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BEAN/COWPEA - CRSP REPORT

May 19 - June 15, 1979
Visit to Kenya, Tanzania, Malawi, Botswana, Zaire and Nigeria

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A. Kenya

1. USAID Mission
   Visited:

   Wilbur Scarborough, Agricultural Research Advisor
   Jack Slattery, Health & Nutrition Specialist
   Linda Meyers, Nutrition Specialist, Lecturer, Cornell University

Discussion of the agricultural program centered on new USAID projects (expected initiation in late 1979) that relate to grain legume crop production. These projects are part of a much larger program aimed at the semi-arid regions in the East Kenya provinces of Machakos/Kitui with rainfall in the range of 500-750 mm. These projects are in collaboration with FAO and the Government of Kenya, and one of the crop areas receiving special emphasis is production of beans, cowpeas and pidgeon peas. This is part of a large, integrated food crops development program for the semi-arid regions and the work would be centered at the Katamuni Dryland Research Station.

Other discussion areas were concerned with health and nutrition of present programs, awareness studies covering nutrition problems, the role of women in food production, intervention type programs and impact studies on nutrition and economics with development of agricultural programs in the semi-arid regions.

At this point in their programs it is believed they are aware of many nutritional-food constraints for different crop production areas in Kenya, including the nutritional weaning problems associated with women in the work force.

Because of the time constraints on the new projects dealing with beans and cowpeas, USAID did not identify specific areas where the CRSP may interface, supplement or complement their planned programs, although it appears to give primary emphasis to maize, while the FAO project includes maize, cowpeas and pidgeon peas. Beans are not emphasized because the projects are aimed at the semi-arid lands.

2. Nairobi University
   Visited:
   Dr. D. M. Mukunya, Senior Pathologist
   Dr. D. Magogi, Chairman, Plant Sciences Department
   Dr. S.O. Keya, Soil Microbiologist
   Dr. R. S. Pathak, Plant Breeder
   Dr H. Ssali, Soil Chemist
   Prof. C.N. Karue, Dean of Faculty
   Dr. D.I. Gomez, Nutritionist

W. Mwangi arranged through Dr. D.M. Mukunya to visit the Kabete campus where the Faculties of Agriculture are located. Individual visits were made with Dr. Mukunya and Dr. D. Magogi, Chairman of the Plant Sciences Department, and a conference with several staff working on an interdisciplinary Integrated Grain Legume Improvement program (beans and cowpeas). These discussions and consultations were very fruitful in determining research directions and program objectives.

The broad approach in their research program on beans and cowpeas offers excellent CRSP interfacing potential in many areas of their program (cropping systems, breeding, pathology, entomology, nutrition, microbiology, soil fertility and with Al toxicity in acid soils). An integrated program on production of beans and cowpeas is broad, involving plant breeding, plant pathology, agricultural entomology, soil chemistry, microbiology, agronomy and nutrition.

The cowpea improvement program is now in its third year. The research program is supported by the Research Division of the Ministry of Agriculture through provision of land at research stations and personnel support for assisting and conducting experiments. A recent agreement between the University and the Scientific Division of the Ministry to carry out cooperative research on legume crops for the semi-arid regions is assurance that the research program at the University is viable and will continue to be an effective research unit in legume crop production.

General areas that would appear to be most fruitful for improving their bean and cowpea programs are:

1) pass-through funds for laboratory supplies and equipment, and back-up technical personnel support for laboratory studies;

2) training of students both in M.S. and Ph.D. programs in the various areas of bean and cowpea research being carried out in the program;

3) a scientist exchange program whereby the University of Nairobi staff could spend 6 months to a year with a counterpart in a U.S. university working on beans or cowpeas, or a similar exchange where U.S. scientists would spend similar periods of time at Nairobi University. The effectiveness of an exchange program would lie in the ability to work out arrangements whereby the relatively small staff at Nairobi would not be decimated or decreased in size as they have at present a heavy teaching load;

4) short term visits of several weeks by U.S. scientists to work cooperatively on bean and cowpea disease and insect problems, and possibly other related problems in production would be beneficial;

5) exchange of germplasm for drought resistance, insect and disease control and other constraints would be very useful in their program, as well as in U.S. programs. Linkages have been made with IITA for receiving germplasm and good progress has been made by the cowpea plant breeder in selecting 3 superior cowpea lines from mixed Kenya genetic material.

The following University of Nairobi staff are working with the Integrated Grain Legume Project called the Plant Protection Program: (see attached to report)

Dr. D.M. Mukunya and Dr. J.P. Singh, Fungal and Bacterial Diseases of Beans in Mixed Cropping Systems

Dr. E.M. Gathuru, Plant Virologist

Dr. S.O. Osiru, Crop Physiologist

Dr. D.N. Ngugi, Crop Physiologist/Weed Scientist

Prof. C.P.M. Khamala, Dr. M. Mueke, Dr. S. Karel, Entomologists

Dr. S.O. Keya, Microgiologist

Dr. Ssali, Soil Scientist

Dr. R.S. Pathak, Plant Breeder

3. Scientific Division of the Ministry of Agriculture
   Visited: Dr. B.N. Majisu

We were not able to make arrangements to visit with the Director of Research. Dr. D.K. Thiarou of the Ministry of Agriculture. However, we did meet with Dr. Majisu, Chief Scientific Officer of the Scientific Division of the Ministry.

He confirmed the interest conveyed to us by the USAID Mission that their primary interest is in crop production in the semi-arid regions of East Kenya. He mentioned the 5-year program planned to begin in late 1979 and the Ministry of Agriculture's full support behind the program.

This program is directed to the small farmers in that region, and one of the primary objectives deals with improving nutrition by concentrating on production of legumes, particularly cowpeas and pidgeon peas, which can be grown successfully in the semi-arid regions. Strong support for the University of Nairobi's Integrated Legume Research Program (beans and cowpeas) was mentioned by Dr. Majisu as part of the overall plan to be carried out in conducting the semi-arid crop improvement program.

Because of a technicality that required Kenya government approval 30 days before a visit for in-country travel the team was unable to visit the Dutch AID bean research team working with the Ministry of Agriculture at the Thika Horticultural Research Station or other government institutions relative to the CRSP trip such as the Plant Quarentine Station at Muguga. Although not usually a problem, the USAID Mission official (who had had no previous information that a team would be visiting) would not tolerate visits to the research stations, even though the University of Nairobi would have provided transportation for such visits. However, we were fortunate enough to be able to meet Dr. B.H. Waite, Director of the Plant Quarantine Station of the Kenya Agricultural Research Institute at Muguga while he attended some meetings held at ILRAD. He mentioned a serious need for technical training for Kenyans as one of the main problems, particularly training those at a level who would be able to conduct the functions of the Quarantine Station when he leaves. Dr. Waite had been at the Station for only 3 months, and the position had been vacant for 10 months at that time, and his concern with training centered on this aspect.

Although the team was unable to visit the research stations, etc., it is believed that sufficient contacts were made to effectively evaluate the potential CRSP areas where supplementary or complementary assistance and support would be helpful. In summary these are:

1) with the University of Nairobi in its established bean and cowpea programs;

2) the USAID Mission has elaborate program plans for research and training to fit projects planned for the semi-arid areas in East Kenya and could not at this time outline specific areas where the CRSP can effectively interface;

3) the Government of Kenya, in assessing their needs for support and cooperation with the USAID Mission and UNDEP (FAO) semi-arid regional projects, is not prepared at this time to indicate how the CRSP could supplement their programs. Training of technical personnel was mentioned, but training would begin at a later time when they are able to evaluate more clearly the needs in the legume production projects.

