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# TANZANIA FARMING SYSTEMS PROJECT

# FINAL TECHNICAL REPORT

December 1986

TANZANIA FARMING SYSTEMS PROJECT
(Contract AFR-0156-C-00-3033-00)

# FINAL TECHNICAL REPORT

Prepared by
Oregon State University
with
The Consortium for International Development
for the
Tanzania Agricultural Research Organization,
United Republic of Tanzania

December 1986

Publication Number 141

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## FORWARD

This document is the final technical report for contract activities carried out under the Tanzania Farming Systems Project. It covers a 3.5 year reporting period from March 1, 1983 through September 30, 1986. In general, this report documents progress made during the life of the Project toward the objectives of the contract. This report was developed after contract completion to provide detailed documentation of Project implementation as a companion to the summary report entitled "Tanzania Farming Systems Project: Final Report", Project publication number 135.

The report puts particular emphasis on the final year of Project activities and as such includes materials which would otherwise have been presented in the 1986 Annual Report. Other annual reports prepared under the Project include:

1983 Annual Report : Tanzania Farming Systems Project Publication Number 15
1984 Annual Report : Tanzania Farming Systems Project Publication Number 97
1985 Annual Report : Tanzania Farming Systems Project Publication Number 118

All reports have been prepared by Oregon State University as the lead university of the Consortium for International Development for this Project.

This publication was funded and produced by the Oregon State University Office of International Agriculture. The opinions expressed herein are the views of the authors.

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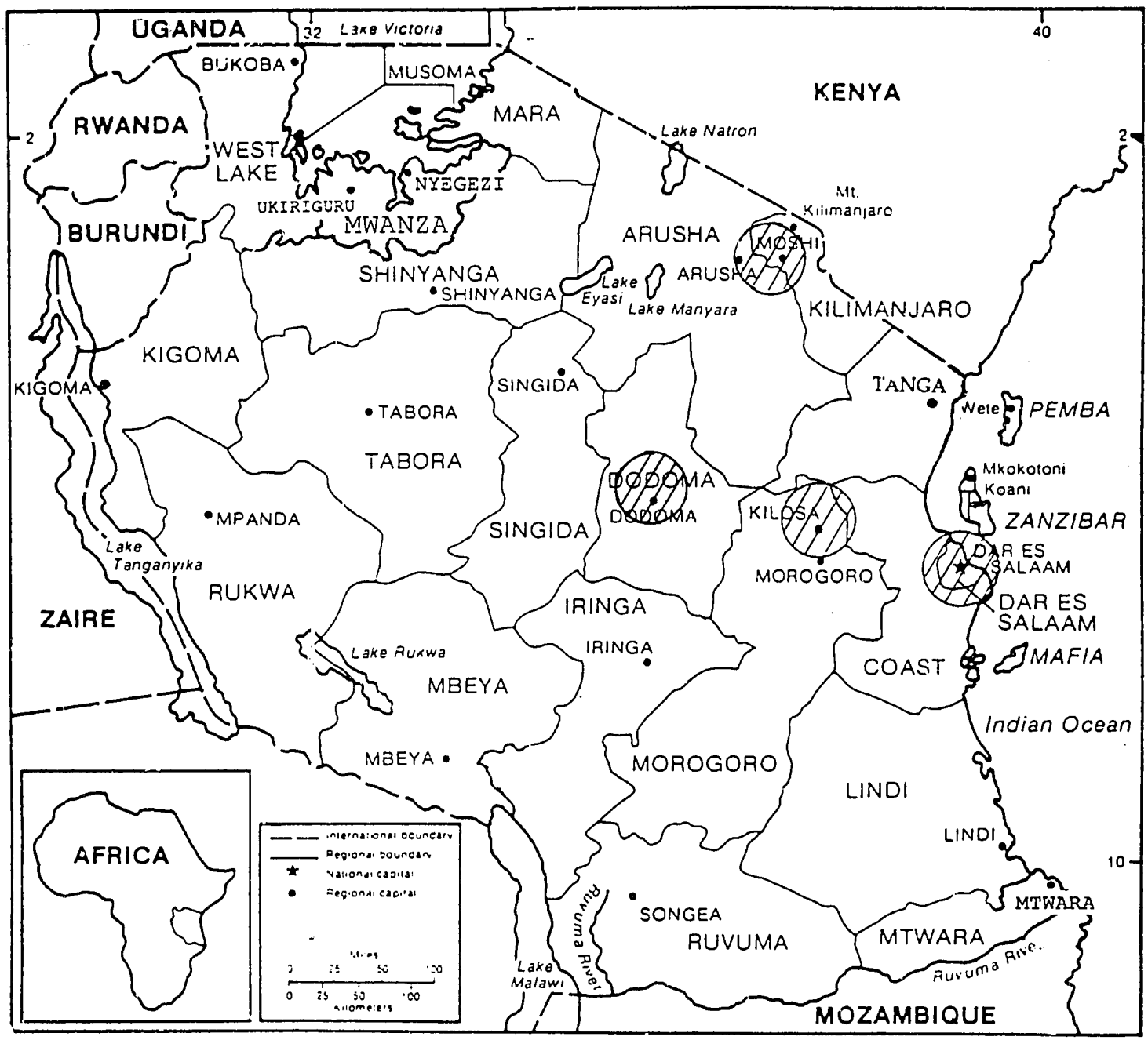
## ACRONYMS

| | |
|---|---|
| AID/W | Agency for International Development/Washington, D.C. |
| ARI | Agricultural Research Institute |
| CID | Consortium for International Development |
| CIMMYT | International Center for Maize and Wheat Improvement El Batan, Mexico and Nairobi, Kenya |
| COP | Chief of Party |
| CP | Congressional Presentation |
| DADO | District Agricultural Development Officer |
| DG | Director General |
| FAO | Food and Agriculture Organization of the United Nations |
| FSR | Farming Systems Research |
| FTE | Full-Time Equivalent |
| FY | Fiscal Year, October 1 through September 30 for AID |
| GOT | Government of the United Republic of Tanzania |
| HHG | Household Goods |
| IITA | International Plant Protection Center, Oregon State University |
| LOP/WP | Life of Project Workplan |
| MALD | Ministry of Agriculture and Livestock Development |
| MOU | Memorandum of Understanding |
| OFT | On-farm Trial |
| OIA | Office of International Agriculture, Oregon State University |
| OST | On-station Trial |
| OSU | Oregon State University |
| PID | Project Identification Document |
| PM | Person Months |
| PP | Project Paper |
| PY | Person Year |
| RADO | Regional Agricultural Development Officer |
| REDSO/ESA | Regional Economic Development Support Office for East and Southern Africa |
| SPA | Senior Production Agronomist |
| SPE | Senior Production Economist |
| SUA | Sokoine University of Agriculture |
| TALIRO | Tanzania Livestock Research Organization |
| TARO | Tanzania Agricultural Research Organization |
| TPRI | Tanzania Pesticide Research Institute |
| TRD | Training for Rural Development Project |
| UAC | Uyole Agricultural Center |
| USAID | U.S. Agency for International Development |
| USAID/T | U.S. Agency for International Development, Mission to Tanzania |


UGANDA
Lake Victoria
32
40
BUKOBA
MUSOMA
KENYA
RWANDA
MARA
Lake Natron
2
2
WEST LAKE
NYEGEZI
UKIRIGURU
MWANZA
Mt. Kilimanjaro
BURUNDI
ARUSHA
MOSHI
SHINYANGA
SHINYANGA
Lake Eyasi
ARUSHA
Lake Manyara
KILIMANJARO
KIGOMA
KIGOMA
SINGIDA
TANGA
Wete
PEMBA
TABORA
TABORA
DODOMA
DODOMA
Mkokotoni
Koani
ZANZIBAR
MPANDA
SINGIDA
KILOSA
MOROGORO
DAR ES SALAAM
DAR ES SALAAM
Lake Tanganyika
RUKWA
ZAIRE
IRINGA
IRINGA
Lake Rukwa
MBEYA
COAST
MAFIA
Indian Ocean
MBEYA
MOROGORO
LINDI
LINDI
AFRICA
International boundary
Regional boundary
National capital
Regional capital
Miles
0 25 50 100
0 25 50 100
Kilometers
10
MTWARA
SONGEA
RUVUMA
MTWARA
Ruvuma River
Ruvuma River
Lake Malawi
MOZAMBIQUE

# I. EXECUTIVE SUMMARY

This document is the final report of Tanzania Farming Systems Project activities undertaken by the Consortium for International Development under contract to the U.S. Agency for International Development Mission to the United Republic of Tanzania (USAID/T). The Project was jointly funded under a bilateral agreement between the Government of the United States of America and the Government of the United Republic of Tanzania. The Project was implemented by the Tanzania Agricultural Research Organization and USAID/T between March 1983 and September 1986.

Under the collaborative assistance mode, the Consortium for International Development, a consortium of ten western U.S. universities, provided technical assistance services during both the Project design and implementation phases. Technical assistance during the Project design phase was provided under the consortium by Colorado State University during 1981. During the Project implementation, technical assistance, participant training and limited commodity procurement was provided under the consortium by Oregon State University during the period 1983-1986.

The purpose of the Project was to improve the availability and use of basic food crops research information through:

1) the introduction of a farming systems approach in TARO and
2) the provision of organizational management assistance to TARO.

Project activities were conducted at TARO headquarters in Dar es Salaam, and in Kilosa, Moshi and Dodoma Districts.

Major accomplishments during the Project include:

- realistic goals which took into account the resources and time available were established and then achieved;
- research and extension staff were trained in FSR/E methodology and operation;
- an effective, fully operational FSR unit was established at TARO headquarters;
- two fully functional adaptive research district teams were organized, trained and developed and a third team was initiated;
- comprehensive documentation was prepared in order that all progress and lessons learned be available to TARO as they continue the work begun under the Project;
- clear demonstration of success of the FSR/E approach from the diagnosis of farm family problems and opportunities and the design of improved technologies to the testing and dissemination of an extremely well received technological package based on the maize variety Kito developed by commodity researcher at Ilonga; and
- working links were forged between commodity and adaptive research scientists as part of a team whose overall objective is the development, testing, adaptation and dissemination of improved science based technology.

Major issues affecting progress included:

- complete reorganization of crop and livestock research just prior to Project initiation and the range of organization development difficulties associated with the reorganization;
- a major reduction in both the anticipated scope of the Project and in funding support from both USAID and Government of Tanzania;
- delay in assignment of counterpart staff to expatriate personnel;
- fragmented organizational structure of agricultural research;
- lack of support for and formal involvement of the extension service; and
- dismissal of 80% of the senior TARO headquarter administration in 1986.

# II. INTRODUCTION

## A. BACKGROUND

This is the final technical report of the Tanzania Farming Systems Project. Specifically, this report is designed to trace the history and describe progress toward Project goals, purpose and outputs of the Tanzania Farming Systems Project (Contract AFR-0156-C-00-3033-00).

The main body of the report focuses on inputs for which the contractor was accountable, outputs for which the contractor was responsible, and the Project purpose to which the contractor was committed.

The U.S. Agency for International Development financed inputs for the Project were managed under contract by the Consortium for International Development with Oregon State University as the lead university. Goods and services were provided during a 3.5 year period from March 1, 1983, through September 30, 1986. The original amount of the contract which was signed on April 27, 1983, was $5.2 million. At the outset of the Project a funding level of $2.225 million was authorized for Years 1 and 2 activities. An additional $3.011 million was anticipated to be available for the remaining 1.5 years. Due to economic conditions within Tanzania, the Brooke Amendment was invoked and, as a consequence, the United States Agency for International Development (USAID) authorized in July, 1984, continuation of the Project through September 30, 1986, but restricted the entire contract to the original funding level of $2.225 million.

## B. PROJECT DESCRIPTION

The Tanzania Farming Systems Project sought to strengthen the institutional structure of agricultural research and extension in Tanzania. The Project was a cooperative endeavor of USAID and the Government of the United Republic of Tanzania, with assigned leadership to the Tanzanian Agricultural Research Organization (TARO), and with assistance from other government agencies.

The stated purpose of the Project was to improve the availability and use of basic food crops research information through:

1. Introduction of a farming systems approach which is characterized by:
   a. the inclusion of farmers along with researchers and extension workers as active participants in an iterative and incremental process of identifying, prioritizing, testing, and evaluating agricultural research on a continuing basis;
   b. research that is directed toward the development of technologies that are farmer and location specific, and that meet high priority needs, and that will gain acceptance by farmers; and
   c. a research process that is near-term and cost-effective in design.

2. Provision of management assistance to TARO in its organization, operation, oversight, control and planning functions to enhance its capability to conduct and sustain adaptive research expanded to a national scale.

3. Provision of encouragement and assistance to TARO, the Division of Research, the Division of Extension and Technical Services, and other research and extension units and agencies to work cooperatively toward the development of common goals and objectives to enhance Tanzanian agriculture and toward the implementation of the goals and objectives established.

The Project was pilot-scale in nature with concentration in the geographical zones served by the Ilonga and Lyamungu Agricultural Research Institutes. A total of six districts were expected to be involved: Kilosa, Dodoma, and Mpwapwa in Ilonga zone; and Moshi and Arumeru in Lyamungu zone. However, because of limited funding, personnel and time, three Districts (Arumeru, Mpwapwa and Morogoro) were designated as secondary Districts. Contract expatriate personnel concentrated field work in the Kilosa, Moshi, and Dodoma Districts and thereby were able to successfully complete two entire cycles of the FSR process in Kilosa and Moshi Districts and one cycle in Dodoma District.

## C. PROJECT HISTORY

In order to understand both the accomplishments and problems of the Tanzania Farming Systems Project, it is essential to understand both its context and its historical development. In the late 1970's, the Project was a logical programmatic outgrowth for both the Tanzanian Government and USAID/T.

After nearly a decade of USAID/T support commodity-based agricultural research in Tanzania, both the GOT and USAID/T agreed that more attention needed to be paid toward ensuring that the end product of this research would be adopted by smallholder producers. The farming systems research (FSR) approach with its focus on farmer problems and opportunities and its emphasis on farmer involvement throughout the research process, was viewed as a near term and cost effective means of achieving this goal.

Early discussions between the U.S. and Tanzanian Governments suggested that this cooperative FSR project would be the centerpiece of agriculture and rural development for Tanzania in the 1980s. The Project was viewed as an important initial step by the newly-formed research organization TARO to build upon the strong base of commodity research which had not been adequately extended to the farmers.

This initial vision of the Project was eroded significantly over the 1982-84 period as U.S. foreign policy objectives shifted and as a direct result of the Tanzanian default on loan repayments. Table I-A displays data on the changes in commitments of both governments between the time the Project was first designed until the close of the contract and the Project on September 30, 1986. Table I-B shows the chronology of Project events.

In retrospect, it is the view of the authors of this report that while the reduced timespan severely hampered the accomplishments of the Project, the reduced size may have, on the whole, been advantageous. The 3-1/2 year life of the Project was totally inadequate for the job at hand. Agricultural research and extension are long-term activities which require continuous and consistent support. Changes in research and extension must be introduced slowly and carefully. It is for this reason that the reduction in the scope of the Project made good sense. It was appropriate to introduce FSR on a pilot scale and proceed to expand slowly as the approach earned it's credibility and as Tanzanian personnel became available.

TABLE I-A. CHANGE IN SCOPE OF PROJECT BETWEEN 1979 and 1986

| | 1979 | 1982 | 1983 | 1984 | 1985 |
|---|---|---|---|---|---|
| | Original Expectation (PID/CP) | Project Paper | Original Contract & Years 1 & 2 Workplan | Contract Amendment #1 Life of Project Workplan | Contract Amendment #2 |
| Level of USAID Funding (in millions of $)* | 25 | 8.3 | 5.2 | 2.2 | 2.2 |
| Number of Districts | 20 | 15 | 15 | 6 | 3 |
| Person months of Expatriate Technical Assistance (TDY & LT) | 930 | 321 | 336 | | 139 + TDY |
| Participant Trainees | N/A | 12 | 12 | 4 | 4 |
| Duration of Project (in years) | 5 | 5 | 5 | 3.5 | 3.5 |
| Extension Involvement | Yes | Yes | No (informal) | Some (informal) | Some (informal) |

*Contract funds represent a portion of the total Project funds specified in the Grant Agreement

## TABLE I-B. PROJECT CHRONOLOGY

| YEAR | QUARTER | EVENT |
|---|---|---|
| 1981 | I-IV | Project Design |
| | II | FSR Project Design Workshop in Arusha with Colorado State University Team |
| 1982 | II | Project paper submitted to AID/W |
| | III | Project authorized by AID/W |
| | III | Initial obligation |
| 1983 | I | Oregon State University selected as lead University to replace CSU |
| | I | Contract negotiation |
| | I | Contract initiated between AID and CID |
| | I | Frank Conklin named Project Director |
| | I | James Deutsch assists in transition to new Project |
| | II | CID/OSU initiates/conducts recruitment for TAs |
| | III | COP designate visits Tanzania with Frank Conklin, Project Director |
| | III | Orientation of Technical Assistance Team |
| | III | Arrival of Buchanan |
| | IV | Arrival of Tang and Cunard |
| | IV | FSR/Resource Efficient Farming Methods Workshop in Arusha |
| | IV | Initial reconnaissance surveys conducted in districts |
| | IV | Richard Wardwell, CSU, assisted in construction of diversion dam at Ilonga ARI |

TABLE I-B. CONTINUED

| | | |
|---|---|---|
| 1984 | I | Mann arrives in Tanzania |
| | I | Announcement made that Project will be reduced in scale |
| | II | Ministry requests termination of services of Maize and Sorghum Improvement Specialists |
| | III | Lev arrives in Tanzania |
| | III | Sokoine University Study Team work conducted |
| | III | Mann departs Tanzania |
| | III | Participant trainees arrive in U.S. |
| | III | Development of revised Life of Project Workplan |
| | IV | Tang departs Tanzania |
| | IV | Price Waterhouse provides training in physical properties management |
| 1985 | I | National FSR Training Seminar conducted at Morogoro |
| | I | National FSR Training Seminar conducted at Dodoma |
| | I | 7.2 million shillings approved by PL 480 Committee |
| | I | Acker named Project Director |
| | II | CID Deputy Executive Director and Project Director conduct internal review of Project |
| | II | Matzke conducts land use study in Kilosa |
| | II | National FSR Workshop held in Arusha |
| | III | Appointment of first Director of Research in TARO |
| | III | Cunard departs Tanzania |
| | III | Project conducts FSR short course at OSU |
| | III | Study conducted of role of extension in FSR |
| | III | Long range planning conducted by Ed Price on organization of FSR in TARO |
| | IV | Participant trainees attend Project workshop and FSR/E Symposium at KSU |

TABLE I-B. CONTINUED

| | | |
|---|---|---|
| 1986 | I | USAID conducts final evaluation of Project |
| | I | Project Director visits Project |
| | II | Matzke conducts land use study in Moshi |
| | II | Buchanan departs Tanzania |
| | II | Project Director visits Project |
| | II | Final Project Conference |
| | III | CID Deputy Executive Director visits Project |
| | III | Lev departs Tanzania |
| | III | FAO support for participant trainees announced |
| | III | Contract completion |
| | III | First participant trainees return to Tanzania |
| | III | Sungusia makes working visit to U.S. |
| | IV | Final Report is prepared |
| | IV | Final Report is delivered to TARO and USAID/T |
| | IV | Final Technical Report is prepared |

Note: Field activity took place continuously beginning with the fourth quarter, 1983. Details can be found in Section IV.

