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EAST AFRICAN MAJOR CEREALS

PROJECT EVALUATION

TEAM REPORT

Prepared at the Request

of

RDOEA and AID/W

Agency for International Development  
Bureau for Africa  
Regional Development Office for East Africa  
Arusha, Tanzania

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The basic objective of the original Major Cereals Project was to develop breeding methodology adaptable to maize, sorghum and millet, and to strive for improvement of these crops. Two years ago an institution-building element was added. More emphasis in this direction is highly desirable. The evaluation details measurements of success in the following: maize genetics and improvement; sorghum, finger millet and bulrush millet improvement; and cereals quality improvement. Major recommendations are: (1) maize breeding should be continued with modification in the program; (2) sorghum breeding should be continued as presently organized and with increased emphasis on improved consumer acceptance in order to move sorghum from a solely subsistence ranking into commercial channels; and (3) research work with the millets should be transferred to the International Crops Research Institute for the Semi-arid Tropics in India. The evaluators also made specific recommendations regarding: (1) research reporting; (2) improving utilization of research results; (3) counterparts and training; (4) emphasis on industrial vs. subsistence crops; (5) institutionalizing cereals research via the East African Agricultural and Forestry Organization; and (6) personnel, administrative and logistical matters.

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\*For the schedule of participation by members of the reviewing team refer to Appendix E.

## ACKNOWLEDGEMENTS

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TABLE OF CONTENTS

	<u>Page</u>
I. BACKGROUND AND INTRODUCTION	1
II. PROJECT ACCOMPLISHMENTS	
A. Maize Genetics and Improvement	5
B. Sorghum Improvement	9
C. Finger Millet	10
D. Bulrush Millet	11
E. Cereal Quality Improvement	12
F. Interrelationships and Linkages between the Major Cereals Project, National and Other Donors	13
III. MAJOR ISSUES, CONSTRAINTS AND RECOMMENDATIONS	
A. Improved Crop Varieties and Supporting Cultural Practice Contributions Recommendations	15 16
B. Research Reporting Recommendations	17 18
C. Utilization of Research Results by National Research Programs Recommendations	18 19
D. Counterparts and Training Recommendations	19 20
E. Industrial vs. Subsistence Crops Recommendations	21 22
F. Institutionalizing Cereals Research in EAAFRO Recommendations	22 23
G. Articulation of National Research Needs to EAAFRO Recommendations	24 24
H. Duties of ADI-ARS Technicians and Performance in Meeting Project Objectives Recommendations	24 25
I. Technical, Commodities and Service Backstopping of Staff Recommendations	25 26
IV. SUMMARY AND CONCLUSIONS	27

APPENDIX

	<u>Page</u>
Itinerary Followed	A-1
Cereals Research and Experimental Stations In East Africa: EAC/EAAFR0 Linkages	B-1
Educational Institutions, Support Training and Agricultural Research Staff	C-1
East African Major Cereals Cooperating Agencies	D-1
Officials Contacted	E-1
Glossary of Acronyms	F-1

## EAST AFRICA

### MAJOR CEREALS PROJECT EVALUATION TEAM REPORT

#### I. BACKGROUND AND INTRODUCTION

The Major Cereals Project terminated on 30 June 1972. The purpose of the present evaluation is to determine what progress has been made to date and in the light of this to evaluate new goals and purposes of the Food Crop Research project approved by AID/W\*, RDOEA and the EAC. In 1964, an agreement with the Scientific and Technical Research Committee for African Unity initiated an Africa-wide research program to improve the varieties of major cereals. Research teams supplied under a PASA with USDA to work on maize, millet and sorghum were posted in Western and Eastern Africa. In time, the Eastern African component was attached to EAAFRO.

The sorghum and millet research has been and is currently conducted at facilities made available through EAAFRO at the Uganda Agricultural Research Station at Serere, with the sorghum breeding component largely supported, until recently, by a Rockefeller Grant. The AID inputs in sorghum have consisted of a sorghum breeder, an entomologist and a soil scientist (agronomist). In addition AID has provided one man to work in millet improvement. Until recently, AID has reimbursed to EAAFRO all miscellaneous local currency costs for labor, materials, supplies and transport for support of this research conducted by the AID-financed technicians. AID has also provided dollar costs for U.S. commodities, certain housing construction, furnishings, transportation and other items in support of the project technicians.

The maize research program in Kenya has consisted of one maize geneticist posted at the Kenya Agricultural Research Station in Kitale, to conduct research on maize breeding methods and to advise Kenyan maize improvement personnel. Costs of labor, materials and supplies at the Kitale location have, until recently, been handled in a manner similar to that at Serere, i.e., through reimbursement by AID through EAAFRO. All local currency costs are now being provided by EAAFRO.

In 1968, a food technologist, stationed in Nairobi at the East African Industrial Research Organization (EAIRO) was added to the PASA Team to conduct seed quality testing of varieties being developed by the project. EAIRO, which has made its facilities available, is reimbursed by EAAFRO for local labor, materials and supplies used in support of the activity. AID provides housing costs for the PASA technician.

\*Refer to Appendix F for Glossary of Acronyms.

During 1970, two Field Trial Officers were added to the PASA Team to conduct cereal trials and demonstrations with Ministry of Agricultural personnel in Tanzania and Uganda. These Field Trial Officers and their local supporting staff serve as liaison to the Tanzania and Uganda Governments to facilitate testing, demonstrating, and use of materials developed by the project. Miscellaneous local costs are provided by EAAFR0.

Since its inception, the EA component of the project has been a part of the International Research Program of AID with the original objective of satisfying an expressed need for developing better varieties and supporting agronomic practices which would then be made available through the bilateral AID programs in East Africa. Since that time, a second objective has evolved, i.e., institutionalizing the project with the EAC/EAAFR0.

In 1969, the funding of the project was transferred to the Africa Bureau. In the 1970 Project Agreement two new elements were included. These were geared toward institutionalization of the project, namely:

1. Participant training to provide African capacity to replace AID technicians.
2. EAC/EAAFR0 agreement to the assumption of sharing local costs by paying for operation and maintenance of AID-supplied vehicles and rent of the house occupied by the maize geneticist at Kitale.

In 1971, EAAFR0 agreed to supply local costs without further AID reimbursements.

Upon termination of the current Major Cereals Project on 30 June 1972, the EA office of the African Bureau in AID/W undertook to assemble a team to review accomplishments of the project in place and to evaluate these in terms of the new Food Crops Research Project, which will include components of the Major Cereals activities that are to be continued. New elements of the food crops research project which would supplement the national research efforts are briefly as follows:

1. Mount an effort to develop maize suitable to low altitude conditions in East Africa,
2. Mount an effort in legume research,
3. Initiate a rice research program, and
4. Introduce a regional element into the wheat research program now well developed in Kenya.

The members of the Evaluation Team agreed upon by AID/W, RDOEA, EAAAFRO and the EA Governments are as follows:

- Mr. B. A. Omolo, Kitale Research Station, Ministry of Agriculture, Kenya
- Dr. John M. Liwenga, Senior Research Officer, Ministry of Agriculture, Tanzania
- Mr. A. L. Kyeyune-Sendagi, Acting Chief Research Officer, Ministry of Agriculture, Uganda
- Mr. J. Miguda-Alila, Secretary EAC National Resources Research Council, Arusha, Tanzania
- Mr. James Hawes, Program Planning Officer, AID/W-TA/AGR
- Dr. Samuel C. Lützenberger, Agronomy Research Specialist, AID/W-TA/AGR (Team Leader)

The Evaluation Team, except for the Ugandan representative who was unable to assist at the initial meeting of the team at Nairobi with other AID officials - Mr. George T. Eaton, Regional Program Officer, RDOEA; Mr. Harold Jones, Food and Agriculture Officer, USAID/Nairobi and Mr. Jack Cornelius, USAID/Dar es Salaam - convened to finalize plans in conducting the review as requested by AID. At the first meeting of the team, with the officials indicated above, an agenda and itinerary were developed. Details of the itinerary followed are indicated in Appendix A.

Procedures employed in the evaluation exercise consisted of visitations and consultations with related personnel, experiment stations, laboratories, seed production and farmer organizations, Ministry of Agriculture and agricultural university personnel. The major experiment stations, supporting testing network and education institutions supporting training and agricultural research staff are included in Appendices B, C, and D. Pertinent detailed descriptions and locations for each station are indicated.

The Team's evaluation of related responses and viewpoints as well as related pertinent issues is discussed under Section III of this report (Major Issues, Constraints, Observations, and Recommendations).

The selected responsible officials contracted in the process of conducting the evaluation are listed in chronological order in Appendix E.

Accomplishments of the EA Major Cereals Project have been discussed and summarized under Section II (Project Accomplishments). These are treated under specific crop headings and their relationships in the three participating countries.

Recommendations deemed appropriate of the Evaluation Team, as included in Section III, have been developed in light of the fact that the new Food Crop Research Project has already gone into effect and that the principal aspect of the Major Cereals Project are being continued on a more permanent basis as an EAAFRO responsibility under the new project.

## II. PROJECT ACCOMPLISHMENTS

### A. Maize Genetics and Improvement

The primary objective of the maize genetics component of the Major Cereals Project was to adapt methods of maize breeding to the capabilities of developing countries and to compare relative progress actually obtained using the various methods. Additionally, it was expected that the breeding methods study would result in improved varieties of maize being released to the farmer. Continual improvement of the parent population was expected to better the derived variety-cross hybrid which was already in commercial production (H611 = K11 x Ec573, released in 1962) at the time the Major Cereals Project was initiated in 1964.

Information from the maize genetics research was to be made available through published reports and papers, personal visits, and the cereals research conferences as they later became available. Visits to the project by other researchers were to be encouraged.

Evaluation of Eastern African materials, under a wide range of ecological conditions, was desired to determine the range of adaptability of the methods and materials compared. Trials were set up on a regional basis, with entries solicited from participating countries.

Details of the comprehensive breeding system proposed by Eberhart, Harrison, and Ogada were published in 1967. The paper covered the entire process: evaluation, compositing, population improvement, and commercial selection. Detailed procedures to be followed for the various methods are outlined in the 1964 Annual Report and in papers (mimeos) on recurrent selection by Eberhart, one of which was presented during the 1965 Cereals Workshop at Kitale.

The maize breeding methods study that was initiated in 1964 compared mass, ear-to-row, half-sib, full-sib,  $S_1$ , and reciprocal recurrent selection under East African conditions. Variations were incorporated in the mass, ear-to-row, and half-sib selection schemes to test the effects of population, selection intensity, random mating, male selection, and number of entries.

Trials are being conducted in 1972, 1973, and 1974 to fully evaluate progress to date in all methods. Final evaluation will be made after ten years of selection have been completed. In the meantime, the more promising methods are being utilized by national programs.

\* Eberhart, S. A., M.N. Harrison, and F. Ogada. 1967. A comprehensive breeding system. *Der Zuchter* 37:169-174.

Personal visits have been made to the following Eastern African countries: Zaire (1968), Ethiopia (1967, 1969), Malawi (1970), Tanzania (1968, 1969, 1971, 1972), and Uganda (1971, 1972). Further contact with individual research workers has been through the Eastern African Cereals Research Conferences. Papers presented have kept all collaborators up-to-date on recent progress and developments. Four such conferences have been held at the following locations: Kitale, Kenya, in 1965; Njoro and Kitale, Kenya, and Serere, Uganda, in 1967; Zaire and Malawi in 1969; and Ethiopia in 1971.

Although training was not specifically an objective, five agricultural officers of the Kenya Government Ministry of Agriculture have served as assistants to the Maize Geneticist. During these periods, each has had the opportunity to learn about the procedures of each method in the breeding study. Unfortunately, these assistants were seconded from the Kenya Maize Research Section and none has remained as a permanent part of the project.

