaborative interaction between IITA and the USDA overseas efforts. When the Sprague-Harrison-Finlay team made its survey in Zaire, it had the benefit of a previous report by Eberhart on a visit he made there in 1968.

The CIMMYT-IITA survey team in Zaire found:

- that Zaire was importing maize and needed to increase production;
- that conditions were good for maize production in large areas of the country;
- that the varieties in use were low yielding and the cultural practices employed were not adequate to take full advantage from the introduction of improved varieties; and
- that the government seemed to be prepared to take the necessary steps for a successful improvement operation.

The team recommended a 10-year program to triple yields, through development of improved varieties and their dissemination with new packages of locally appropriate cultural practices. The government and the A.I.D. Mission, in which Neptune now was the Agricultural Officer, accepted the team's findings and recommendations. CIMMYT and the Zaire Ministry of Agriculture in September of 1971 signed a contract under which a three-man CIMMYT team would operate the National Maize Program at Kisanga, near Lubumbashi (old Elizabethville), Zaire nationals to staff the Program organization would be trained to the necessary scientific levels in the United States and at CIMMYT and IITA, a Zairean would assume the role of co-director as soon as his suitable training could be completed, and the Program would operate under guidelines established by a Maize Committee, with representatives from the Ministry, CIMMYT, and the A.I.D. Mission.

To expedite initiation of the program, it was financed through a release by A.I.D. of local currency counterpart funds generated under the U.S. assistance program, with the government converting into dollars from its own resources the amount required for foreign exchange costs under the CIMMYT contract. After the first year, the project's costs were included in the regular Zaire government budget, and both local currency and foreign exchange requirements became the full responsibility of the government, without further A.I.D. support.

This assumption of financial responsibility by the government made it possible for CIMMYT to select personnel for the Zaire assignment without regard to nationality, as it prefers to do in keeping with the international character of the CG-sponsored institutions. The Maize Agronomist/Team Leader is an American, Tom Hart, who has had extensive experience in Liberia. His colleagues are a Dutch Maize Breeder, Frans de Wolff, and a Plant Protection Specialist from India, Mahesh Pandey. Hart arrived in Zaire in January 1972. The others joined him in mid-year. An initial group of six trainees has completed eight months of training at CIMMYT and has returned to undertake important technician responsibilities in program operations. Six additional trainees, with B.Sc. degrees from the national university, are now in Mexico, after a preliminary period of working experience with the CIMMYT team at Kisanga. An M.Sc. candidate has been selected, the first of the future Zairean scientific staff, and is in practical training at CIMMYT before entering Cornell University this coming fall. Ph.D. candidates who will eventually be trained in the U.S. for senior scientific positions in the Zaire organization will do their degree research at Kisanga, CIMMYT, or IITA, within the practical, problem-oriented atmosphere of an operating maize improvement program.

The research and breeding program in Zaire began with the considerable asset of access to the plant materials coming out of previous international efforts, in Africa and elsewhere. With guidance from Sprague and Harrison, the team has been able after only 16 months to get the project off to a remarkable start. One of the Kenya Kitale hybrids, H632, which had combined East African and Central American strains, was crossed with a Rhodesian hybrid commercially available and widely used in nearby Zambia, SR52. The advanced generation of this cross, named Shaba Safi and grown as an open-pollinated variety so that farmers could save their own selected seed for replanting, was chosen for initial, interim use in the program. Enough seed was available for sowing in farmers' field demonstration plots in the 1972-73 growing season, just completed. The Kisanga team, including the CIMMYT personnel and CIMMYT-trained maize program technicians, working with Zaire extension personnel, managed to get 18 widely-dispersed on-farm plots planted in late 1972, some with adjacent variety and fertilizer trials.

The demonstrations have been an outstanding success and have resulted in high morale, increased prestige for the program, and solid support by the government. The yield of Shaba Safi, up to 10 tons per hectare, was 4-10 times local averages and produced great interest and enthusiasm. This reaction was not limited to farmers who had plots on their own farms but was found also among their neighbors and other local farmers who had observed growth of the crop in the plots

and were invited to special Demonstration Days for an introduction to Shaba Safi and an explanation of the cultural practices which had produced the high yields. The demonstration farmers will make some of their seed available to their neighbors, and there should be a rapid spread of the new level of maize yields in Shaba province.

In the meantime, with continued technical guidance from Sprague and Harrison and their specialist colleagues in CIMMYT and IITA, the team in Zaire is proceeding with further improvement of Shaba Safi and with the determination of still better cultural practices (time of planting, fertilizer type and application rate, etc.) based on research at Kisanga and the demonstration plot experience. More importantly, a selection and trial program is underway at Kisanga to produce a new variety adapted to local conditions but incorporating the best material available in the network. Already the National Maize Program personnel have planted trials of a wide range of maize materials (171 from CIMMYT alone) received from network colleagues. Improved materials will continue to become available from CIMMYT, IITA, CIAT, IACP, and the African sub-regional programs. Continued selection and new crosses will be made from this broad genetic base to provide, for release by the 1974-75 season, a new composite variety with higher yields, wider geographical adaptability, and better resistance to lodging, to disease, and to insect pests.