## III. PROJECT IMPLEMENTATION

### A. PERSONNEL

#### 1. Expatriate Personnel

A total of 151 person-months of in-country technical assistance was provided under the contract. This total includes both long and short-term technical assistance. Table II displays data on both US-based and Tanzania-based long-term technical assistance. Along with their Tanzanian counterparts, the long-term personnel were responsible for all of the core FSR activities achieved during the Project. Table III displays data on short-term technical assistance provided under the Project.

TABLE II. LONG TERM PROFESSIONAL PERSONNEL ASSIGNED TO PROJECT

| NAME | TITLE | POST | BEGINNING | END | PERSON MONTHS |
|---|---|---|---|---|---|
| Mark T. Buchanan | Chief of Party | Dar es Salaam | Sept. 1983 | Apr. 1986 | 30 |
| Alex Cunard | Senior Production Agronomist | Dar es Salaam | Sept. 1983 | Aug. 1985 | 23 |
| Chin Yan Tang | Maize Crop Improvement Specialist | Ilonga | Oct. 1983 | Nov. 1984 | 13 |
| John Mann | Sorghum/ Millet Crop Improvement Specialist | Ilonga | Feb. 1984 | Aug. 1984 | 7 |
| Larry S. Lev | Senior Production Economist/ Chief of Party | Dar es Salaam<br>Dar es Salaam | May 1986<br>May 1986 | Apr. 1986<br>Sept. 1986 | 27 |
| Frank S. Conklin | Project Director | Corvallis Oregon | March 1983 | Feb. 1985 | 16 |
| Jean R. Kearns | Deputy Executive Director Consortium for International Development | Tucson Arizona | March 1983 | Sept. 1986 | 11 |
| David G. Acker | Project Director | Corvallis, Oregon | Feb. 1985 | Sept. 1986 | 12 |
| TOTAL | | | | | 139 |

TABLE III. SHORT-TERM PROFESSIONAL PERSONNEL ASSIGNED TO PROJECT

| Reporting Year | Consultant | Time (PM) | Nature of Work | Source of Funding |
|---|---|---|---|---|
| 1983 | Dr. James Deutsch, Maize Breeder CIMMYT | 2.0 | Assisted in transition of maize program to the Project. | CID/AID |
| 1983 | Dr. Richard Wardwell, Civil Engineer Colorado State University | 1.0 | Assisted in diversion dam construction at Ilonga ARI. | CID/AID |
| 1983-4 | Mr. Bruce Maxwell, Architect | 3.0 | Prepared 17 drawings for the land development master plan at Ilonga ARI. | CID/AID |
| 1984 | Price Waterhouse | 1.5 | Developed and assisted in implementing physical properties inventory, allocation, processes, and procedures for improved handling of such items by TARO. | CID/AID |
| 1984 | Mr. David Eding, Data Specialist | 1.0 | Assisted in developing questionnaires for verification surveys | CID/AID |
| 1985 | Dr. Gordon Matzke, Land Tenure/Land Use Specialist, Oregon State University (in conjunction with District Agricultural Development Office Personnel) | 1.5 | Conducted study of land tenure/land use problems and opportunities in Kilosa District | CID/AID |
| 1985 | Dr. Edwin C. Price, FSR Economics, Oregon State University, in conjunction with Dr. G. Semuguruka, Director of Research, TARO, Mr. M. Polepole, Agricultural Economist, TARO. | .5 | Conducted study and planning sessions related to the long range planning and organizational issues confronting the future of FSR in Tanzania. | CID/AID/ TARO |
| 1986 | Dr. Gordon Matzke, Land Tenure/Land Use Specialist, Oregon State University (in conjunction with Moshi District Agricultural Development Office personnel). | 1.5 | Conducted study of land tenure/land use problems and opportunities in Moshi District | CID/AID |
| TOTAL | | 12 person months | | |

2. Tanzanian Personnel

The accomplishments of the Project would have been hollow if they had been achieved by the expatriate personnel in isolation. This was not the case as several large and enthusiastic groups of Tanzanian scientists participated fully in all Project activities.

The first group, shown in Table IV, consists of TARO personnel who were directly assigned to the Project as members of the FSR Section. These individuals shared with the technical assistance team the primary responsibility for all core FSR activities.

TABLE IV. TARO FSR PERSONNEL

| POST | NAME | TITLE |
|---|---|---|
| Dar es Salaam | Mr. D. Sungusia | National FSR Coordinator |
| Ilonga | Mr. A. Mwanjali | Zonal Agronomist & Coordinator |
| Ilonga | Mr. W. Sumari | Zonal Economist |
| Ilonga | Mrs. L. Mushi | Field Trials Officer |
| Ilonga | Mr. F. Nkamu | Field Trials Officer |
| Ilonga | Mr. J. Mamkwe | Field Trials Officer |
| Ilonga | Mr. S. Mndolwa | Field Trials Officer (joint with National Sorghum Program) |
| Ilonga/Hombolo | Mr. A. Chilagane | Agricultural Engineer/District Coordinator |
| Hombolo | Mr. O. Kitundu | Field Trials Officer |
| Lyamungu | Mr. T. Samki | Zonal Economist |
| Lyamungu | Mr. V. Akulumuka | Zonal Agronomist |
| Lyamungu | Mr. D. Mallya | Field Trials Officer |
| Lyamungu | Mr. S. Swai | Field Trials Officer |

In addition to building a team of FSR staff, the Project succeeded in attracting cooperation from researchers in the commodity programs. Table V and VI provide the list of TARO personnel who cooperated on joint experiments and planning with the Project.

TABLE V. TARO PERSONNEL INVOLVED IN JOINT EXPERIMENTS

| POST | NAME | TITLE | PROGRAM AFFILIATION |
|---|---|---|---|
| Ilonga | Mr. I. Mhando | Soil Chemist | National Soils Service |
| Ilonga | Mr. R. Chambuya | Entomologist | National Grain Legumes Program |
| Ilonga | Dr. J. Kabissa | Entomologist | National Cotton Program |
| Lyamungu | Mr. P. Matowo | Agronomist | National Maize Program |
| Lyamungu | Mr. O. Mbuya | Agronomist | National Bean Program |
| Lyamungu | Mr. E. Koinange | Breeder | National Bean Program |
| Lyamungu | Mr. I. Kullaya | Soil Chemist | National Coffee Program |

TABLE VI. TARO PERSONNEL WHO PARTICIPATED IN PLANNING MEETINGS AND DISCUSSIONS

| POST | NAME | TITLE | PROGRAM AFFILIATION |
|---|---|---|---|
| Ilonga | Dr. A. Moshi | Breeder | National Maize Program |
| Ilonga | Dr. G. Mitawa | Agronomist | National Sorghum Program |
| Ilonga | Mr. H. Saadaan | Breeder | National Sorghum Program |
| Ilonga | Mr. F. Mbowe | Agronomist | National Grain Legume Program |
| Moshi | Mr. D. Kessy | Agronomist | National Coffee Program |

Another group of individuals who actively contributed their expertise to Project management through the National FSR Committee, as well as through other means. They are listed in Table VII.

TABLE VII. NATIONAL FSR COMMITTEE MEMBERS

| NAME | AFFILIATION |
|---|---|
| Dr. F.A. Shao | Ministry of Agricultural and Livestock Development |
| Mr. S.A.N. Muro | Ministry of Agricultural and Livestock Development |
| Mr. M.N. Polepole | TARO |
| Dr. J.N.R. Kasembe | TARO |
| Mrs. F.F. Malima | Ministry of Agricultural and Livestock Development |
| Dr. G.H. Semuguruka | TARO |
| Dr. A.J. Moshi | TARO |
| Dr. R. Kikopa | Ministry of Agricultural and Livestock Development |

A final group which was critical to the successful implementation of an adaptive research program over large and diverse geographical areas were the village- and district-based extension personnel. Table VIII shows personnel who were assigned and participated in Project field work.

TABLE VIII: EXTENSION PERSONNEL WORKING WITH FSR PROJECT

| POST | NAME | TITLE |
|---|---|---|
| Kilosa District | Mr. P. Kichelere | District Agricultural Development Officer |
| Kilosa District | Mrs. J. Kaganda | Extension Agent |
| Dodoma District (Urban) | Mr. R. Matary | District Agricultural Development Officer |
| Dodoma District (Urban) | Mr. J. Mindolo | Assistant DADO |
| Dodoma District (Rural) | Mr. H. Kisoli | DADO |
| Dodoma District (Rural) | Mr. T. Maembe | Assistant DADO |
| Moshi District | Mrs. Mushi | DADO |
| Moshi District | Mrs. N. Isangya | Assistant DADO |

Supplementary PL480 funds were used to fund supporting investigations in Tanzania utilizing existing expertise in the country. Table IX lists the individuals who contributed to the Project in this way.

TABLE IX. SHORT-TERM IN-COUNTRY ADVISORY SERVICES

| DATE | NAME | MONTHS | TASK |
|---|---|---|---|
| 1985 | Mr. D. Sungusia Extension Specialist, TARO, in conjunction with Mr. David G. Acker, Extension Specialist Oregon State University | 1 | Conducted study of the role of extension in FSR in Tanzania. |
| 1985 | Dr. I. Minde, FSR Economist- Sokoine University of Agriculture, in collaboration with Mr. M.T. Mtoi, FSR Economist, Sokoine University of Agriculture, and Dr. Larry Lev | 3 | Reviewed FSR literature in Tanzania. Production of annotated bibliography. |
| 1985 | Mrs. V.F. Malima, Ministry of Agriculture and Livestock Development, in collaboration with Dr. Jean R. Kearns | 1 | Planned "Women in Farming Systems Survey." |
| 1986 | Dr. I. Minde, Economist, Sokoine University of Agriculture | 1 | Marketing in Kilosa District |
| TOTAL | | 6 | |

The Project began with a relatively large team of expatriate technical assistants and a relatively small cadre of Tanzanian personnel. Over the course of the Project, as the FSR/E approach became more widely accepted, additional Tanzanian staff were assigned. By the end of the Project, a capable group of more than 32 full- and part-time people were running the program with the assistance of one expatriate advisor. Table X displays the involvement of both expatriate and Tanzania personnel in the Project.

TABLE X.

INVOLVEMENT OF U.S. AND TANZANIAN PROFESSIONAL PERSONNEL DURING THE PROJECT

| | 1983 | 1984 | 1985 | 1986 |
|---|---|---|---|---|
| RESEARCH | | | | |
| U.S. Full-time | 2 | 4 | 2 | 1 |
| Tanzania Full-time | 0 | 2 | 12 | 12 |
| Tanzania Part-time | 4 | 6 | 11 | 11 |
| EXTENSION | | | | |
| U.S. Full-time | 0 | 0 | 0 | 0 |
| Tanzania Full-time | 0 | 0 | 0 | 0 |
| Tanzania Part-time | 0 | 0 | 20 | 20 |
| RESEARCH HEADQUARTERS ADMINISTRATION | | | | |
| U.S. Full-time | 1 | 1 | 1 | 1 |
| Tanzania Full-time | 0 | 0 | 1 | 1 |
| Tanzania Part-time | 1 | 1 | 0 | 0 |

The Project was supported by a number of USAID/T Agriculture and Rural Development personnel throughout it's lifetime. Table XI shows the names of individual officers assigned to the Project by time period.

TABLE XI. USAID PROJECT OFFICERS ASSIGNED TO THE PROJECT

| NAME | APPROXIMATE PERIOD |
|---|---|
| Michael Fuchs-Carsch | 1981 - 82 |
| Ron Harvey | 1982 - 83 |
| Ken Lyvers | 1983 - 84 |
| Jerry Rann | 1984 - 85 |
| Joel Strauss | 1986 |

3. Support Staff

The U.S. Project office operated within the Office of International Agriculture (OIA) at Oregon State University. Under the direction of Mr. Kenton Daniels, the OIA centralized support staff provides service to all international Projects which include those in the Yemen Arab Republic, Sri Lanka, Rwanda, Tunisia, Malawi, Bangladesh, Oman, and Tanzania. OIA support staff functions and responsible personnel are displayed in Table XII.

TABLE XII. OIA SUPPORT STAFF

| Section | Personnel | Functions |
|---|---|---|
| Travel | Lolita Encinas | Duties included making arrangements for all international and U.S. domestic travel and handling all travel reimbursements. |
| Accounts | Al Arp, Karen Steele, Jerry McGuire, Joan Wood | Duties included all functions related to Project accounting. |
| Commodities/ Shipping | Janet Faulk, Traci Klink Gale Tsuruya | Duties included procurement and shipping of Project commodities purchased under the contract and shipment of personal effects. |
| Participant Training | Julie Monk, Jim Lenhart | Duties included administrative support services for all participant trainees financed under the contract. |
| Personnel | Donna Castillo | Duties included recruitment, screening and processing of long- and short-term personnel. |
| Secretarial/ Administrative | Bobbi Weigman | Duties included word processing, telex communications, and general administrative responsibilities. |
| Mailing Services | Jim Lenhart | Duties included packaging of mail and record keeping. |

## B. COMMODITY PROCUREMENT

Requests for Project commodities originated in the field and were based on the expressed needs of TARO and the Project technical assistance team. Such requests were processed by the purchasing and shipping section of OIA. The following commodities were purchased and shipped during the Project period (detailed specifications are available in Project inventory):

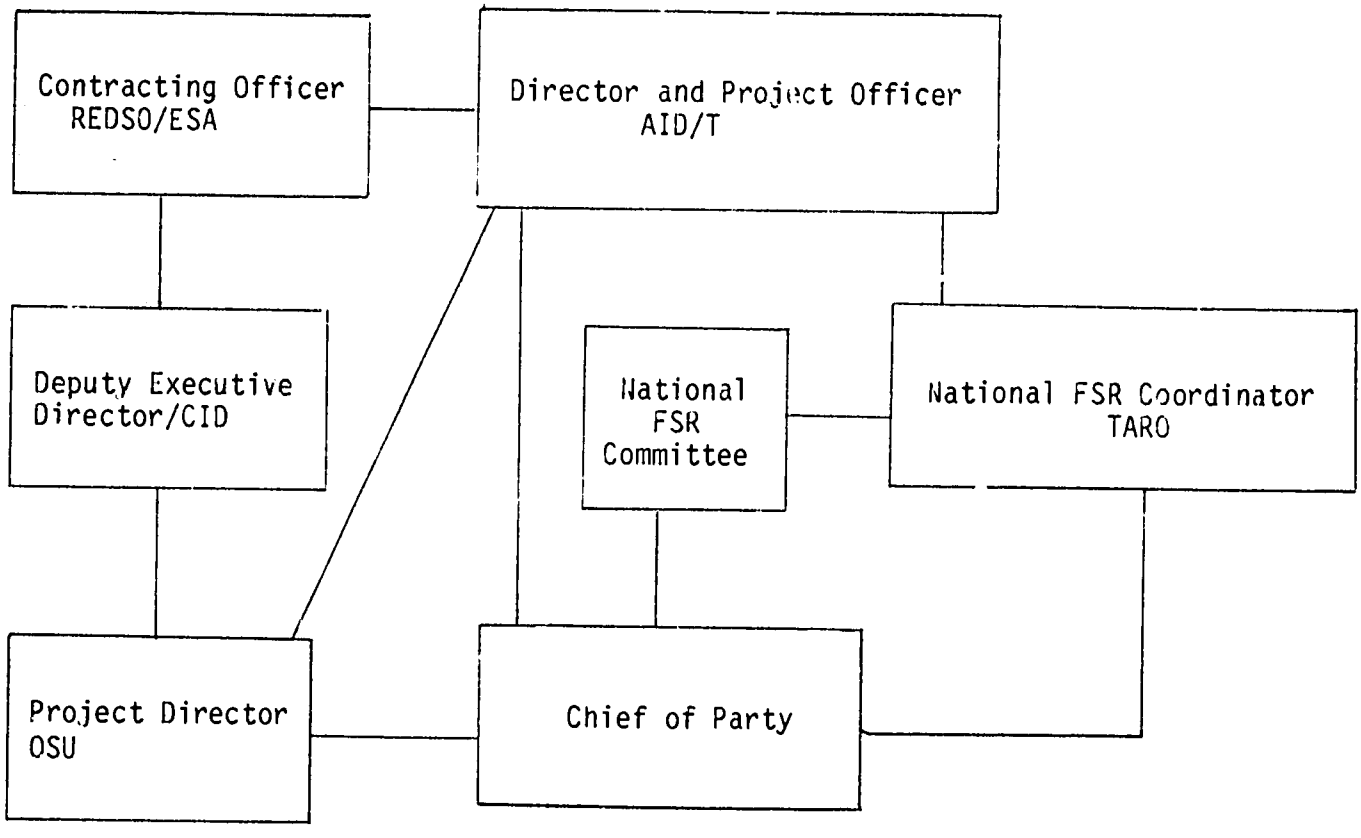
Photocopy Machines(2)
Photocopy Machine Supplies
Mimeograph Machine (double width)
Mimeograph Machine Supplies
Stationery
Dot Matrix Printers (5)
Emergency Kits for Vehicles
Books (102 Titles)
Computer Spares
Computer Supplies
Printer Supplies
Printer Spares
Computer Software
Filing Drawers
Stabilizers
Transparencies
Land Rover Seat Belts
Film
Microcomputer (256K)
Microcomputer (256K)
Microcomputer (10MB)
Computer Paper
Mimeograph Paper