Four regional maize variety trials have been conducted since 1964. Participating countries included: Burundi, Cameroon, Ethiopia, Kenya, Madagascar, Malawi, Nigeria, Tanzania, Uganda, Zaire, and Zambia. Interest has grown in this type of trial as shown by the number of sites requested: 21, 41, 38, and 87, respectively in the four trials.

Utilization of the concept of a comprehensive breeding system has been widespread in Eastern Africa. Stations using these concepts, and their materials and methods are given below:

<u>Station</u>	<u>Material and Method*</u>
Katumani Ag. Res. St., Machakos, Kenya	Kat. SynVII and VIII (S)
Embu Ag. Res. St., Embu, Kenya	Embu I and II (S) Embu III and IV (M)
NARS, Kitale, Kenya	KCB and KCE (S and F) KCF (M)
EAAAFRO, Kitale, Kenya	K11 and Eo573 (R)

\*Methods are shown in parenthesis and are keyed as follows:

- M = mass selection
- H = half-sib selection
- F = full-sib selection
- S = S<sub>1</sub> testing
- R = reciprocal recurrent selection
- C = composite formation

<u>Station</u>	<u>Material and Method</u>
Ukiriguru Res. and Tr. Inst., Mwanza, Tanzania	UCA, UCB-W and UCB-FW (F)
Ilonga Res. and Tr. Inst., Ilonga Tanzania	IC and MAS (F) ICA and ICB (M)
Chitedze Ag. Res. St., Lilongwe, Malawi	CCA, CCB, Makanga Comp. A (C)
Kawanda Res. St., Kampala, Uganda	KwCA (S and F)
Makerere Univ., Kampala, Uganda	KwCA syn.2 (S and M)
Mt. Makulu Res. St., Chilanga, Zambia	ZCA (S) ZCZ (H)

Similar composite formation and improvement as developed by the East African maize genetics activity is being adopted in West Africa under the guidance of M. N. Harrison, presently Maize Breeder, IITA, Ibadan, Nigeria, and formerly maize breeder at Kitale, in cooperation with the major cereals project.

Of the populations listed, the following are presently used by farmers directly or in hybrids: Kat. Syn VII and VIII, Embu 11 and 12, Ec573, Kitale 11, UCA, IC, and KwCA. Data on the actual utilization of these populations is not available, except for Kenya. In 1970, 74.5 percent of the hybrid seed sold in Kenya was from material which was undergoing some form of population improvement. The remaining 25.5 percent was of traditional hybrids which have a fixed percentage of inbred lines and are not subject to recurrent improvement.

The 1971 hybrid seed production information from Kenya, for small scale farms only, showed that of the 148,747 hectares planted to hybrids, 53.7 percent of the seed sold utilized Ec573(R12)02 from the Maize Genetics Project as the male parent of the hybrid. A slightly higher percentage is expected when the entire hectareage (212,284 hectares) is taken into consideration, as H613C accounted for 70 percent of large scale farm sales in 1971. The current cycles of K11 and Ec573 from the reciprocal recurrent selection (R) study are also being utilized for variety-cross hybrid production by the Tanganyika Wattle Company in southern Tanzania.

Estimates for Kenya in 1972 indicate that the total hectareage of hybrid maize grown in Kenya for seed sales will be about 260,000 hectares. This increase of more than 20 percent over 1971 is largely due to the increased use of hybrid seed by small scale farmers and not by the larger growers. In Tanzania in the Arusha and Kilimanjaro areas, where Kenya hybrid seed is made available through the Tanganyika Farmers Association (TFA), farmers have planted 85 to 100 percent of their maize crop to hybrids.

The Project has provided foundation seed stocks of parents of recommended hybrids as well as composites to seed production agencies of partner states. Experimental quantities have been sent as requested to other cooperating countries as well. An AID-financed cold storage facility is providing a means to maintain viable stocks of basic germ plasm for breeding improvement in Eastern Africa.

The dramatic progress made in yield, lodging resistant and reduction in ear heights in the commercial hybrids using the improved Ecuador male parent is shown in the following table. (Darrah, Eberhart, and Penny, 1972.)

Hybrid Performance of Original Hybrids and  
Their Improved Versions at  
Nine Locations in Western Kenya in 1970

Hybrids	Yield		Lodging %	Ear Height cm
	q/ha	%		
H611 (original version)	54.8	100	67	253
H611C (improved version)	69.2	126	57	245
H613B (original version)	54.9	100	78	241
H613C (improved version)	68.2	124	72	238
H632 (traditional hybrid)	46.0	-	82	203
LSD (P = .05)	7.5	-	9	8

Four years of reciprocal recurrent selection has produced rapid improvement in one of the parental varieties (Ecuador 573), in the variety cross, and in a commercial topcross maize (Zea Mays L.) hybrid. The improved strain of Ecuador 573 is now used as the male parent of the current commercial hybrids, H611C and H613C, and they yield approximately 25 percent more than the original versions.

With the posting of field trial officers (one in Tanzania in 1970 and the other in Uganda in 1971) financed by AID, it was possible to give needed emphasis to: (1) evaluate regional research under local conditions and (2) promote the utilization of pertinent research by farmers. These officers serve as a linkage between the research effort and its utilization at the national level. Their extensive trials compared the most advanced

varieties and supporting cultural practices under different local and climatic environments. Progress has been achieved in identifying maize hybrids and populations of promise for medium and high altitude areas. Promising populations have been identified for the coastal areas. Soil fertility data have been accumulated on low-yielding, short-season composites. This work is being extended to include potentially higher yielding types. Using only a single example of what research has shown from the efforts of these trial farmers using fertilizer and improved husbandry with their own maize variety would double their yield. Using improved varieties, yields could be increased four to six fold.

### B. Sorghum Improvement

The primary objective of the sorghum activity has been and continues to be to develop improved varieties with high yield, insect resistance, shorter-statured plant type and consumer acceptance of the grain.

Sorghum improvement in East Africa was started in 1958 under Rockefeller support with one research officer, Dr. H. Doggett, who continued as the breeder of this activity when AID began providing some assistance to the project in 1964. Following his departure in December 1970 and until the position was filled about a year later by Dr. J. T. Kern, the sorghum breeding activity was maintained on a reduced basis. Other than the major input of the Rockefeller Foundation to support Dr. Doggett, AID has continued to provide financial assistance as needed for the sorghum breeder and his related costs--transportation, supplies, equipment and labor costs.

The primary objective of the sorghum activity is to develop improved varieties with high grain yield, ideal plant type and consumer acceptance. The most recent accomplishments are that seed of CKcO A and B lines have been released to the Uganda and Tanzania Seed Schemes. Two hybrids utilizing these lines as parents, HX57 (CK60A x SB65) named Hijak and HX471D (CK60A x 5DX36D) have performed well and are expected to move into commercial production as facilities and competence develops. A third hybrid, a white grained type HX467 (CK60A x 5D x 61/6/2) is also performing well and is expected to replace Hijak, like Serena a brown-seeded type. In Tanzania in 1970-71 where five locations were compared and in Kenya, the new hybrids averaged more than 20 percent more grain than Serena. In a single trial during the 1971 second rains at Serere, the yields of the hybrids were even greater, averaging about 50 percent more than Serena which yielded 17.3 quintals per hectare. Serena, a commonly grown variety, was an early development of the project. It yields about 15 percent more than traditionally grown varieties.

In an experiment comparing variety, population, planting date, fertilization, weed control, and shoot fly control at six locations in Uganda it was found that the most important single factor was variety followed in decreasing order by planting date, plant population, fertilizer and weed control. Seed treatment for shoot fly control was least effective.

Two types of shoot fly resistance have been identified--primary and recovery. In the recovery type of resistance, plants are able to recover from dead hearts which are the result of insect feeding on the primary shoots. Certain plant genotypes have been found that have the capability for rapid production of new tillers. The recurrent selection method of breeding for this type of resistance has been found to be highly effective. Lines from India having primary resistance, i.e., resistance to initial attack, have been introduced for use in a breeding program. With the stem borers which have caused losses ranging from 35 to 100 percent, no progress has been obtained in their control by breeding. Storage insects have been found to be less of a problem on the corneous-type grain sorghums than the floury types and new varietal developments have been evaluated for resistance to the more important storage insects.

In the selection of characters possibly associated with resistance to damage by birds, lines with long glumes and awns are being evaluated. Similarly brown-seeded types with high tannin are also being studied for bird damage control as well as quality for consumer acceptance.

Foundation seed stocks and increased quantities of the sorghum lines and improved varieties have been provided through EAAFRRO channels to the Uganda Seed Scheme and the Tanzanian Wattle Seed Farm. Seed of these improved types of sorghum have thus been made available to farmers in these countries where sorghum represents an important subsistence food crop and a principal base for local and commercial beer manufacture. Only limited efforts have been made in Kenya for improved sorghum seed production and distribution. Currently Kenya is interested in developing cold tolerant varieties for the highlands above 6,000 feet.

During the lifetime of the sorghum breeding activity of the project, Drs. D. Jowett and B. N. Majisu and Mr. S. Z. Mukuru have gained valuable working knowledge and skills in sorghum breeding. Mr. Mukuru is presently working on a Ph. D. at Purdue University under Rockefeller sponsorship. Upon completion of this training, he will return to the sorghum activity. Six assistants to the plant breeder and nine subordinate staff workers have achieved on-the-job training in sorghum breeding. Dr. Majisu currently heads EAAFRRO. Drs. Judy and Whigham, in their respective countries, have provided on-the-job training opportunities for a large number of national personnel in their work of organizing a system of evaluation of sorghum plant materials and cultural practices. This linkage has also served as a major means of getting research results to the Extension Service and ultimately to the farmer.

### C. Finger Millet

Major emphasis on the improvement of this self-pollinated crop has been to provide for greater grain yields and improved grain quality. During the life of the project all known varieties have been observed and tested under Ugandan conditions at Serere. By 1965, only 52 varieties had been worthy of further study; 12 of these were selected for wide-scale

testing in 1966. Presently three selections have been developed by this project and released for increase by the Uganda Seed Scheme. These are Engenyi, Serere 1, and Gulu E. While these improved varieties have yielded only slightly more (about 5 percent) than the locally-grown varieties, with timely planting, adequate soil moisture and proper fertilization, it has been demonstrated with the new varieties farmer yields can be multiplied by 5 to 6 times (2,500 to 3,000 kgs./ha.).

A pyramid gene pool breeding scheme program was started in 1968 and approximately 2,500 crosses have been made. The most advanced crosses have been increased and 186 selections have been made from this population for further evaluation.

Work in blast and lodging resistance, two major limiting problems to improved production, was started in 1968 and 83 selections have been made for further testing.

The breeding effort with finger millet represents virtually the only effort of its kind in the world. Techniques in breeding this crop have been developed to overcome the handicaps of hybridizing this specie which is difficult to work with because of its very small flower parts.

Observations of the project have shown that so far insect problems are of no consequence to the growing crop or the stored grain.

Approximately ten tons of seed of the newly released variety Engenyi is expected to be available through the Uganda Seed Scheme this year. This should plant about 3,000 acres.

#### D. Bulrush Millet

Bulrush millet, a subsistence crop grown by farmers, is considered to be a valuable insurance crop against unpredictable climatic variables in East Africa. This is a cross pollinated crop, thus the breeding technique used with maize improvement has been utilized. At the beginning of the work there were 12 bulk populations and approximately 2,000 lines from the World Collection available for use in the breeding program. The primary objectives were to classify the World Collection and develop divergent populations for the initiation of a recurrent selection breeding improvement program. Fourteen populations are being developed. Selection pressures are now being applied on the composite populations. After only the first cycle of selection, S<sub>1</sub> testing and recombination, the first composite, Serere Composite 1, was the top entry in a 49 entry trial, where it produced a grain yield of 37.3 quintals per hectare. After the second cycle of improvement, an increased grain yield of 17.6 percent was obtained when compared to the first cycle.