Progress to date and the scheduled future work program give every reason to expect that the National Maize Program targets for 1980 will be achieved without difficulty. Early indications also are encouraging with respect to the prospects for complete and competent Zairean staffing by the end of the 10-year period.

Though this is formally not an A.I.D. project, the Mission continues to be intimately involved. J.G. Neptune uses the facilities of his office and A.I.D. generally to support the program and facilitate its operations. His participation in their meetings is sought by both Ministry officials and the CIMMYT personnel. He interviews trainee candidates and determines final selection on behalf of the Maize Committee. The Mission is initiating a new project with the Ministry to bring a team of USDA and contract agricultural economists to staff a new section in the Ministry and train Zairean personnel for their eventual replacement. The Mission now is discussing with the government a new project for IITA assistance with the important manioc or cassava crop, after scientists from the Institute were able in a brief visit to diagnose and prescribe curative action for a previously unidentified bacterial wilt that was causing serious damage to the crop and creating severe hunger stress in some areas of the country. A further request to A.I.D. for IITA assistance with food legumes also is under consideration.

Ministry support for the National Maize Program has been extraordinary, marked particularly by giving it a special status which has freed the Zairean personnel from government pay scales and promotion procedures. Performance now will be controlling in their salary structure, rather than years of education, as in the civil service.

The Zaire-CIMMYT agreement provides for eventual training in Zaire for personnel from other countries in the region and for genetic materials and other research results from Zaire to be made available to cooperative programs in other countries. The CIMMYT team at Kisanga has a specialized research assignment within the international system, as do other network units, and will work on the streak virus problem for all of Africa. The National Maize Program will concentrate on varieties for the higher altitudes of the plateau areas of Zaire, where most of the crop is grown. IITA is working on varieties and cultural practices for the lowland humid tropics and can be counted upon to provide help for Zaire in this lower-priority area.

This description of the Zaire national program shows how the network focuses its resources in a single country. Let us turn now to examples of each of the various types of collaboration.

Planning and Program Design

The basic coordination of roles is by the Consultative Group and the Technical Advisory Committee, which have taken a firm position that for each crop or problem only one of the sponsored institutions should have a comprehensive, global function, with others assuming regional relay and adaptation responsibilities. Each of the international centers has the global leadership role for one or more crops or problems. Details are elaborated and further collaborative relationships between the international centers are worked out in periodic meetings. The Consultative Group and Technical Advisory Committee meet several times each year, with secretariat support by the IBRD and FAO respectively. During Centers' Week each year, delegations from each of the CG members, members of the TAC, Directors and members of the Boards of the international centers, and observers from other interested organizations spend a full week in comprehensive review of progress and problems in international agricultural research. The Directors of the centers meet once or twice each year for working discussions on policies and operations of the international network.

In the maize network, their respective roles mean that IITA does not make the same comprehensive effort that CIMMYT does. CIMMYT currently is operating 40 separate maize populations, each built on a collection of original plant materials directed at a specific situation, regional need, or production problem. Each population is being manipulated through recurrent selection on the basis of plant height, ecological adaptability, disease and insect resistance, and yield. Protein level and quality concurrently are being bred into a portion of each improved population with a one-generation lag, so that when most of the potential improvement has been achieved and standardized, a refined "experimental variety" with high protein value can be made available to the world's maize breeders for use in their regional and local testing and adaptation programs. Even in advance of this stage, seeds from the most promising populations are included in CIMMYT trials and nurseries sent to cooperating stations, and the material can be incorporated in their breeding programs if local results are favorable.

IITA, on the other hand, maintains a smaller number of populations, based more heavily on African strains, and aims its selection and improvement efforts at specific African requirements, diseases, insects, and user preferences. In a subregional or national program, the research is still more sharply focused on the circumstances and problems of the country or countries involved.

The CG's influence on program determination of the international centers is effective enough to stimulate some passing concern in the IITA Board of Trustees that its own authority was being circumscribed unduly.(7) It is important for the international centers to have senior and highly competent people on their Boards and for the Board members to take their function seriously, while recognizing the overall policy context determined by the donors' Consultative Group.

The following specific examples of collaborative planning, role assignment, and division of labor are indicative of the degree to which there is coordination in the maize network segment examined for this study:

1. The research pathologist being assigned, under the A.I.D./USDA West African project, to the Nigerian research station at Moor Plantation near Ibadan is a virologist. IITA, at its nearby location, also is filling a pathologist position on its staff. They are choosing a scientist with complementary specialized skills, so that the two men can cooperatively provide comprehensive pathology coverage for the two related research programs.