Professional Journals
Rain Gauges
Auto Parts
Motorcycle Helmets
Batteries
Stencils
Calculators
Slide Trays
Surge Protectors
Cultivators (3)
Report Binding Supplies
Soil Testing Supplies
Typewriters
Motorcycles
Desks
Assorted Field Research Supplies
Assorted Office Supplies

C. MANAGEMENT AND COMMUNICATIONS

Regular communications among and between field personnel, AID/T, TARO, OSU and CID contributed to efficient management of Project inputs. Such communication also facilitated the relatively precise management required under conditions where funds and other resources are scarce. Regular communication links contributed to a collaborative management environment incorporating the needs and abilities of all major stakeholders in the Project. Figure I illustrates the communications network of Project stakeholders:

FIGURE I. PROJECT MANAGEMENT NETWORK




Telex services provided the primary means of communications to and from the field. Telephone contact with the technical assistance team in Tanzania was made approximately three times per month during the Project period.

The on-site working meetings between key contract personnel were an important complement to such long distance communication. Frequent working field visits were made by Dr. Jean R. Kearns, Dr. Frank Conklin, and Mr. David G. Acker. Additionally, the Chief of Party met in the United States with the CID Management Team and the OSU administrative support staff.

## IV. FARMING SYSTEMS RESEARCH FIELD ACCOMPLISHMENTS

### A. INTRODUCTION

In Tanzania, as in many other African countries, Farming Systems Research (FSR) represents a recent addition to existing commodity research programs. This section summarizes the work accomplished by the FSR teams over the three-year life span of the USAID-sponsored FSR Project within the Tanzanian Agricultural Research Organization (TARO).

The performance of the Tanzanian agricultural sector, which is crucial to the national economy, has been poor in recent years with food crop production, in many instances, falling dramatically. Agricultural research has been saddled with its share of the blame. The authors of "The Tanzanian National Agricultural Policy" (1982, p.44) bleakly noted:

> The current situation in agricultural research is that, apart from the serious research efforts being made at the Wheat Research Station in Arusha and at Uyole Agricultural Centre, there is virtually no research activity being undertaken in all the other stations.

The objectives of the FSR Project were to begin to overcome these perceived problems through a pilot scale intervention. The success of the Project can be measured in terms of three factors:

1) Technologies developed and tested;

2) Personnel trained; and

3) Attitude towards FSR on the part of commodity researchers, extensionists, and farmers.

The Project Team played a key role in mobilizing the inputs necessary to productively carry out an applied research effort. These inputs included:

1) Expatriate staff;
2) Tanzanian personnel;
3) U.S. and Tanzanian funds; and
4) The FSR methodology.

The mobilization of Tanzania personnel and Tanzanian shilling funds played an important role in permitting the Project to move ahead. The work plan which we formulated was based upon a single overarching principle - - the FSR section should only initiate work in districts where it would be able to ensure that at least one entire cycle of FSR activities (diagnosis, planning, experimentation, and evaluation) would be completed before the end of the Project. Based upon this principle, the six primary districts were reduced to three (Kilosa, Dodoma, and Moshi). Since they represent such diverse agro-ecological zones, independent FSR workplans were derived for each.

The emphasis which we have placed upon completing a cycle of experimental work is important for two reasons. First it provides a demonstration of what the FSR approach can accomplish. If, for example, the Project had focused on carrying out as many diagnostic studies as possible, outside evaluators would have no means of assessing the value of the FSR approach as a complement to existing research. Secondly, and of equal importance, the approach taken permitted us to provide on the job training in all phases of the research process to the FSR section staff.

The FSR/E approach and methods are intended to complement rather than replace on-going commodity research. The experience of the Project has been that FSR succeeds best where there is a strong base of commodity research to build upon. Thus any credit for the development and dissemination of a new technology must be shared among those who participate at all the different stages of the process.

The power of the FSR/E approach is that it draws together many different participants to work on a common effort. This is in contrast to the previous situation in which the individual commodity groups worked in relative isolation and social scientists were largely excluded from direct involvement in the process of technology development and dissemination. A good example of this latter point is the plethora of survey research activities conducted in both Moshi and Kilosa District, none of which had had any impact on the commodity researchers.

The differences between FSR and commodity research are outlined in Table XIII.

TABLE XIII. HOW FSR/E DIFFERS FROM COMMODITY RESEARCH

| | Commodity Research | FSR/E |
|---|---|---|
| APPROACH: | Single discipline or crop orientation. | Multidisciplinary (social and technical sciences) and holistic in scope. |
| OBJECTIVE: | Maximum exploitation of biological potential of individual crop. | Multiple objectives which reflect problems, opportunities and goals of the farmer. |
| PARTICIPANTS: | Researchers. | Researchers, extensionists, and farmers. |
| EXPERIMENTAL METHODS: | Research conducted on-station following standardized procedures, with non-experimental variables often set at "optimum" levels. | Research often conducted on farmers' fields, with non-experimental variables often set at farmers' levels. |
| EVALUATION: | Maximum output per unit of land. | Complex. Based upon:<br>- biological feasibility<br>- economic viability<br>- labor requirements<br>- risk<br>- systems compatibility<br>- tastes and preferences |
| FINAL OUTPUT: | Component technology which must be fine-tuned before dissemination. | Intervention adapted for a particular target group and ready for dissemination. |

The stages in the FSR/E process and the participants and locations are indicated in Table XIV. The on-farm experiments represent the principal focus of the research effort. The supplementary on-station experiments can be classified into three categories. First, there are those experiments which represent on-station replications of on-farm experiments. These serve as a valuable supplement to the information gathered from the on-farm trials. A second category consists of exploratory trials on subjects for which little existing information is available. In many instances, it is possible to generate this initial data more easily and inexpensively on the research station. The final category of on-station experiments consists of politically sensitive trials which involve cropping practices which are not currently approved by local political authorities (such as maize/cotton intercropping).

Throughout the FSR/E process the participants undergo a profound change in their traditional roles. The researchers spend much more time in learning and cooperating with others. The extension officers and farmers become full participants in the technology generation process rather than respectively providers and recipients of information.

In the district reports which follow, the emphasis will be placed on providing a summary of the experimental results generated to date. Considerable descriptive and other data are available in the Project documents which are available for each district (see Appendix A). The annual district research reports provide detailed statistical information about the results of the individual experiments.

TABLE XIV. PARTICIPANTS AND ACTIVITIES BY STAGE IN THE FSR PROCESS

| STAGE | DIAGNOSTIC/ DESCRIPTIVE | DESIGN | TESTING | EVALUATION | DISSEMINATION |
|---|---|---|---|---|---|
| By Whom | FSR Team<br>Farmers<br>Extension<br>Commodity Researchers<br>Political Leaders | FSR Team<br>Commodity Researchers<br>Extension<br>Farmers<br>Political Leaders | Farmers (OFR)<br>FSR Team (FSR)<br>Cooperating Researchers<br>Extension | Farmers<br>FSR Team<br>Cooperating Researchers<br>Extension<br>Commodity Researchers<br>Political Leaders | Farmers<br>Extension<br>FSR Team<br>Political Leaders |
| Where | Villages<br>Research Station | Research Station<br>Villages | Villages<br>Research Station | Villages<br>Research Station | Villages<br>District |
| What | Zonation<br>Farmer Objectives<br>Farmer Problems<br>Hypothesis Formulation<br>Available Technologies | Prioritization<br>Hypothesis Refinement<br>Brainstorming | Application of Scientific Methods<br>Data Gathering | Questionnaires<br>Village Meetings<br>Statistical Analysis | Word of Mouth<br>Demonstrations<br>Pamphlets<br>Meetings |

## B. KILOSA DISTRICT

Kilosa District is one of five districts in Morogoro Region. The terrain is flat to rolling hills over much of the district rising to the Kaguru mountains on the west and the Uluguru mountains on the east. A number of rivers and streams traverse the district giving rise to frequent valley bottoms.

Within the district, the decision was taken to concentrate the initial research activity on the lowland area located within an approximate thirty kilometer radius of Ilonga A.R.I. Within this restricted area, the quantity and reliability of rainfall decreases as one moves from south to north.

Maize, cotton, and rice are the principal crops grown, but they are supplemented by a wide variety of secondary crops. The overall farming system could be characterized as extensive rather than intensive crop production and little livestock production.

The size and experience of the FSR staff at Ilonga A.R.I. has permitted the Kilosa district research program to be the largest and strongest of the three district programs. Over the three years of the Project, all five phases of the FSR/E process were initiated by the FSR team. By September, 1986, substantial support for the FSR approach had been developed among area farmers and political leaders.

The proximity of Kilosa district to both Ilonga A.R.I. and the Sokoine University of Agriculture in Morogoro has made it a frequent site for socioeconomic studies. Only on rare occasions, however, have the results of these studies served directly as inputs to applied agronomic research in the area. The FSR effort, which began in 1983, sought to overcome this shortcoming through the institution of a single, well-directed effort in which information would be continuously updated and used as an input to the experimental program.

The research process followed the standard FSR process of beginning with a rapid reconnaissance survey followed by a more directed verification survey which focused in on potential research opportunities.

Over the last two years (four seasons), the FSR team has conducted experiments both on farmers' fields and on the research station. The on-farm experiments represent the heart of the program and have involved approximately fifty farmers a year in a total of twelve villages. In addition, many hundreds of other farmers have participated in FSR outreach activities (primarily the sale and distribution of Kito maize seed).

Since detailed experimental results are available in the papers presented at the National Crop Coordinator's Conference over the last two years, they will not be presented here. Furthermore, instead of reporting the results on an experiment by experiment bases, the results and their interpretation will be classified in the following four categories:

1. Comparative results for maize production during the Vuli and Masika seasons;
2. Crop sequencing experiments;
3. Agronomy
   a. Density;
   b. Intercropping; and
4. Soil fertility.

1. Maize Production in the Vuli and Masika Seasons

The most significant discovery during the diagnostic phase of the research was that, in sharp contrast to the researchers at Ilonga A.R.I. who focused virtually all of their experimental work during the Masika (main) rains (February through May), area farmers relied heavily on crop (specifically maize) production during the Vuli (short) rains which last from November through January. Although rainfall during Vuli is lower and more variable than during Masika, the farmers have established this production pattern for a number of reasons. First, maize is their preferred staple and by planting it early, they harvest it early. Typically the farmers who plant in November can begin to eat green maize in February and can harvest dried maize early in March. Maize planted during the main rains will only be consumed from late May onward. Second, planting maize early is a risk reducing strategy since, if the short rains are poor or other problems arise, the farmer still has an opportunity to replant for the main rains. Third, by planting early, the farmer reduces the competition between maize and the two other important crops in the system -- rice and cotton. Whereas rice has to be planted when the rains are well established but still have a long way to go (hence a December/January planting) and cotton must be planted so that it matures in dry weather (January - March), maize will produce adequately (if perhaps not optimally) when planted at a variety of times throughout the growing season.

This improved understanding of farmer preferences and objectives permitted the FSR Team to recognize the newly released, but largely unknown, Kito maize variety as an attractive innovation for area farmers. In comparison to the most frequently grown existing varieties, Kito had a shorter maturity (90 as opposed to 120 days) and a lower yield potential (30% less

in on-station trials). Based upon farmer interviews, it was felt that Kito would gain acceptance because:

a. The farmer would be able to harvest his/her initial crop in February which is one month earlier than a full season crop planted in November and four months earlier than a full season crop planted during the "optimal" period identified by research.

b. The use of the short season variety would open up the possibilities for crop production during the main rains and thereby improve land and labor use.

c. The possibilities for total crop failure would be reduced since the farmer has a second chance if the Vuli maize should fail.

d. The potential for intercropping would be increased due to the smaller stature of Kito.

In this section we will review our findings with respect to the relative merits of growing maize during the Vuli and Masika seasons. The role of Kito in transforming sequential cropping patterns will be more fully studied in section 2, while the potential of Kito in intercropped systems is examined in section 3(a).

Table XV presents the actual monthly rainfall for the 1984/85 seasons and the 30 year average monthly rainfall for Ilonga A.R.I. The year to year variations in rainfall pattern are substantial and represent one of the major risks faced by farmers. In both seasons, crop success was highly dependent upon planting date as there were mid-season moisture stress periods.

TABLE XV. MONTHLY RAINFALL AT ILONGA A.R.I. (in mm.)

| Year | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Total |
|---|---|---|---|---|---|---|---|---|---|
| 1984/85 | 64 | 213 | 117 | 177 | 140 | 129 | 161 | 86 | 1087 |
| 1985/86 | 0 | 80 | 148 | 216 | 90 | 191 | 136 | 60 | 921 |
| 27 year average | 36 | 78 | 142 | 142 | 125 | 201 | 217 | 74 | 1015 |

The most striking result of the experimental work to date is that during this two year period on-farm maize yields (for all varieties) have been superior during the Vuli rains. The lower Vuli rainfall appears to be offset by other factors which include the initial nitrogen flush received by crops during Vuli, the much increased incidence of maize streak virus during the Masika rains, and the better management (due to reduced competition for labor) which the Kilosa farmer gives to the Vuli maize crop. Visual assessment of the crops in the field has indicated healthier, more vigorous growth during the Vuli. Thus, purely on a yield per hectare basis, the farmers' traditional practice of planting maize early has been shown to be quite rational.

An on-station time of planting trial conducted during the 1984/85 cropping year provided a similar result with the Vuli planting having the higher yield. This experiment must, however, be run over a longer time period before any firm conclusions can be drawn. It should be noted that since fertilizers are used and labor constraints are not a consideration, two of the principal on-farm advantages of Vuli maize are not captured in this on-station experiment.

Field comparisons and farmer assessments of the different maize varieties during the Vuli season has shown a broad similarity in yields between short season and full season varieties (Table XVI) with an average advantage of only 8% for the full season variety. In contrast, the on-station advantage for the full season variety (derived from averaging across a number of experiments) is 27%. Once again this experiment must be continued in order to determine what the difference will be when averaged over a greater number of years.

TABLE XVI. A COMPARISON OF ON-FARM AND ON-STATION MAIZE YIELDS DURING THE VULI SEASON (kg/ha)

| | On-Farm | | | On-Station | |
|---|---|---|---|---|---|
| | Kito | Local | Staha | Kito | Staha |
| 1984/85 | 1562 | 1765 | X | 2050 | 2570 |
| 1985/86 | 1860 | X | 1920 | 1140 | 1480 |

X= not grown

In many respects it is perhaps more appropriate to compare the yields of the different maize varieties on a per growing day basis. This method of comparison reflects the fact that the Kilosa farmer generally seeks to make use of the same field for a Masika season crop. It is in this comparison (Table XVII) that the 90-day Kito variety demonstrates its attractiveness when compared to the 120-day, full season varieties.

TABLE XVII. MAIZE YIELD IN KILOGRAMS PER GROWING DAY DURING THE VULI SEASON

| | On-Farm | | | On-Station | |
|---|---|---|---|---|---|
| | Kito | Local | Staha | Kito | Staha |
| 1984/85 | 17.3 | 14.7 | X | 22.8 | 21.4 |
| 1985/86 | 20.6 | X | 16 | 12.7 | 12.3 |

When the data are presented in this fashion, it is not surprising that Kito represents the overwhelming choice of farmers. The shorter maturity of Kito speeds the harvest by 30 days. In some Kilosa villages, Kito has been dubbed "Mkombozi" or the "Liberator" for its ability to ease the stress of the hungry period.

It is important to note, however, that many farmers have indicated that they would choose to plant multiple varieties during Vuli and thereby reduce their risk of crop failure. In so doing, farmers are recognizing that varieties with different maturities would not all suffer from a given dry spell. One innovation seen on several fields and subsequently tested at the research station is the growing of maize varietal mixtures. No firm conclusions are yet available on this practice.