The male-sterile line, Tift 23A, was introduced from the USA. Using this germplasm, one adapted strain (Serere 10LA), and eight others have been developed. Preliminary tests of Serere 10LA began in 1969, at Serere Research

Station. When the same pollinator was used, the average grain yield of eight Serere LOLA hybrids was over 34.2 quintals per hectare, 19 percent higher than the average for the Tift 23A hybrids. Tests carried out at twenty locations in East Africa in 1970 showed the average performance of Serere LOLA hybrids was 7 percent better than either Tift 23A hybrids or their pollinator parents.

Dwarf millets have been developed from crosses with dwarf types from India. Bulrush millets with long bristles have been observed for possible protection from bird damage but protection by means of bristles has not been as effective as hoped.

Bulrush millet has been found to be the most drought tolerant of the cereal crops under improvement at Serere. Comparatively good grain yields have been obtained under favorable conditions of moisture and soil fertility.

Limited specific entomological work has been initiated with the bulrush millet primarily because of its comparative resistance to prevalent insects in the field. The only pests observed to cause damage are stem borer in the field and insect damage to stored grain which is quite comparable to the situation in sorghum. Of the limiting plant diseases, rust, mildew and ergot have been observed to be the most serious.

Serere Composite 1 has been released to both the Tanzanian and Ugandan Seed Schemes. Approximately 60 pounds of seed have been provided to each. The Uganda Seed Scheme will have eight acres of production near Serere during the second rainy season of 1972.

Training of counterparts in bulrush millet improvement was not one of the major objectives at the onset of this project. Thus, no effort was made to provide training in this area to date.

#### E. Cereals Quality Improvement

Since a sizeable segment of the population utilizes sorghum as a primary staple, efforts have been made by EAIRO to characterize existing varieties through physical and proximate analyses of the grain. The development of standards of plant breeders in selection of improved types and development of simple milling procedures to increase consumer acceptance and possibly the nutritional value of the cereals as human food is also an effort of EAIRO.

A large number of breeding samples of sorghum, bulrush millet and finger millet have been characterized for seed size, hardness and proximate analysis. A smaller number of samples have been analyzed for amino acid composition. Sizeable variation in protein percentage and lysine content were found. The Udy method, a simplified procedure for estimating lysine and other basic amino acids, was found not to be satisfactory for sorghum.

Studies indicate that "massa" (the dough from which tortillas are made) can readily be made from sorghum. This food use, however, is not native to Africa.

Following extensive laboratory tests, village trials were made of a CeCoCo cereal polisher. The whole kernel polished product is similar to that made in a deep wooden mortar but with much less kernel breakage and loss. Under village conditions, costs of operations ranged from 35 to 65 cents per debbe (four imperial gallons). The economics appear reasonable and the product fully acceptable. The use of the polisher provides a method for preparing a whole polished grain from the commonly grown sorghums with brown testa, which is a characteristic responsible for resistance to bird damage.

Extensive cooperative recipe development with cereals has been continued with the Home Economics Department of the University of Nairobi. A revision of the sorghum recipe booklet is in draft form.

F. Interrelationship and Linkages between the Major Cereals Project, National Programs and other Donors

There has been close cooperation between the plant breeding, entomology, agronomy and cereal efforts of the Major Cereals Project. While these have been separate research efforts, the Major Cereals Project has attempted to tie its coordinated efforts into the national programs of the three partner states. In the past, in most cases, it has been difficult to determine where the Community and national program efforts begin and end. For example, in Kenya, in the maize improvement work, the maize breeder complements the national program which he has helped develop. This has made for a well coordinated, integrated team approach. Other donors such as the UK providing agricultural specialists to work in maize research and production management are also integrated into the team efforts to satisfy needs that cannot yet be met by national personnel.

The accompanying table shows a listing of donors and their field of technical assistance being provided which were related to the Major Cereals Project in 1970-71.

Perhaps the most significant linkage in supporting national programs has come about by establishing the Field Trial Officers' positions for Uganda and Tanzania as described previously under the different crop improvement units of the project. In these two countries their national programs have not yet advanced to the stage of providing this important linkage between research and extension work. Kenya, on the other hand, has developed a strong research and production program in maize and is satisfying this need through its own Field Trial Officers and liaison staff which have been developed partly by donor supported programs and private enterprise, such as the Kenya Seed Company. This company has provided several essential supporting activities which are basic to any

Technical Assistance 1970/71

U.S.A.I.D.

Maize/sorghum/millet work

Crop and Animal

O.D.A/U.K.  
*F*

Overseas Aid Scheme (Maize)

Armyworm Research

Hydrological Research Institute

Training

ROCKEFELLER FOUNDATION

Sorghum Research

E. A. Literature Service

Technical Assistance Personnel

Animal Nutrition Grant

Training

FORD FOUNDATION

Technical Assistance Personnel

Training

CANADIAN I.D.A.

Technical Assistance Personnel (Wheat)

Equipment, etc.

Training

N.O.R.A.D.

Technical Assistance Personnel

DANISH A.I.D.

Technical Assistance Personnel

maize production program. Appendices B and C provide a listing and a description of universities, experiment stations and sub-stations where Field Trial Officers' work has been performed in good cooperative relationships with national efforts.

Some achievements have been made to tie the results of the Major Cereals Project to AID bilaterally-supported programs of the community states. In Tanzania where the greatest bilateral efforts of AID are being made, programs are being developed in the areas of maize, rice and legume research and seed multiplication and distribution. AID's bilateral assistance to Uganda and Kenya where considerable research capability already exists is currently directed to production efforts and not research. Interrelationships of these efforts to the Major Cereals Project is through EAAFRO.

To date, only brief contacts have been made with the AID-supported International Network of Agricultural Research Centers (CIMMYT, IRRI, IITA, CIAT, and ICRISAT) to support the Major Cereals. Efforts are underway, however, to get greater involvement of the centers to support research efforts in both the regional and national programs, especially in the fields of organizing evaluation testing of world-wide collections of improved plant materials, improved cultural practices and the training of personnel in agricultural technologies.

### III. MAJOR ISSUES, CONSTRAINTS AND RECOMMENDATIONS

#### A. Improved Crop Varieties, and Supporting Cultural Practice Contributions

Maize improvement has been very successful in East Africa thanks to the development of high yielding hybrids and related agronomic practices, especially for the medium elevations. In view of this marked success in increasing production, priority of the partner states in the area of cereal improvement is to be provided primarily to maize with increased emphasis on production. Thus a false impression has been created among the partner states that the need for further research for the major cereals can now be diminished, especially for sorghum. This is unfortunate as maize by itself cannot be expected to satisfy the entire cereal grain needs, especially in the drier, more severe climatological environments and basically less fertile soils which in terms of a maize production environment would be classed as marginal or sub-marginal. Accordingly, a low priority has been generally assigned by the partner states to sorghum and millet. To date, only Tanzania has expressed continued interest in sorghum and bulrush millet improvement as much of their land would be most productive with these crops. As indicated in the accompanying table, the importance of millet and sorghum cannot be denied as the total area sown to these crops is about the same as that planted to maize.

Acres, in millions, sown to the major cereals in  
East Africa

COUNTRY	Maize	Sorghum	Bulrush Millet	Finger Millet	Total
Kenya	3.0	0.5	0.3	0.3	4.1
Tanzania	2.0	1.2	0.7	0.4	4.3
Uganda	<u>0.5</u>	<u>0.8</u>	—	<u>1.3</u>	<u>2.6</u>
Total	5.5	2.5	1.0	2.0	11.0

The importance of sorghum and millet as subsistence crops in the more difficult farming areas justify the need for continued support in spite of the Kenyan and Ugandan governments decision to emphasize maize. This does not infer that research on maize should be reduced since

consumer preference with relation to availability and price in the three partner countries is still maize greater than sorghum and sorghum greater than millet.

Recommendations:

In view of the great soil and climatic variability that exists in the East African States and the fact that basically the major cereal crops do not respond similarly to these environments and that there is an existing need for continued research to develop improved populations with increased yield, improved nutrition and consumer preference, resistance to limiting destructive insects, diseases and birds, and improved agronomic plant type the following recommendations are suggested with reference to this issue.

1. Maize breeding should be continued in basic breeding methodology with modifications in the program to provide assistance in low-land maize adapted to the coastal environments of Tanzania and Kenya, and to a lesser degree, the high lands where very early maturing varieties are needed. Population improvement should be undertaken to identify and incorporate (a) resistance to streak virus, (b) resistance to root rots and physiological lodging, (c) shorter plants with lower ear height and (d) improved nutritional quality (improved protein and lysine) and consumer acceptance.

2. Sorghum breeding should be continued as presently organized and with increased emphasis on improved consumer acceptance (white, corneous endosperm and acceptable taste for human consumption and large scale beer brewing industry) in order to move sorghum from a solely subsistence ranking into commercial channels of marketing. At the same time, work on brown-seeded types which, because of their tannin content and related bitter taste, are presently considered relatively unacceptable by some human food needs, should be continued in order to satisfy needs for sorghum varieties with bird resistance, for animal agriculture and other uses.

If, in time, ICRISAT establishes a satellite regional research center on semi-arid crops in East Africa (possibly in Uganda), as many phases as possible of sorghum research should be transferred to the ICRISAT program for East Africa as are deemed appropriate. To keep the research aspect regional or community oriented, EAAFRRO should investigate the possibility of contracting with ICRISAT to have needed research conducted through EAAFRRO.

3. Since finger millet and bulrush millet are considered subsistence type crops and the national programs are interested largely in the production phase of these crops, research work with

the millets should be transferred to ICRISAT as soon as the Center in India is able to accept this responsibility. Results from ICRISAT research would be made available either through EAAFRO or directly to national programs. To facilitate the continued support of research on a coordinated community basis, EAAFRO should immediately investigate the possibility of ICRISAT satisfying its needs for an outreach program in East Africa for millets by conducting it through EAAFRO.

#### B. Research Reporting

Research reporting has been recognized as a major constraint toward assuring that research results are adequately disseminated. The technical reports prepared by the USDA are distributed through EAAFRO channels to appropriate recipients, but many of the designated recipients have not redistributed the copies to appropriate personnel, e.g., Dr. J. Liwenga, a Senior Research Officer in Tanzania, had not seen the 1971 Annual Report of the Major Cereals Project. Many officials contacted felt that the USDA report was too technical and also a need existed for a less technical publication which could be readily digested by the Country Senior Extension Production personnel. The EAAFRO Monthly Newsletter attempts to satisfy this second need, however, much space is devoted to administrative news items which are of little or no technical interest or value.

A recent publication by EAAFRO and the Home Economics Department of the University of Nairobi on Sorghum Recipes is an excellent publication, but it can serve only the more sophisticated segment of the population. Even these would not by choice prefer to use sorghum in their food preparation even if available at this level. In order to get to the regular potential user of sorghum, a recipes booklet should be prepared in such a way that the housewife could use it, e.g., appropriate measurements, understandable language, availability of ingredients, etc., must be adoptable at the village level.

Bi-annual and annual workshops and conferences have had a valuable impact in reporting research. When USDA project staff assisted and directed these conferences, community participation was high.

There seemed to be a general lack of simple publications, leaflets, brochures which were aimed to assist the farmer in cereal production. Exceptions to this case were the Uganda Crops Handbook and the Kenya Seed Company leaflets, posters and brochures on recommended maize varieties and their culture.

### Recommendations

With reference to improving research reporting the following recommendations are suggested.

1. EAAFRO publications should be geared to understanding by mid-level research and extension technicians who, in turn, can digest the material for further utilization by technicians and farmers in production programs.