B. Tanzania

1. USAID Mission

Visited: Peter Shirk, Deputy Director

Our visit with USAID personnel was considerably shortened because of the Memorial Day holiday on Monday, May 28. We met with Peter Shirk on the morning of the 29th as a result of previous telephone arrangements and discussed briefly with him the CRSP and our objectives for the visit. He was interested but did not know how the CRSP might fit in with their present program, which is centered on grain production. The meeting was shortened because of a staff meeting of their group and because we had made previous arrangements to hire a car and visit with the University of Dar es Salaam Agricultural College located at Morogoro, which is 126 miles from Dar es Salaam.

Mr. Shirk mentioned to us the IITA program at Llonga Research Station (40 miles beyond Morogoro) but our shortened schedule did not permit a visit there. However, Dr. Patel, Plant Breeder at the Llonga Station, was in Dar es Salaam and he visited with us concerning their program.

2. University of Dar es Salaam, Faculty of Agriculture, Morogoro
Visited:
P. R. Kavishe, Assistant Dean of Students
Dr. B. J. Ndungura, Plant Physiologist
Dr. A. L. Doto, Plant Breeder
Dr. M. S. Chowdhury, Soil Microbiologist
Mr. A. Haq, Food Science and Technology Department

The College is located about 126 miles from Dar es Salaam, and the road there is blacktopped and in fair shape. Following telephone contact with the Dean of Faculty, Prof. M. L. Kymo, a luncheon meeting was arranged with key faculty working on beans and cowpeas. Unfortunately Dean Kymo had meetings outside the College and could not join us, but he was represented by Mr. P. R. Kavishe, Assist. Dean of Students.

The discussion of the bean/cowpea program was led by Dr. B. J. Ndungura (bean program), who was assisted by Dr. M.S. Chowdhury, Soil Scientist, and Dr. Doto (cowpea program). The approach to the research program for both beans and cowpeas is an interdisciplinary type designed to integrate plant science, soil science and plant protection (disease and insect) into the program.

The Ministry of Agriculture is engaged in the improvement of legumes, with emphasis on beans (Phaseolus vulgaris) and the cowpea (Vigna unguiculata). Beans are grown in the relatively wetter area of the highlands, with cowpeas grown in the highlands and in the lower, drier regions. The bean program (breeding and variety trials) has been underway for 3 years, while the cowpea program (variety testing) has been underway for one year. Dr. Doto, who recently completed his Ph.D. at Nottingham, is heading this program.

Although seed bean production of bush type cultivars for European export has been a major industry in northern Tanzania for generations, little to nothing has been done with the cultivars used by the subsistence farmer. The Tanzanian Ministry of Agriculture has recognized this need and is emphasizing the need for increased research on all food legumes. Bean research at the Morogoro Station is just in the initial exploratory phases. They have grown some local varieties obtained from several outside sources (total plus or minus 1500) to evaluate them for agronomic characteristics, diseases and insect pests. Dr. B. J. Ndungura, Plant Physiologist, is initiating a study of bean plant characteristics in a number of locations to evaluate the genotype environmental interactions, and Dr. Chowdhury, Soil Microbiologist, will isolate and evaluate N_2 fixing apability of rhizobium collections. Dr. Karel, Entomologist, is scoring the type and severity of insect damage to Dr. Ndungura's plots, while Dr. Keswa.. , Plant Pathologist, is scoring the type and severity of the diseases found. We did not visit with Drs. Karel or Keswani, but discussions with Dr. P. N. Patel, Legume Breeder/Pathologist, IITA/USAID/Tanzanian Grain Legume

Research Project at the nearby Llonga Agricultural Research Institute, indicate they have about the same disease and insect problems encountered in Kenya. The type and severity of the problems would vary somewhat with season and environment. Their Plant Breeder, Dr. A. L. Doto, would like to study some of the genotype environmental interactions. The information generated by this team evaluation should provide valuable germplasm for a potentially productive breeding program.

A visit was made to the variety plot studies at the Research Station. IITA is cooperating in providing seed lines in cowpeas, and has a staff of six people located at Llonga Research Station about 40 mi. beyond Morogoro. This group is working on various production problems on beans and cowpeas, and is cooperating to a limited extent with the Morogoro program.

The total program on beans and cowpeas at Morogoro appears to be well planned and is sufficiently staffed with well trained scientists (10 of 12 faculty in the Crop Science Department with titles of lecturer, session lecturer and professor have Ph.D.s) to carry out a good research program on grain legumes, and they are sufficiently supported with plot space and agricultural operations.

The critical constraints are:

1) laboratory equipment and supplies (chemical and basic) for making routine measurements and special equipment for research on basic problems for that area;

2) technical backup support is seriously needed. At present funds are not available to support technicians, and the faculty is required to do the entire research program, thus seriously limiting a research program;

3) transportation to the Llonga Field Station or to the College Research Station is extremely limited, and therefore collection of data when needed from the field studies is a critical problem in the research program.

4) short term assignment of U.S. scientists, particularly in the plant protection areas, is needed and would be welcomed by the faculty;

5) long term assignments would also fit into the program; living accomodations could be provided;

6) training of technicians to support the staff is available from the diploma program (about 300 undergraduates at the College); although the need for Ph.D.s in the bean/cowpea program is not critical, a provision should be made for this aspect during the expected 5-year program.

3. Llonga Research Station

Because Monday, May 28, was a USAID holiday, our time for programming in Tanzania was limited to one day. We were not able to visit with the Ministry of Agriculture, but were assured by Peter Shirk, Deputy Director at USAID, that the Bean/Cowpea CRSP is fully supported by the Government of Tanzania (GOT). We had hoped also to visit the Llonga Research Station, but one day did not allow time for that visit. A large project on legumes is being conducted at the Station, "IITA/USAID Tanzania Grain Legume Research Project," a National Legume Research Program for Tanzania (cowpeas, green gram , phaseolus bean and soybean). However, we were fortunate to meet Dr. P.N. Patel, Legume Breeder/ Pathologist of IITA, at the hotel. He has been at Llonga since 1975, and he discussed with us the general program, and in particular his cowpea breeding program for resistance to pest and disease. He believes that during this period of time he has identified the important pests and diseases in Tanzania relative to legume production, and the following summarizes his work on cowpeas and the relevance to disease and pest control in Tanzania:

1. Diseases of grain legumes in Tanzania: distribution and relative importance.
2. Breeding of cowpeas for multiple disease resistance and high yields in Tanzania.
3. Strains of cowpea yellow mosaic virus in Tanzania and sources of resistance.
4. Genetics of host reaction in cowpea to strains of cowpea yellow mosaic virus in Tanzania.
5. Studies on the prevalence of sap transmissible viruses in cowpea in Tanzania using differentially reacting cowpea cultivars.
6. Reaction of elite cowpea cultivars to some diseases in Tanzania during 1978 under both natural epiphytotic and artificial inoculations.
7. Sources and inheritance of resistance in cowpea to the strain of cowpea aphid borne mosaic virus prevalent in Tanzania.
8. Pathogenic variability and host resistance to bacterial pustule pathogen in cowpea.

9. Inheritance of resistant reactions to race 1 and 2 of bacterial pustule pathogen in cowpea.
10. Inheritance of resistance in cowpea to bacterial blight disease.
11. Host resistance to important diseases of green gram (mungbean) in Tanzania.
12. Reaction of bean germplasm lines to important diseases in Tanzania.
13. Bacterial pustule disease of soybean in Tanzania: Reaction of some AVRDC breeding lines.
14. Pathogenic variability in bean halo blight organism in Tanzania.
15. Cowpea selection and breeding work in Tanzania during 1976-1979.
16. Green gram cultivar evaluation in Tanzania during 1976-1979.