All in all, farmer reaction to the Vuli season maize production experiments has been extremely enthusiastic. In preparation for the 1985/86 and 1986/87 Vuli seasons, the FSR team assisted the extension staff in obtaining and distributing Kito seed to hundreds of local farmers. During the 1986/87 Vuli season, the team will assist individual farmers who wish to grow ordinary grade seed for sale. This should serve to meet the burgeoning demand for seed which the government seed farms

have been unable (or unwilling) to meet and represents a good example of the FSR team operating well beyond a traditional research role.

Both the Masika season production results and their interpretation by participating farmers present a sharp contrast. The maize breeding program has for many years focused on Masika growing conditions. As a result the researchers established resistance to maize streak virus as its top priority. The on-farm trials conducted during the 1984/85 season (Table XVIII) demonstrated that the released, streak-tolerant variety (Staha) provided a two-to-one yield advantage over local varieties which are quite susceptible to this disease. During the 1985/86 season, the experimental variety EV8311B was added to the varieties tested and showed itself to be superior to Staha under Masika conditions.

TABLE XVIII. MASIKA ON-FARM VARIETAL EVALUATION TRIAL (tons/ha)

| | Kito | Local | Staha | EV8311B |
|---|---|---|---|---|
| 1984/85 | X | 0.70 | 1.48 | X |
| 1985/86 | 0.84 | X | 1.06 | 1.38 |

X = not grown

Despite the demonstrated superiority of the new full-season varieties, the participating farmers remain largely unimpressed. Since they grow relatively little maize during the Masika season, they did not compare the Staha or EV8311B yields to yields obtained with traditional varieties but rather to their alternative uses of land and labor during Masika. Their comments indicate that the yield levels achieved probably are not sufficient to compete with the dominant rice and cotton enterprises during that period. This has provided an excellent example of the importance of obtaining farmers' evaluation of the outcome of trials rather than solely examining the statistical results.

A second interesting outcome of the Masika testing program has been the performance of Kito during that season. The original impetus for the development of Kito was the desire for a shorter maturity "catch-up" variety which could be used when the farmer was delayed in planting during Masika. Data from the last two years, however, demonstrate that Kito, due to its susceptibility to maize streak virus, does not perform well during Masika. Thus, many farmers who have tried Kito during the Masika now view it as almost exclusively a Vuli season crop.

2. Crop Sequencing

The FSR team's realization that Vuli season maize production could provide an important contribution to the family's food supply represents one aspect within the overall focus on the importance of sequential cropping patterns under the prolonged rainfall conditions of Kilosa district. Specifically, both the FSR team and local farmers quickly realized that the introduction of a shorter maturity maize variety during Vuli would provide new opportunities for crop production on the same piece of land during Masika.

Farmers who participated in the 1985/86 experimental program were instructed to follow the Vuli season maize crop with either cotton, maize, or cowpeas on the same piece of land in the Masika.

The first two (cotton and maize) represent relay cropping experiments since the Masika crop must be established before the initial maize crop is removed. Cowpeas have a shorter maturity and can be double cropped. Although relay cropping is a traditional practice, it is officially discouraged because of the fear that yield of the second crop (generally cotton) will be reduced.

The principal advantage of relay cropping under Kilosa conditions is that considerable land preparation labor can be saved during the establishment of the second crop. If, as the government suggests, the second crop is planted on newly prepared land, the farm family must remove three months of unchecked weed growth in the midst of a rainy and busy part of the growing season.

The 1985/86 season marked the first time in which maize/cotton relay cropping experiments were planted. The experiments focused on two issues:

1. Documenting the yield levels obtained from the two crops; and
2. Comparing the cotton yields obtained following Kito (short maturing ) and Staha (full season variety) maize.

The maize yields were presented above in Table XVI, and indicated a modest advantage for Staha (only 8% from the on-farm trials). The cotton yield results of the on-farm and on-station trials are presented in Table XIX.

TABLE XIX. COTTON YIELD (kg/ha) OBTAINED FROM 1985/85 MAIZE/COTTON RELAY CROPPING TRIAL

| | On-Farm | | | | On-Station | | |
|---|---|---|---|---|---|---|---|
| Initial Maize Variety | Kito | Staha | Mean | | Kito | Staha | Mean |
| | 908 | 734 | 821 | : | 1332 | 696 | 1014 |
| % increase in yield | 24% | | | : | 91% | | |

The overall higher yield of cotton from the on-station trial (1014 kgs/ha vs. 821 kgs/ha) is a function of better management in terms of weeding, spraying, and fertilizer application. The greater increase for cotton relayed into Kito from the on-station trials provides an upper bound to the returns which can be realized from the cotton enterprise relayed into Kito. Both the on-station and on-farm trials results as well as farmer comments indicate that there is little difference in cotton yields for cotton relayed within Kito in comparison to cotton planted on land freshly prepared for the Masika season.

As an overall package, the Kito/cotton relay combination provides an increase in the value of production from the field of 20% from the on-farm trial, and more than 60% from the on-station trial during the 1985/86 season. If these figures are confirmed in future years, the promotion of this pattern of relay cropping should be initiated.

The results of these experiments must however be interpreted with caution because of the need for more detailed data relative to the following two issues:

1. The possibility for a decrease in cotton yields due to a buildup of insects passed along from the maize; and
2. The potential for a decline in soil fertility associated with the increase in cropping intensity.

Other less important options for Masika season crops to follow an initial Vuli maize crop include maize and cowpea. Due to timing considerations, the maize crop must be relayed within the first season crop and thus Masika yields will be increased through the planting of Kito in Vuli. One on-farm observation provided the following results:

TABLE XX. MAIZE/MAIZE RELAY CROPPING (tons/ha.)

| Masika Maize Variety | Vuli Planted Maize Variety | | |
|---|---|---|---|
| | Kito (short) | Staha (full season) | Mean |
| Kito | 0.90 | 0.64 | 0.77 |
| Staha | 2.76 | 1.36 | 2.06 |
| EV8311B | 3.34 | 1.50 | 2.42 |
| ICW | 2.04 | 1.08 | 1.56 |
| Mean | 2.26 | 1.15 | 1.70 |

These results (an almost doubling of second season maize yield) indicate that Masika maize may profit even more from the switch to Kito for Vuli than does cotton.

In order to better evaluate other relay cropping possibilities, an on-station trial which also includes cassava, sorghum, and pigeon peas has been added for the 1986/87 season.

3. Agronomy

Under this heading a variety of experiments which examine plant density and intercropping will be reviewed. These interventions have been inconclusive to date.

a. Density

At the beginning of the on-farm trials program, there was a widespread belief that lower than optimal plant density for maize represented a major factor contributing to the low yields achieved by farmers. While the on-farm work has confirmed that farmer densities are in fact lower (27,000 plants per hectare versus a recommended 44,000 and 66,000 plants per hectare for full and short maturity maize varieties respectively), the trials conducted over the past two years have not demonstrated that large yield increases are associated with changes in density. The following three tables present the results obtained in each season beginning with the 1984/85 Masika season.

TABLE XXI. 1984/85 ON-FARM MASIKA MAIZE DENSITY TRIAL (tons/ha.)

| Density Level | Staha | Local |
|---|---|---|
| 24,700 | 1.75 | 0.53 |
| 34,200 | 1.63 | 0.57 |
| 44,400 | 1.80 | 0.73 |
| Mean | 1.73 | 0.61 |

TABLE XXII. 1985/86 ON-FARM VULI MAIZE DENSITY TRIAL (tons/ha.)

| Density Level | Kito | Density Level | Staha |
|---|---|---|---|
| 29,600 | 1.70 | 24,700 | 1.91 |
| 41,000 | 1.80 | 34,000 | 2.12 |
| 55,000 | 2.00 | 40,400 | 2.16 |
| Mean | 1.83 | | 2.06 |

TABLE XXIII. 1985/86 ON-FARM MASIKA MAIZE DENSITY TRIAL (tons/ha.)

| Density Level | Kito | Staha |
|---|---|---|
| 24,700 | 1.23 | 1.35 |
| 34,200 | 1.54 | 1.15 |
| 44,400 | 1.50 | 1.41 |
| Mean | 1.42 | 1.30 |

When a comparison is made across variety and season the increase in yield achieved when going from the lowest to the highest density level is .19 tons or 13% (from 1.41 tons for the low density to 1.60 tons for the high density). This was neither a statistically significant nor a consistent advantage as in many instances lower densities provided higher yields. Farmer comments have indicated that most of them do not consider this increase to be sufficient to convince them to adopt the higher density level. They are quite concerned with increased labor requirements for planting and weeding, as well as the higher seed costs associated with the higher density. A secondary concern is the higher probability of crop failure as a result of moisture stress.

b. Maize/Legume Intercropping

In comparison to other areas of Tanzania, the percentage of maize acreage which is intercropped with grain legumes in Kilosa is relatively small. Substantial on-station research conducted by the National Grain Legume Program had demonstrated impressive results for these crop combinations. The introduction of the shorter stature Kito maize variety was regarded as further enhancing the possibilities for intercropping. In light of this, the FSR team established increased intercropping as a priority intervention prior to the 1984/85 season.

Farmer performance and reaction has not, however, been erthusiastic. One factor is that during the 1984/85 season many of the grain legume plots were destroyed by an elegant grasshopper attack which focused on these crops and left the maize largely unaffected. Farmer reluctance to intercrop during the Vuli, however, goes beyond the elegant grasshopper problem. Simply stated, cowpea and green grain are not high priority crops and thus farmers are not willing to complicate their Vuli season production through the introduction of a grain legume intercrop which will require an additional six trips to the field. The

commodity based on-station work has not adequately accounted for the increased labor and management requirements. In an FSR managed on-station trial the inclusion of cowpeas as an intercrop resulted in a 50% increase in labor requirements over the alternative of sole cropped maize. It is questionable whether the farmers would value the five bags of cowpeas obtained that highly.

A second attempt to find a viable intercropping scheme focused on an on-station experiment that examined the potential for a reorganization of the planting arrangement of the two crops through the pairing of rows of each crop. Under the new configuration it was felt that the reduced shading of the cowpeas would permit that crop to more nearly approach its sole crop yield. Secondly, the planting arrangement would also allow a later planting date for the cowpeas and thus permit them to escape the elegant grasshoppers which are an early Vuli season phenomenon. The results to date of this experiment have been largely inconclusive as both maize and cowpea yields have been similar under the single and paired row patterns. Since labor requirements are somewhat higher under the new paired configuration, it is unlikely that the new pattern will gain favor in Kilosa.

c. Cotton/Maize and Cotton/Cowpea Intercropping

In a previous section, the attractiveness of a maize/cotton relay cropping scheme was discussed. A related, but quite different, intervention which the FSR team has studied over the last two years is the possibility of simultaneously intercropping maize and cotton.

The diagnostic work carried out by the FSR team indicated that low cotton production should to a large extent be attributed to the lack of attention which farmers paid to the crop. As the weedings and sprayings declined, so did the cotton yields. As a result, the FSR

team began to examine ways of increasing the attractiveness of the cotton enterprise. The most significant step in this area has been work done on relay cropping cotton within Vuli maize (specifically Kito). A second area of potential importance, however, is the intercropping of either maize or cowpeas between the cotton rows. Earlier work conducted in the 1960's on maize/cotton intercropping revealed a substantial reduction in cotton yields. The results of the past two years of on-station experiments which are reported in Tables XXIV and XXV provide a different story.

TABLE XXIV. COTTON/MAIZE INTERCROPPING TRIAL (tons/ha.)

| | Cotton Sole | Kito(Cotton) | Kito Sole | Staha(Cotton) | Staha Sole |
|---|---|---|---|---|---|
| 1984/85 | 1.30 | 2.50 (0.90) | 2.60 | 3.20 (0.47) | 3.50 |
| 1985/86 | 1.27 | 1.13 (1.01) | 1.39 | 1.25 (0.78) | 1.36 |

Intercropped cotton yields are in ( )

When summed over the two years, the following results are generated:

TABLE XXV. COTTON/MAIZE INTERCROPPING IN COMPARISON TO SOLE COTTON

| | Cotton/Kito | | Cotton/Staha | |
|---|---|---|---|---|
| | 1984/85 | 1985/86 | 1984/85 | 1985/86 |
| Cotton yield as % of monocrop | 69% | 80% | 36% | 61% |
| Maize yield as % of monocrop | 96% | 81% | 91% | 92% |
| Total value of production as a % of sole cotton* | 151% | 117% | 141% | 103% |

* using 1986 crop prices

In each year, both the total value of production and the level of cotton production are higher in the cotton/Kito system. Whereas the farmers may be primarily concerned with the total value of production, the government has a decided preference for maintaining high levels of cotton production in order to earn foreign exchange. Thus, it is important to derive a production pattern which is acceptable to both. Cotton/Kito intercropping, with the same cautions as indicated above for maize/cotton relay cropping, may be such an intervention.

The initial work on cotton/cowpea intercropping was undertaken in an on-station trial conducted during the 1985/86 season. The assumed advantage of this intercropping combination is that both crops will profit from the same insecticide. Some farmers have been observed practicing a similar system but no on-farm data has been collected to date. An important potential benefit associated with the cowpeas is the maintenance or improvement in soil fertility levels which this crop provides.

As a result of moisture stress at the time of planting, the cotton crop was replanted too late in the season to produce a harvest. Observations of the interaction of cotton and cowpeas have produced a number of preliminary conclusions. First, it is clear that spreading cowpea plants overrun the cotton and will seriously reduce cotton yield and complicate management activities. Determinant cowpeas are less competitive with cotton but, because of their rapid maturity, their planting date must be delayed so that the cowpeas can benefit from the spray schedule adhered to for cotton. Once again the key question which must be addressed is whether the combined cotton/cowpea enterprise is sufficiently attractive to encourage improved farmer management.

4. Soil Fertility

A recent review of soil fertility experiments conducted over the last twenty years in Kilosa district revealed that few produced economic returns. Furthermore, the FSR team's diagnostic work indicated that only the small percentage of farmers growing irrigated onions are currently using fertilizers and that other farmers do not cite fertilization as a priority problem area.

Soil fertility related trials were none the less initiated for two reasons. First, it is quite possible that soil fertility levels are or will be declining even if farmers do not yet recognize this. Second, the increased use of organic sources of fertilizer has become a national priority based upon the report of impressive results from certain areas in Tanzania. There has thus been political pressure encouraging the rapid spread of this intervention.

The main focus of the soil fertility work has been on the integration of the green manure crop, Crotalaria Ochroleuca, into the cropping patterns of Kilosa District farmers. Crotalaria is a multi-purpose crop which not only fixes high levels of nitrogen in the soil, but also is believed to suppress weeds and is an excellent source of livestock feed.

The experiments conducted have examined the possibilities of both simultaneously intercropping Crotalaria and growing Crotalaria in a rotation with maize. The majority of this work has been carried out on the research station at Ilonga. The results of the intercropping trials which were carried out during both the Vuli and Masika seasons are presented in Table XXVI below.

TABLE XXVI. 1985/86 MAIZE/CROTALARIA INTERCROPPING TRIAL

| Season | Treatment | Yield(t/ha) | % Change From Mono Maize |
|---|---|---|---|
| Vuli | Mono maize | 1.73 | - - |
| Vuli | Maize/Crotalaria (same planting date) | 0.46 | - 73% |
| Vuli | Maize + Crotalaria after first weeding | 0.84 | - 51% |
| Vuli | Maize + cowpea after first weeding | 1.85 | + 07% |
| Masika | Mono maize | 1.07 | - - |
| Masika | Maize/Crotalaria (same planting date) | 0.16 | - 85% |
| Masika | Maize + Crotalaria after first weeding | 0.62 | - 42% |
| Masika | Maize + cowpea after first weeding | 1.04 | - 03% |

These results were confirmed on a larger plot in the on-station "economic analysis trial" in which the maize yield was reduced by 57% when Crotalaria was broadcast after the first weeding. In all of the trial plots it was clear that the Crotalaria competes quite fiercely

with the maize for water and nutrients. The reduction in maize yield was much higher than expected and effectively rules out farmer acceptance. One possibility is to delay the planting of the Crotalaria until after the second weeding, but this procedure would rule out planting during the Vuli season.

The rotation cropping experiment examined the yields achieved by successive Vuli and Masika maize crops which followed a Crotalaria crop in the previous Masika season. Summing across varieties and densities, the following results were obtained:

TABLE XXVII. MAIZE YIELDS FOLLOWING CROTALARIA

| Season | Following Fallow | Following Crotalaria | % Change |
|---|---|---|---|
| Vuli | 2.36 | 2.72 | 15% |
| Masika | 0.61 | 0.74 | 21% |
| Mean | 1.49 | 1.73 | 16% |

The relatively small increase in yield achieved is not sufficient to justify the land and labor use required for the establishment of the Crotalaria in the previous year. Thus, it is extremely unlikely that such a cropping pattern would be adopted. Overall the series of Crotalaria experiments have provided initial evidence that the exciting results achieved elsewhere in Tanzania are not directly transferable to Kilosa District. Unless future research results are substantially different, this intervention should not be disseminated in Kilosa District.

5. Feedback to Commodity Programs

One of the major objectives of the FSR section is to serve as a source of farmer feedback to the commodity programs in order to increase the relevance of the research carried out by those programs. This section briefly summarizes the most significant messages which have been brought back.