2. To facilitate understanding of research and production conditions and needs in the partner states and to provide personal contacts of research workers at various levels travel of EAAFRO personnel should be encouraged and supported.

3. EAAFRO administrators should make a special effort to ensure that EAAFRO reports are received by appropriate recipients, especially research workers. Partner states should join with EAAFRO in updating the list of recipients in each country who should receive EAAFRO research information.

### C. Utilization of Research Results by National Research Programs

The Evaluation Team as well as those officials consulted considered the utilization of results of the project in their national program as the number one problem. Utilization by the partner states definitely was not equal. For example, in Kenya, the results of the EAAFRO program are utilized 100 percent. This is probably due to the total integration of the EAAFRO program into the Kenyan National Maize Improvement Program. There are no linkage problems as both EAAFRO and the national maize personnel have been working as a team with the EAAFRO maize geneticist also serving as the Officer-in-Charge of the Maize-Genetics Section. Furthermore, with the existence of the Kenyan Seed Company, an efficient means of seed production and distribution already existed.

At the other extreme, with recent decentralization of existing research in Tanzania and a general lack of scientists assigned to cereals improvement, utilization of EAAFRO research results by the Tanzanians were, until very recently, almost nil. It is only since the Field Trials Officer of EAAFRO has been assigned to Tanzania that any real utilization has occurred.

The Field Trial Officer in Uganda is working effectively in a similar capacity. Because of existing political constraints that may affect the operation of the project, utilization of research results may not be as effective as hoped for in the future. Basically the needed ingredients for a successful cooperative program with EAAFRO are in existence in Uganda.

Recommendations:

1. The Evaluation Team considers the Field Trial Officer as one of the keys to the successful utilization of research results of community efforts. It is recommended that every support be given positions of Field Trial Officers in Tanzania and Uganda as presently planned, including national assistants and EAAFRO counterpart assignments. The Kenya maize program should continue to operate as it is currently organized, i.e., as a team effort.

D. Counterparts and Training

The need for counterparts and trained personnel at all working levels is considered to be of highest priority in order to institutionalize cereals research at the earliest opportunity in EAAFRO as required to effectively support partner state's production programs. The lack of counterparts in recent years has been considered a serious constraint, especially in the case of the Field Trial Officers in Tanzania and Uganda. Originally there was no provision for counterparts in the program. After decisions were made to institutionalize the cereals program difficulties were encountered in the establishment of posts and recruitment of counterpart personnel to fill them.

The Field Trial Officers in Uganda and Tanzania do not have counterparts. In Kenya this has not been a constraint to the success of the Major Cereals Project since the maize geneticist also served as an integral part of the national maize improvement program. Too, salary differentials between the community and Kenyan national pay scales discouraged Kenyans from seeking employment in EAAFRO. Thus there are few Kenyans in EAAFRO compared to Ugandans and Tanzanians where conditions for civil servant employees are not as favorable as those of EAAFRO and where the National Programs can least afford to lose them. With the establishment of the USDA PASA personnel in the project, they have effectively trained responsible personnel for day-to-day activities. Only since December 31, 1971, have EAAFRO posts been established for counterparts. Until this was done, EAAFRO was not able to officially recruit counterparts.

East African Agricultural Education institutions contacted by the Review Team have indicated their willingness to cooperate in selection and training of university graduates and undergraduates for candidates to these posts and to provide for possible advanced degree training in selected subject matter fields.

In the area of on-the-job training, it was recognized that EAAFRO could play a significant role in training of national research and production personnel. This would be of special benefit to Uganda in cereals production and to Tanzania in cereals research and production.

Relative to the academic level of those counterparts that will ultimately replace the PASA Team personnel, the consensus of those contacted was that it was much more important to have personnel with experience who could perform necessary research in the program than to have high ranking academic personnel without experience. However, it was deemed most desirable to have both conditions satisfied if obtainable for the most responsible positions within EAAFRO.

#### Recommendations:

The following recommendations are made with respect to counterparts and training:

1. A serious recruitment campaign should be mounted for the recruitment of the best personnel available within the partner states to serve as counterparts of the USDA PASA Team professionals in appropriate locations. EAAFRO must make it known to all potential supplies of candidates the number of posts that are available and the fields of specialization so they can assist in recruitment of qualified personnel.

2. EAAFRO needs to follow up on the interest expressed in combining undergraduate and/or graduate training of university students in a cooperative arrangement within the EAAFRO project activities for their possible future placement. As another alternative or additional method to alleviate the staff shortage within EAAFRO, a program should be initiated to provide for bonding of interested and qualified first and second year university students enrolled at the National Agricultural Faculties at Morogoro, the University of Nairobi, and Makerere University at Kampala. This is a long-range approach, but worthy of support under existing circumstances.

3. As a service to national programs, short-term, on-the-job training sessions should be initiated and developed in cooperation with the appropriate national researchers. They would be especially

designed to train selected national research workers in various subject matter disciplines of competence, especially field trial techniques and field demonstrations. The length of training in the different disciplines would range from a week to a full crop season depending on the nature of the training needs of the participant.

4. Graduate training for M.Sc and/or Ph.D. degrees, either in East African or U. S. universities, should be supported for selected high performance individuals in critical subject matter fields within EAAFRO as rapidly as qualified candidates can be identified. Training for participants must include a maximum amount of practical training in their major subjects such as is presently programmed for graduate candidates at Makerere University.

#### E. Industrial vs. Subsistence Crops

National production programs have their greatest interest in industrial crops, particularly cotton, oil seeds, grain legumes and the two cereals maize and wheat, the crops more or less listed in order of priority. As a result, resource allocations are being directed to support these crops. Kenya, in the case of maize, is planning to provide even greater emphasis to production, rather than research. A constraint therefore results from national policies which do not strongly support community research efforts in maize, sorghum and millets. These policies are based on short term objectives in spite of the awareness of research needs in the subsistence crops from the long-term food requirement standpoint.

The EAAFRO long-term objectives to provide continuing support for research in the subsistence crops are justified. Every effort should also be made to promote commercialization of the subsistence crops such as feed for livestock, beer making and processed foods (flour, macaroni, etc.) for human consumption, some of which should include the soybean. The soybeans observed growing in Uganda and other locations appeared to require the least protection against destructive insects and diseases of any of the grain legumes observed growing. Soybeans appear to offer for a large part of East Africa an almost unlimited opportunity for exploitation in terms of satisfying human, livestock and industrial needs. In relation to other cereals, rice in Tanzania, although considered to be both a subsistence and industrial crop, is considered to be of relatively low priority for improvement and increased production.

Recommendations:

The following recommendations are made concerning emphasis on industrial vs. subsistence crops:

See recommendations A1, A2 and A3.

2. With reference to soybeans it is recommended that EAAFR0 consider this crop as the major one to be supported in the new Food Crops Research Project preferably at Kampala. In any bilateral program in which donor contributions are involved, concentration should be given to support the testing and development of soybean production in areas where it appears to have the greatest promise. An important element would be to coordinate activities with those of the three on-going or proposed AID-supported projects in soybean improvement which are international in scope.

3. In view of the USAID/Dar es Salaam interest in probable support of one rice breeder for the national program in Tanzania, it is recommended that concentration for improvement of this crop be left to the Tanzanian national program unless two or more partner states indicate strong interest for regional support for rice research. In any program developed very close linkages should be established for germ plasm introduction and training with IRRI, IITA and WARDA.

4. In view of the existing interest and technical assistance currently provided by CIDA to cooperating wheat-producing East African States, Kenya and Tanzania, to bring about greater regional support and benefit to this crop in the critical factors of higher grain yields and license resistance from established international centers, it is recommended that both EAAFR0 and National Wheat improvement programs more closely link themselves with CIMMYT's breeding and training programs in Mexico and its out-reach research production activities in North Africa and Brazil.

F. Institutionalizing Cereals Research in EAAFR0

The basic objective of the original Major Cereals Project at its inception was to develop breeding methodology adaptable to maize, sorghum and millet, and as by-product to strive for improvement of these crops. Since the objective was modified only two years ago to include an institution-building element, the success of such institution building can hardly be measured. Only a start has been made to institutionalize and Africanize the project and more emphasis in this direction is highly desirable.

The relationship of EAC/EAAFRO and the three partner states through which the project is implemented is a very delicate one. In fact, in some instances, activities have become somewhat competitive. Each is striving to survive independently and to make its own impact. As of this date EAC/EAAFRO is coming out second best in obtaining staff to conduct their program. Without the USDA personnel to lead the project, the program as now operating could not function. If EAAFRO is to survive, it must be in a position to accept its responsibility to perform basic research as requested by the partner states. Some of the partner states have been dissatisfied with EAAFRO in making decisions affecting research activities and they have gone on their own to satisfy their research needs. The best example of this is Kenya and the maize improvement program. Kenya feels that it can now benefit from EAAFRO only by utilizing the germ plasm<sup>pool</sup> that EAAFRO has established for special needs. Kenyan officials feel that their program has advanced in maize breeding beyond the point that EAAFRO can assist, since Kenya is already employing the best breeding methods that EAAFRO has developed with Kenya for<sup>maize</sup> improvement under tropical conditions.

The historical development of events in Kenya is certainly desired for each of the three partner states. Unfortunately, this has not happened in the other states, perhaps because there were no USDA project personnel assisting until just recently in their program. Improvements are expected with the presence of Field Trial Officers and direct support to be provided to national programs by USAID in Tanzania and donors in Uganda.

An EAAFRO effort without relatively strong national programs would be ineffective. But EAAFRO must be able to take the lead and initiative in conducting basic research needed by the partner states, otherwise there would be no need for its existence. This includes initiative with respect to serving as a linkage between the research of international centers and national programs.

#### Recommendations:

The following recommendations are made concerning institutionalizing cereals research via EAAFRO:

1. EAAFRO, in relation to the partner states, should establish a policy of greater flexibility of its work program if it is to respond to the current and long-term research needs of the partner states as soon as they are able to assume them if this indeed is the wish of the partner states.

2. All research efforts with cereal crops by EAAFRO must compliment but not duplicate efforts of existing national programs

in order to satisfy needs for practical research results which have early application in national production programs. Such community efforts should be closely coordinated with national programs so that with the possibility of an eventual scaling-down or termination of the EAAFRO program, the national program would continue essential research.

3. Research in cereal quality should be expanded at EAIRO to satisfy regional needs of quality improvement especially in maize and sorghum. This might best be satisfied through direct cooperation with the Quality Laboratory of CIMMYT which is doing similar work on an international basis.

#### G. Articulation of National Research Needs to EAAFRO

Based on interviews, this area seems to be a real constraint for EAAFRO as respective national interests and actions have taken priority over those of the Community. Possibly this has come about because of insufficient contact between EAAFRO and the partner states at Resource Research Council or technical levels. While initiative is essential on the part of EAAFRO it can only be effective if it satisfies a real need of national programs. It therefore becomes essential that common research needs are generated from national requests. To make these known also requires initiative on the partner states, requesting assistance from EAAFRO in areas which can be most effectively handled by the Community rather than by any one of the national research programs.

#### Recommendations:

1. EAAFRO technical and administrative personnel should meet annually as a minimum with leading national research and production personnel of the partner states following the annual working conferences to determine progress to date and what orientation should be for the next year's efforts.

2. EAAFRO technical and selected administrative personnel should make a special effort to regularly assist at National Field Days where EAAFRO inputs are being put to effective use.

#### H. Duties of AID/ARS Technicians and Performance in Meeting Project Objectives

In general, the Evaluation Team found that the past performance of PASA personnel was in keeping with the duties described in their job descriptions and needs of the program. PASA personnel seemed

to have a full understanding of the objectives of their responsibilities and they have performed well in relating their programs with that of the project effort. In some instances it was observed that more time and initiative should have been used as well as improvisation in resolving field problems with their supporting field staff and workers.