2. IITA, which has the necessary environmental conditions and staff at Ibadan, is pursuing investigation on behalf of the network as a whole of factors which limit yields of maize in the lowland humid tropics, particularly the effect of soil temperature on the rate of seedling growth.

3. A.I.D. currently is in an advanced stage of negotiations with IITA to provide a three-man team for an agricultural research project in Tanzania. Maize improvement will be one of the priority areas of work. Special attention is needed because Tanzania has not benefitted, measured by the accomplishments of Kenya, from the research advances made in the EAAFRO project by Michael Harrison and the USDA team, as described previously. The April 1971 planning survey report devoted a chapter specifically to "Coordination of Agricultural Research Programs between Tanzania, the East African Community, and International Organizations."(8) The project documents have stipulated that duplicative efforts would be avoided and all possible utilization made of results from other network units. Funds are provided to finance the travel of Tanzanian staff members "to insure adequate coordination....with regional and international research organizations."(9) Duties of the Maize Breeder on the team include making "full use...of breeding and agronomic research done by the East African Community research organizations and other foreign research" and "planning varietal adaptation testing of EAAFRO and other exotic varieties and hybrids..."(10) Selection of IITA as the contractor was determined in part to "strengthen linkages between National/Regional/International Research Institutions."(11)

4. A.I.D. and the East African Community currently are considering an expansion of the EAAFRO/USDA research team's effort on maize, with some of the work being located in Tanzania. Discussions have been initiated to assure that any eventual decision along these lines will be compatible with the new A.I.D./Tanzania/IITA project, pursuing specialized regional problems which would complement and not duplicate the national program.

5. The June 1972 A.I.D. approval decision for the current phase of the EAAFRO/USDA project made specific provision for dollar and local currency funding "to cover liaison-training activities with the international research centers... and with the national research institutions of the member states."(12)

6. Coordination between Purdue University and CIMMYT on the maize protein research has been the subject of periodic planning meetings and is specifically addressed in the University's annual reports to A.I.D. under their contract.

7. The A.I.D./USDA West African research team is guided by an African project coordinator in the Lagos office of the Organization for African Unity's Scientific and Technical Research Commission, which includes representatives of the 16 countries served by the project. There is full integration of the team's work with the Nigerian national maize improvement efforts, with the American scientists located at the Institute for Agricultural Research at Ahmadu Bello University, Samaru, near Zaria in the Northern Region. Periodic planning discussions are held with Michael Harrison to assure coordination with the program at IITA. Trials and seed multiplication plantings are made cooperatively at research stations in Francophone African countries of the Institute for Tropical Agricultural Research (IRAT), the French assistance program's regional research organization.

Exchange of Materials

1. CIMMYT in 1970 filled 88 maize seed requests from 34 countries, providing 3,237 populations to the requesting institutions(13)

2. All significant maize research centers are linked in the large international testing program, in which CIMMYT and all the other projects in the network segment examined for this report, as well as many others, submit materials

and reciprocally plant uniform trials. In 1972 there were 401 trials in 52 countries.[14] Results are circulated and provide the basis for further selection for variety improvement or adaptation to a particular requirement. Any of the trial materials which show characteristics desired in the local breeding program can be incorporated in their own populations by cooperating stations.

3. The West African cooperative regional trials organized under the A.I.D./USDA/STRC project in Nigeria have led to the first regular exchanges of germ plasm between Francophone and Anglophone countries in the region.

4. Purdue University for many years has provided opaque-2 breeding materials to other researchers, after the superior protein quality of maize with this mutant gene was identified in 1963. It was not adapted to tropical conditions, and the grain type was not generally acceptable to people who eat maize as a direct human food staple. Research continues on protein quality at Purdue under an A.I.D. contract. CIMMYT, under a special project agreement with the UNDP, recently has succeeded in incorporating the opaque-2 gene into improved maize populations with satisfactory grain type. The first 100 kilo crop of high protein quality maize was multiplied in plantings by CIMMYT network collaborators in 15 Asian, African and Latin American countries in 1972 and has since been put into demonstration trials on farmers' fields in those countries. The improved seed for local multiplication or further adaptive breeding is available to any country.

5. The high yielding varieties and hybrids developed in Kenya through the A.I.D./USDA/EAAFRO project's cooperation with the Kenya national program are available to farmers in other countries by purchase of seed from the very effective and successful Kenya Seed Company.

Training

Training is an essential and basic means for achievement of the long-term objective of improving the yield of maize on farms throughout the developing world. It alone can provide the countries of Asia, Africa, and Latin America with their own capability to continue the research and adaptation work. In the short run, it extends the collaborative fraternity of action-oriented researchers, breeders, and supporting technicians and helps assure the reliability of breeding efforts and trial results in cooperating stations around the world.