1. There should be a re-orientation of the maize program toward the testing of varieties and production practices during the Vuli season.
2. Emphasis should also be placed on the production of a streak resistant, early maturing variety which could be successfully grown late in the Masika season.
3. Increased emphasis should be given in the cowpea breeding program to the development of varieties which are large seeded and cream colored. Other characteristics, including maturity, may be less important.
4. The objective of the rice breeding program should include palatability and stability of yield rather than just mean yield. None of the currently released varieties will ever gain acceptance over the traditional Super India variety.
5. The cotton agronomy program should re-examine the suggested timing and frequency of the spraying schedule. Farmers feel that they can "reasonably" control pests with 3-4 sprayings versus the recommended 6-8.

In general, the FSR section has been influential in encouraging the other programs to broaden the factors which they use in evaluating new technologies.

## C. MOSHI DISTRICT

Moshi District, which is situated on the Tanzanian-Kenyan border, has been one of the most economically dynamic areas in Tanzania since early in this century. Mount Kilimanjaro and its slopes are the dominating features of the district. Cultivation occurs on the slopes of Kilimanjaro up to 2000 meters, as well as on the drier Sanya Plain, which has an average altitude of 800 meters.

Rainfall patterns vary considerably as a function of placement on the contour and distance from the mountain. Although peak rainfall occurs throughout the district during the month of April, both the average amount and reliability of rainfall are considerably higher on the mountain slopes than on the plains.

The Moshi District FSR Team is comprised of researchers located at Lyamungu A.R.I. and members of the Moshi District extension staff. The team, in agreement with previous research in the area, divided the district into three recommendation domains based upon altitude. These are the upper zone (above 1500 meters), the intermediate zone (900-1500 meters) and the lower zone (below 900 meters). This zonation captures a variety of differences including rainfall distribution and amount, cropping patterns, soil variations, and distance to the fields.

The initial focus of the FSR program was on farms in the densely populated intermediate altitude zone. Land use in that zone is dominated by coffee/banana intercropping with much of the remaining land devoted to the intercropping of maize and beans. Farm families also engage in intensive livestock production, small business activities, and farming on more distant lowland plots.

As a result of the food crop orientation of the National FSR Program, the district team chose to focus initially on the maize/bean enterprise. Within this enterprise, the maize crop, which is retained for home consumption, is viewed as the principal crop. The beans represent a combined food and cash crop and are accorded a lower priority.

Based upon our interviews and a review of production figures, it was clear that maize production is quite reliable as neither moisture stress nor disease pose problems for this crop. The principal maize production problems cited were the lack of available land and low soil fertility. Bean yields, in contrast, do vary quite markedly in response to the timing and amount of rainfall received and local outbreaks of disease and pests.

The on-farm and on-station which were executed during the 1985 and 1986 cropping seasons were planned in cooperation with the commodity researchers at Lyamungu A.R.I., the Moshi District extension staff, and the regional representative for the FAO fertilizer trials program.

Moshi District farmers have been in the market sector since the establishment of small holder coffee production more than fifty years ago, and thus they are quite used to selling outputs and buying inputs. The soils on the mountain slopes have been continuously cropped for many years and require fertilization in order to produce reasonable yields. Although Farmers regularly purchase both seed and fertilizer, by our best estimates they are only using half of the recommended fertilization rate. In terms of other practices, our research indicated that densities for both maize and beans were much lower than the current farmer recommendations (25,000 versus a recommended 44,000 plants per hectare for maize and 45,000 versus 136,000 plants per hectare for beans). The use of crop protection chemicals on both crops is spotty.

The details of the experiments conducted over the past two years are available in the papers presented to the National Crop Coordinator's Conference. In this review, the research work will be discussed in terms of three basic areas:

1. A fine tuning of the existing system through the manipulation of planting patterns, densities, and fertilization levels;
2. The introduction of a green manure crop; and
3. Interventions planned for lowland areas.

1. Fine Tuning

The on-farm trials program has received excellent support from area farmers over the past two years. In the first year the program focused on density issues, while in the second year the interaction between density and fertilization was considered. The results for maize and beans will be considered separately.

a. 1985 Density Experiment

In the initial year of experimentation, the maize density levels were specified at 34,000 and 44,000 plants per hectare. In addition, a density treatment within the trial was left to the farmer's choice. The farmers, however, replicated the 34,000 plants/ha treatment so the decision was made to collect yield data from randomly selected portions of a neighboring maize field grown by the same farmer.

The average density level on these sampled fields was 25,000 plants per hectare. The average maize yield for the three density levels is provided in Table XXVIII.

TABLE XXVIII. 1985 MAIZE YIELDS IN A MAIZE/BEAN DENSITY EXPERIMENT
(kg/ha)

| Maize Density | Yield | Yield Increase | % Change |
|---|---|---|---|
| 25,000 | 2847 | - - | - - |
| 34,000 | 3895 | 1048 | +37% |
| 44,000 | 3925 | 1078 | +38% |

The within-trial treatments of 34,000 and 44,000 plants/ha are remarkably close in yield. In contrast, these two density levels differ significantly from and represent a 37% yield increase over the farmer's practice of planting 25,000 plants per hectare. The interpretation of this yield difference must, however, take into account the fact that other factors such as fertilization, plant protection, and weeding were also at lower levels under the farmer's practice. As a result, the difference in yield must be attributed to a combination of these factors.

In the second year of the on-farm density trial, the intermediate density level of 34,000 plants per hectare was replaced by the lower level of 24,000 plants per hectare. The different density levels were further tested across the three fertilizer levels of 0, 40, 80 kilograms of nitrogen per hectare which represent 0, 50% and 100% respectively of the recommended fertilization rate. The average maize results summed across farmers are shown in Table XXIX.

TABLE XXIX.

MAIZE YIELDS IN FROM 1986 MAIZE/BEANS DENSITY X FERTILIZER EXPERIMENT

(kg/ha)

| Level of Nitrogen | High Density | Low Density | Yield Increase | % Increase Due to Higher Density |
|---|---|---|---|---|
| 0 | 2662 | 2030 | 642 | 32% |
| 40 | 3119 | 2446 | 673 | 28% |
| 80 | 4321 | 3149 | 1172 | 37% |
| Mean | 3367 | 2542 | 829 | 32% |

Simple calculations reveal that the increased seed requirement (12 kg/ha) is easily paid for by the increased yield in this particular season. These figures must be confirmed across seasons and a more detailed study of the additional labor requirement of the higher density field and the farmers evaluation of that labor must be made.

The data presented above provides a clear demonstration that there is an interaction between the increase in density and the level of fertilizer applied. In this experiment, the increase in yield attributed to the change in density is 85% higher (1172 kg/ha vs 632 kg/ha) for 80 kgs of N. per hectare treatment as opposed to the no fertilizer treatment. When the results are reorganized to examine the effect of the fertilizer treatment, the following results are observed:

TABLE XXX. EFFECT OF FERTILIZER TREATMENT ON MAIZE YIELDS

(kg/ha.)

| Density Level | 0 N. | 40 N. | 80 N. | Mean |
|---|---|---|---|---|
| Low | 2030 | 2446 | 3149 | 2542 |
| High | 2662 | 3119 | 4321 | 3367 |
| Mean | 2346 | 2783 | 3735 | 2955 |
| Yield Increase Due to Fertilizer Increment | | 437 | 952 | |
| % Increase | | 19% | 34% | |

The increase in maize yield from 0 kgs N to 40 kgs N is 437 kgs or 19% and the increase from 40 kgs N to 80 kgs N is 952 kgs of maize or 34%. Although this would imply that even higher fertilization rates should be examined, at least initially it was appropriate to use the recommended rates as the upper limit. Using simple benefit/cost analysis it can easily be shown that added benefit to the farmer, even using the relatively low official maize price, should be sufficient to convince them to move toward a fertilization level of 80 kgs N.

The intercropped beans in the experiments have not fared as well over the past two years of experimentation. Prior on-station results and farmer interviews had indicated three key factors. First, the absolute level of bean yields is relatively low under intercropping - a good estimate is 50% of the sole cropped yield. Second, bean yields vary on a year to year basis based upon the interrelated effects of rainfall, disease, and pest incidence. Third, most farmers do not dust their beans with insecticides.

The results generated to date have been consistent across the two years. The 1985 results (Table XXXI) provided an average yield level of less than 200 kgs/ha.

TABLE XXXI. 1985 BEAN YIELDS FROM A MAIZE/BEAN DENSITY TRIAL
(kg/ha)

| Planted Density Level | Harvested Density Level | Yield |
|---|---|---|
| 1. 185,000 | 81,121 | 137 |
| 2. 145,000 | 83,850 | 189 |
| 3. 102,000 | 78,613 | 176 |
| 4. unknown | 75,000 | 186 |
| 5. unknown | 53,000 | 226 (farmer practice) |

It is interesting to note that despite the difference in planted density level, the harvested densities for the first three treatments all converged on 80,000 plants per hectare. Treatment four was set up as a within trial farmer practice treatment, but the farmers more or less copied the researcher treatments. Treatment five was measured outside the trial and represents a true farmer treatment.

Once again no easy comparisons are available between the within trial treatments (1-4) and the outside trial treatments (5) since many other factors were left to vary. It is interesting to note that, at a time when the recommended bean density even under intercropping remains as high as 190,000 plants per hectare, farmers are consistently planting a much lower bean density and apparently doing just as well.

In the second year of experimentation, two bean density levels were used - 55,555 and 111,110 plants per hectare. During this second season a modest increase in yield was associated with the higher bean density as is shown in Table XXXII.

TABLE XXXII. 1986 BEAN YIELDS FROM A MAIZE/BEAN DENSITY TRIAL
(kg/ha.)

| Density | 0 N | 40 N | 80 N | Mean |
|---|---|---|---|---|
| Low | 257 | 207 | 176 | 213 |
| High | 317 | 246 | 240 | 267 |
| Mean | 287 | 227 | 208 | 240 |

The average increase in bean yield, however, of 54 kg/ha is only slightly more than the increase in seed required to achieve that higher density (between 20 and 40 kg/ha depending on the variety used). The higher cost of beans at seeding time and the extra labor required for planting certainly make the lower density the more attractive option.

The table above also illustrates an interesting inverse relationship between the level of fertilizer applied and the bean yield. The bean yield obtained when 0 N is applied exceeds the yield at 80 kgs N per hectare by 79 kilograms or 38%. The intuitive explanation of this relationship is that the fertilizer results in more vigorous growth of the maize which in turn increases the shading of the beans and thereby reduces the bean yield. The bean yield foregone is a fairly significant amount and should be factored into the farmer's decision about the level of fertilizer to use.

In the hopes of deriving a maize/bean intercropping pattern which provides a higher bean yield, an innovative spatial arrangement trial was planted during the 1986 season. On-farm observations during 1985 and previous seasons indicated that farmers often have multiple maize/bean fields within the intermediate zone. Some farmers take advantage of this by varying the ratio of the two crops on the individual fields. One variation found on a relatively small percentage of fields involved what looked like the removal of every other maize row which resulted in a field dominated by the beans. Farmer comments indicated that, as the competition with maize was reduced, the quantity and quality of the bean crop was increased.

The paired row intercropping trial was initiated as an attempt to develop a new cropping system which would improve upon the yields achieved under more traditional arrangements. In the paired row arrangement, the individual maize rows are moved together into closely spaced pairs in order to open a broad area which is more conducive to bean production. The resulting intercrop maintains the same density levels for both maize and beans. The goal is to maintain the maize yield while increasing the bean yield.

In the initial year of research, the results (Table XXXIII) are inconclusive.

TABLE XXXIII. 1986 MAIZE/BEAN PAIRED ROW INTERCROPPING TRIAL (kg/ha)

| | Single Rows | Paired Rows | % Change |
|---|---|---|---|
| Maize | 2944 | 2823 | -04% |
| Beans | 206 | 279 | +35% |

The maize yields, although not significantly different statistically, are reduced by 4% under the paired row arrangement. The bean yields in contrast are increased by 35% under the new arrangement. In terms that are more meaningful to the farmer, the change in plant arrangement results in a 121 kg/ha decrease in maize yield and a 73 kg/ha increase in bean production. Since this represents a very minor change, it is unlikely to be adopted by farmers. A critically important consideration is the effect of the new planting pattern on labor requirements. The data collected to date are mixed with half of the farmers reporting no change in labor requirements, while the other half felt that more labor was required. Our preliminary assessment is that more work remains to be undertaken before a new innovation is introduced which has a chance of gaining acceptance among farmers.

2. The Introduction of a Green Manure Crop

In order to address the problem of decreasing soil fertility, three on-station experiments were carried out during 1986 which examined the potential for integrating the green manure crop, *Crotalaria Ochroleuca*, into the farming patterns in this area. Crotalaria has been widely viewed as a miracle crop based upon experimental results reported from the Southern Highlands, an area with soil and climatic conditions quite similar to Moshi District. Crotalaria is viewed as a multi-purpose crop which both increases soil fertility and provides a source of feed for cattle and smallstock.

Due to the nature of the experiments conducted, it will take several years before any conclusive results are known. The performance of Crotalaria, a non-food crop (for humans), will have to be quite spectacular for it to

earn a place in the cropping system. If Crotalaria is to enter as a rotation crop, the increased yield in the crop following Crotalaria must more than make up for the crop foregone in order to grow Crotalaria. If it is to enter as an intercrop with maize and replace beans, the yield advantage which can be traced back to the Crotalaria must exceed the value of the bean production, as well as any potential harm to the maize. The results are still being analyzed at this writing.

3. Interventions in the Lowland Areas

The lowland area of Moshi is considerably drier and therefore agricultural production is much more uncertain. An initial intervention examined in this zone is the use of conservation tillage practices such as tied ridges in order to conserve moisture. The tied ridge treatment did not vary significantly from the other treatments. The use of the shorter maturity Kito variety did provide a statistically significant 22% increase in yield over the longer maturing Staha variety. It may well be that Kito is better suited to these climatic conditions. The comparison of maize varieties and tillage practices will continue to be examined by the FSR team.

4. Feedback to Commodity Researchers

A good working relationship has been established between the FSR team and the commodity sections. The messages which have been brought back to these sections include:

1. A more detailed description of current farming practices in the different agro-ecological zones in the district;
2. A better understanding of farmers' preference ranking among bean varieties; and
3. A greater focus on labor use issues.

## D. DODOMA DISTRICT

Dodoma District is located on the semi-arid central region of Tanzania. Local farmers place almost equal emphasis on crop and livestock production. Sorghum and millet are the principle crops grown in the area and are followed in importance by maize and groundnuts.

The TARO/FSR only has the mandate to investigate crop orientated interventions in the farming systems. It would be more appropriate if TARO and TALIRO (the livestock research organization) would cooperatively operate an FSR program since livestock and crop enterprises are closely interrelated.

With an average rainfall of only 562 mm (at Hombolo substation), the low and uncertain rainfall represents the single most significant constraint to crop production. Other problems include low soil fertility, poor use of available manure, soil erosion, and poor crop husbandry which is related to the distance to the fields and other labor requirements.

Very little adaptive research has been done specifically for the difficult climatic conditions of Dodoma. An indication of this is that, prior to the 1985/86 season, the commodity research carried out at Hombolo was based upon planting dates, plant densities, and tillage methods which were inappropriate for the local conditions.

The progress of the FSR program has been hampered by the lack of available staff. Only a single FSR field trials officer is present at Hombolo. Staff members from Ilonga try to make frequent visits, but the distance definitely has a negative influence on the work accomplished. Although an attempt has been made to shift a substantial portion of the work to the extension staff, to date this has not been achieved.

The rainfall during the 1985-86 season was erratic and, with total rainfall only 476 mm, was below normal. Crop failures were widespread and the FSR experiments were not spared. The limited results available will be discussed in the following three categories:

1. Conservation tillage;
2. Soil fertility; and
3. Varietal trials.

All of the experiments were planned in collaboration with the commodity researchers located at Ilonga ARI and the Dodoma District extension staff. The sub-set of the on-station experiments which focus on soil fertility issues are being jointly managed with the National Soils Service.

1. Conservation Tillage

The current farmers practice for sorghum and millet in Dodoma is a version of zero tillage with the farmers dry planting directly into the untilled soil. The alternative proposed is the introduction of tied ridges to trap more of the water. Although the tied ridge treatment out-yielded the control in this experiment, the difference was not statistically significant.

Additional data with respect to the labor requirements of the tied ridges are required. This includes the labor required to form the tied ridges and a determination as to whether the ridges can be used for more than a single season.

2. Soil Fertility

A series of soil fertility experiments were initiated during the 1985-86 season. These included separate trials on the application of rock phosphate and farm yard manure in order to increase crop production. Meaningful results from these sorts of trials can only be expected after several years. In addition, a Crotalaria intercropping trial was also planted. As elsewhere, the Crotalaria competed heavily with the cereal crop and severely reduced their yields. Once again, the preliminary conclusion of the FSR team is that it will be difficult to find a niche for this green manure crop within the existing farming system.

A more promising area of experimentation focuses on the inclusion of the perennial Leucaena Lecocephals into the cropping patterns. This tree crop serves the multiple uses of providing nitrogen, reducing erosion, and producing feed for livestock. Experimental results will be available in future years.

3. Varietal Work

Varietal testing was carried out for both maize and sorghum varieties. All of the maize varieties, including the more rapidly maturing Kito variety, were effected by moisture stress. This trial re-emphasised that there is no such thing as drought resistant maize.

In the sorghum varietal evaluation, the recently released Tegmeyo variety scored well among farmers. Tegmeyo maintains the shorter maturity and higher yield of the other introduced sorghum varieties, but does not suffer from the palatability or storage concerns which have marked these varieties.

The Dodoma District program has not yet achieved the momentum of the other two districts. This momentum may be difficult to achieve without an influence of full-time manpower to the program. These new FSR team members need not be researchers. It is in fact obvious that better integration of extension personnel is essential if the FSR effort is to be spread more widely.