While the way of operating the program was, of necessity, that also of directing it, this was essential in the early phases of the project. At that time, PASA personnel took advantage of national inputs of land, labor and a limited amount of technical expertise of the national experiment stations to successfully conduct the EAAFRRO program.

The Evaluation Team has not recognized any serious constraints regarding this issue, although the problem may arise as the EAAFRRO program becomes more institutionalized. When this occurs, working relations could become somewhat competitive for EAAFRRO. Resolution of these problems may require that EAAFRRO accept a shifting, flexible role in working with national governments. Likewise, the PASA personnel must be aware of the need for this flexibility role and work accordingly. EAAFRRO personnel must continue to take full advantage of all inputs from the national programs in an integrated, harmonious manner to maximize joint efforts and efficiency.

In the past, turnover of PASA personnel has not been a problem as there was adequate overlap, orientation and USDA supervision prior to coming on the job and during their tour of assignment. There may be problems in the future with respect to overlap or duration of assignments in Uganda in view of the isolation of the Serere Experiment Station and the presently sensitive political and security situation. Some EAAFRRO assigned personnel indicated their reluctance to return following their current assignment.

#### Recommendations:

Because of the highly technical nature of the work and the special knowledge and experience required, careful recruitment of all PASA personnel should be made from candidates who (a) have had broad farm experience and a minimum of two years working experience in their specialty and (b) are especially capable of adapting to new environments and (c) are capable of improvising as the situation requires.

#### I. Technical, Commodity and Service Backstopping of Staff

Technical backstopping of PASA personnel has been outstanding. Adequate supervision and guidance has been provided through annual

and intermittent visits of U.S. based USDA personnel, coordination of report preparation and through other means. Every opportunity has been given to technical support of the PASA staff to attend professional-international conferences and workshops.

Certain equipment supplied to PASA personnel for project work has proved to be unsatisfactory because of service problems and over-sophistication. In the case of U.S. source vehicles, there exists the problem of lack of local service and availability of spare parts. As a consequence almost all project vehicles have reached the point of undependability. Transportation is a serious constraint and must be dealt with on a priority basis if project activities are to continue. This is especially true in Uganda and Tanzania.

Processing of travel vouchers, logistic support, communications and other administrative support problems have become quite serious as some have been unattended for more than one year. Other administrative and logistic support to the PASA personnel provided by USAIDs in Dar es Salaam, Kampala and Nairobi has been very satisfactory.

Recommendations:

1. The Evaluation Team recommends that U.S. source vehicles be purchased for the EAAFRO project only when spare parts and service for such vehicles can be assured. Requests should be made for waiver authority to purchase foreign make vehicles for which adequate local services and spare parts can readily be provided when this is deemed appropriate.

2. More effective administrative and logistic support should be provided to PASA personnel assigned to isolated posts both by the Project Manager and the administration of EAAFRO at Magugu headquarters.

SUMMARY AND CONCLUSIONS

At the request of RDCEA and AID/W, an intensive review of the Major Cereals Project was conducted at project sites in Kenya, Uganda and Tanzania. The terms of reference for the evaluation addressed issues considered to be possible constraints, identified and evaluated accomplishments and evaluated the project with respect to changing goals and objectives. A series of recommendations were prepared to suggest possible further direction of some elements of the new Food Crop Research Project into which the terminated Major Cereals Project is phasing.

The evaluation consisted of visits, consultations and interviews by a six member team with project and related activities in the three partner states comprising the East African Community. A report prepared during the fourth week of the review indicated results of the Evaluation Team's efforts.

An overall conclusion of the Review Team is that phenomenal progress has been made in Kenya with maize breeding and production, due largely to the coordinated efforts of the EAAFRRO Major Cereals Project in consort with the research and production personnel of the Ministry of Agriculture, the Kenya Seed Company and the Kenya Farmers Association. This effective pattern of coordinating research, production and marketing could also serve to attain similar progress in maize and other food crops in all partner states.

EAAFRRO, in evaluating breeding methods adapted to East Africa, has successfully developed improved varieties and hybrids and related cultural practices which are being incorporated into national production programs. In the past, EAAFRRO has satisfactorily performed its role in conducting basic research for utilization in partner states. The future of EAAFRRO depends on its ability to initiate research, to promptly respond as requested to the expressed needs of the partner states for research and production and to coordinate its work with that of the international research centers. Likewise, its effectiveness and viability depends on the ability of the partner states to utilize results from EAAFRRO.

APPENDIX AITINERARY FOLLOWEDDATE

21 August	AID/TAIAGR component of Review Team* departed Washington, D.C.
22 August	Visit FAO Cereal Improvement Officer, Rome
23 August	Enroute Kenya
24 August	At USAID/Nairobi - Developed detailed program of individual country and EAC visitations
25 August	Visit EAAFRO Center, Maguga and FAO Kenya Country Office, Nairobi
26 August	Visit Cereals Quality Laboratory, EAIRO, Nairobi
27 August(Sun)	Nairobi
28 August	Visit Kenya Farmers Association National Headquarters
29 August	At Kenya Research Experiment Station, Kitale, regarding maize improvement activity
30 August	Visit Kenya Seed Company Headquarters and Seed Farm, Kitale and return to Nairobi
31 August	Enroute Agricultural Research Experiment Station, Serere
1 September	Confer with EAAFRO Major Cereals and Ugandan Station Staff, Serere, regarding sorghum-millet research activity
2 September	Observe field and laboratory research at Serere and return to Kampala
3 Sept (Sun)	Kampala
4 September	Visit Kawanda (Perennials) and Namulonge (Annuals) Stations and Makerere University and Kabonyolo Expt. Farm
5 September	Confer with Commissioner for Agriculture at Entebbe and USAID officials and travel to Nairobi
6 September	Confer with Kenyan Agriculture Ministry Research Officer, Dean Faculty of Agriculture, and USAID Officials and travel to Dar es Salaam
7 September	Confer with Tanzanian Government and USAID Officials at Dar es Salaam
8 September	Visit Longa Station with overnight at Morogoro
9 September	Return to Dar es Salaam and fly to Arusha
10 Sept (Sun)	Enroute to Arusha
11 September	Confer with RDOEA/Arusha staff and Tanganyika Farmers Association Manager
12 September	Confer with Dr. F. Ogada at Nairobi
13-15 Sept	At Arusha preparing report

\* See Appendix E for review team members that assisted at the different locations.

APPENDIX BCEREALS RESEARCH AND EXPERIMENTAL STATIONS IN EAST AFRICA:  
EAC/EAAPRO LINKAGESMedium Altitude (1500-5500 feet)

Embu (K)\*  
 Katumani (K)  
 Kisi (K)  
 Kakamenga (K)  
 ++ Ilonga (T)  
 Ukiriguru (T)  
 ++ Serere (U)  
 ++ Kawanda (U)  
 ++ Namulonge (U)  
 /++ Kabanyolo (U)  
 /++ Morogoro (T)

Kenya = 4  
 Tanzania = 3  
 Uganda = 4

High Altitude (5500 feet)

++ Kitale (K)  
 Njoro (K)  
 Lyamungu (T)

Kenya = 2  
 Tanzania = 1

Low Altitude (1500 feet)

Mtwapa (K) \*\*\*  
 Mtwara (T) \*\*\*  
 Mlingano (T) \*\*\*

Kenya = 1  
 Tanzania = 2

++ denotes stations visited by Review Team  
 /++ University Farm - Faculty of Agriculture  
 \*\*\* Coastal Corridor with elevations less than 500 feet  
 Letter designations in parenthesis indicate countries:  
 K - Kenya  
 T- Tanzania  
 U - Uganda

1. Experiment Station: Embu Agricultural Research Station, EMBU, Kenya
2. Responsible to: Ministry of Agriculture, Nairobi
3. Date of Formation: 1965
4. Altitude: 3000'-5000' (914-1524 m)
5. Soil Characteristics: Dark red, friable clay, well drained, (Latosolic soils). A-horizon over lies a dark-red, subangular blocky friable clay.
6. Topographical Data: Rolling
7. Ecological Classification: Land not forest, large shrubs mostly evergreen. Dry sub-humid to semi-arid.
8. Climatic Data: Mean Rainfall 30-40"  
Minimum Temp. 10<sup>o</sup>-14<sup>o</sup>C.  
Maximum Temp. 26<sup>o</sup>-30<sup>o</sup>C.
9. Physical Facilities: On administration building; two laboratories with offices. Machine shop, irrigation facilities, electricity and treated water. Senior and Junior Staff quarters, dairy and machine shed.
10. Field of Investigation: Maize, pasture and beans improvement, dairying.
11. Projects Under Investigation: Maize breeding and agronomy projects. Dry beans project and pasture improvement programme.
12. Personnel: Senior staff -6  
Technical Staff -10  
Clerical Staff -3  
Drivers -2  
Subordinate Staff -30  
Casual -20 on and off
13. Publications - Library: Annual Report, Thesis and Handouts on cultural practices of these crops.
14. Results - Contributions: Results from this station apply directly to the Central, Eastern Provinces and the drier parts of Machakos and Kitui districts
15. Observations:

Maize Breeding and agronomy cover three main ecological regions, one of which is medium altitude or maturity zone headquartered at Embu. This is one station whose materials apply directly to Uganda as a whole and most parts of Tanzania other than the coast. There has been a lot of exchange of materials between this programme and most of neighbouring States who fall under a similar zone. It has been used as one of the locations for the Major Cereal Project under the EAAFRD, Maize Genetics Division. The hybrids H 511 and H 512 which are produced commercially have been grown extensively in partner States as well as Ethiopia. This being the bean area, in other words beans form part of the staple food, soybeans would be very much appreciated here.

1. Experiment Station: Katumani Agricultural Research Station, Machakos, Kenya
2. Responsible to: Ministry of Agriculture
3. Date of Formation: 1955
4. Altitude: 1575 m.
5. Soil Characteristics: Dark brown loams, derived from tuff.
6. Topographical Data: Fairly flat, more or less like range land.
7. Ecological Classification: Land not of forest potential, carrying a variable vegetation cover, woodland, bush land or savannah.
8. Climatic Data: Mean rainfall 20"-30" (510-760 mm)  
Minimum Temp. 10<sup>o</sup>-14<sup>o</sup>C.  
Maximum Temp. 22<sup>o</sup>-26<sup>o</sup>C

Two seasons a year, long and short rains.

9. Physical Facilities: One rectangular block containing administration, laboratories and offices; senior and junior staff houses, machinery workshop, engine house for electricity, and irrigation facilities.
10. Field of Investigation: Maize, sorghum, pasture, beans and castor for oil project. Millet improvements are also covered.
11. Projects Under Investigation: Maize, sorghum, castor oil and beans. Dairy cattle, sheep and goats.
12. Personnel: Senior staff - 5  
Tech. Assts. - 8  
Clerical - 4  
Drivers - 6  
Subordinate -30
13. Publications - Library: Annual Reports
14. Results - Contributions: Results from the station are utilized in most marginal parts of the country.
15. Observations:

Bearing in mind that two thirds of Kenya is semi-arid and therefore marginal, the importance of this station to the nation need not be over-emphasized

In Kenya, this area is more often than not hit by drought, and as such, this early maturing maize program is just ideal. The method used to improve the two main composite populations is S<sub>1</sub> Selection, a method that has come directly from the breeding method study done by the Major Cereals Project.

