Acknowledgements

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Grateful thanks is also due to the Government of Upper Volta and His Excellency, the Minister of Higher Education and Scientific Research, for providing research facilities and the Coordination Office in Ouagadougou, and to organizations like the Institut de Recherches Agronomiques Tropicales of France, the International Crops Research Institute for the Semi-Arid Tropics, Purdue University, the U.S. Agency for International Development, the International Development Research Center of Canada, and to other institutions for their cooperation and assistance.

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ORGANIZATION OF AFRICAN UNITY
Scientific Technical and Research Commission
Joint Project 31 Semi-Arid Food Grain Research and Development

Maize and Cowpea Improvement in Semi-Arid Africa

The Contribution of the International Institute of Tropical Agriculture in Semi-Arid Food Grain Research and Development (SAFGRAD)

International Institute of Tropical Agriculture

"The most insecure type of existence man can subject himself to is a situation where there is no stock of food for a rainy day."

A. O. Odelola, Executive Secretary
Scientific, Technical and Research Commission
Organization of African Unity
Sorghum and Millet Workshop, Mombasa, Kenya, 1980

Foreword

Joint Project No. 31 Semi-Arid Food Grain Research and Development (SAFGRAD) is a regional research project coordinated by the Scientific, Technical and Research Commission of the Organization of African Unity (OAU/STRC) through the Coordination Office in Ouagadougou, Upper Volta. Its principal objective is to develop improved cereal varieties (maize, sorghum and millet) and grain legumes (cowpeas and groundnuts) and cultural packages suitable to the small-scale farming systems common in semi-arid Africa, and to promote their adaptation and use in farmers' fields.

Drawn up in 1977, SAFGRAD became operational in 1978 under a multi-donor support approach to finance its research activities. To date, the bulk of this support has come from the U.S. Agency for International Development (USAID).

Among the various research units in the project is the SAFGRAD-IITA (International Institute of Tropical Agriculture) group of researchers with regional responsibility for maize and cowpeas. This team initiated its work by planting a maize breeding nursery in 1978 and began its full program in the 1979 cropping season. Under the dynamic leadership of Dr. Vishnoo Asnani, excellent progress has been made during this three-year period. These accomplishments are summarized in this publication. The SAFGRAD-IITA maize and cowpea team has in a very short span of time produced very good results in terms of better varieties and agronomic practices. It is expected that the 25 OAU member states currently participating in the project will take advantage of these findings to increase the production of maize and cowpeas through appropriate on-farm tests and other development programs. JP 31 SAFGRAD looks forward to working closely with international institutions and helping to strengthen the various national programs.

Although the major focus of this publication is on the IITA component in SAFGRAD, there are other equally important research teams from other international agricultural research units and universities participating in the project. A team of researchers from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India, is working on sorghum and millet at Samaru/Zaria in Nigeria, and a farming systems unit comprising researchers from Purdue University, West Lafayette, Indiana, U.S.A., is based at Kamboinse, Upper Volta.

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Contents

Summary

The semi-arid tropics of Africa stretch across the southern edge of the Sahara, then down through the center of the continent. Three-quarters of the people of this region are small farmers who earn their living cropping less than two hectares of land. But food production in this relatively dry region is not keeping pace with its rapid population growth.

In a concerted effort to make more efficient use of the limited resources of the area's millions of farmers, the Semi-Arid Food Grain Research and Development project (OAU/STRC JP 31 SAFGRAD) was organized and started through the cooperation of 25 countries* of the region and several international organizations. SAFGRAD is organizing research and development for three cereal crops — maize, sorghum and millet, and two food legumes — cowpeas and groundnuts. The emphasis is on developing improved varieties and cultural practices for small farmers. Research at three regional stations is combined with variety and cultivation trials in cooperating countries, along with the training of national scientists to conduct their own research and communicate the results to farmers.