## E. MAIZE AND SORGHUM IMPROVEMENT

The two specialists who filled these positions were expected to ensure good cooperation between the commodity programs and the new FSR teams. During their relatively brief tours of duty, the two specialists were fully integrated into the maize and sorghum programs at Ilonga ARI. When they were asked to leave, the commodity focus of the Project was lost.

The maize improvement specialist accepted responsibility for the following areas:

- maize breeding in the Southern Highlands;
- investigation of maize food and storage quality;
- breeding for streak resistance;
- set up of a computer system for data analysis; and
- assistance in coordinating the National Maize Research Program.

The greatest progress was achieved in the area of computer data processing. Although a microcomputer had been purchased by the previous Agricultural Research Project (ARP) and arrived at Ilonga in August, 1983, the system was not initially operational due to the lack of suitable software. The Maize Improvement Specialist developed a new program called Maize Data Analysis Program(MDAP). The MDAP can handle analysis of large data sets containing 21 variables and up to 600 entries. This program is designed in such a way that senior research scientists need only provide

the basic information initially by filling out the computer master sheet. Thereafter, research assistants can enter data in routine predesignated formats.

The MDAP consists of eleven subprograms and seven supporting programs and text files. The operations of the MDAP can be divided into four steps: (1) Preparation, (2) Data Storage, (3) Data Retrieval and Analysis, and (4) Across Location Analysis.

The MDAP can perform eight kinds of analysis of variance: one-way, two-way, factorial experiments (2-3) factor, split plot and lattice design. Outputs of the program include mean tables, ANOVA tables, adjusted means in lattice design and across mean tables.

The Sorghum Improvement Specialist sought to establish a sound basis for the long-term breeding program in Tanzania. More than 4,000 lines of Texas A and M University (TAMU) material, much of which had been specially prepared for Tanzania, were catalogued, sorted and planted.

During the growing season several field trips were made for purposes of collecting sorghum and millet cultivars from farmers' fields throughout Western Tanzania and Kenya. The purpose was the assessment of farmers' fields and sub-station trials, and presentation of papers at workshops related to sorghum/millet work.

With the cancellation of the sorghum/millet component, these activities were handed over to Tanzanian counterparts.

## V. RESEARCH PLANNING AND MANAGEMENT ACCOMPLISHMENTS

### A. BACKGROUND

In the USAID Project Paper of August, 1982, research planning and management assistance to TARO was viewed as necessary to bolster the development of a fledgling organization with great potential.

Prior to the establishment of TARO in 1980, agricultural research programs were small and managed independently with minimal linkage among research program coordinators, research station directors and Ministry of Agriculture officials. The Tanzanian Government's establishment of TARO represented an explicit recognition that the old system was inadequate. Substantial strengthening was needed and TARO was the first important stage in that process.

Based on the Project paper (1982), the original contract between USAID/T and CID contained a description of the research planning and management component of the Project.

> The project will assist the GOT by:
> Improving the national agricultural research management system by better planning and budgeting procedures and institutionalizing a system of establishing priorities for research which are in accordance with farmers' needs by providing organizational guidance, management assistance and training for the Tanzania Agricultural Research Organization.

After the Project was scaled down (1984) this description was modified to take into account the substantial reduction in the scope of the Project.

The project will assist the GOT by:

Provision of management assistance to TARO in its organization, operation, oversight, control and planning functions to enhance its capability to conduct and sustain adaptive research expanded to a national scale, and provision of encouragement and assistance to TARO, the Division of Research, the Division of Extension and Technical Services, and other research and extension units and agencies to work cooperatively toward the development of common goals and objectives to enhance Tanzanian agriculture and toward the implementation of the goals and objectives established.

These modifications suggest a clearer understanding of organizational problems faced by TARO in 1984, as well as possibly an assessment of TARO's limited absorptive capacity for improvement at that stage of its organizational development.

In line with the above cited documentation, activities in the area of research planning and management were focused on (1) strengthening and consolidation of the FSR approach within TARO, (2) assistance in budget planning and preparation, (3) long range research planning, (4) documentation of Project experiences in support of Project continuation, (5) contribution to the network of FSR activities in Tanzania and establishment of linkages with other Tanzanian institutions serving agriculture, and (6) general support to TARO.

## B. STRENGTHENING AND CONSOLIDATION OF THE FSR APPROACH WITHIN TARO

The integration of the FSR approach into existing commodity and discipline oriented structures of research was an important objective of this Project. A significant achievement was the influence of the Project-supported FSR

section on the commodity oriented research programs. FSR, to some extent, served as a catalyst in redirecting commodity research programs towards more practical topics. An example is found among commodity Program breeders who now place greater emphasis on the development of new varieties which will gain farmers' approval. This can be seen as a reaction to past disappointments; for example, releases such as the Serena and Lulu sorghum varieties. These varieties were high yielding, but suffered key flaws in terms of other characteristics and thus never gained widespread farmer approval. A list of these favorable signs within the commodity programs include:

1. Expanded use of the "zoning" concept for varietal development.
2. Greater focus on time-to-maturity as an important varietal characteristic. This permits the development of varieties which will fit into particular niches in specific farming systems. This focus was most noticeable in the maize, grain legume, and rice programs.
3. More attention to the palatability and milling characteristics of new varieties.
4. Focus on the testing of proposed new varieties under both mono and intercropped situations.
5. More attention to the labor requirements of production packages.
6. Finally, greater weight is being given to farmer evaluation which implies that criteria other than yield are being factored into the decision.

One of the most successful means of achieving good cooperation with the commodity programs was through the planning and execution of joint experiments with the individual programs. These joint experiments will allow the FSR section to focus primarily on on-farm experiments while the commodity programs focus on the on-station work.

A questionnaire administered during the final project conference demonstrated the strong relationship which has developed between the FSR and commodity programs. The commodity researchers now view the FSR section as a viable and valuable addition to the traditional commodity-based approach to agricultural research in Tanzania.

One of the methods used to strengthen support for the FSR approach was to involve all major stakeholders as advisors to the Project. The structure developed for facilitating their function is a body called the National FSR Committee and was originally constituted as follows:

- Director of Research, MALD
- National FSR Coordinator
- USAID Project Officer
- Representatives of TARO Headquarters
- National Maize Coordinator
- MALD Manpower Planning Officer
- Assistant Commissioner for Farmer Education
- Researchers from Ilonga ARI
- CID/OSU Contract Team

The National FSR Committee met ten times during the Project period. The committee served as a policy body for field work in Tanzania and as a conduit for communicating FSR field experiences back to TARO and MALD research officials.

Another critical component of the Project's efforts to strengthen the FSR approach within TARO was the successful proposals for supplemental funding submitted by the Project and TARO to the MALD PL480 committee. PL480 grants enabled the Project to expand its sphere of influence, involve greater participation of Tanzanian researchers in research studies related to FSR, indirectly extend the period of service of the long-term technical advisors, as well as, to direct dollar funds to such critical areas as off-shore procurement and graduate training for TARO personnel in the U.S.
The Project also developed highly specific workplans for the FSR section of TARO. These plans provided guidance to expatriate and Tanzanian personnel.

C. ASSISTANCE IN FINANCIAL PLANNING AND RECORD KEEPING

The Tanzania Farming Systems Project staff provided assistance to TARO in the following ways:

1. The preparation of a program and budget for the beginning year of the FSR Section of TARO, intended to become a long-term "follow- on" under primarily GOT funding from beginnings made under the present USAID Project.
2. Preparation of a request for and award of supplemental PL 480 funding to assist the FSR Section in TARO during the transition to full-program status.
3. Development of a long-term program and its budget implications for the TARO FSR Section.
4. Conducted a study on guidelines for improved financial management of TARO (Paliwal/Buchanan study).

5. Prepared detailed proposals for improved financial and research management record keeping.
6. Prepared detailed proposal for the development of an improved system for the publication of research results in Tanzania.
7. Served as an advisor to the Director General of TARO on planning, budgeting, control and reporting systems.
8. Introduced computers to assist in financial planning and record keeping.

## D. DOCUMENTATION OF PROJECT EXPERIENCE

1. Final Report

Under the terms of the contract a final report was produced by Dr. Larry Lev and Mr. David Acker, with assistance from Mr. Don Sungusia, at Oregon State University. A draft of the report was went to USAID/T and TARO for review. The final report was received in Tanzania on December 23, 1986.

2. Annual Reports

The Annual Reports were prepared by OSU/CID with extensive input from both field- and U.S.-based personnel. These reports were printed and distributed during the first quarter of each ensuing year.

3. Quarterly Reports

Quarterly reports were prepared in the field with input from all technicians. These reports were also distributed according to the above list. Over the life of the Project, streamlined procedures were developed for preparing these reports.

4. Annual Project Review Report

Dr. J. Kearns (CID) and Mr. D. Acker (OSU) presented their findings of the contractor review process in the "Annual Project Review Report." This report was printed and distributed in August, 1985.

5. Consultant's Report

All consultants were required to submit a written summary of the work conducted under the Project. These reports are listed in Appendix A.

6. Prepared Life of Project Workplan

The "Project Workplan: Year 1 and 2" was developed and submitted in June of 1983. This planning document guided the field activities during the 1984 reporting year. In 1984, a no-cost extension was granted by the Agency for International Development, Washington (AID/W), authorizing Project continuation until September 30, 1986. Due to the nature of this extension, OSU/CID prepared the Life of Project Workplan (LOP/WP) reflecting the significant changes in availability of funds and the loss of two long-term technicians. This documentation was submitted to USAID/T and TARO during the 1984 reporting year and was approved in February 1985.

7. Prepared Initial Draft of Phase Out Plan

Dr. Kearns prepared an initial draft of a phase out plan for use by the Project. This draft was later supplemented by additional detail from Dr. Kearns and served as the basis of a phase-out plan to be finalized by the COP and submitted to AID/T in early 1986.

8. Technical Reports

The technical reports completed by U.s. and Tanzanian staff are the most significant written record of Project activities. A complete listing is found in Appendix A.

E. FSR NETWORKING ACTIVITIES

One of the expected outputs of the Project was to establish linkages with other Tanzanian Government institutions serving agriculture. Numerous activities during the life of the Project contributed to strengthening of the network of contributors to the technology generation, adaption, and dissemination process.

The Project participated in the following major activities aimed at increasing the affectiveness of the network of FSR/E participants in Tanzania and in the region.

- April, 1981, Farming Systems Research Project Development Workshop, Arusha
- October, 1983, National Farming Systems Research Training Workshop, Arusha
- October, 1985, Farming Systems Research and Extension Symposium, Kansas
- November, 1985, National Farming Systems Conference, Arusha
- 1985, 1986 Regional Networking Conferences Lesotho, Zimbabwe, Ethiopia Swaziland
- June, 1986, Final Project Conference, Arusha

Other activities which contributed to improvements in the network of FSR/E participants included the following.

- meetings of the National FSR Working Committee
- publication and distribution of an FSR directory of personnel in Tanzania
- distribution of publications prepared by the Project
- participation in annual food crops coordinators conferences
- participation in the Sokoine University of Agriculture study team

## VI. HUMAN RESOURCE DEVELOPMENT

### A. LONG-TERM TRAINING

Post-graduate participant training was provided for four Tanzanian participant trainees funded under the Project and was coordinated for six Tanzanian participant trainees funded under the Training for Rural Development (TRD) Project. All ten of the participants were trained in the U.S.; nine individuals arrived in August/September, 1984, with one arriving in March, 1985. Academic progress and performance of each participant was monitored continuously by the OIA Participant Training Specialist. Progress reports were submitted to USAID/T. Table XXXIV provides details of participant training.

TABLE XXXIV. PARTICIPANT TRAINING

| Name | Funding Source | Arrival in U.S. | Subject Matter | University |
|---|---|---|---|---|
| Mr. Nick Lyimo | FSR | 5/1/84 | Plant Brdg. | U. of Missouri |
| Mr. Emil Mmbaga | FSR | 6/1/84 | Agronomy | Michigan State |
| Ms. Evelyne Chota | TRD | 8/5/84 | Ag. Econ. | Michigan State |
| Ms. Zainab S. Mbaga | TRD | 8/5/84 | Ag. Econ. | U. of Missouri |
| Mr. Otto Ringia | TRD | 8/5/84 | Ag. Econ. | Colorado State |
| Mr. Kija Bunyecha | TRD | 8/5/84 | Ag. Econ. | U. of Missouri |
| Mr. Clemence Mushi | FSR | 8/18/84 | Agronomy | Kansas State |
| Mr. Juma Katundu | TRD | 9/1/84 | Entomology | Oregon State |
| Ms. Anatolia Mpunami | FSR | 10/1/84 | Plant Prot. | Oregon State |
| Mr. Nurdin Katuli | TRD | 3/10/85 | Ag. Eng. | Oregon State |

Three short-term specialized farming systems research training opportunities were made available to all ten U.S. based participant trainees as a supplement to their discipline oriented, long-term academic program. These included a course designed by Oregon State University specifically for the participant trainees of this Project as, a special two-day workshop on project activities in Tanzania, and finally the Farming Systems Research and Extension Symposium at Kansas State University.

B. IN-SERVICE TRAINING

The FSR/E team benefitted from two in-service training sources. The first was a series of four in-country training courses conducted under the direction of the International Maize and Wheat Improvement Center (CIMMYT/Nairobi). These training courses permitted the Tanzanian staff to proceed through the FSR process on a phase-by-phase basis and focused on the use of actual case studies in Tanzania and elsewhere. At each training session interdisciplinary CIMMYT teams were supplemented by the expatriate project staff.

The second source of in-service training was participation in field activities, with the Project staff teaching by example. This apprentice-style approach was especially valuable in equipping team members with the skills to continue to administer FSR/E effectively in years to come.

## VII. ISSUES AFFECTING PROGRESS AND RECOMMENDATIONS

### A. MAJOR ISSUES

Issue #1: Organizational Barriers

The process of generating, testing, adapting, and disseminating agricultural technologies for use on small farms is impeded by several organizational barriers in Tanzania. In a number of ways, progress of the Project was impeded by these same barriers.

Fragmentation of research authority in Tanzania remains a critical problem. Crops research responsibility is divided among five different units including the Tanzanian Pesticide Research Institute, The Uyole Agricultural Center, the Tanzanian Agricultural Research Organization, Sokoine University of Agriculture, and the Ministry of Agriculture and Livestock Development. Responsibility for livestock research lies in a separate parastatal, the Tanzanian Livestock Research organization. This fragmentation developed as a result of donor preference, geography, disciplinary focus, and commodity specialization. Communication and cooperation among these units requires significant improvement. The existing fragmentation reduces the strength of national programs, obstructs vital professional scholarship and communication among scientists, and often turns the energies of scientific inquiry toward territorial struggle.

A further hindrance to effective rural development in Tanzania is the fact that research and extension services are organizationally separate in Tanzania. It appears that the only formal link between research and extension occurs at Ministry Headquarters between the heads of the respective

services. Local collaboration between researchers and extensionists is minimal. Since extension was dropped from the Project early in the design process in an effort to cut cost, the Project suffered from lack of official involvement of the extension service. In a program such as adaptive research where a great deal of manpower is required in dispersed rural areas, it is essential to integrate the extension service into the program as they are the arms and legs of a successful adaptive research effort.

Overall, no clear direction from the Ministry of Agriculture and Livestock Development was forthcoming as to the proper role and place of Farming Systems Research in Tanzania. The Project spent considerable energy in attempting to define a role simultaneously satisfactory to the Ministry of Agriculture and Livestock Development, TARO, and other stakeholders in the technology system in Tanzania.

Recommendation #1

An efficiently run system of generating, adapting, and disseminating appropriate technologies for small farmers requires an improved integration of crops and livestock research, as well as the extension service. Tanzania could benefit from the reduction in cost and increase in efficiency associated with a better integrated system of agricultural research and extension.

Issue #2: Absorptive Capacity

TARO was a very young organization when the Project began. Organizational and financial procedures were not fully developed and key staff were slow in being appointed. For example, the first Director of Research was not appointed until 1985. The Director General of TARO was, due to competing demands on his time, unavailable to participate fully in the direction of the Project.

As a result of these organizational problems, TARO was not in a position to make optimum use of the technical assistance provided under the Project. In particular, the Research Management Advisor had no counterpart with whom he could interact in the various areas in which TARO was weakest. In fact, there was a significant delay in assignment of counterparts for all headquarters based Project personnel.

TARO headquarter's offices were also split between three different locations. As office space was at a premium, the Project office was not included in any of the TARO facilities until the last few months of the Project. Prior to this time, the Project office moved three times to be accommodated in temporary quarters. With poor communication connections between the Project office and other TARO offices, coordination was further undermined.

Recommendation #2

Precedent conditions must be agreed to and fulfilled if expensive technical assistance efforts are to succeed. Office space, operating funds, counterparts, and other essential host country government contributions should be fulfilled for optimum Project performance.

Issue #3: Erosion of Original Project Design

What began as a 25 million dollar Project in AID's Congressional Presentation, ended as a 3 million dollar Project. The Tanzanian contribution to the Project was also significantly reduced. Along with the reduction in funds was a concomitant reduction in the length of the Project and the scope of work. These significant changes created a gap between the expectations of the government of Tanzania based on the original design documents and discussions, and the actual Project implementation.

Because these significant changes were occurring during Project implementation, there were considerable periods of uncertainty among both Tanzanian and American personnel as to the future of their jobs and the Project. Morale was significantly hurt by the cancellation of the commodity specialist components. This cancellation weakened the very relationship the Project sought to strengthen that is the relationship between adaptive and commodity research.