1. Experiment Station: Nyanza Agricultural Research Station, Kisii, Kenya
2. Responsible to: Ministry of Agriculture
3. Date of Formation: 1963
4. Altitude: 5000'-7000' or 1524-2134 m.
5. Soil Characteristics: Dark red friable clay, (latosolic soils) humid region well drained soils.
6. Topographical Data: Quite hilly
7. Ecological Classification: Land not forest potential carrying variable vegetation cover, moist woodland, bushland or savannah, dry sub-humid to semi-arid
8. Climatic Data: Mean Rainfall 70"-80"  
Minimum Temp. 14°-18°C.  
Maximum Temp. 26°-30°C.
9. Physical Facilities: Main administration building, stores, dairy, junior and senior staff houses, electricity and treated water.
10. Field of Investigation: Maize, pasture, soybeans, bananas and passion fruit Breeding and agronomy.
11. Projects Under Investigation: Maize and soybean improvement with pasture evaluation.
12. Personnel: Senior Staff -4  
Technical Staff -8  
Clerical Staff -2  
Drivers -2  
Subordinate Staff-20  
Casual off and on-0
13. Publications - Library: Annual Reports and handouts on cultural practices of these crops
14. Results - Contributions: Results from this station are utilized in Nyanza and parts of Rift Valley Province, however, it is available to any other part of the country with similar conditions.
15. Observations:

Extended maize agronomy project under the British O.D.A. is going to centre their interest in this station and the national soybean and groundnut for oil and protein will be directed from this station since Nyanza will be main focus in these projects.

1. Experiment Station: Western Agricultural Research Station, Kakamega, Kenya
2. Responsible to: Ministry of Agriculture
3. Date of Formation: 1953, first crop planted in 1956 and farm boundary was finally surveyed in 1958
4. Altitude: 3000 - 5000' (194 - 1524 m)
5. Soil Characteristics: Well drained, dark brown sandy loam (podsollic soil).
6. Topographical Data: Rolling
7. Ecological Classification: Tropical forest, humid to dry sub-humid equatorial climate Forest and derived grassland and bush land with or without glades
8. Climatic Data: Mean Rainfall 70"-80"  
Minimum temp. 14°C-18°C.  
Maximum temp. 26°C-30°C.
9. Physical Facilities: One administration building; one office and laboratory, senior and junior staff housing, dairy and workshop.
10. Field of Investigation: Maize, pasture, peanuts, soybean and dairy improvement program.
11. Projects Under Investigation: Maize Agronomy Project.
12. Personnel: Senior staff - 4  
Technical staff - 10  
Clerks - 2  
Drivers - 2  
Subordinate Staff - 42
13. Publications - Library: Annual Reports, Thesis.
14. Results - Contributions: Results from this station are utilized in Nyanza and Western Kenya.
15. Observations.

This is one of the locations used by the EAAFR0 Maize Genetics Division for evaluations of the breeding methods as well as the hybrids, composites and varieties that have come out of the Major Cereals project

1. Experiment Station: Ilonga Research & Training Institute, Kilosa, Tanzania.
2. Responsible to: Ministry of Agriculture.
3. Date of Formation: Approximately early 1930's.
4. Altitude and Location: 503 metres, 10 kilometers North East of Kilosa, in Morogoro Region.
5. Topographical Data: Flat plains at base of Kilosa Mts.
6. Soil Characteristics: Alluvial Soils
7. Ecological Classification: Wooded grassland.
8. Climatic Data: Two rainy seasons, first occurring March-June, and second from September-November.
9. Physical Facilities: The area of the station is in the region of 820 hectares of which about 300 hectares are used for experimental purposes. Buildings include one for Administration, laboratories and accommodation for institute staff. A food science teaching unit has been added recently (July 1972)
10. Field of Investigation: 1. Plant selection and breeding. Breeding of cotton for yield and disease resistance and selection of locally adapted varieties of cotton and kenaf. 2. Crop husbandry. Cultural practices and fertilizer trials on maize, soybeans, ground nuts, local and introduced legumes, crop rotation and soil maintenance. 3. Entomology. Bionomics and control of pests of economic importance, particularly on cotton.
11. Projects Under Investigation: Cotton breeding, maize breeding, rice, pastures, grain legumes
12. Personnel: 10 Research Officers.
13. Publications - Library: Monthly reports, annual reports of progress. International journals, "East African Agricultural Journal", "Annual Reports of the Research Division "
14. Results - Contributions: A number of improved varieties of maize, cotton and rice
15. Observations:

It is the principal cotton research center for the Eastern growing zone. Research work on a wide range of crops including maize, rice, legumes, pastures and horticulture is carried out. Human nutrition, nutrition research, crop breeding

1. Experiment Station: Ukiriguru Research & Training Institute, P.O. Box 1433, Mwanza, Tanzania
2. Responsible to: Ministry of Agriculture
3. Date of Formation: Early 1930's when two agricultural officers began working on the selection of improved varieties of cotton.
4. Altitude and Location: 3,200 feet, 27 kilometers South East of Mwanza town, on Mwanza to Tanbora road.
5. Topographical Data: Hilly with shallow valleys here and there.
6. Soil Characteristics: Hill sands, cracking mbuga soil.
7. Ecological Classification: Mainly a grassy area with occasional shrubs and trees
8. Climatic Data: Mean maximum temperature 28.6°C  
September/October warmest  
Mean minimum temperature 17.4°C  
Annual Average Rainfall 44"  
(February and March)
9. Physical Facilities: Laboratories, office and library block, staff quarters. A teaching block for over 200 students.
10. Field of Investigations: 1. Cotton breeding agronomy. 2. Fibre technology. 3. General entomology. 4. Corn breeding. 5. Agronomy of corn. 6. Fertility and soil chemistry. 7. Food crop breeding and agronomy. 8. General pathology.
11. Projects Under Investigation: 1. Pasture research 2. Food crop improvement 3. Corn breeding 4. Cotton breeding 5. Fibre technology.
12. Personnel: 12 Research Officers
13. Publications - Library: Internal journals; E.A. Agricultural Journal, Annual Reports of the Research Division.
14. Results - Contributions: Improved varieties (maize and cotton) have been developed
15. Observations:

The institute is the largest providing a 2-year agricultural training for students completing secondary school education. Its major contribution has been in the cotton industry.

1. Experiment Station: Serere Research Station, Soroti, Uganda
2. Responsible to: Ministry of Agriculture
3. Date of Formation: In 1920, as a demonstration area to encourage ox-ploughing.
4. Altitude and Location: 1,180 meters. 18 miles South West of Soroti in Teso District.
5. Soil Characteristics: Greyish brown sandy loams overlying orange to reddish brown loams
6. Topographical Data: Generally gently rolling.
7. Ecological Classification: Butyrospermum Savannas - Kyoga Basin savannah type with a thick but open canopied stand of deciduous species.
8. Climatic Data: Mean maximum temperature 27.5° to 30°C  
Mean minimum temperature 17.5° to 20°C.  
Annual average rainfall - 1,384 mm. bimodally distributed
9. Physical Facilities:

The station occupies 686 hectares, of which some 404 hectares are farmed on a rotational basis and are used for field experimentation, while a further 120 hectares of land cleared from bush in 1961 is being progressively reclaimed. The remaining area is occupied by Kakudam Hill, houses, offices, laboratories, workshops and farm building.

There was considerable expansion in laboratory space in 1950's providing blocks for food crops, chemistry, entomology and livestock research and in the early 60's laboratories were erected for the East African Community sorghum unit with funds from the Rockefeller Foundation. The most recent additions have been laboratories, stores and offices financed by USAID for the cereal scheme.

A most valuable system of Variety Trial Centres controlled by extension service, with research direction from Serere, is maintained. In all there are approximately 25 of these each one fenced, with set rotational blocks and additional land and facilities for running trials. These provide each season an extremely useful range of data on the performance of experimental material and methods over a range of edaphic and climatic conditions in the North and East.

10. Field of Investigation: Food crops, cereals, cotton, entomology, chemistry, seed testing, pasture agronomy, livestock, ox cultivation,
11. Projects Under Investigation: The broad aim of the program is to maximize yield per hectare using a rotational system of agriculture which ensures maintenance or improvement of soil fertility.

Reselection of groundnut stocks, development of higher yielding cereal varieties and hybrids, better quality types of cotton, pest control, crop rotational studies, agronomy of grasses and legumes, improvement of livestock and testing of ox-cultivation systems are presently under investigation.

12. Personnel: 15 Senior staff, 12 diplomat staff, 50 research assistants, and 450 laborers.
13. Publications - Library: Annual Reports of Progress, circulars, bulletins, booklets, pamphlets and hand-outs concerning cultural practices crops, varieties, agronomy, etc. A general library covering most subjects is maintained for staff use.
14. Results - Contributions. Improved crop varieties (cereals, food crops, cotton, and pasture grasses and legumes), have been developed and released. Improvement of the E. A. Zebu crossbreeding of local with exotic blood, and pasture studies have been carried out.
15. Observations:

The Station is part of the Research Division of the Department of Agriculture which functions under the direction of the Chief Research Officer. In addition to Uganda Government staff, three further organizations work within the framework of the overall cropping program. They are the East African Community unit, concentrating mainly on sorghum breeding and agronomy for the whole of East Africa, the US/ARS cereal unit which deals with cereal crops, e.g., finger and bulrush millet as well as certain facets of the sorghum work, and the Cotton Research Corporation which concentrates its efforts on the breeding and agronomy of the cotton crop, specifically for the North and East areas of Uganda.

1. Experiment Station & Address: Kawanda Research Station, P.O. Box 7065, Kampala, Uganda
2. Responsible to: Ministry of Agriculture, Entebbe, Uganda
3. Establishment Date: 1937
4. Altitude and Location: 3924 ft. and is 12 km. north of Kampala.  
( 32° 32'E and 0° 25'N)
5. Soil Characteristics: The underlying rocks are of preCambrian age and are chiefly granite and quartzite with a little schist, all of which are included in the Karagwe-Ank-Olean system. Soils are mostly reddish-brown loams about 10 inches deep overlying uniform red clay which is free draining and has a loamy consistency.
6. Topographical Data: Landscape is typically that of a dissected pediplain having undulations of about 300 to 400 feet amplitude.
7. Ecological Classification: The natural vegetation of Kawanda is mostly fine climax and seral stage grassland, with scattered evergreen trees. It can be described as Pennisetum purpureum - Hyparrhenia rufa Imperata cylindrica grassland under Chlorophora excelsa trees. The natural climax would be moist semi-deciduous forest.
8. Climatic Data: Climate of Kawanda is moist, sub-humid, with a mean annual rainfall, bimodally distributed of 48 inches per annum---The main wet season being April-May and the short rains in September - November
9. Physical Facilities: Station area comprises of 406 acres of main arable farm to support scientific work on maize, beans, sesame, bananas, fruits and vegetables. There are research laboratories for Chemistry, plant breeding, entomology, and agronomy, a coffee research unit, a library, a museum and seed laboratory now under construction. There are housing quarters for Senior and supporting staff which constitute the major buildings.
10. Field of Investigations: Coffee, cocoa, sugar and annual crops such as beans, maize, sesame, soybeans and vegetables - mainly breeding improvements and agronomy and supporting services such as entomology, chemistry and biological control (CIBC).
11. Projects Under Investigation: Work is concentrated on crop improvement through breeding, soil fertility improvement, plant pathology, entomology and agronomy of related crops and seed technology.
12. Personnel: Senior staff - 9 M.Sc. 25 B.Sc. and 25 diploma  
4 Technical assistants  
360 Labourers  
20 Administrative staff

1. Experiment Station and Address: Namulonge Research Station, P.O. Box 7084, Kampala, Uganda
2. Responsible to: Ministry of Agriculture, Forestry and Cooperatives, Entebbe, Uganda
3. Date of Formation: Cotton research began 1946
4. Altitude and Location: Altitude - 1,150 meters  
Latitude - 0° 32'  
Longitude - 32° 35'
5. Soil Characteristics: Deep well drained soils with high natural fertility. Responsive to nitrogen and phosphorus application but not to potassium. Red sandy clay loam soil.
6. Topographical Data: Undulating with swamps in the valleys.
7. Ecological Classification: Tropical medium altitude mixed forest.
8. Climatic Data: Mean maximum temperature 27.7°C. (January-February warmest) Mean minimum temp. (January and July coolest) 15.8°C mean Annual average rainfall 1254 (March-May and Sept.-November heaviest)
9. Physical Facilities: Station includes 400 primarily devoted to cotton research. Research laboratories for chemistry, breeding, physiology, pathology, entomology and fiber quality. Sr.-Jr. Housing.
10. Field of Investigations: Cotton research-breeding and management practices.
11. Projects Under Investigation: Quality control of cotton, insect and disease resistant cotton varieties.
12. Personnel: 22 senior staff--3 Ph.D., 3 M.Sc., 14 B.Sc., 2 diploma
13. Publications - Library: Most well know technical journals covering genetics, breeding, pathology and entomology as well as general agronomy.
14. Results - Contributions: Improved cotton varieties for growth in the south and west of Uganda.
15. Observations:

This station is the main cotton research station in Uganda. In 1972 Uganda Government posted the field trials officer at Namulonge. Through this posting the U. S. Department of Agriculture Trials Officer is centrally located to travel to variety trial centers throughout Uganda. The trials officer comes to Uganda under PASA through EAAFRO to supervise cereal cultural and variety trials and to demonstrate cereal crops to farmers.