With world responsibility for cowpea research and regional responsibility for maize, the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, was chosen as contractor in the SAFGRAD project to improve these two food crops, to develop improved genetic material and agronomic practices capable of producing greater economic yields, and to test and exchange improved genetic material and other improved technology among the cooperating countries. To help accomplish this work, IITA has placed four of its scientists at the SAFGRAD headquarters in Upper Volta. The coordination of resident research in Upper Volta with regional program development has made possible many achievements by SAFGRAD-IITA during the first three years of the project:

- Promising varieties of maize and cowpeas that already exist and were developed by national and international institutions have been tested across the region. This has led to the exchange of genetic material between English and French-speaking countries.
- Through regional testing trials, BDS III and POOL-16 emerged as two early maturing maize varieties which have performed well in several SAFGRAD countries. IRAT-81 and TZPB have shown good promise as medium maturing varieties of maize. Three other new maize varieties with high yields have been developed: SAFITA-2 and SAFITA-104, both early maturing varieties, and SAFITA-102, a medium maturing maize.
- KN-1 has been found as a promising cowpea variety for areas with more than 700 mm annual rainfall. Kpodiguegue is another variety with good potential. In the dried areas, Gorom-Gorom Local cowpea variety has given consistently good performance.
- Maize yield increases of about 50% — ranging from 15 to 300% — have been obtained by using tied ridges as a moisture conserving cultivation practice.
- Deep plowing with oxen or tractors has given higher maize and cowpea yields than either the conventional hand hoeing or zero tillage methods.
- Maize yield increases of 50 to 100% have been obtained using crop residues as mulch.
- Management practices are being developed for the maize-cowpea relay cropping system. The practice can give good yields for both crops in the Guinea Savanna.
- Local varieties of cowpeas have been identified that have yield potentials close to those of the improved varieties. However, these local varieties often respond differently to certain management factors compared with the improved varieties.
- Insecticide treatments of cowpeas at flowering stage have the maximum effect on reducing losses due to insects. The most effective are treatments at the post-flowering stage.
- The K-biotype of aphid was identified at the Kamboinse Center in Upper Volta in some cowpea varieties resistant elsewhere to the A and B-biotypes. Three cultivars have been proven resistant to the K-biotype.
- Identification of resistance in cowpeas to aphids, flower thrips, *Maruca*, and bruchids is leading to development of an integrated pest management system.
- Production courses at IITA have been attended by 53 cowpea researchers and 43 maize researchers from 17 SAFGRAD countries. Seven national technicians have been trained at Kamboinse, and another six have conducted research there as part of their university degree work, thereby contributing to the development of the research capabilities of the SAFGRAD countries.

These and other accomplishments of SAFGRAD-IITA for improving maize and cowpea production in the region are being carried out through on-farm trials and demonstrations by the Accelerated Crop Production Officers (ACPO) and the Farming Systems Unit of SAFGRAD contracted to Purdue University.

This publication is intended to be useful to policymakers, research scientists, and others interested in agricultural development in finding ways to benefit from SAFGRAD's network of activities and also in the ways of contributing to its success.

*Benin, Botswana, Cameroon, Cape Verde, Central African Republic, Chad, Ethiopia, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Somalia, Sudan, Tanzania, Togo, Upper Volta and Zambia.

Introduction

The semi-arid tropics of Africa stretch across the southern edge of the Sahara, then down through the center of the continent. Three-fourths of the people here are small farmers who earn their living cropping less than two hectares of land. Annual rainfall, ranging from less than 400 up to 1,100 mm, is highly seasonal and erratic. Soils are of low fertility, and erosion is a problem even on gentle slopes.

The growing season — from three to five months — is controlled by the rains. Farmers need improved crop varieties and cultivation practices suited to the short season, yet with high yield potentials to take full advantage of every drop of rain.

Entire crops may be wiped out in the field or in storage by insect attacks. Experts say over half of the cowpea crop, for example, is lost because of insect damage.

Food production in the semi-arid tropics is not keeping pace with the region's rapid population growth. Increasing the food supply is a top priority for improving the quality of life of the people, yet not enough information is available on the problems of small farming systems.

National agricultural research institutes often are poorly equipped and inadequately funded to accomplish this task. Many lack trained researchers with actual farming experience in semi-arid agriculture.

Better ways must be found to make more efficient use of the limited resources of these millions of small farmers. Increasing their productivity is a basic strategy for a regional agricultural development program. Strengthening the national agricultural research systems of the region is the foundation upon which to build.

SAFGRAD

The Semi-Arid Food Grain Research and Development (SAFGRAD) project was started through the cooperation of 25 countries of the region and several international donor organizations. It is authorized by the heads of state and Government Assembly of the Organization of African Unity (OAU) and is known as Joint Project 31 of the Scientific, Technical and Research Commission (STRC).