In response to these sorts of situations consideration should be given to the following question by donors, host country cooperating institutions and contractors:

- Is there a specific minimum amount of resources such as time, money, personnel, equipment and donor and government support below which the Project cost outweigh Project benefits?

B. MINOR ISSUES

The following issues are significant enough to mention as having had a decided effect on Project performance, while at the same time being less significant than issues presented in the previous section.

1) Office Robbery

The theft of all of the major office equipment was expensive, demoralizing, and had significant effects on the efficiency with which the office operated until the equipment was replaced.

2) Expatriate Staff

There were considerable delays in fielding two of the five long-term advisors. None of the long-term advisors were recruited from CID member institutions. The only long-term connection between the Project personnel and CID is that which developed with Larry Lev returning to the OSU campus for two years. Of the five long-term advisors, one had previous East African experience, while two others had West African experience. Two of the team members had no previous African experience.

3) Pressure on Participant Trainees

Participant Trainees were sent to the United States with the understanding that their funding would terminate at the close of the Project, rather than at the completion of their studies. While USAID made this abundantly clear to the participant trainees, nonetheless, considerable pressure was experienced by these trainees as they rushed to complete as much of their program as possible before their funding ran out. On the positive side, all but three completed their degrees in the allocated time. On the negative side, all of the trainees missed a large number of non-academic learning opportunities due to the pressure of their academic schedules. One trainee was forced to enroll in a degree program which had less than full bearing on his professional career plans.

4) Funding Constraints

Dollar funds under the contract were limited after the contractor was asked to complete its commitment without a follow-up allocation of funds. Operating funds from the Tanzanian government were more severely limiting. Much of the budget line item for Farming Systems Research in

the Ministry's budget was used as development funds for station and land development at Ilonga Agricultural Research Institute. As a consequence, recurrent funding for Farming Systems Research was constrained. Fortunately, PL 480 monies were obtained and used to support local operating expenses. After these funds were obtained, many local costs were no longer a problem.

# APPENDIX

APPENDIX A

TANZANIA FARMING SYSTEMS PROJECT
LIST OF PUBLICATIONS

2. Tang, C. Y., Maize Production and Tentative Parameters for Maize Breeding in the Farming System in Kilosa District, December 9, 1983, 8 pp.

3. Cunard, Alex C., Mndolwa, S., and Mwanagosi, N., Interim Report, Reconnaissance Survey of Dodoma District, December, 1983, 76 pp.

15. 1983 Annual Report, March, 1984, 42 pp. plus Annexes

16. Wardwell, Richard E., Review of Design and Construction Procedures, Lake Ilonga and Service Reservoir Embankments, Ilonga Research Station, Ilonga, Tanzania, November, 1983, 51 pp.

29. Quarterly Report: January 1, 1984 - March 31, 1984, April 10, 1984, 21 pp. plus Annexes

37. FSR Workshop Documentation, Continuing Center for Education, University of Dar es Salaam, Morogoro, May 16-19, 1984: List of Participants; Summary of Cunard, Alex C., Findings from the Diagnostic Survey of the Farming Systems Prevailing in the Kilosa District, May 16-19, 1984, 6 pp; Anandajayasekeram, Characteristics of Data Collection Techniques Usually Employed by CIMMYT, May 16-19, 1984, 2 pp., and Anandajayasekeram, Pre-screening, CIMMYT, May 16 - 19, 1984, 4 pp.

40. Mann, John A., The Role of INTSORMIL in Sorghum and Millet Improvement in Eastern African, Presented to the 3rd Annual SAFGRAD/IDRC East African Sorghum and Millet Workshop, Morogoro, Tanzania, June 5-8, 1984, 7 pp.

47. Quarterly Report: April 1, 1984 - June 30, 1984, July 13, 1984, 73 pp. plus Annexes

51. Tang, C. Y., and Moshi, A. J., Proposed Workplan for Maize Improvement Program in the Southern Highlands of Tanzania, July, 1984, 8 pp.

52. Tang, C. Y., Proposed Workplan for Maize Improvement Program in the Lowland Tropics and Intermediate Altitude Regions of Tanzania, July 1984, 6 pp.

59. Tang, Ching-yan, Maize Data Analysis Program (MDAP), Program and Users Manual, September 1984, 85 pp. plus diskettes.

62. Paliwal, Ripsudan L., and Buchanan, Mark T., Some Suggestions Regarding Budgeting, Accounting and Reporting Systems in TARO, September 20, 1984, 12 pp.

65. Quarterly Report: July 1, 1984 - September 30, 1984, October 10, 1984, 73 pp. plus Annexes.

68. MacVicar, R., et.al., Report of the Study Team on the Sokoine University of Agriculture, October 1984, 52 pp.

69. Cunard, Alex C., Tang, C. Y., Nyasi, P., Mushi, L. (Mrs.), Masomo, S., Mamkwe, J., Nahamu, S., Swai, I. E., F. Shao - National FSR Coordinator, Interim Report of the Diagnostic Survey of Moshi District: 27th - 31st December 1983, October 29, 1984, 86 pp.

70. Croon, I., Deutsch, J., and Temu, A. E. M., Maize Production in Tanzania's Southern Highlands: Current Status and Recommendations for the Future, October, 1984, 130 pp.

74. Lev, Larry S., A Descriptive Summary of Kilosa District, Report presented at Arusha, Tanzania, November 7, 1984, (Revised May, 1986) 46 pp.

75. Lev, Larry S., Planning Short Term Season Field Trials in Kilosa District, Report presented at Arusha, November 7, 1984, 5 pp.

76. Life of Project Workplan, as modified by Oregon State University and the Consortium for International Development, December 27, 1984, 37 pp.

77. Quarterly Report: October 1, 1984 - December 31, 1984, January 10, 1985, 28 pp. plus Annexes

82. Buchanan, Mark T., Minutes for Working Committee Meeting, February 8, 1985, 8 pp.

83. Lev, Larry S., Kilosa District Verification Survey Summary, February 1985, 7 pp.

84. Lev, Larry S., Moshi District On-Farm Trials Recording Forms and Supplemental Questionnaire, February, 1985, 11 pp.

85. Cunard, Alex C., Summary of the Findings from the Dodoma District Diagnostic Survey, March 18, 1985, 24 pp.

86. Quarterly Report: January 1 - March 31, 1985, April 13, 1985, 23 pp. plus Annexes.

90. Cunard, Alex C., Interim Report, Results of the Diagnostic Survey in Arumeru District: January 2 - January 6, 1984, April 29, 1985, 75 pp.

92. Lev, Larry S., The Inclusion of Time Factors in the Design of On-Station and On-Farm Trials: A Case Study from Kilosa District, Tanzania. Paper presented at the Farming Systems Research and Extension Symposium, Kansas State University, October 13-16, 1985, 14 pp.

97. 1984 Annual Report, 1984, May, 1984, 50. pp.

100. Quarterly Report: April 1 - June 30, 1985, July 13, 1985, 9 pp. plus Annexes

101. Acker, David G., and Kearns, Jean R., Annual Project Review Report, July 1985, 20 pp.

102. Cunard, A. C., End of Tour Report, July, 1985, 17 pp.

103. Cunard, A. C., Reconnaissance Survey of Kilosa District, 15-19 November 1983, Final Report, July 1985, 94 pp. (A preliminary report was issued as Publication Number 1 in November, 1983.)

104. Lev, Larry S., The Kito Story: An Example of On-Farm Experimentation in Kilosa District, July 1985, 5 pp.

105. Lev, Larry S., 1984-85 Vuli Season Report, Kilosa District, August 1985, 17 pp.

106. Matzke, Gordon, Report of Land Use/Land Tenure Specialist's Reconnaissance of Selected Villages in Kilosa District, Tanzania, August 1985, 49 pp.

107. Lev, Larry S., A Summary of the Current Status of FSR Field Activities, October 4, 1985, 9 pp.

108. List of Publications, Tanzania Farming Systems Project, September 1983. Updated in April, 1986, May 1986, July 1986, February 1987, 5 pp.

109. Buchanan, Mark T., FS-Checks, A Computer Program to Assist in the Management of the Farming Systems Project and Other Checking Accounts in Tanzania, November, 1985, Diskette plus 28 pp.

110. Buchanan, Mark T., FS-Cash, Notes on Computer Assisted Management of the Cash Accounts in Tanzania, September, 1985, Revised February 1986, Diskette plus 28 pp.

111. Quarterly Report: July 1 - September 30, 1985, October 4, 1985, 13 pp. plus Annexes.

112. Acker, David G., and Sungusia, Don, A Study of the Role of Extension in Farming Systems Research in Tanzania, November, 1985, 46 pp.

113. Price, Edwin C., Suggested Plans for Farming Systems Research and Extension in the Ministry of Agriculture and Livestock Development, November, 1985 (in draft).

114. Buchanan, Mark T., Functional Structure for the Professional Component of Farmers/Professionals Farming Systems Research and Development, Paper Presented at National Farming Systems Conference, Arusha, November 13, 1985, 6 pp.

115. Ilonga Zone FSR Team, Kilosa District 1985/86, On-Farm and On-Station, Experimental Programs, Prepared for : The 1985 National FSR Coordinating Conference, November 12-13, 1985, 30 pp.

116. Ilonga Zone FSR Team, Dodoma District 1985/86, On-Farm and On-Station, Experimental Programs, Prepared for the 1985 National FSR Coordinating Conference, November 12-13, 1985, 21 pp.

117. Lyamungu Zone FSR Team, Moshi District 1985/86, On-Farm and On-Station, Experimental Programs, Prepared for the 1985 National FSR Coordinating Conference, November 12-13, 1985, 18 pp.

118. 1985 Annual Report, January, 985. 56 pp.

119. Lev, Larry S., Summary of Fieldwork and Related Activities for the Fourth Quarter, 1985, January 6, 1986, 13 pp.

120. Lev, Larry S., A Trip Report for the 1985 National Crop Coordinator's Conference, November 30, 1985, 6 pp.

121. Quarterly Report: October 1 - December 31, 1985, January, 1986, 18 pp. plus Annexes.

122. Buchanan, Mark T., dBASE II and WORDSTAR, Powerful Aids to Record Keeping, Accounting and Financial Management, January, 1986, 15 pp.

123. Lyamungu Zone FSR Team, Summary of the Moshi District On-Farm Trials, Prepared for the 1985 National FSR Coordinating Conference, November 12-13, 1985, 13 pp.

124. Sungusia, D., and Lev, Larry S., Minutes of the National Farming Systems Workshop, Arusha International Conference Center, November 12-13, 1985, 38 pp.

125. Sungusia, D., The Role of Farming Systems Research in Peasant Agriculture, Paper Presented at the National Farming Systems Workshop, Arusha, November 12-13, 1985, 3 pp.

126. Lev, Larry S., A Project Summary of the Tanzania Farming Systems Project, Prepared for the National FSR Conference held in Arusha, June, 1986, 4 pp.

127. Buchanan, Mark T., End of Tour Report, May, 1986, 12 pp.

128. Quarterly Report: January 1 - March 31, 1986, April, 1986, 33 pp.

129. Quarterly Report: April 1 - June 30, 1986, July, 1986, 20 pp.

130. Ilonga FSR Team, Summary of the 1985 Masika Season On-Farm Trials and Observations for Kilosa District, October, 1985, 12 pp.

131. Minde, Isaac J., Marketing of Farm and Non-Farm Products in Kilosa District, Tanzania, A Reconnaissance Survey, August 8, 1986, 20 pp. plus Appendix

132. Lev, Larry S., Chilagane, A., and Mvungi, E., (Editors), Minutes of National FSR Executive Committee Meeting, June 24-25, 1986, 17 pp. plus Appendix.

133. Lev, Larry S., and Sumari, W. (editors), Minutes of TARO/FSR Internal Meeting, Held at Manyara Room, Arusha International Conference Center, June 26-27, 1986, 19 pp.

134. Matzke, Gordon, Farming Systems Research and Extension Opportunities on the Lowland Plains of Moshi District, Tanzania: A Reconnaissance Report, August, 1986, 60 pp.

135. Lev, Larry S., and Acker, David G., Final Report, December, 1986, 16 pp.

136. Sungusia, D., and Lev, Larry S., The Involvement of Farmers and Extension Personnel in Carrying Out On-Farm Research, August, 1986, 8 pp.

137. Minde, I., Mtoi, M., and Lev, Larry S., An Annotated Bibliography of Farming Systems Studies in Tanzania, September 9, 1986, 52 pp.

138. Lev, Larry S., The Relationship Between FSR and Commodity Research Programs: A Case Study from the Tanzania Farming Systems Project, Paper presented at Farming Systems Research and Extension Symposium at Kansas State University, September 9, 1986.

139. Lev, Larry S., End of Tour Report, September 9, 1986, 14 pp.

140. Quarterly Report: July 1 - September 9, 1986, September, 1986, 4 pp.

141. Acker, David G., and Lev, Larry S., Final Technical Report, January, 1987, 110 pp.

The following four reports were completed after September 30, 1986, but reflect work carried out during the Project.

Ilonga FSR Team. FSR/E Experimental Program Report for the 1985/86 Vuli and Masika Seasons in Kilosa District. November, 1986. 58 pp.

Cunningham, Lyida and Sumari, Wilfred. A Case Study of Farming Systems and Technology Adoption in Kilosa District. November, 1986. 31pp.

Chilagane, Amos. Preliminary Results from 1985/86 FSR Trials in Dodoma District. November, 1986. 12 pp.

Lyamungu FSR Team. Summary of the 1986 Moshi: District On-Farm and On-Station Trial Results and Proposals for the 1987 Cropping Season. November, 1986. 25 pp.

# APPENDIX B

# THE KITO STORY

## An Example of On-Farm Experimentation in Kilosa District, Tanzania

Dr. Larry Lev
Agricultural Economist
Oregon State University

and

Tanzania Farming Systems Project
Consortium for International Development
United States Agency for International Development

August 1985

qV

## INTRODUCTION

The farming systems research program in Kilosa District, Tanzania seeks to address the priority problems and opportunities of area farmers through the provision of short and long-term technological innovations. In late 1983, a diagnostic process which included an initial rapid appraisal survey and a subsequent written survey of a sample of farmers in the area was initiated by an interdiscliplinary team of research and extension personnel. Based upon the system diagnosis and the results of prior on-station research an experimental program was planned for the short rains which began in November 1984. This report summarizes those activities and highlights the widespread farmer acceptance gained for the chief intervention proposed, the newly released Kito maize variety.

## SYSTEM DESCRIPTION AND DIAGNOSIS

The research area is characterized by a long but highly variable growing season which consists of the short rains (November through early February) and the long rains (late February through May). In planning the timing of their agricultural activities over the course of the year, area farmers give their highest priority to the provision of an adequate food supply throughout the year. As a result, they choose to concentrate their production of maize, the main staple crop, during the short rains. Although this early established maize is often adversely affected by the lack of rains during critical vegetative stages the farmers prefer this system because it enables them either to harvest the crop in March or to replant if there is a crop failure. It should be noted that most maize research conducted in the area has been focused on the long-season maize crop which has a higher production potential due to greater and more reliable rainfall.

Farmer interviews revealed that they would prefer an even earlier maize harvest for two reasons. First, maize is in short supply in the period immediately before the March harvest so any early harvested maize has high value to farmers. Secondly, the short season maize fields are almost without exception relay or double cropped with other crops (principally cotton but also cassava, cowpeas and maize). An early harvest of the short season crop would provide an extra month for the establishment of this second crop.

PROPOSED MODIFICATIONS IN SHORT SEASON PRODUCTION PRACTICES

Based upon these observations it was felt that certain innovations could be introduced to improve upon current production practices during the short rains. Specifically the availability of the Kito maize variety, developed under a CIMMYT project funded by USAID, provided new alternatives which had not been adequately evaluated by either farmers or researchers.

When Kito is evaluated solely in terms of characteristics such as yield and cob size (two very important characteristics for farmers) it does not compare favorably with either other introduced or local varieties. Partly as a consequence of these seemingly deficient characteristics Kito received relatively little attention by researchers. It nonetheless has it's own advantages. Kito matures in 90 days or about 30 days more rapidly than the most frequently used local materials. Although it is similar in maturity to the older Katumani variety, Kito appears to be more drought tolerant. Finally, it's smaller plant size should make it more suitable for intercropping. It was therefore felt that Kito could improve the reliability of maize production during the short rains, hasten the harvest by one month which would ease the hungry season problem and also add an extra month to the

growing season for the long rains, and finally permit more intensive intercropping. All in all, it seemed likely that Kito would be a welcomed addition to the farmers' system.

## RESULTS

The experimental program in the short rains in Kilosa consisted of 48 farmers spread among 12 villages. Each farmer provided a one-quarter acre plot of land which was divided into two subplots one of which was planted in sole cropped Kito maize while the other was planted in an intercrop of Kito and either green gram or cowpeas. During the course of the season virtually all of the legume crops were destroyed by insect attacks so the farmers were basically evaluating the new Kito variety versus other maize varieties. Kito's moderate yield of about 1500 kilos per hectare was 15% less than full season corn varieties.

The participating farmers were nonetheless unanimous in declaring their satisfaction with Kito and in indicating their desire to expand planting of Kito during the short rains. Their reasons are summarized below.

1. The 1984-1985 short rains were 30% above normal and well distributed. The farmers realize that in drier years Kito may have a decided advantage over the full season varieties and they appreciate the reduction in uncerainty that this implies. It should be noted that the long rains were 30% under normal so farmers who placed all of their hopes on those rains were sorely disappointed.