C. Malawi

1. USAID Mission, Lilongwe

visited: Gil Scheinbaum, American Embassy staff
Mary Quinn, Program Coordinator

The USAID program is just getting underway as they have not had a program in Malawi for several years and were concentrating their efforts in Swaziland. Mr. Cole, assigned as the Agricultural Officer, was in Washington, D.C. Mr. Scheinbaum, assigned to the Embassy and formerly in charge of the Agricultural section, discussed briefly with us the Malawi Department of Agricultural Research (DAR) and indicated the cooperative nature of the proposed program. A rough draft of the program proposal to assist the DAR was made available to us for a quick review during our visit. In brief, the project was concerned with grain crops (maize, sorghum, etc.), farming systems dealing with all crops, and studies on production economics. The approach would be an integrated research project, but the total program was not developed.

The level of skills of the DAR is low and is an acute problem, research equipment and physical facilities are inadequate or nonexistant, even for routine plant and soil analyses. At present the total complement of technical officers and assistants is 348; the project plan is to upgrade and increase the number to 431. However, housing must be provided at the research stations

before recruitment for the project and training can be initiated. At present there is a need for systems or activities directed toward assisting the small farm holders.

At this point in time, with programs yet to be initiated or adequately defined, the role of the Bean/Cowpea CRSP in a supporting role cannot be defined.

2. University of Malawi, College of Agriculture at Bunda
   Visited:
   Dr. O. T. Edje, Plant Physiologist
   Dr. L. K. Mughogho, Irrigation Specialist
   M. L. Mwinjilo, Agriculture Engineer
   Dr. Y. P. Rao, Plant Pathologist
   Dr. W. A. B. Msuka, Plant Pathologist

Arrangements to visit the College of Agriculture were arranged directly by phone with Dr. O. T. Edje of the Crop Production Department. The program, an integrated approach involving several disciplines, is primarily concerned with beans. Cooperation in this phase has been established with CIAT and IITA, where a few varieties of cowpeas are being tested in field plots. The following is a summary of the visit and indicates where support is needed in their program:

The Bunda College of Agriculture campus at Lilongwe is relatively new (plus or minus 10 years), the staff relatively young, and well trained for teaching and research. Many are currently abroad in the U.S. and England working on advanced degrees. Dr. O. T. Edge, Plant Physiologist, is in charge of the bean program and, with the cooperation of Irrigation Specialist Dr. L.K. Mughogho, and Plant Pathologists Drs. Y. P. Rao and W. A.B. Msuku, he has evaluated a large (±2,000) collection of Malawi varieties and lines from CIAT and all over the world. The best of these determinate and indeterminate types have been used in a series of well-conducted cultural-agronomic experiments in mono and mixed (maize) culture to investigate such factors as spacing, fertilization, time of planting, mixed cropping, planting patterns, strip cropping, relay cropping, polycropping bean blends and staking. They have also studied the relative effects of various degrees of defoliation (bean leaves are sometimes used as a green vegetable) and the effects of the number of pods per

per plant on dry seed yields. Their rhizobium inoculation results show a slight but insignificant advantage to inoculation. Since most of their beans are relatively poor N_2 fixers, they get responses to artificial N up to 60 kgs/ha; phosphorous also is needed to up to 80 kgs/ha. Disease control sprays at fortnightly intervals can almost double yields, indicating the relative importance of halo blight, rust and anthracnose. A mild mosaic virus symptom resembling bean common mosaic virus was found in a visit to their field plots, although Dr. Edje was unaware BCMV was in the country. Producing seed under dry season conditions using furrow irrigation reduces disease incidence and severity immensely. However, most small farmers do not have access to irrigation during the dry season. Sometimes there is enough residual soil moisture in some areas toward the end of the long rainy season to allow small white canning beans (Mexico 142) to mature in the dryer but cooler environment (June-July-August) with fewer disease problems. However, low soil temperatures during emergence are a problem during this period, and Dr. Edje is screening for cvs able to emerge rapidly and uniformly under these conditions. White canning type beans are grown only for export; Malawians prefer reddish colored (i.e. Canadian Wonder and Dark Red kidney types) because the cooked bean resembles a piece of meat. Dr. Edje and his colleagues would welcome any Title XII collaboration at the primary level. One of their greatest needs is a Plant Breeder to develop locally adapted multiple disease resistant cvs of the regionally preferred types.

D. Botswana

1. USAID Mission

Visited: Jack Morris, Agricultural Development Officer

Contact by phone was made with Phil Bueschler, USAID Representative-Research, at his home on Sunday, June 3, 1979 and he had received the telex sent from Tanzania indicating our arrival. Arrangements were made to visit with Jack Morris on Monday, June 4. He had contacted LeRoy Peters, Chief of Crop Improvement Division of the Government of Botswana, but support is paid by USAID and they had asked him to be responsible for our visit to Botswana.

USAID is seeking continuing funding for a project (FY 1981) to increase the capability of the GOB/MOA to develop and expand crop research activities for commodities grown by small farmers. The frequent droughts and difficult ecological conditions of Botswana require special efforts to gain research information needed in small farmer programs. Dryland crop research has been underway since the 1960's, largely supported by Great Britain. AID involvement has been marginal and limited to crop screening (corn, millet and sorghum). It has become apparent that genetics/plant breeding, soil fertility and cash crops have not received effective attention, largely due to limited numbers of qualified researchers. The GOB is now planning a major new Arable Lands (ALDEP) program with emphasis on small farmers, and needs an accelerated fully-developed research program, along with improved research and extension linkages. The program is designed for a geneticist/plant breeder, cash crop (legumes/pulses/oil seed) specialist, soil fertility specialist and research liaison specialist. They would join the staff of the Arable Lands Research Station and carry out their specialized activities with other team members under the direction of the Chief Research Officer. Counterparts would be identified and sent out of country for appropriate training.

The major outputs projected for the four year program are:

a) Data on specie and variety adaptability of plants to be grown by small farmers.
b) Improved field trials program.
c) Closer linkages between research and extension personnel.
d) Trained Botswana research personnel.

The proposed AID-financed inputs for 1981 are:

1) Contact with Title XII institutions.
2) Procurement of research equipment/commodities.
3) Initiation of counterpart training.

The life of project cost is estimated at $2,800,000.

2. College of Agriculture

Visited: Dr. Duane Everett, Professor of Education, SDSU
Dr. Dale Reeves, Plant Breeder, SDSU

The College of Agriculture serves agriculture and animal health programs. A 5-year Title XII project has recently been awarded to South Dakota State University (SDSU) to upgrade the curriculum, assist in restructuring the certificate program, to develop and implement a diploma program, and to upgrade the staff to handle the new programs. About 15 staff will be trained in the U.S., 15-20 at the Swaziland University, and the certificate program will be increased from 125 to 250. New buildings to accomodate these changes are planned.

Botswana and Swaziland have had a common share in the University located in Swaziland but are now separated to some degree, which gives impetus to developing a full program in agriculture and the animal health sciences in Gaborone, Botswana. Dr. Duane Everett, who is accompanied on a long term assignment by Dr. Dale Reeves, briefed the team on SDSU's project.