1. CIMMYT provided in-service training for periods of 6-9 months for 93 trainees from 29 countries in the period 1966-72. Senior scientists from developing countries who already have advanced degrees or hold directing positions in their countries' maize breeding or production organizations are invited to spend from a month to a year at CIMMYT as visiting scientists. M.Sc. or Ph.D. candidates at American or foreign universities are provided the opportunity to do their degree research on maize problems at CIMMYT, which some universities now recognize for supervision of their work. Kansas State University and Cornell have formalized such joint graduate studies programs with CIMMYT. Postdoctoral fellows, eight currently in the maize program, serve for up to two years on the scientific staff of CIMMYT and frequently become members of outreach teams on national projects. CIMMYT has limited funds in its own budget to finance these various types of training, but most trainees are funded by their own governments or by an assistance donor, particularly by A.I.D.

2. The other international centers are developing comparable training programs and facilities. A very significant contribution of the network thus will be the establishment on each continent of stable institutions with high level, long-tenure scientific staffs recognized for research purposes by graduate educational

institutions in the developed countries and conducting programs which can provide degree research opportunities on operationally significant problems for candidates from either developed or developing countries.

3. Each of the international centers is located near an important agricultural university of its host country and makes special arrangements for extensive cooperation with these institutions to provide practical training for their students. In-service trainees at the centers also have access to academic courses at the universities.

4. Training at the international centers offers a uniquely effective means of developing the national staffs of maize research and production organizations in the developing countries, both to support current programs involving foreign experts and to replace them when assistance is no longer needed. Thus, EAAFRO looks forward to sending future staff members to IITA under its project with A.I.D. The new A.I.D. project in Tanzania anticipates training for Tanzanian nationals at CIMMYT and IITA.

5. CIMMYT has cooperative arrangements with Cornell University for nursery plantings on the university farm, to adapt new varieties to the different seasonal and day-length characteristics of New York state. CIMMYT also sponsors some of its in-service trainees for M.Sc. work at Cornell, and these trainees do the planting, management, and harvesting of the CIMMYT nurseries, thus acquiring familiarity with practical operations and with rigorous scientific methods.

Information Exchange and Dissemination

1. Conferences and workshops are held frequently to permit researchers to report on their work, to exchange information on methodology, to become aware of progress in related efforts, and to become acquainted with their colleagues in other organizations and other parts of the world. Some are global and others are regional. The Eighth Inter-Asian Corn Improvement Workshop was held in October 1972. The Fourth Eastern African Cereals Research Conference met in 1972 in Ethiopia. CIMMYT held a maize workshop in September 1971 and hosted last December a worldwide maize protein quality symposium. The Ford Foundation in 1970-72 financed and co-sponsored with IITA and the French Institute of Tropical Agricultural Research a series of 15 international seminars, some of which dealt with maize.

2. The international centers publish annual reports, periodical newsletters, conference and workshop proceedings, and special monographs. Publications are distributed to all network collaborators. IITA initiated a bi-monthly newsletter in January 1973, sending out 1,000 copies and asking interested individuals and organizations to indicate if they wished to be added to the mailing list. The newsletter reported recent research program developments and cited new publications available. CIMMYT has made tentative plans to publish a specialized newsletter for the maize network.

3. IITA is the West African distribution and contact center for AGLINET, the worldwide Agricultural Library Network. Maize research centers and their personnel in Kenya, Tanzania, and Uganda benefit from the East African Literature Service (EALS), an activity of EAAFRO, with financial support by the Rockefeller Foundation. The EALS is an apparently successful response to the problem of library support for agricultural research in countries where neither research centers or individual scientists can afford their own subscriptions to needed scientific journals. The Service sends to research personnel and institutions xerox copies of contents pages of journals previously identified as of interest to recipients. Scientists then can request xerox copies of articles which seem important to their work. Volume of use in 1971 averaged over 19,000 copies per month.

Professional Collaboration

1. Purdue University's protein quality research on high lysine maize has been operated in close cooperation with CIMMYT. Laboratory analysis is a crucial tool in this research, since protein level and amino acid type must be measured on large numbers of maize samples to guide plant selection. The Purdue biochemist, E.T. Mertz, and the chemist in charge of CIMMYT's lab, Evangelina Villegas, together worked out new analytical methods and standards and jointly authored a publication describing the recommended new procedure for use in developing countries.[15] The most crucial analyses made in each of their laboratories are checked in the other.

2. The four-man team required for the Tanzanian research program will be composed of three specialists form IITA, which is the basic contractor for the project, plus Dr. Michael Colegrove from CIMMYT, who will be financed separately by the Ford Foundation and will act as Field Coordinator for the activity. This unusual arrangment is not expected to create problems, because of the integration of policy and methodology among network institutions.

3. The international centers have established working relationships for cooperative research with universities and scientific centers in the developed countries. These arrangements make use of already established facilities and serve to involve highly qualified research personnel in the problems of the developing countries. The universities thus can undertake the more fundamental and radical long-term tasks, such as attempting wide crosses to develop new crops, while the international centers pursue their more applied research. IITA has such relationships with Reading, Durham, and Wye Universities in the U.K. CIMMYT is cooperating with Prof. Bates at Kansas State University, who is examining wide cross possibilities. He consults frequently with CIMMYT's scientists and uses the facilities in Mexico to grow a second generation each year.