SAFGRAD is organizing research and development efforts in the area for three cereal crops: maize, sorghum and millet, and two food legumes: cowpeas and groundnuts. The emphasis is on developing improved varieties and cultural practices for small farmers. Research at three national stations is combined with variety and cultivation trials in cooperating countries, along with training of national scientists to conduct their own research and communicate the results to farmers.

Accelerated Crop Production Officers (ACPOs) in cooperating countries are a link between the regional research of SAFGRAD and the national agricultural research and extension systems. This ACPO (right) and his counterparts are examining a cowpea demonstration plot in Mali.

The Accelerated Crop Production Officer (ACPO) in each cooperating country is the catalyst in developing close links between the regional research conducted through SAFGRAD and the national agricultural research and extension agencies. ACPOs are trained, experienced agricultural specialists who are integrated into their national extension and research systems to initiate testing of the new varieties and cultural practices developed by SAFGRAD resident research. They conduct on-farm trials and keep regional scientists informed of farmers' problems that may need research attention.

SAFGRAD is a multi-donor project with the major funding by the U.S. Agency for International Development (USAID).

Two international agricultural institutes and one U.S. university organize and coordinate the regional research and development, and maintain ties with the national research programs:

- International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria: maize and cowpeas.
- International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Hyderabad, India: sorghum, millet and groundnuts.
- Purdue University, West Lafayette, Indiana, U.S.A.: farming systems.

Regional research activities are centered at these three national research stations:

- National Agricultural Research Center, Kamboinse, Upper Volta.
- Institute of Agricultural Research, Ahmadu Bello University, Samaru, Nigeria.
- National Agricultural Research Center, Bambey, Senegal.

IITA

The International Institute of Tropical Agriculture was established in Ibadan, Nigeria, in 1967, the first of the international network of agricultural research and training centers to be located on the African continent.

Through research, IITA seeks to increase the production of food crops by:

- Increasing yields and improving the quality of food crops in the humid and subhumid tropics, especially by developing of high-yielding and insect and disease-resistant plants.
- Distributing improved plant materials to national research centers where they can be of significant value to breeding and improvement programs.
- Developing soil and crop management practices and farming systems for millions of small farmers to make possible a stable, permanent and productive agriculture in place of the centuries-old shifting cultivation and related bush-fallow systems.
- Building the capacity of developing countries to solve their food production problems through intensive training programs.
- Publishing and circulating research findings to agricultural scientists worldwide, to policymakers, and to extension workers in national programs, and through them, to farmers.
- Operating an information center and library with a collection of the world's literature on tropical agriculture in both English and French.
- Organizing and conducting conferences, forums, and seminars which review new research, consider current problems, and discuss needs for the future.

The work of IITA is organized around four core programs that concentrate on major tropical food crops: cereal improvement, grain legume improvement, root and tuber improvement, and farming systems.

In addition to the research and training carried on at its Ibadan headquarters, IITA is an experienced partner for the SAFGRAD project, providing the regional program with a support base in an international center with ties to the worldwide agricultural research network.

IITA draws on the extensive experience of the Institut de Recherches Agronomiques Tropicales (IRAT) of France for its work in SAFGRAD. For many years IRAT has conducted research in farm-

ing systems and the genetic improvement of crops in the French-speaking countries of the semi-arid tropics of Africa.

Activating the Regional Project

The SAFGRAD-IITA initiative is to strengthen national agricultural research programs. Through SAFGRAD each country is taking part in a range of voluntary activities that will lead to a better developed research system and improved food production capability.

Most national agricultural researchers have little professional contact with their counterparts in neighboring countries. SAFGRAD-IITA is helping bridge the informational gaps from country to country, especially between the English and French-speaking areas. Stronger national programs are used as models. Trained researchers share their expertise with scientists of other countries who have not yet acquired the needed skills.

The SAFGRAD-IITA multidisciplinary team includes a cowpea breeder, cowpea agronomist, a maize breeder, an entomologist, and a maize agronomist. This research effort is headquartered at the National Agricultural Research Center, Kamboinse, Upper Volta.