3. Ministry of Agriculture, Department of Agricultural Research

Visited: Dr. LeRoy Peters, Chief, Crop Improvement Division, GOB
D. E. Gollifer, Chief Arable Crops Research Officer
K. Oland, Director of Research

The Ministry of Agriculture Research Station is located adjacent to the College just outside Gaborone but is operated independently under government policy. The research unit has two research officers in entomology, a crop screening specialist, a soil fertility specialist, and a plant nutritionist. They are supported by a staff of five technical officers, 12 technical assistants, and 4 laboratory assistants. Several of the technical staff have received further training at the international centers (IITA, ICRISAT, CYMMT) and other places that fit their specialities.

The role of the Division of Arable Crops Research is to develop information to increase and stabilize crop production. Emphasis on production of legumes was initiated in 1976, and nutrition studies of these crops were initiated in the 1977/78 crop year. Cowpea variety "Black Eye" trials (the preferred type in Botswana) were started in 1947. In accord with the new legume research plan, special emphasis was placed on cowpeas in 1976 when germplasm was obtained from IITA.

The priorities in the new ALDEP legume program are: 1) groundnuts, 2) cowpea, 3) sunflower, 4) white haricot beans, 4) soybeans. Some trials will be carried out with chickpea, tepary bean, jugo bean, pidgeon pea and china pea. Although the emphasis on this report is on cowpea, about 13% of the arable land (650,000 ha in crop farming) is listed under beans and cowpeas but is not separated as Phaseolus vulgaris or Vigna unguiculata. The climate of Botswana is generally semi-arid, and overall is better suited to cowpea production. However, some observation trials on Phaseolus vulgaris were initiated at Sebelle in 1977-78; these were obtained from CIAT and Cambridge, U.K. and will be further tested at Sebelle and Mahalpye Research Stations.

In discussing the Bean/Cowpea CRSP program in terms of ongoing research and future research plans, the following needs for their research program to overcome the constraints are:

1) Technical backup support in the cowpea research program. An example of this is the research being conducted by Ms. G. Maphanyane, B. Sc. Agric., University of Swaziland, who began screening cowpea varieties for nutrition studies in 1977/78. Technical support for this program for the field work and laboratory work is sorely needed in view of the emphasis on legumes and the need for nutrition information. Other areas in the proposed research plan for improving and stabilizing legume production would be greatly strengthened with technical support.

2) Long term support by U.S. scientists, such as plant pathologists, agronomists, soil scientists (interested in soil physical properties), or plant scientists on weed control would greatly increase the research output towards meeting the research objectives.

3) Short term U.S. scientists. This group could assist in program research planning, conducting experiments, identifying plant and pest diseases, and suggesting controls.

4) Training of technical support will probably be met by the College of Agriculture and its upgrading program. There is a need to train some students to the Ph.D. level to broaden the areas of research in plant pathology, soil science and in soil and water management. This aspect should be coordinated with USAID training programs in their crop production projects.

5) The GOB has expressed a strong interest in cowpea collaboration. Their renewed interest in grain legume production, both as a cash crop and from a nutrition standpoint, as well as small farmer assistance, is a positive step in seeking collaboration. Housing is very limited in Gaborone and providing space for long term support may be a problem. They have indicated their support in this effort as needed and to the best of their ability in cooperative programs. (See attached material prepared by Mr. Gollifer in support of their interest).

4. Botswana Agricultural Marketing Board (BAMB)

Visited: Peter Mulligan, Executive Director

Executive Director Mulligan outlined the functions of the BAMB in price setting, supply and distribution, and stabilization of prices. A system of storage depots has been provided throughout the country (8 of 11 are now in operation and all will be by September 1979). This plan appears to be a viable system for marketing throughout Botswana, and additional increases in yield production through the research plans should not cause marketing problems.

E. Zaire

1. USAID Mission

Visited: James E. Hawes, Food & Agric. Officer
Walter Boehme Program Officer

Mr. Hawes had received our telex sent from Dar es Salaam and had programmed our visit. The USAID program, with a strong emphasis on grain legumes, was recently submitted to AID/W for funding and a contract was signed with Multiple Agribusiness Systems Inc. (MASI) in Washington, D.C. The 4-year project will be located at Mulungu Research Station in eastern Zaire, 25 miles from Bukava. The project objectives are:

a) to increase the capability of the Institut National pour l'Etude de la Recherche Agronomiques (INERA);

b) create productivity packages for food legume production (beans, cowpeas, soybeans, etc.) through adaptive and applied research at Mulungu Research Station;

c) provide reliable production potentials and limitations of soil in Zaire; and

d) allocate INREA's resources for optimal use.

The Mulunga Station has 1000 ha and is located at about 2000 m altitude. Most of the land is cultivated with relatively deep silty loam soils that are well drained. The long term staff for the project are: soil scientist, land classifier, research agronomist, rural sociologist, management planner, laboratory technician, and business management consultant. There are 12 short term backup staff for disease and insect control, extension, soil fertility, etc. Cooperation in variety testing will be with PNM/CYMMYT, IITA, Intsoy and local screening. Training will include counterparts and advanced training M.Sc. degrees in the U.S. from selected counterparts, and short courses for INERA staff. The total program will operate under the auspices of INERA in cooperation with USAID. Transportation to the outlying area at Mulunga Station from Kinshasa is extremely difficult and will be handled by use of a small aircraft from Kinshasa.

2. Government of Zaire

Visited: Citizen Mukendi Mbuyi Tshingowa, Secretary of State for Agriculture (equivalent to a Vice Minister)

Citizen Mukendi discussed the role of INERA and their very strong interest in grain legume production. At present they have agreements with CYMMYT on maize production and with IITA on cassava; no contact has been made with CIAT on beans.

We discussed in general terms work being done at other Research Stations at Yangambi, Gandajika, M'Vuazi as well as Mulunga. Special mention was made that living accomodations and family facilities are available at M'Vuazi where research is being conducted on common pea, peanuts and cowpeas, among other crops. This Research Station is located between the coast and Kinshasa and IITA's cassava program is located at that Station.

Citizen Mukendi has a very strong interest in grain legume production because of the short supply of food that apparently exists at the present time

in Zaire, and also because a large part of the diet is cassava, and nutrition studies have shown the need for protein that could be supplied by the legume food crops.

There are a number of constraints relating to a bean/cowpea CRSP in Zaire:

1) The French language. MASI is having problems with this aspect in filling their program staff, even though the backup universities for the project are the University of Illinois and Hawaii;

2) a supporting role for any bean/cowpea project by a U.S. university or other institution would be with INERA and may not offer a strong institutional link for research, but might offer such links for certain training aspects;

3) affiliation with INERA could be made at certain Research Stations, but more information would need to be obtained on this point by an interested U.S. institution;

4) there is a possibility of affiliation with the MASI program, but this would come under INERA. Also, the field studies will not get underway until the second year because of the logistics involved in getting equipment, housing etc., completed before the program gets underway.

At the present time the economy in Zaire is extremely inflated, increasing at the rate of 100-200% in the last 2 years, and it does not appear to be decreasing. Director Gamble (IITA) indicated a default in payments to their cassava program, and because of this they have decreased their staff support considerably. How this inflation trend will affect a collaboration program cannot be determined, but there exists a negative attitude among some U.S. universities for programming in Zaire.

F. IITA, Ibadan, Nigeria

Visited:

Dr. W.K. Gamble, Director General
Dr. B.N. Okigbo, Deputy Director General
Dr. P.R. Goldsworthy, Leader, Grain Legume Improvement Program
Dr. W.H. Reeves, Training Officer
Dr. R. Lal, Soil Physicist
Dr. L. Jakai, Entomologist (postdoctoral)

Since IITA was officially visited by Dr. D.H. Wallace and the Bean/Cowpea CRSP team representing West Africa the comments here will be brief.