4. L.L. Darrah, the Statistical Geneticist working on breeding methodology in the A.I.D./USDA/EAAFRO project at the Kitale station of Kenya's National Agricultural organization, and Festus Ogada, the Kenyan Maize Breeder, live in adjoining houses and cooperate extensively in planning and conducting the companion EAAFRO and Kenyan research programs in maize.

5. William Judy, the USDA/EAAFRO Field Trials Officer in Tanzania, travels widely to agricultural areas and research centers in the country to arrange trials and demonstrations for all of the crops of interest to EAAFRO. He thus comes in contact with scientists and agricultural specialists from many countries, under projects of the multiple donors active in the country. He finds many opportunities to tie together activities which are potentially mutually reinforcing but for which there are no other coordinating mechanisms. Thus, when he found that an American professor at the national university, Dr. Phillip Porter, was planning basic research on photo-synthesis, he influenced him to choose maize as the plant for his studies, which thus will be coordinated with maize work under both the EAAFRO and A.I.D./IITA/Tanzania programs.

V. LIMITATIONS AND OPPORTUNITIES

The foregoing makes it apparent that the maize research network functions remarkably well in synchronizing diverse activities to avoid duplication and maximize mutual reinforcement. The system understandably is not perfect, however. It perhaps would be a mistake to seek total and absolute integration of all efforts for improvement of this or any other crop, since research and innovation cannot be mechanically programmed, and a variety of directions need to be under exploration for optimum progress. There seems to be little danger of such dangerously rigid uniformity, and to some extent opportunities for further constructive coordination do seem to exist.

As previously suggested, the requirements of the maize network can hardly be expected to overcome strong nationalistic feelings and the pressures and tensions that result from real international differences and rivalries. Thus, the recognized progressive weakening of the East African Community as a result of differences among Tanzania, Uganda, and Kenya has limited the effective functioning of EAAFRO and the ability of Tanzania and Uganda to match Kenya's achievements in exploiting the results of the regional maize research. A.I.D. has withdrawn the USDA team members who were working in Uganda under the project, as a result of the difficult situation in that country for foreign advisors. Tanzania has imported maize seed from the Kenya Seed Company for its upland areas but the necessity to do so has become a matter of substantial sensitivity within the Government and some limitations have been placed on full utilization of improved varieties from this source.

It seems to be more difficult to achieve real coordination and cooperation in research and field testing programs run by organizations which <u>represent governments</u> than in the non-governmental programs of CIMMYT, IITA, and the other CG-sponsored international centers. In both East Africa and West Africa, there has been a tendency to identify the supposedly joint, intergovernmental activity with the country in which it physically is located, so that utilization of the results is influenced in West Africa by attitudes to and relationships with Nigeria and in East Africa by relationships of the other two countries with Kenya. The Agricultural Ministry of Senegal has been reported as "trusting its own research work more than that" of the OAU/STRC activity assisted by the A.I.D./USDA team in Nigeria. (16)

Another apparent limitation of the network is that the fullest degree of cooperation seems to be found within what one might call a predominantly Anglo-Saxon or English-speaking context. The significant donors within the Consultative Group are governmental and non-governmental organizations from the U.S., Canada, and the U.K.; the United Nations and the World Bank; plus Sweden, Germany, and the Netherlands. The working language of the CG and of the international centers is English, which makes it difficult for some developed countries to identify with the network. France is not a contributor, although it does participate in the CG, and its Research Institute for Tropical Agriculture (IRAT),which is active throughout Francophone Africa, does not have as close links with the international system as do the research organizations in Anglophone countries of Africa or countries in Latin America and Asia generally.

Similarly, Belgium, which has made some financial contribution to the CG system, operates a large research program in Zaire through its foreign assistance structure. But the Belgian experts in the National Agricultural Research Institute have resisted close contact and cooperation with the CIMMYT-assisted National Maize Program, apparently tending to see it as an unwelcome foreign intrusion in an area that previously had been reserved for

Belgium. Fortunately, this situation seems to be improving.

Another Belgian assistance project in maize was being negotiated with the Government of Zaire at the same time the CIMMYT project was being planned. The Belgian representative mentioned his country's project at the Consultative Group meeting in May 1971, but little or no effort was made to relate the two activities. The Belgians launched a 10,000 acre mechanized maize production operation in southern Zaire, directed specifically at supplying the 70,000 tons now imported for milling in Shaba province. Some foreign observers were dubious about the venture's economic and technical feasibility, and the first year's very low yield has seemed to justify their skepticism. The Belgians have seen some of the National Maize Program demonstrations and learned of the yield results on farmers' fields, and they recently have shown more interest in collaborative approaches, offering acreage for research plantings on their farm in return for early access to new varieties and related technical guidance. IITA is making a substantial effort to make its work and publications bi-lingual, to facilitate cooperation with French-speaking countries.