1. Experiment Station: University Farm, P.O. Box 16047, Kampala, Kabanyolo, Makerere, Uganda
2. Responsible to: Government of Uganda
3. Date of Formation: 1953 with student hostel opening in 1957
4. Altitude and Location: The University Farm is located at Kabanyolo (0°28'N, 32°37'E) about 17 km north of Kampala. The elevation on the highest point is 1195 meters while the valley floor is about 1130 meters ( or just below the level of Lake Victoria).
5. Soil Characteristics: Deep tropical red soils, heavy but well drained; heavily weathered latosols derived from precambium schists and quartzites, rather acid (pH about 5.0) with about 2-3 percent of organic matter in the surface horizon and water storage capacity of 10-15 percent.
6. Topographical Data: Gently rolling hills typical for a large area of southern Uganda.
7. Ecological Classification: Originally tropical forest now most area under private small holdings and different types of cultivation.
8. Climatic Data: The climate is classified as moist tropical with moderate temperatures. Maximum occasionally exceeds 30°C while minimum may fall below 15°C. Minimum values for relative humidity may fall below 40 percent in dry season with an exception day recording near 20 percent. There is wide daily variation in both intensity and duration of sunshine. Annual rainfall is about 1300 mm on up 150 rain days. Hail may fall once or twice a year. Periods of soil water deficiency for crops occur frequently during dry spells, most often in Jan-Feb and July-Aug. Winds are normally light.
9. Physical Facilities: Farm Office, poultry, dairy, and hog barns, staff quarters, Engineering workshops, postgraduate housing, 206 hectares for crops, library.
10. Field of Investigation: Teaching: B.Sc degrees in Agriculture and post graduates research leading to MSc and PhD.; crop improvement projects with soybeans, pigeon peas, beans, maize, sorghum, rice and pasture grasses, physiology and agronomy studies with peanuts, sorghum and rice; pasture and maize silage for livestock and maize and sorghum for carbohydrate concentrate feeding.
11. Project Under Investigation: Mechanically and oxen powered farm machinery and tillage equipment testing, soil moisture and nutrient studies, weed control, agronomical and physiological research on legumes, cereals, root and tuber crops, cereal and legume inter-cropping (mixed cropping), interspecific hybrids for fodder production (elephant grass x bulrush millet), study of model small holdings, legume inoculation studies, nutrient and water requirements of bananas, biology and control of insects attacking cereals, diseases of cereal, legume and flower crops, selection of disease resistant potatoes, digestibility studies of grasses

- and legumes.
12. Personnel: 11 professors, 8 senior lecturers, 23 lecturers, 10 research assistants, and 13 graduate assistants.
  13. Publications - Library: Very complete up-to-date library is maintained in support of research needs; publications are regularly effected by research staff on a wide range of related subjects for local distribution as circular bulletins, and for international journals.
  14. Results - Contributions: The faculty produces agricultural graduates in BSc, MSc and PhD. Fourty were registered for higher degrees during 71/72. The number of graduates has risen from 15-20 in 1958/64 to 120 in 1971/72. A proportion of the postgraduate students live in accommdations at Kabanyolo and the whole of the second year undergrads.
  15. Observations:

Makere University is the oldest in East Africa and is, therefore, expected to play a major role in training of specialists and agricultural scientists required for the research stations, agricultural education institutions and extension services throughout East Africa.

The BSc degree in Forestry is the only one in Eastern and Central Africa and students for this degree are drawn from throughout this region.

1. Experiment Station: University of Dar es Salaam, Faculty of Agriculture, Box 643, Morogoro, Tanzania
2. Responsible to: Ministry of Education
3. Date of Formation: July 1969
4. Altitude and Location: 515 meters, 6°South, 37°East, 120 miles west of coast line.
5. Soil Characteristics: Variable, sandy loam.
6. Topographical Data: Amphitheatre on the bottom of the slopes of Ukiriguru Mountains.
7. Ecological Classification: Tropical woodlands and grasslands.
8. Climatic Data: Rainfall 840 mm per year  
Maximum temperature 28°C Minimum 18°C
9. Physical Facilities: 3000 hectares; 6 teaching labs., 4 lecture theatres, 7 student dorms with capacity for 300 students, research lab. under construction, five Departments (crop science, animal science, agricultural chemistry, agricultural engineering, extension and rural economy).
10. Field of Investigations: Each Dept. does research in the relevance of its own department.
11. Projects Under Investigations: Crop breeding, crop physiology, agronomics, entomology investigations, plant nutrition, animal husbandry, and genetics.
12. Personnel: 50 senior staff; 12 PhD, 19MSc, 19 BSc 30 Adm. Staff, 30 tech. staff, 200 laborers.
13. Publications - Library: Various international journals, library center, 425 periodicals.
14. Results - Contributions: Institution only recently established.
15. Observations:

Main institution for Agriculture Education and Research in Tanzania.

1. Experiment Station: Kenya National Agricultural Research Station,  
P. O. Box 450, Kitale, Kenya
2. Responsible to: Ministry of Agriculture
3. Date of Formation: Grassland improvement activities 1920 and cereal improvement research 1955.
4. Altitude and Location: 6000 feet on Kenya Highlands west of Rift Valley.
5. Soil Characteristics: Variable, well drained, deep, basically sandy loam of volcanic origin and relatively fertile, responsive to nitrogen, phosphate and sulfur applications but not to potassium.
6. Topographical Data: Undulating with well-watered valleys.
7. Ecological Classification: Tropical high altitude forest clearings from mixed forests.
8. Climatic Data: Mean maximum temperature 24.6°C (Oct.-Nov.)  
Mean minimum temperature 11.5°C (July-Aug.)  
Annual average rainfall 1250 mm (March-Sept)
9. Physical Facilities: Station area comprises 2,000 acres with major research efforts devoted to maize and pasture improvement and related to cultural practices with pasture investigations supporting dairying and beef enterprises. Research laboratories for chemistry, plant breeding, plant physiology, animal nutrition and seed storage (temperature and humidity control) are available. Sprinkler irrigation is available to extend growing season to 12 months for maize research making it possible to produce a minimum of three crops in two calendar years. Four major offices- laboratory buildings and housing quarters for senior and supporting staff constitute the major buildings. A conference room with a capacity of 30 is available.
10. Field of Investigations. Pasture and cereal crops - breeding improvement and supporting cultural practices.
11. Projects Under Investigation: Primarily cereals including high lysine maize and pasture crops, secondarily oil crops (soybeans and sunflowers) improvement, soil fertility improvement, plant physiology and agronomy of related crops. University related graduate studies in maize and pasture improvement are encouraged.
12. Personnel: 30 senior staff - 4 Ph.D., 8 M.Sc., 12 B.Sc. and 6 diploma  
40 technical assistants  
200 labourers  
8 Administrative staff
13. Publications - Library: Annual Reports of Progress; circulars, bulletins, booklets, pamphlets and hand-out concerning cultural practices crops, varieties, agronomy, etc. A general library covering most subjects is maintained for staff use.
14. Results - Contributions: Improved crop varieties (pasture grasses and legumes, maize hybrids and composites) have been developed and released for mid-altitudes for the tropics as well as related supporting cultural practices. Breeding materials have been also made available to interested cooperators.

15. Observations:

This station is considered as the main station for maize and pasture improvement in the country. Results serve the EAC Partner States as well as Zaire, Zambia, Ethiopia, Malawi, and Somalia. The Maize Genetic Division of EAAFRRO is directly integrated into the Kenyan National Maize Breeding Program with the results made available to EAC States and other interested countries and orginations.

In 1964 USAID in agreement with the Scientific and Technical Research Committee of the Organization for African Unity initiated an Africa wide research program to improve the varieties of major cereals. Through this agreement a maize geneticist was supplied by the U. S. Department of Agriculture under PASA to EAAFRRO and assigned to work on breeding methods and advise the Kenyan maize breeder at the Kitale Station.

1. Experiment Station: Plant Breeding Station, Njoro, Kenya
2. Responsible to: Ministry of Agriculture, Nairobi
3. Date of Formation: 1920
4. Altitude: 2000-2000' (2'34-2'43 m)
5. Soil Characteristics: Dark Brown clay with light textured top soil (planosolic soils). These soils occur on both levels and sloping land between 1,500-2,700 m
6. Topographical Data: Fairly rolling and a bit of plains.
7. Ecological Classification: Forest and derived grassland and bushland, without glades.
8. Climatic Data. Mean Rainfall 40-50" (1015-1270 mm)  
Minimum temp. 6-10°C  
Maximum temp. 18-22°C
9. Physical Facilities: Main office building, food quality laboratory, pathology laboratory, breeding laboratory, green houses, electricity and treated water. Senior and Junior staff houses and dairy farm.
10. Field of Investigation: Wheat, barley and oats. Rape and flax for oil.
11. Projects Under Investigation: Wheat project - breeding and selecting against diseases.
12. Personnel: Senior Officers -12 (2-3 with PhDs)  
Tech. Assistants -10  
Executive Officer -1  
Clerical Staff -4  
Drivers -5  
Messengers -2  
Subordinate Staff -30  
Casual Labourers -10-20
13. Publications - Library: Annual Reports, Thesis, handouts on wheat diseases. Variety releases and related cultural practices.
14. Results - Contributions: The results from the station are not only used in Kenya but in the whole Africa south of the Sahara.
15. Observations:

Apart from the one in South Africa, this is the only wheat breeding station south of the Sahara and as such, the information therefore is used by the Community as well as countries outside the Community.

For many years cereal breeding was all done at Njoro. It was not until 1955 that a Maize Breeder was appointed and posted to Kitale, thus making Kitale a sub-station of Njoro.

Effectively in 1964, the time when the Major Cereals Project started, is when wheat and maize were divided as separate divisions of the Kenyan National Research Division.

Outside technical assistance in wheat improvement is directly provided by the Canadian International Development Agency (CIDA) and indirectly through international research institutes such as CIMMYT to which AID is providing financial assistance.