Director Gamble discussed the training available at IITA. He expressed the need for American graduate students to fill the void of talented backup support for the permanent staff. He indicated that with the large legume improvement program (including cowpea) and the need to continue the farming systems studies to incorporate legumes into the rotations, many openings for talented American graduate students could be made available through Title XII at IITA that would include: agronomy, entomology, physiology, pathology, plant breeding, microbiology, virology, soil science, nematology and farming systems. This would provide an applied approach to subtropical research more relevant to the African situation than is now available at American universities.

Dr. Reeves, Training Officer, mentioned that at present 35 graduate students are at IITA, but nearly all are from developing countries or Europe. Title XII could offer an opportunity to train American graduate students, and this,on their return as U.S. university staff, increases the institution's technical base for overseas assignments.

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SUMMARY - EAST AFRICA

W. Mwangi

Faculty of Agriculture, University of Dar-es-Salaam, Morogoro, Tanzania

The department of Agricultural Economics at this facility is relatively young. The Acting Chairman is Prof. Foote (MSU, 1935) since the Chairman (a Tanzanian) is in the U.S. undertaking a Ph.D. program. There are a few other expatriates in the department. No socio-economic study is being undertaken or has been undertaken in the area of beans and cowpeas and the future capability by Tanzanians in the department to undertake such studies will take a few years to build.

The Lbnga Research Station has been provided with a farming systems economist by IITA, a Dr. Jodha, formerly with ICRISAT. Any collaboration with this station would lead to such studies as socio-economic factors influencing the production of beans and cowpeas in Tanzania.

While at Morogoro we also visited with Dr. A. Haq, Department of Food Science and Technology, the department that deals with studies on nutrition impact of various crops. Here again the department is young and there is no Tanzanian with a doctorate. Thus, it is mainly concentrating on training of Tanzanians to take over. The main research work has been on MSci theses, two of which have been written on the nutritive value of cowpeas and beans as seeds; these studies have shown that the protein content of these seeds is greater than 15%. A MSci thesis is being completed on the protein content of cowpea leaves.

The major constraint here is finance. The availability of funds would lead to accelerated training of local faculty as well as easing such constraints as transport, lack of laboratory equipment and space. It was felt that there is a spirit of cooperation, but again local capability will take time to build. Consequently, what research can be undertaken on nutrition impact of beans and cowpeas will be limited to MSci theses for a while unless CRSP brings in personnel.

Malawi - Bunda College of Agriculture

Here the department of Agricultural Economics as such is nonexistent. A lot of work has been done on breeding of beans by Dr. Edje et al., but nothing has been done on the socio-economic side and the capability to undertake such studies is lacking; only one Malawian Ph.D. Agricultural Economist has returned from the U.S. to undertake his thesis research. Thus, any cooperation with the College in the area of socio-economic studies would mean that CRSP would have to provide not only the funds but the personnel to undertake such studies. Hence, their first basic need is to train local personnel. The work on nutrition is also lacking since the College does not have a department of Food Science and Technology. This would mean that the first need in the area of nutrition would be to establish such a department from scratch.

Botswana

The USAID in Botswana mainly cooperates with the Ministry of Agriculture since the Faculty of Agriculture is located in Lesotho. The Ministry of Agriculture has a Research Station which has been doing some work on cowpeas and beans; the area of socio-economics in production of these legumes has been ignored. The current program submitted to AID by the Ministry of Agriculture for funding of the Research Station includes such professionals as plant breeder, soil scientist, agronomist, etc., but no farming systems economist. It would appear that planners are only interested in natural scientists at the Station; the role of a farming systems economist needs to be included. The planning section of the Ministry of Agriculture is including socio-economic studies on various food crops, and perhaps the results of these studies will enlighten the policy makers concerning the role of agricultural economists in the whole area of food production. The CRSP, if involved, should at least provide the Research Station with a farming systems economist as the local capability in this area is lacking and there is no work being done on nutrition.

Zaire

In Zaire as in Botswana USAID cooperates with the Ministry of Agriculture.

The little work that is being done on beans and cowpeas does not include any work on socio-economics of the production of these crops. The local capability is lacking and any involvement of CRSP would mean provision of both finance and personnel in this area. In the area of nutrition USAID is undertaking a consumption survey in Western Zaire to attempt to determine nutrition problems in the area.

In trying to rejuvenate the M'Vuazi Research Station the USAID program completely ignores the role of farming systems economist. This is unfortunate, as again if CRSP were to be involved it would mean providing such capability.

SUMMARY - EAST AFRICA - BEANS §

M. J. Silbernagel

Beans are grown extensively in Kenya, Uganda and Tanzania. It is the most important pulse crop in Kenya (being grown on virtually every small farm), with about 322,600 ha, most of which is intercropped with maize (1 and 2). Uganda produces beans on about 300,000 ha, and Tanzania on about 12,000 ha. They are best grown at altitudes between 1,000-2,000 m, and require about 300-375 mm of rainfall over a 10 week-2 month period, followed by a 4 week dry period for harvest. Varieties are usually mixtures, but Canadian Wonder, Rose Coco and Miwezi Moja are favorites in Kenya and Tanzania. Mexico 142, a small white dry bean, is grown mainly for canning and export. French beans are also grown mainly for export or consumption by expatriots.

In Uganda, Banja 2 and Mutibhe 4 are the leading varieties. Seed yields average about 500 kg/ha, but have a potential of 2,000-3,000 kg/ha if all recommended production practices are followed. For the subsistence farmer however, pesticides and fertilizers are out of the question for a low priority crop like beans. Primary emphasis is placed on cash crops, which are taken care of by men, who also collect and handle the cash returns. Often the proceeds go into purchasing beer, and the family is forced to sell food beans and seed stocks for next year's crop in order to buy necessities.

The "shamba" or family garden is mainly taken care of by women, who sell part of the excess produce to pay children's school fees. The potential return from the best cash crops (coffee, tea, sugar cane, sunflower, pyrethrum, etc.) often causes reduction in planting of food crops like maize and beans, which then have to be purchased later for food and seed.

Later, if the family then cannot afford to buy a nutritionally balanced diet, malnutrition ensues (as much as 80% in children under 5). In most cases high carbohydrate weaning foods such as cassava, maize gruel and banana mush are heavily used. Protein-rich foods such as beans/cowpeas are seldom used

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for weaning because of digestibility (diarrhea) problems. This may be partly due to insufficient booking in areas where cooking fuel is scarce. A May 29, 1979 article in the Tanzania Daily News cites a government official as requesting the Tanzania Food and Nutrition Center to advise the government on cheap ways of preparing weaning foods.

A possible future source of collaboration in the nutrition field will be the traditional Nutrition Research Institute, which is under the Government of Kenya Ministry of Health, and which will be directed by Dr. Steven Kinaote, who is presently at Cornell University working on a MSci degree on international nutrition under an AID scholarship.

The consumption of beans in the average Kenya diet was estimated by Dr. Mukunya to be 1/4-1/2 kg/day, mixed with other foods such as maize, potatoes and other vegetables. Beans have increased in price as much as eight-fold in the past few years, making them less available in the diets of poor people to whom they are a primary source of dietary protein.

Dr. I.M. Gomez, with the University of Nairobi Department of Food Science, is presently very interested in collaborative nutritional studies with legumes, and is part of an Integrated Grain Legume Project which also includes agronomy, weed science, soil chemistry, plant pathology, microbiology, entomology, and plant breeding. This group has a Rockefeller Foundation grant to study pest management techniques for small scale mixed cropping farms. The project is called the Plant Protection Program (PPP) and is just finishing its first year. This program allows for some exchange scientists and some graduate student training.