While there have been some instances, as described, of cooperation between researchers in the developed countries and the international network, this probably represents the most important opportunity for extending and reinforcing the network. Much research is carried on in this country by the USDA, the land grant universities, and state agricultural services. U.S. domestic corn breeders work with a much narrower genetic base than do those in the international network who are concentrating on the broad-spectrum maize problems of developing countries on three continents. The latter tend to believe that the use of broader lines and of some features of their breeding systems could be beneficial for the U.S. domestically as well as reinforcing the international work. University researchers often pursue theoretical and academic basic research. More of them might be influenced to follow lines of investigation that are relevant to practical problems of increased food production in the developing world.

While these missed opportunities to extend and strengthen the international network deserve further attention, their relatively limited nature indicates the high degree of interrelationship that has been achieved.

VI CONCLUSIONS

This study suggests:

---that network coordination of organizationally independent agricultural research units is feasible and produces desirable effects;

---that the donors collaborating in the Consultative Group have made a noteworthy advance in practical international cooperation;

---that opportunities might well be examined for extension of this precedent to other areas of research and technical assistance;

---that most of the apparent avenues for operational interrelationship have been pursued with substantial effectiveness in the maize network, if the segment examined for this study is indicative;

---that the organizational and technological means are available to assist developing countries to accomplish major increases in maize production, with improved food value;

---that much of the earlier international cooperation in maize research and much of the strength of the current structure has resulted from the collaborative impulse of researchers functioning through the informal international scientific fraternity;

---that financial sponsors and administrators should recognize the contribution of this "old boy network" and facilitate its extension and operation;

---that A.I.D. in particular has achieved a high degree of coordination among activities that it finances or can influence; and

---that continuing efforts should be made by those involved to further refine and extend the agricultural research and technical assistance networks, building on the comprehensive system already functioning, with A.I.D. having a major opportunity and responsibility because of its widespread presence overseas and the potential impact of its financing, its facilities, and its encouragement.

FOOTNOTES

1. "Agricultural Research Needs of Tanzania", A.I.D./Washington, April 1971, page 20.

2. "Guidelines on Strengthening the Innovative and Research Thrust of AID Programs", A.I.D., Office of the Administrator, Sept. 14, 1972, page 1.

3. Technical Assistance Guidance Series, #1, "Research Networks", A.I.D./TAB, November 1972.

4. "What Is CIMMYT?", International Maize and Wheat Improvement Center, Mexico City, February 1973, page 6/1.

5. Details of the network chart are from "International Agricultural Research Networks: The Maize Network", A.I.D./TAB/AGR, March 14, 1973.

6. S.A. Eberhart, M.N. Harrison, and F. Ogada, "A Comprehensive Breeding System", Der Zuchter, vol. 37, no. 4, 1967, pp. 169-174.

7. "Report of Board of Trustees Meeting", International Institute for Tropical Agriculture, Ibadan, Nigeria, May 1971, page 5.

8. Sprague, H.B. and others, "Agricultural Research Needs of Tanzania," A.I.D. Washington, April 1971, page 140.

9. Project Implementation Order/Technical Services, #621-107-3-30007, "Agricultural Research," A.I.D./Tanzania, Dec. 13, 1972, page 10.

10. Ibid, page 13.

11. A.I.D. Africa Bureau memorandum dated Jan. 9, 1973, subject "Tanzania, Agriculture Research Project, PIO/T 621-107-3-30007, Selection of... Contractor", page 3.

12. A.I.D. Project Approval, East African Community Food Crop Research, June 22, 1972, page 2.

13. "1970-71 Report on Maize and Wheat Improvement", International Center for Maize and Wheat Improvement, Mexico City, March 1, 1972, page 73.

14. "What is CIMMYT?", op. cit., page 6/2.

15. Villegras, E. and Mertz, E.T., "Chemical Screening Methods for Maize Protein Quality", Research Bulletin No. 20, CIMMYT, Mexico City, May 1971.

16. Organization for African Unity, Scientific and Technical Research Committee Conference Report, Joint Project #26, October 17-19, 1972, Lagos, Nigeria, page 4.