2. The one month advancement in the harvest was greatly appreciated and made these farmers the envy of their neighbors. More research is needed to determine what value the farmers put on moving up the harvest date (or alternatively what reduction in yield is acceptable to farmers).

3. The earlier harvest also permitted a one month head start on long season production. Once again further research is needed to evaluate the economic significance of this change.

It is unlikely that Kito will completely replace other varieties in the short rains since it does have lower yields and smaller cob size. Nonetheless all of the benefits outlined above will be gained by the partial replacement of full season varieties by Kito.

FUTURE RESEARCH

Since Kito is a new introduction, a number of issues remain to be examined on farmer's fields. For the short rains experimental program these include:

1. the appropriate planting densities and arrangement given farmer practices and risk preferences,

2. the implications of any changes in farmer management practices which are required (is Kito, for example, more sensitive to timely weeding than other varieties?),

3. how Kito's storage characteristics compare to those of other varieties,

4. and whether or not relay cropping with a one month delay in the planting of the legume crop (in order to avoid early season insect problems) is feasible.

Finally, attention should also be directed to the testing of whether Kito provides advantages over other varieties when farmers are forced to plant late during the long rains. The hypothesis would once again be that Kito would be well served by it's short maturity. Thus, it may turn out that Kito will occupy two distinct niches in the farming system.

Although there clearly remains much research to be completed, the emphasis should now shift towards ensuring that adequate supplies of Kito are produced on government seed farms. The research conducted in Kilosa has gone a long way towards demonstrating the high level of acceptance for this new maize variety.

# APPENDIX C

ALPHABETICAL LISTING OF SCIENTIFIC AND TECHNICAL PERSONNEL ASSOCIATED WITH THE TANZANIA FARMING SYSTEMS PROJECT, MARCH 1986

| Lastname | Firstname | Title | Discipline | Organization | City | St. | Country | Telephone |
|---|---|---|---|---|---|---|---|---|
| Acker | David G., | Project Director | Education | Office of International Agr., OSU | Corvallis, | OR | USA | (503)754-2226 |
| Akulumuka | Vincent | Scientific Officer | Agronomist | TARO/FSR | Moshi | | Tanzania | 4411 |
| Amable | Richard A. | IITA | Agronomy/Physiology | SUA | Morogoro | | Tanzania | 056-3511/4 |
| Anandajayasekeram | Ponniah | Regional Training Officer | Agric. Economist | CIMMYT | Nairobi | | Kenya | 592059/592206 |
| Antapa | P. Leonard | S.S.O. | Agric. Engineer | TARO | Arusha | | Tanzania | 3883 |
| Buchanan | Mark T. (Ph D) | Res. Mgt. Advisor & COP | Economics | Tanzania Farming Systems Project | Dar es Salaam | | Tanzania | 30937 |
| Bujulu | Joel | PRO | Pathologist | IPRI | Arusha | | Tanzania | 2303 |
| Bunyecha | Kija | Participant Trainee/TRD | Agr. Economics | TARO | Columbia | MO | TZ/USA | |
| Chambi | Juhudi Y. | Scientific Officer | Plant Breeder | TARO | Mtwara | | Tanzania | 2085 |
| Chambuya | R. | Entomologist | Entomology | TARO/National Grain Legumes Program | Ilonga | | Tanzania | |
| Chari | A.V. | PPMB Agronomist | Agronomy | Min. of Agri. & Livestock Dev. | Dar es Salaam | | Tanzania | 27231 |
| Chilagane | Amos | S.O. | Agric. Engineer FSR | TARO/FSR | Kilosa, Morogoro | | TZ | Kilosa 49 |
| Ching'ang'a | Henry M. | S.S.O. | Breeding | TARO | Morogoro | | Tanzania | Ifakara 78 |
| Chota | Evelyne | Participant Trainee/TRD | Agricultural Econ. | TARO | East Lansing | MI | TZ/USA | |
| Collinson | M. (PhD.) | Director | Economics | CIMMYT/E. Africa | Nairobi | | Kenya | 02-592054 |
| Cunard | A.C. (PhD.) | Formerly Sr. Prod. Agronomist | Agronomy | AID/Senegal | Dakar | | Senegal | 217491 |
| Elia | W.M. | Former FSR Zonal Coordinator | Agronomy | TARO Ilonga | Kilosa | | Tanzania | 69 |
| Gilbert | Fredrick (PhD) | Mission Director | Economics | USAID/Tanzania | Dar es Salaam | | Tanzania | 22531/2/3/4 |
| Guutazi | Athman Saidi | S.O. | Entomologist | TARO | Kilosa | | Tanzania | kilosa 49 |
| Tjani | Afihini S.M. | R.O. | Plant Pathologist | T.P.R.I. | Arusha | | Tanzania | 3557/8 |
| Isangya | Ndevera | AFO II | Extension | Extension/FSR | Moshi | | Tanzania | 2294 |
| Ishumi | M. | Regional Agric. Dev. Officer | | RADO | Morogoro | | Tanzania | 056-2101 |
| Issangya | N. | Assistant DADO | General Agriculture | Extension | Moshi | | Tanzania | |
| Kabatange | Mary | Scientific Officer | Animal Nutrition | TALIRO | Mpwapwa | | Tanzania | 21 |
| Kabissa | J.C.B. (PhD.) | Entomologist | Entomolngy | TARO Ilonga | Kilosa | | Tanzania | 69 |
| Kaganda | J.K. (Mrs.) | Extension, Kilosa District | | TARO, Ilonga | Kilosa | | Tanzania | 69 |
| Kasembe | J.N.R. (PhD.) | Director General | Agronomy | TARO | Dar es Salaam | | Tanzania | 44735 |
| Katuli | Nurdin | Participant Trainee/TRD | Agr. Engineering | TARO | Corvallis | OR | TZ/USA | |
| Katundu | Juma | Participant Trainee/TRD | Entomology | TARO | Corvallis | OR | TZ/USA | |
| Kearns | Jean (PhD.) | Deputy Executive Director | Soc./Anthro. | Consortium for International Devl't | Tucson | AZ | U.S.A. | (602)745-0455 |
| Kessy | Daniel L. | SSO | Agronomy | TARO | Moshi | | Tanzania | 4411 |
| Kichelere | P. | District Agric.Dev.Officer | | TARO Ilonga | Dar es Salaam | | Tanzania | 69 |
| Kikopo, | R. (DVM) | Chief Research Officer | Veterinary Sciences | Min. of Agric. & Livestock Dev. | Dar es Salaam | | Tanzania | 27231 |
| Kirway | Timothy N. | S.R.O. | Agric. Economist | UAC | Mbeya | | Tanzania | 2116 |
| Kisoli | H. | DADO | General Agriculture | Extension | Dodoma | | Tanzania | |
| Kitalyi | Aichi | Scientific Officer | Animal Nutrition | TALIRO | Mpwapwa | | Tanzania | 21 |
| Kitundu | O. | Field Trials Officer | | TARO | Ilonga | | Tanzania | |
| Koinange | E.M.K. | S.O. | Breeding | TARO | Moshi | | Tanzania | 4411 |
| Kullaya | I. | Soil Chemist | Soil Chemist | TAN National Coffee Program | Lyamungu | | Tanzania | |
| Lev | Larry S. (PhD.) | Team Leader and Sr. Production Econ | Economics | FSR Project | Dar es Salaam | | Tanzania | 30937 |
| Lugole | John Serafin | Assistant Lecturer | Agric. Economist | SUA | Morogoro | | Tanzania | 3511-4 |
| Lussewa | | RADO | | Extension | Moshi | | Tanzania | |
| Lyatuu | Henry A. | SRO | Weed Specialist | T.P.R.I. | Arusha | | Tanzania | 6232 |
| Lyimo | E.W. | Regional Coordinator | Agronomist | KILIMO/FAO | Moshi | | Tanzania | 4001 |
| Lyimo | E. | Agricultural Economist | Economics | U.A.C. | Mbeya | | TZ | |
| Lyimo | Nick | Participant Trainee/FSR | Plant Breeding | TARO | Columbia | MO | TZ/USA | |
| Lyvers | Ken | ADO | | USAID/SUDAN | Khartoum | | Sudan | |
| Maembe | T. | Assistant DADO | General Agriculture | Extension | Dodoma (Rural) | | Tanzania | |
| Makwaia | B.M. | Principal | | MATI Ilonga | Kilosa | | Tanzania | 49 |

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|---|---|---|---|---|---|---|---|---|---|
| Malima | V.F. (Mrs.) | Research and Training Officer | | Min. of Agric. & Livestock Dev. | Dar es Salaam | | Tanzania | 27231 |
| Mallya | D. | Field Trials Officer | | TARO | Lyamungu | | Tanzania | |
| Mankwe | J. | Field Trials Officer | | TARO | Ilonga | | Tanzania | |
| Mannento | Joas E. | SAO | Agric. Extension | Extension | Dar es Salaam | | Tanzania | 27231 |
| Matary | R. | DADO | General Agriculture | Agricultural Extension | Dodoma (Urban) | | Tanzania | |
| Matee | James J. | R.O. | Bird Pests Research | TPRI | Arusha | | Tanzania | 3557/8 |
| Matowo | Peter | Scientific Officer | Agronomist | TARO | Moshi | | Tanzania | 4411 |
| Matzke | Gordon (PhD.) | Associate Professor | Geography) | Oregon State University | Corvallis | OR USA | | |
| Mbaga | Zainab | Participant Trainee/TRD | Agricultural Econ. | TARO | Columbia | MO TZ/USA | | |
| Mbowe | Frank F.A. | S. O. & Nat'l Legume Coordinator | Agronomist | TARO | Kilosa | | Tanzania | Kilosa 49 |
| Mbuya | W. | S.O. | Agronomy | TARO Lyamungu | Moshi | | Tanzania | |
| Mgale | Esther | Assistant Research Fellow | Economist | IRA/UDSM | Dar es Salaam | | Tanzania | 49039 |
| Mgonja | Andrew P. | Director | Pathology | TARO | Morogoro | | Tanzania | Ifakara 78 |
| Mhando | Immanuel Richard Oswald | S.O. | Soil Scientist | TARO | Kilosa | | Tanzania | Kilosa 49 |
| Minde | I. | Lecturer | Economics | Sokoine University of Agriculture | Morogoro | | Tanzania | 056-3511/4 |
| Mindola | Mr. J. | Assistant DADO | General Agriculture | Agricultural Extension | Dodoma | | Tanzania | |
| Minjas | Athanasio H. (Ph.D) | Sr. Lecturer & Head, Dept. Crop Sc. | Agronomy | Sokoine University of Agriculture | Morogoro | | Tanzania | 3511 |
| Mitawa | G.M. (PhD.) | Research Institute Director | Plant Breeding | TARO Ilonga | Kilosa | | Tanzania | 69 |
| Mizambwa | Ralph | A.O. | Seed Agronomist | KILIMO | Dar es Salaam | | Tanzania | 29481 |
| Mlambiti | Melchior e. | Senior Lecturer | Agric. Economist | SUA | Morogoro | | Tanzania | 3511 |
| Mwari | Eli V. | AFO | Agronomy | TARO | Arusha | | Tanzania | 3883 |
| Mabaga | Emil | Participant Trainee/FSR | Plant Breeding | TARO | East Lansing | MI TZ/USA | | |
| Mndolwa | S.I. | FSR Field Officer | | TARO Ilonga | Kilosa | | Tanzania | 69 |
| Mnzava | Moses William | Irr. Agronomist | Agronomist | USAID Project | Mbeya | | Tanzania | |
| Mosha | A.S. | F.S.O. Director | Director | TARO | Arusha | | Tanzania | 3883 |
| Moshi | A.J. (PhD.) | Coordinator, Maize Research | Plant Breeding | TARO Ilonga | Kilosa | | Tanzania | 69 |
| Mpunami | Anatolia | Participant Trainee/FSR | Plant Protection | TARO | Corvallis | OR TZ/USA | | |
| Mrisho | V.F. | Asst. Comm. Planning & Marketing | | Min. of Agric. & Livestock Dev. | Dar es Salaam | | Tanzania | 23271 |
| Mshiu | Edward P. | Consultant | Entomology | SANDOZ Limited | Arusha | | Tanzania | 3191 |
| Msomba | William Solomon | S.O. II | Entomologist | TARO | Morogoro | | Tanzania | Ifakara 78 |
| Mtoi | Manasse | Lecturer | Agric. Economist | SUA | Morogoro | | Tanzania | 3511-4 |
| Mtui | M. Julley | Tech/Representative | Agronomist | TWIGA Chemicals | Arusha | | Tanzania | 2987 |
| Mukiibi | Joseph K. | R.I.O. | Pathologist | ITTA | Morogoro | | Tanzania | 3511 |
| Muliahela | Leonard Emmanuel | S.O. | Agronomist | TARO | Morogoro | | Tanzania | Ifakara 78 |
| Muro | S.A.M. | Assistant Commissioner | | Min. of Agric. & Livestock Dev. | Dar es Salaam | | Tanzania | 27231 |
| Mushi | Mrs. | DADO | General Agriculture | Agricultural Extension | Moshi | | Tanzania | |
| Mushi | Clemence | Participant Trainee/FSR | Agronomy | TARO | Manhattan | KS TZ/USA | | |
| Mushi | L.C. | FSR Field Officer | | TARO, Ilonga | Kilosa | | Tanzania. | 69 |
| Mvungi | Eleuther David | S.O. | Agronomist | TARO | Morogoro | | Tanzania | Ifakara 78 |
| Mwambene | Reuben O.F. | PRO | Plant Breeder | UAC | Mbeya | | Tanzania | 2116/7 |
| Mwanjali | Mfaume David | Senior Scientific Officer | Breeder/Agronomist | TARO/FSR | Kilosa | | Tanzania | Kilosa 49 |
| Mwenda | Festus f. | Scientific Officer | Groundnut Breeder | TARO | Mtwara | | Tanzania | 2085 |
| Ndondi | Richard V. | SSO | Breeding | TARO | Arusha | | Tanzania | 3883 |
| Nkamu | F. | FTO | | TARO | Ilonga | | Tanzania | |
| Owenya | Zakayo J. | F.O. | Agronomy | TARO | Arusha | | Tanzania | 3883 |
| Palmer | Anthony F.E. | Regional Maize Agronomist | Agronomist | CIMMYT | Nairobi | | Kenya | 592151/59226 |
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| Polepole | M.M. | Planning Officer | Economics | TARO, Dar es Salaam | Dar es Salaam | | Tanzania | 44735 |
| Price | Edwin C. (PhD.) | Director | Economics | Office of International Agr., OSU | Corvallis | OR USA | | (503)754-0686 |
| Rann | Jerry | ADO | Entomologist | USAID/T | Dar es Salaam | | Tanzania | 22531/2/3/4 |
| Renson | Joel | Maize Agronomist | Agronomy | CIMMYT | Nairobi | | Kenya | 592151/59226 |
| Ringia | Otto | Participant Trainee/TRD | Agricultural Econ. | TARO | Fort Collins | CO TZ/USA | | |
| Ringo | D.F.P. | S.S.O. | Entomologist | TPRI | Arusha | | Tanzania | 3557/8 |
| Saadan | H.M. | Sorghum Breeder | | TARO, Ilonga | Kilosa | | Tanzania | 69 |
| Saakyi | Thomas | Scientific Officer | Agric. Economist | TARO/Lyamungu | Moshi | | Tanzania | 4411 |

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|---|---|---|---|---|---|---|---|
| Sassi | S.O.Y. | Agric. Officer | Extension | RAD[illegible] | Arusha | Tanzania | 2099 |
| Schulman | M. (PhD.) | Representative of the Director | Education | USAID/Tanzania | Dar es Salaam | Tanzania | 22531/2/3/4 |
| Sempeho | George | Scientific officer | Agr. Economics | TALIRO | Mpapwa | TZ | 21 |
| Semuguruka | G.H. (PhD.) | Director of Research | Plant Breeding | TARO, Dar es Salaam | Dar es Salaam | Tanzania | 44735 |
| Shao | Francis M. | CRO(L) | Plant Pathologist | MALD | Dar es Salaam | Tanzania | 23616 |
| Shayo | Edith | A.O. | Extension | Extension | Morogoro | Tanzania | 2101 |
| Shriver | Ann | Agric. Economist | Agric. Economist | USAID/T | Dar es Salaam | Tanzania | 22531/2/3/4 |
| Sosovele | Hussein | Assistant Research Fellow | Sociologist | IRA/UDSM | Dar es Salaam | Tanzania | 49039 |
| Stroud | Ann | Regional Weed Specialist | Agronomy | REDSO/Nairobi | Nairobi | Kenya | |
| Sumari | Wilfred L. | Scientific officer | Agric. Economist | TARO/FSR | Tilosa | Tanzania | Tilosa 4[illegible] |
| Suncuzi | Don | FSR Coordinator | Agric. Economist | TARO/FSR | Dar es Salaam | Tanzania | 30937 |
| Suncuzia | | Assistant RAO | | Extension | Moshi | Tanzania | |
| Swai | M. S. | Field Trials Officer | | TAR | Lyazumbo | Tanzania | |
| Tarimo | G.S. | Director of Research Planning | Entomology | TALIRO | Dar es Salaam | Tanzania | 63191/2 |
| Tibarijuka | Anna | Lecturer | Economics | ERB/UDSM | Dar es Salaam | Tanzania | |
| Tshaye | Gabriel Amon (PhD.) | S.M. | Soil Scientist | TARO | Tanga | Tanzania | Mzomeni 9 |

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