The four major areas under study are: 1) entomology, 2) plant disease (fungal and bacterial), 3) virology-nematology, and 4) cropping systems and weeds. The work will progress in three phases: 1) a field survey, 2) an evaluation of cropping systems, and 3) experimentation on pest management practices. The main objective of the PPP is to train students and encourage research in systems of integrated pest management, with special emphasis on the problems of small farmers since more than 75% of the small farmers in East African countries have 3-5 acres of land.

A meeting was held with available members of the PPP team at the University of Nairobi, Kabete (agricultural) campus. In general the group is young, well trained, and eager for collaborative Title XII bean/cowpea research at the primary level in the following areas:

Dr. D.M. Mukunya and Dr. J.P. Singh - Fungal and bacterial diseases of beans in mixed cropping systems, halo blight, and anthracnose are the primary diseases, although common blight, angular leaf spot and bean common mosaic virus (BCMV) are also frequently encountered. Diseases and pests are the principal causes of yield reductions. Beans are not planted late in the season (whereby they could take advantage of the dry harvest conditions) because late-planted beans are more subject to aphid damage and apid-vectored BCMV. Most farmers don't recognize disease as abnormalities because they see them so frequently.

Dr. E.M. Gathuru - Plant Virologist - Viral diseases of beans in mixed cropping systems. Bean common mosaic virus (BCMV) is widespread but usually of low frequency because of early planting when apid populations are low. No work has been done to identify which strains of BCMV are present in any parts of Africa. However, the cool, wet conditions during the early part of the rainy season are most conducive to the rapid, severe development of rust, halo blight and anthracnose. All these diseases are seed-borne, so farmers perpetuate their own problems. If BCMV could be controlled, growing beans in the dryer part of the season could greatly reduce damage from rust, halo blight and anthracnose. "Bean yellow spot" is also seed-borne, widespread and low in frequency. It may be of potential economic importance however, in regard to future bean seed production programs for genetically improved varieties.

Dr. S.O. Osiru - Crop Physiologist - Cropping systems used by small farmers. The most common mixture is maize and beans, with maize being the most frequently grown and most important crop. Beans were also found in mixture with potatoes, mostly in the short rains period, while maize and beans were most frequent during the long rains.

Dr. D.N. Ngugi - Crop Physiologist/Weed Scientist - Cropping systems and weeds on small scale farms. Maize and bean mixtures were found to have about 30 species of weeds in 13 families. Hand-hoeing with available family labor is the main means of weed control. Herbicides or tractor cultivation is only feasible for high return cash crops like coffee or tea. A few practice some rotation to reduce weeds, pests and disease and to maintain soil fertility. The shortage and/or expense of hand labor and the low return on beans precludes more than early season control to give the maize and beans a head start. By harvest, weeds are thick. Improved, low cost methods must be developed that are compatible with mixed cropping.

Prof. C.P.M. Khamala, Dr. M. Mueke, Dr. S. Karel - Entomologists - Insect pests of beans in mixed cropping systems. The most damaging insect pests found on beans were the bean fly Ophicomyia phaseoli and aphis fabae. Both of these pests can be controlled by pesticides, but these are generally too expensive and their safe use too complicated for the subsistence farmer. Biologic control (predators or parasites) or genetic resistance should be found to these and other insect pests.

Dr. S.O. Keya - Microbiologist - Role of rhizobium N_2 fixation in beans in mixed culture. There is a need to isolate and evaluate strains adapted to their highly weathered, acid soils. Beans are often found without nodulation. Once superior adapted strains of rhizobium are found, commercially available inoculum needs to be produced locally. There is a need to develop suitable carriers using endigenous materials, and for student training for advanced degrees abroad.

Dr. Ssali - Soil Scientist - Mentioned some highly acid soils (pH 3.5-5) require liming, and that aluminum toxicity can be a serious problem in sensitive crops like beans. Genetic tolerance to aluminum toxicity would be desirable.

Dr. R.S. Pathak - Plant Breeder - Is making selections among locally adapted cowpea mixtures for seed types, leafy types (for fresh vegetable use), and combination types. The Bean Breeding is presently being done by a Dutch AID

group at the Ministry of Agricultural Horticultural Research Station at Thika. We were unable to visit this group, but their tour is almost completed and they will soon be returning to Holland. A number of Kenyan graduate students need to be trained in breeding for disease resistance so the Kenyans can carry on their own program of variety improvement. These students could work with the other members of the PPP (and for the Ministry of Agriculture) on their return. The main breeding emphasis is for resistance to Halo blight, rust, anthracnose and Bean Common Mosaic Virus.

Beans are available for seed increase and distribution through private (Kenya Seed Co.) and government channels (Ministry of Agriculture/Extension Service). In summary, the academic and governmental climate for potentially fruitful research and training collaboration with members of the agricultural faculty at the University of Nairobi appears extremely good.

RESEARCH PROPOSAL

(Tanzania)

NAME: B. J. NDUNGURU

FACULTY AND DEPARTMENT: Faculty of Agriculture, Forestry & Veterinary Science
University of Dar es Salaam, Morogoro, Tanzania

SUBJECT OF PROPOSED RESEARCH: Phaseolus Research in Tanzania

OBJECTIVES:

The status of research on Phaseolus vulgaris (beans) is critically inadequte at present in Tanzania, although it is one of the most important grain legume groups in the country. The Ministry of agriculture is engaged in the improvement of grain legumes in general, but much emphasis has been laid on cowpeas, and to certain on other grain legumes. Phaseolus beans are grown in the relatively wetter highlands (of cowpeas) either as a sole crop or in mixture (Acland, 1971), most production occurring on small holdings where there is little use of mechanization, fertilizer, chemical weed control and pesticides. Commercial production is only being carried out in the northern part of the country.

Several factors limit bean production, including, among others, plant diseases and pests. Grain yields of Phaseolus beans vary considerably but they commonly range between 60 to 750 kg/ha, although experimental yields close to 3000 kg/ha are common in trials carried out at CIAT (Cummings, 1976). These low yields are associated also with the use of varieties which have low yield potential. Within the species, tremendous variations exist in size, shape, colour, texture and taste and there seems to exist tremendous potential for improvement of both yield and quality (TAC, 1975). In recognition of the place of beans in the human diet, the Bean Improvement programme is to be initiated with the objective of essentially finding and assembling an efficient and economic package for dry seed production.

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What Has Been Discovered About This Problem and What Remains to be Done

In grain legumes present evidence suggests that a common set of components is essential for all high yielding ideotypes (TAC, 1975) namely

a. high pod number potential
b. greater number of seeds per pod
c. large seed size (weight)
d. a canopy profile structured for maximum light interception
e. node number, internodal lengths, and branching pattern in keeping with the requirements of (a-d) above
f. leaf size and orientation in keeping with items (a-c) above, and with the cultural-environmental situation
g. a growing period and leaf area duration to fit the needs of the cropping system in use, but which should be as long as possible in the reproductive period
h. a root and stem morphology (physiology) capable of undering the crop effective symbiosis (Sinha, 1977)
i. structural attributes favouring a high partition ratio of total plant dry weight increases into grain

On the basis of the existing information about grain legumes and the environments in which the crop is to be grown, superior lines might be exploited for breeding purposes.

Work Proposed to be Done, Where Work to be Done, What Method to be Adopted

Initially work will involve assembling and evaluating the germplasm to determine the relative yield potential of plants with different growth habits and to evaluate their responses to intra-crop competition. Response to inoculation by *Rhizobium*, by which the nitrogen fixing ability of beans can be maximized will also be studied, together with the distribution of fixed nitrogen to different parts of the plant. Studies will also be conducted on plant structure and physiology in order to seek traits that will bring higher yields.