PERSONNEL CONTACTED

A.I.D. Washington

Technical Assistance Bureau

Omer J. Kelley
Guy B. Baird
Samuel C. Litzenberger
Samuel H. Butterfield
Erven J. Long

Africa Bureau

John L. Cooper
Stanley L. Peek
Charles A. Sanders

International Maize and Wheat Improvement Center (CIMMYT)

Haldore Hanson, Director General
Robert D. Osler, Deputy Director, Resident Programs
Keith W. Finlay, Deputy Director, Outreach & Special Programs
Ernest W. Sprague, Director, Maize Program
E.C. Johnson, Maize Breeder
Peter Goldsworthy, Maize Agronomist
Carlos De Leon, Maize Pathologist
Michael Colegrove, Maize Agronomist
Alejandro Violic, Maize Training Agronomist
Don Winkelman, Agricultural Economist

Participants in CIMMYT "Presentation Week"

H.G. Dion, Special Advisor in Agriculture, Canadian International Development Agency and Trustee of IITA
Andrew Urquhart, Consultative Group Secretariat, IBRD
Peter Oram, TAC Secretariat, FAO
Guy Camus, France, CIMMYT Trustee and member of original Board of Trustees, IITA
Leonel Robles, Mexico,CIMMYT Trustee
Manuel Elgueta, Chile, Director of Turrialba Center, Costa Rica, Member of TAC.

International Institute for Tropical Agriculture (IITA)

Herbert R. Albrecht, Director
John L. Nickel, Associate Director
Michael N. Harrison, Program Leader, Cereal Improvement
Wade H. Reeves, Training Director

Nigeria

Russell W. Olson, Food and Agriculture Officer, A.I.D. Mission
James H. Clifton, Seed Multiplication Agronomist and Team Leader, USDA Team, West Africa Major Cereals Improvement Project, Samaru, Nigeria
K.L. Stockinger, Plant Pathologist, USDA Team, Samaru, Nigeria
D. Barry, Entomologist, USDA Team, Samaru, Nigeria

Kenya

Harold Jones, Food and Agriculture Officer, A.I.D. Mission
J.F. Wangati, Deputy Director, East African Forestry and Agriculture Research Organization, Maguga, Kenya
L.L. Darrah, Research Geneticist, USDA Team, East Africa Food Crop Research Project, Kitale, Kenya
Festus Ogada, Senior Maize Breeder, Kenya Agriculture Experiment Station, Kitale
W.H. Verburgt, Managing Director, Kenya Seed Company, Ltd., Kitale, Kenya

Tanzania

Oleen Hess, Food and Agriculture Officer, A.I.D. Mission
H.C. Wiggin, Project Manager for Agricultural Research and Seed Projects, Office of Food and Agriculture, A.I.D. Mission
Jack Cornelius, Project Manager, Office of Food and Agriculture, A.I.D. Mission
William Judy, Food Trials Officer for Tanzania, USDA Team, East Africa Food Crop Research Project, Dar es Salaam, Tanzania
George W. Ramsay, Project Manager, East Africa Food Crop Research Project, A.I.D. Regional Development Office, Arusha
Franklin N. Fanberg, Project Director, Experience, Inc., Seed Multiplication Project, Dar es Salaam

Zaire

J. Gerard Neptune, Food and Agriculture Officer, A.I.D. Mission

BIBLIOGRAPHY

The Network Concept

1. Kelley, Omer J., Long, Erven J., McDermott, James K., "Development of an International Network of Agricultural Sciences; the Case for the Network", A.I.D./TAB, June 15, 1970.

2. Long, Erven J., "Research in A.I.D.: A Research Philosophy and Its Implementation", A.I.D./TAB, 1972.

3. "Guidelines on Strengthening the Innovative and Research Thrust of AID Programs", AID, Office of the Administrator, Sept. 14, 1972.

4. TA Guidance Series #1, "Research Networks", AID/TAB, November 1972.

5. "International Agricultural Research Networks: The Maize Network", AID/TAB/AGR, March 14, 1973.

The International Centers

6. "A Note on the Consultative Group on International Agricultural Research", International Bank for Reconstruction and Development, Washington, D.C., July 1972.

7. "Selected Notes: Meeting of Directors, International Agricultural Research Centers," February 11-16, 1973.

8. "Informal Summary of Proceedings of International Centers Week, July 31 - Aug. 4, 1972", Consultative Group on International Agricultural Research, Washington, D.C.

The International Maize and Wheat Improvement Center (CIMMYT)

9. "What Is CIMMYT", CIMMYT, February 1973.

10. "1970-71 Report on Maize and Wheat Improvement", CIMMYT, March 1, 1972.

11. "The Puebla Project 1967-69: Progress Report of a Program to Rapidly Increase Corn Yields on Small Holdings", CIMMYT, 1970.

12. "CIMMYT Report", Vol. 1, Nos. 1-6, CIMMYT, November-December 1972.

13. Wortman, Sterling, "A Visitor's Notes on the Wheat and Maize Programs", CIMMYT, March 1973.

14. "Maize Training Program", CIMMYT, March 1973.

15. "Program Review 1972-73 by CIMMYT Senior Professional Staff", CIMMYT, March 26, 1973.

16. Johnson, E., "Maize Breeding Commentary for Poza Rica Field Visit, April 5-6, 1973", CIMMYT, April 1973.

Protein Quality

17. "Annual Report on the Inheritance and Improvement of Protein Quality and Content in Maize, Contract csd/2809, July 1, 1970-June 30 1971" and "July 1, 1971-June 30, 1972", Purdue University.