1. Experiment Station: Lyamungu Research and Training Institute, P. O. Box 3004, Moshi, Tanzania
2. Responsible to: Ministry of Agriculture
3. Date of Formation: Established in 1934 as a National Coffee Station.
4. Altitude and Location: 4,200 ft. on the southern slope of Kilimanjaro mountain 1/4 miles from Moshi by road. Near railway connection and international airport.
5. Soil Characteristics: Clay loam, dark chocolate in color and of variable depth. In parts, there is friable latosol type weathered from volcanic rock. pH6-7.2; responds well to nitrogen and phosphate fertilizer but rarely to potash.
6. Topographical Data: Undulating land.
7. Ecological Classification: Most areas at present under intensive cultivation but originally tropical medium altitude forest of variable composition.
8. Climatic Data: Generally a very rainy area, the relatively dry months are between August and October. Annual average rainfall is over 1400 mm (March-July and Nov-Dec.); mean max. temp. 24.8°C (Jan-Mar); mean min. temp. 13.9°C (July-Sept. coolest).
9. Physical Facilities: Area of the station is about 600 acres out of these 149 acres are under coffee, 55 acres in bananas for cover and 226 acres under improved grass. Also there are 117 acres which comprise the Usagara farm, 93 acres in coffee and the remainder in roads, buildings and tree cover. The Station includes administrative buildings, staff houses, a dairy barn, laboratories, etc.
10. Field of Investigation: 1. Crop research, mainly on coffee, wheat, bananas and horticultural crops. 2. Training in horticulture. 3. Livestock management (dairy).
11. Projects Under Investigation: Coffee agronomic and breeding trials, phytopathology-coffee berry disease, wheat agronomic trials, soil investigations on fertility, horticultural variety trials and selection including banana breeding experiments, center for horticultural research and activity, national institute for horticultural training.
12. Personnel:
 

Research Officers	20	Labourers	350
Field Officers	8	Adm. Staff	10
Assistant Field Officers	35		
13. Publications - Library: Well equipped library on coffee research literature, regularly receive regional annual and monthly reports, journals including East African Agric. and Forestry Journal, Journal of Agric. Sc., Horticultural Abstracts, etc.; publications from the station include a Handbook of Arabic Coffee first published in 1964 and the Lyamungu Newsletter (a monthly publication).
14. Results - Contributions: Improved varieties of coffee and wheat released, plant protection methods recommended, fertilizer

recommendations, coffee cultural practices, first Diploma graduates in Horticulture in 1971.

15. Observations:

The Station is the only one in Tanzania for coffee research and thus plays a major role in the development of coffee industry in Tanzania, a position it has enjoyed over the last four decades. Being situated in a potentially rich horticultural area, the Station plays a similar role in horticulture to that of coffee.



1. Experiment Station: Mtwara Research & Training Institute, P. O. Box 509, Mtwara, Tanzania
2. Responsible to: Ministry of Agriculture
3. Date of Formation: 1952 groundnut and soybean research begun, 1968 cashewnut research begun.
4. Altitude and Location: 13 km from Mtwara along Mtwara-Newale road. 100 metres of altitude.
5. Soil Characteristics: Sandy loam, slightly acidic (pH 5).
6. Topographical Data: Lower eastern slopes of Malconde plateau.
7. Ecological Classification: Thick bush woodland.
8. Climatic Data: Rainfall about 35 in. falling between Dec. & April.
9. Physical Facilities: 1000 acre farm, 4 wing laboratory, administration building, library, a workshop, garage and housing for staff (22 units). Adequate farm implements.
10. Field of Investigations: 1. Cashew breeding, 2. Agronomy of oil seed crops and legumes.
11. Projects Under Investigation: 1. Testing of 49 selected trees of cashew for yield. 2. NPK fertilizer trial on cashew.  
3. Selection of groundnut cultivars. 4. Testing of EAAFR0 cereal and legume varieties
12. Personnel: Research officer - 7 assistant field Officer -12  
Field Officers - 7 Labourers -80
13. Publications - Library: Several on cashew establishment and agronomy, soybean breeding in agricultural journals.
14. Results - Contributions: 1. Method of cashew cultivation and husbandry. 2. Soybean varieties released for low altitude areas of Tanzania. 3. NPK fertilizer recommendation available for use by the farmer.
15. Observations:

Mtwara is going to be an important cashew research center in the country. It is located in an area where no other perennial cash crop would thrive. An important development of the institute is the construction of a training wing for 185 students to be undertaken soon.

1. Experiment Station: Milingano Research & Training Institute, Milingano, Tanzania
2. Responsible to: Ministry of Agriculture
3. Date of Formation: Approximately 1930
4. Altitude and Location: Approximately 500 feet altitude, located 18 miles inland from Tanga.
5. Soil Characteristics: Red sandy loam.
6. Topographical Data: Gently undulating to flat terrain.
7. Ecological Classification: In heavy equatorial rainforest but not cleared under cultivation mostly to sisal.
8. Climatic Data: Two rainy season, 1st Mar.-June (heavy) 2nd Sept-November.
9. Physical Facilities: Soils laboratories, 1000 acres of land under sisal, administrative building, food processing unit, housing for staff, service building, livestock unit.
10. Field of Investigations: Sisal research, soil research coordinating center.
11. Projects Under Investigation: Soil science, sisal research, nutrition, farm management training, coconut, sorghum and maize research.
12. Personnel: 4 Research Officers (BSc) and supporting field officers and labourers.
13. Publications - Library: Library with substantial collection of references.
14. Results - Contributions: Comprehensive handbook for sisal prepared. Various technical publications in Soils Science Journals and journals of Agriculture.
15. Observations: This is only sisal research center in Central and East Africa

APPENDIX CEDUCATIONAL INSTITUTIONS, SUPPORT TRAINING AND  
AGRICULTURAL RESEARCH STAFF

<u>Name</u>	<u>Degrees Granted</u>
Dar es Salaam University (T)*	B.Sc., M.Sc.
Makerere University (U)*	B.Sc., M.Sc. Ph.D.
Nairobi University (K)*	B.Sc., M.Sc.

K = 1            T = 1            U = 1

COLLEGES, TRAINING, AGRICULTURAL EXTENSION AND  
OTHER STAFF

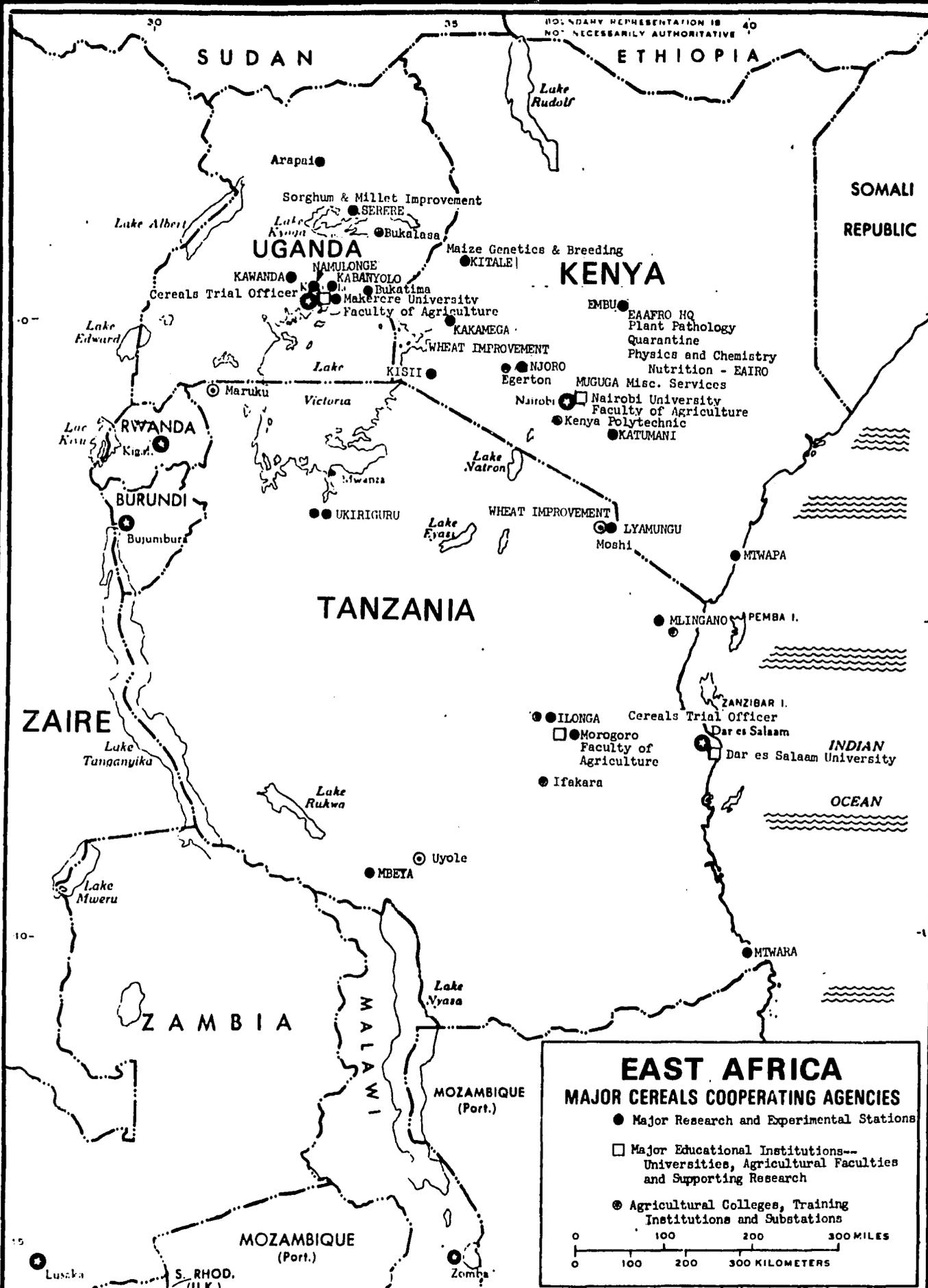
Egerton (K)  
Embu (K)  
Kenya Polytechnic (K)  
Bukalasa (U)  
Arapa (U)  
Ukiruguru (T)  
Lyamungu (T)  
Tlonga (T)  
Mlingani (T)  
Ifakara (T)  
Gyole (T)  
Mareke (T)  
Nyegezi (T)  
Busetima (U)  
Lucatima (U)

K = 3            T = 8            U = 3

\* Letter designations in parenthesis indicate countries:

K - Kenya, T - Tanzania, and U - Uganda

BOUNDARY REPRESENTATION IS NOT NECESSARILY AUTHORITY



**EAST AFRICA  
MAJOR CEREALS COOPERATING AGENCIES**

- Major Research and Experimental Stations
- Major Educational Institutions--  
Universities, Agricultural Faculties  
and Supporting Research
- ⊙ Agricultural Colleges, Training  
Institutions and Substations

0 100 200 300 MILES  
0 100 200 300 KILOMETERS

APPENDIX EOFFICIALS CONTACTED

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APPENDIX F

GLOSSARY OF ACRONYMS

AID	Agency for International Development
AID/W	Agency for International Development, Washington, D.C.
CIDA	Canadian International Development Agency
CIAT	International Center for Tropical Agriculture (Columbia)
CIIMYT	International Center for the Improvement of Maize and Wheat (Mexico)
EAAFRRO	East African Agricultural and Forestry Organization
EAC	East African Community
EAIRO	East African Industrial Research Organization
FAO	Food and Agricultural Organization of the United Nations
ICRISAT	International Crops Research Institute for the Semi-arid Tropics (India)
IITA	International Institute for Tropical Agriculture (Nigeria)
IRRI	International Rice Research Institute (Philippines)
ODA/UK	Overseas Development Agency/United Kingdom
TA/AGR	Technical Assistance/Office of Agriculture
U.S.	United States
U.S.A.I.D.	United States Agency for International Development
USLID	
USDA	United States Department of Agriculture
PASA	Participating Agency Service Agreement
RDOEA	Regional Development Office for East Africa
WARDA	West Africa Rice Development Association