Probable Duration of the Work

3 years initially

Importance of the Results to be Obtained and Where You Hope to Publish Them

The ultimate goal is increased bean production, the importance of which has been stated in the preceeding section. Results will be published in any relevant Agricultural Research Journal.

Names and Addresses of Persons to be Consulted Concerning this Application

Dr. R.J. Summerfield, University of Reading
Plant Environment Laboratory, Cutbush Lane
Shinfield Grange, Shinfield, Reading, England

Prof. E.H. Roberts
Department of Agriculture and Horticulture
University of Reading, Earley Gate, Reading, England

Bodies to Which Application Has or Will be Made for Assistance in the Project

None

Cowpeas, a crop for dry conditions

(Botswana)

INTRODUCTION

Botswana is situated between latitudes $17^{1/2}$°S and 27°S and has a land surface of 562,000 Km^2. It consists of an elevated plain of between 1200 and 1400 m above sea level. Approximately 85 per cent of the country is covered by Kalahari sand, on which grows a low thorn bush savannah vegetation. The climate is semi-arid, the average yearly rainfall varies from 700 mm in the north east to less than 250 mm in the south west. The rain falls in the summer months(October-April). Rainfall in the main arable areas varies from 550 to 350 mm per annum, but the variation in annual rainfall is high. Mean maximum temperatures rise to 33°C (January) and mean minimum fall to 4°C (June/July) at Gaborone. During the summer months the soils have high surface temperatures (up to 70°C) and evaporation rates are high. Pike(1) estimated that the potential evaporation of freely watered crops was 1400 mm per annum, with daily maximum of 13.6. The total open - water evaporation (ten year mean) at Gaborone is 1731 mm per annum.

Due to climatic factors, Pike(1) estimated that arable dryland agriculture can only be practised without extreme risk in an area of approximately 45,000 km^2 of suitable soils in the south-eastern region of the country. Probably only between 2-3% of the total land area is suitable for dryland agriculture if areas of poor and shallow soils are taken into account, and even in that small area the risk of crop failure is still high.

As a result of the semi-arid climate, Botswana is principally a pastoral country, but the distribution of cattle is such that nearly 50% of farmers have insufficient cattle to make a living from them. Dryland farming is the most wide-spread economic activity in Botswana and a 1971 Agricultural survey showed that of 69,000 rural families, 87% had farming lands of whom 52,000 (75%) planted in an average year. Of these families half were able to plough using their own draught power and the other half had to rely on assistance with draught animals from other farmers. Only c. 9% of farmers ploughed with a tractor. Other factors limiting crop production in Botswana besides drought and draught power are extremes in temperature, pests, diseases, bird, weeds (including witch-weed) and an inherent low soil fertility.

Government policy is to increase arable crop production by introducing more profitable and reliable methods of farming and to ensure that every rural household has the opportunity to obtain a useful income from agricultural activities. This is to be done by encouraging production of cash crops, marketing of surplus food grains and the development of new farming activities.

RESEARCH PROGRAMME

Agricultural research does contribute to the implementation of Government policy by providing information and indicating ways in which the aims of the Botswana Development Plan can be achieved. Part of the research programme of work is to screen germplasm of cowpeas *Vigna unguiculata* so that the varieties and types best suited to the environment can be selected. Cowpeas have been selected as a crop which should be given emphasis in the research programme, because they are an important high value food crop ~~and~~ are well adapted to the environment and are capable of producing reasonable yields of grain even in dry years. This is probably due to the fact that the roots can extend deep into the hard soil (Fig. 1) whereas the roots of sorghum, maize and sunflower are inhibited in these dense soils. Cowpeas are therefore likely to be a useful crop in rotations as the deep penetrating roots are capable of improving the physical conditions of the soil and the soil chemical status may be enhanced by nitrogen fixation.

Selection criteria for screening cowpea germplasm will be tolerance to drought conditions, earliness of maturity, a determinate flowering habit, an upright growth form and high yields of good sized quality grain. Resistance to diseases including cowpea mosaic virus (CPMV) and to infestation by insects in the field and in storage will be sought. After the improved cowpea types have been selected for Botswana conditions, agronomic and harvesting practices will be investigated. These will include studies on fertilizer use, weeding, time of planting, spacing, intercropping and investigations into suitable harvesting and threshing techniques. Initial studies on the role of cowpeas in rotation have been initiated because of their beneficial effect on soil chemical and physical properties.

PREVIOUS RESEARCH

Germplasm evaluation

Variety trials in Botswana have been carried out since at least as far as back as 1947. Table 1 shows the yields obtained during several seasons for the cultivar 'Black Eye' (2,3,4,5,6,7,&8).

Table 1. Seed yields in (Kg/ha) for the cowpea variety 'Black Eye'

Season	~~Bun.~~ Seed Yield(Kg/Ha)	Site	
1950/51	161	Mahalapye	(Lat. 23° 8'S, Long. 26° 50'E)
1951/52	678	Mahalapye	
1953/54	1,110	Mahalapye	
1954/55	691	Mahalapye	
1962/63	967	Gaborone	(Lat. 24° 34'S, Long. 25° 57'E)
1966/67	598	Mahalapye	
1967/78	812	Goodhope	(Lat. 25° 28'S, Long. 25° 27'E)
1970/71	1624	Sebele	
1971/72	1,121	Sebele	
1972/73	475	Sebele	
1976/77	1,180	Mahalapye	
1977/78	463	Sebele	

With effect from the 1976/77 season, germplasm was introduced from the International Institute for Tropical Agriculture in Nigeria (IITA). The highest yields obtained from this material were 2031 Kg/ha (1976/77) and 1730 Kg/ha (1977/78), (7&8). During the dry season of 1979/80, yields of up to 880 kg/ha were obtained at Sebele where total precipitation for the period 1 July/28 February was 346 mm. Planting took place during late October.

Farmers appear to prefer the Blackeye type of cowpea because of its large seed size and flavour. The disadvantage of the variety Blackeye are (1) indeterminate flowering habit i.e. flowering over a long period of time which requires several harvests and hence more labour, (2) semi-upright growth habit, often long, trailing runners that make harvesting more difficult, (3) low - yielding ability and (4) susceptibility to parasitization by witchweed *Alectra vogelii*. (8)

On farmers land the highest recorded yield of 'Blackeye' cowpeas obtained during the 1977/78 season by the Evaluation of Farming System & Agricultural Implements Project was 780 Kg/ha (9).

Spacing

The few trials conducted on spacing of cowpeas have failed to achieve a significant difference between treatments. Espacements tested were inter and intra row spacings of 60 & 90 cm and 15 & 30 cm, respectively (2).

Rotations

In a four - course rotation experiment comprising cowpeas, cotton, maize and sorghum which was maintained for eight years the detrimental effect of growing the same crop continuously was apparent for all crops. The advantage of a rotation was to double the yield of the four crops rotated compared to those grown continuously on the same site (4 & 5).

A four course rotation on the ox-unit (10 and 11) comprising sorghum, millet, cowpeas and sunflower produced yields of Blackeye cowpea of 849, 100, 713 and 1135 Kg/ha in four successive years. Yields of the variety 'Rhenoster' in a rotation of sorghum, cowpea maize and sunflower during this period were 800 kg/ha (10 & 11).