18. Bauman, L.F. and Mertz, E.T., "The Status of Development of Maize with Improved Protein Quality", Research Progress Report 405, April 1972, Purdue University Agricultural Experiment Station, Lafayette, Ind.

19. Sprague, G.F. and H.L. Wilcke, "Protein Quality in Maize", AID/TAB, 1973.

The International Institute for Tropical Agriculture (IITA)

20. "Research Toward More Food from Tropical Agriculture", IITA, November 1972.

21. "1973 Program and Budget Presentations", IITA, June 1972.

22. "IITA Letter", No. 1, January 1973, IITA.

23. "Maize Briefing by M.N. Harrison, IITA In-House Review, Feb. 1973", International Institute for Tropical Agriculture, Ibadan, Nigeria.

West Africa

24. Project Proposal (PROP), "Major Cereals Improvement--West Africa", A.I.D./AFR/CWR, approved May 11, 1970.

25. Project Appraisal Report, "Major Cereals Improvement--West Africa", A.I.D./AFR/CWR, Oct. 31, 1972.

26. Organization for African Unity, Scientific and Technical Research Committee Conference Report, Joint Project #26, October 17-19, Lagos, Nigeria.

27. "Criteria for Evaluation Team, Major Cereals Project", A.I.D. Area Development Office, Niamey, Niger, Feb. 28, 1973.

28. Tatum, Lloyd A.,"Report of Maize Breeding Investigations," Institute for Agricultural Research, Ahmadu Bello University, 1972", OAR/STRC Joint Project 26.

29. Tatum, Loyd A., "1972 Annual Report, Major Cereals in West Africa, OAU/STRC J.P. 26", USDA PASA Team, Samaru, Nigeria.

30. Clifton, James H., "1972 Progress Report on Maize and Sorghum Seed Production Investigation", OAU/STRC, USDA PASA Team, Samaru, Nigeria.

31. Project Proposal (PROP), "Food Crop Production", A.I.D. Lagos, Nigeria, Mar. 9, 1973.

East Africa

32. Eberhart, S.A., Harrison, M.N., and Ogada, F., "A Comprehensive Breeding System", Der Zuchter, vol. 37, no. 4, 1967, pp. 169-74.

33. Harrison, M.N. and others, "How Hybrid Seed Is Revolutionizing Maize Growing in Kenya", International Development Review, Sept. 1968, pp. 9-13.

34. Harrison, M.N., "A Review of the Third Eastern African Cereals Research Conference", CIMMYT Regional Coordination Office, Kitale, Kenya, 1969.

35. Leakey, C.L.A., editor, "Crop Improvement in East Africa", Commonwealth Agricultural Bureau, U.K., 1970, especially Ch. 1 on maize, pp. 21-59.

36. Project Proposal (PROP), "East African Community Food Crop Research" A.I.D./AFR, June 22, 1972.

37. Darrah, L.L., Eberhart, S.A., and Penny, L.H., "A Maize Breeding Methods Study in Kenya", Crop Science, Vol. 12, Sept-Oct. 1972, pp. 605-608.

38. Darrah, L.L., "Annual Report of the Maize Genetics Division, East African Agriculture and Forestry Research Organization, East African Community", Kitale, Kenya, Feb. 1972.

39. "East African Major Cereals Project Evaluation", A.I.D./AFR/RDOEA, Sept. 15, 1972.

40. Munn, Robert F., "The East African Literature Service", UNESCO Library Bulletin, Jan.-Feb. 1973, pp. 29-32.

41. Verburgt, W.H., "Kenya Seed Company Limited", K.S.C. Ltd., Kitale, Kenya, March 1973.

42. "Agricultural Research in Uganda; A Survey, Evaluation, and Recommendations", Ohio State University, Oct. 1971 (Under an A.I.D. contract)

43. "A Time Phased Seed Multiplication, Distribution and Implementation Plan for the Government of Tanzania", Experience Incorporated, Minneapolis, Minn., Nov. 1969. (Under an A.I.D. contract.)

44. Project Proposal (PROP), "Seed Multiplication and Distribution", A.I.D./ Tanzania, Nov. 6, 1969.

45. Sprague, H.B. and others, "Agricultural Research Needs of Tanzania", A.I.D., Washington, D.C., April 1971.

46. Project Proposal(PROP), "Agricultural Research, Tanzania", A.I.D./AFR, May 1971.

47. Project Implementation Order, Technical Services", #621-107-3-30007, "Agricultural Research", A.I.D./Tanzania, Dec. 13, 1972.

Zaire

48. Harrison, M.N. and Ballaux, J.C., "Diary Notes, Zaire Trip, 26 February - 6 March 1973", International Institute of Tropical Agriculture, Ibadan, Nigeria, 1973.

49. "Memorandum of Understanding between the Government of the Republic of the Congo and CIMMYT with respect to the Development of a National Maize Research and Production Program", Sept. 1971.