Tillage

A tillage trial incorporating a rotation of sorghum, cowpea, maize and sunflower was conducted at Sebele (10 & 11) which compared the use of the mouldboard plough (200 mm depth); chisel plough(200 mm); shallow sweep (100 mm) and precision strip tillage using a subsoil type plough (250 mm) on subsequent crop growth and yield. In the shallow sweep treatment, no significant sorghum, maize or sunflower root growth was observed below the tillage depth of 100 mm. However the cowpea roots were observed to extend to 400 mm(Fig. 2) and were therefore able to penetrate through the hard soil below the tillage depth whose bulk density was shown to be 1.8 Mg/m^3 (11). Many of the soils of Eastern Botswana have high bulk densities (c. 1.8 Mg/m^3) and the cultivation of cowpeas on these sites will improve the soil physical properties. This is particularly important in circumstances where draught power is limiting and implementation of deep tillage difficult if not impossible.

Harvesting and threshing

The labour requirement for harvesting cowpeas is high (up to 440 men h/ha) and it was estimated that for all operations the grain yield per unit of labour input varied from 0.8 - 2.1 kg grain/man hour (10 & 11). It is for this reason that investigations into suitable harvesting and threshing techniques have been included in the research programme so that the labour inputs can be reduced. Time of planting should be taken into account so that harvesting does not coincide with the period when sustained rainfall is likely, or compete for labour during the cereal harvest.

Intercropping

Investigations into intercropping have only just been started in Botswana. Willey (12) has outlined the useful role that cowpeas can play in intercropping system. It is increasingly apparent that this approach should be applied to crop research in Botswana, to determine if crop production can be substantially increased by the adoption of this system of cropping.

SEED MULTIPLICATION UNIT

The Seed Multiplication Unit of the Department of Agriculture Research organises the production of seed of sorghum, maize, millet, cowpeas and sunflower for sale to farmers. Table 2 shows the distribution of cowpea seed by cultivar for the 1978/79 season.

Table 2 Distribution of cowpea Seed by the Seed Multiplication Unit

Variety	Amount (metric tons)
Black Eye[1]	15.6
Tswana[2]	9.7
Rhenoster[3]	2.4

1. Semi upright habit, indeterminate flowering, good quality seed, susceptible to parasitization by Alectra.
2. Fairly resistant to parasitization by Alectra. Medium sized seed. Yields well in dry years, but in wet years produces vines at expenses of seeds.
3. Upright habit, determinate flowering, small brown seed, fairly resistant to parasitization by Alectra. Not favoured by consumers.

ABSTRACT

Cowpeas yield well, even in dry years in the arable areas of Botswana where the normal precipitation is 400-500 mm. The roots penetrate deep into the soil, under conditions in which the roots of sorghum and maize are unable to penetrate. Cowpeas would be a valuable component in a crop rotation system, as the deep penetrating roots may create a favourable soil condition for the production of good subsequent cereals yields.

ACKNOWLEDGEMENTS

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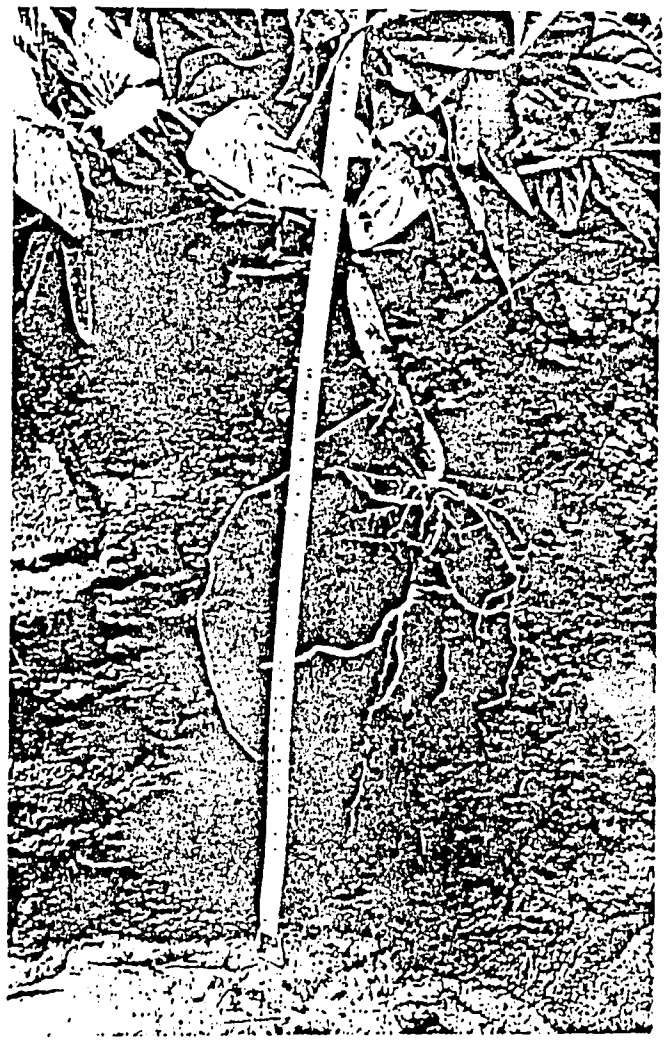

Fig. 1. Cowpea roots extending deep into the soil profile during the dry season of 1978-79 at Sabele.

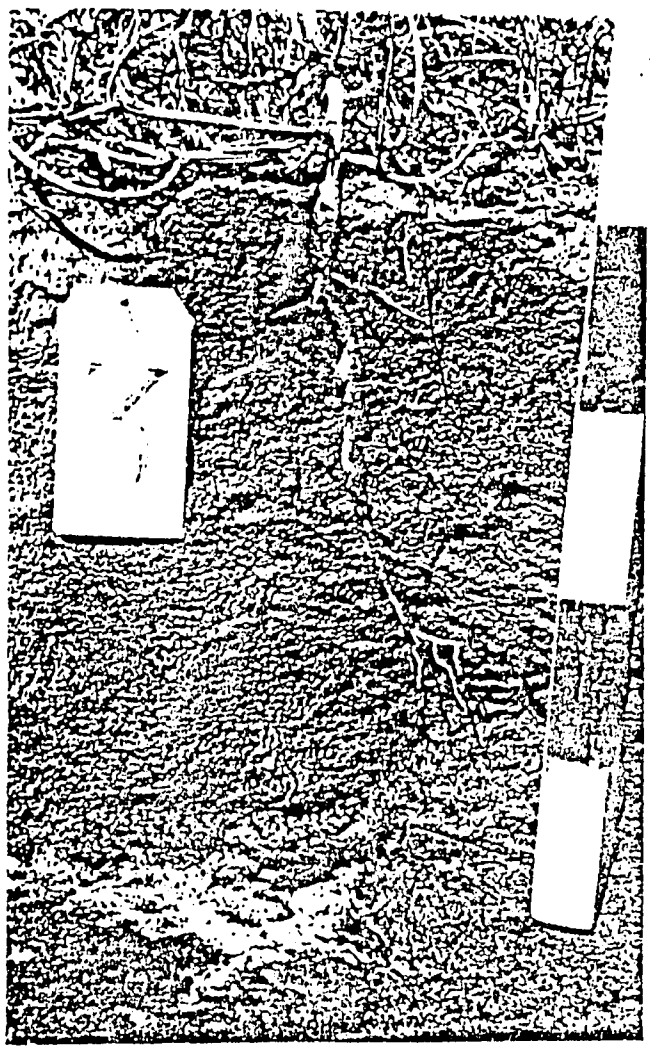

Fig. 2. Cowpea roots growing to a depth of 400 mm are able to penetrate through the plow (cultivation) pan which developed in the shallow 100 mm tillage plots (1977-78) at Sabele.