Participation in workshops

	1979	1980	1981
Benin	x	x	x
Botswana		x	x
Cameroon	x	x	x
Central African Republic			x
Chad		x	x
Gambia	x	x	x
Ghana	x	x	x
Guinea	x	x	x
Guinea Bissau			x
Ivory Coast	x	x	x
Kenya			x
Mali	x	x	x
Mauritania	x	x	x
Niger		x	
Nigeria	x	x	x
Sengal	x	x	x
Sierra Leone	x		
Somalia			x
Sudan	x		
Tanzania	x		x
Togo			x
Upper Volta		x	x

IITA's research effort at Kamboinse is centered on a crop-oriented multidisciplinary team — a plant breeder, an agronomist and an entomologist. Team members work across disciplines to develop improved varieties and better production practices for cowpeas and maize. This team approach — the research centerpiece of international centers — is being adopted by national programs.

The SAFGRAD-IITA approach is using practical, applied research in seeking useful answers to problems which the region's small farmers face in growing their plots of maize and cowpeas. The research program has these specific three-to-five-year objectives:

- Strengthening national maize and cowpea improvement programs in the SAFGRAD countries.
- Developing improved genetic materials and agronomic practices capable of producing greater economic yields.
- Systematically testing and exchanging improved genetic materials and other improved technology among SAFGRAD countries.

The regional contacts began with the first maize workshop in February 1979, attended by scientists and technicians from 15 countries and five international organizations. They compiled guidelines for the SAFGRAD-IITA maize research program that would:

- Improve germplasm for testing in the semi-arid region and in their national programs.
- Systematically test and evaluate their best materials in a wide range of environments in regional trials conducted jointly by SAFGRAD-IITA and the country programs.
- Evaluate the variability of diseases and insects.

In 1980 the workshop was expanded to include cowpea scientists. Trials for cowpeas were set up similar to those for maize. Better drought, disease and insect resistance, and higher yields received priority in the breeding program. SAFGRAD-IITA was asked to coordinate all regional trials for maize and cowpeas.

The third workshop in 1981 requested maize agronomists to continue with improved water conservation techniques. The approved breeding program was to work for maize adaptability and stability, to introduce new lines to improve protein value, to increase disease and drought resistance, to develop earlier maturing varieties, and to cross temperate with tropical materials for better germplasm.

The national cowpea researchers asked for varieties adapted to the region's varying climatic zones, resistance to storage and field insects, and incorporation of the preferred seed color and larger size into the high-yielding varieties.

The workshops bring national scientists and technicians together with SAFGRAD personnel to develop annual research priorities. Seated for the opening session of a recent workshop are Dr. V. L. Asnani, SAFGRAD-IITA Project Leader (center left) and Dr. K. O. Akadiri-Soumaïla, International Coordinator, OAU/STRC JP 31 (center right).

Monitoring tours for national maize and cowpea scientists are an important element of the regional program. Every year researchers from several SAFGRAD countries join these educational tours, with SAFGRAD-IITA scientists serving as leaders. Each tour group — one for cowpeas, another for maize — visits variety and on-farm trials in selected countries, comparing the performance under differing conditions of their varieties with other entries. The tours give scientists a better understanding of the technology in which they are working and prepare them to make better judgements in their own national crop improvement programs.

The workshops and tours are complemented by country visits of SAFGRAD-IITA scientists with the officials and researchers of the national programs. During these visits the visiting scientists offer technical advice, assist in pinpointing areas to strengthen national research capabilities, and identify elite germplasm. The visits are an opportu-

The National Director of Agricultural Research in Cameroon (left) and the SAFGRAD-IITA Project Leader confer on maize research strategy for that country. Country visits keep regional scientists in close touch with problems faced by the small farmers of the semi-arid tropics.

Participation in montoring tours

	Maize			Cowpeas	
	1979	1980	1981	1980	1981
Benin	x	x		x	
Cameroon		x	x	x	
Gambia			x		x
Ghana	x	x			
Guinea			x		
Ivory Coast	x				
Mali	x	x	x		x
Niger				x	
Nigeria				x	
Senegal	x	x	x		x
Tanzania			x		
Togo			x		
Upper Volta	x	x	x	x	x

nity for an interchange of ideas and research results among the SAFGRAD countries.

The research of SAFGRAD is a regional partnership with the national programs which gives each country an opportunity to learn from the accumulated experience of tests at many locations in the region. Within a few growing seasons, each country has performance evaluations of its materials that would not otherwise be possible, either in such a short time or under a variety of conditions.

SAFGRAD-IITA, as the regional coordinating agency, provides the linkage for this system for maize and cowpeas. It draws together the best available materials for evaluation and distribution, and strengthens the region's resource base. The resident research at Kamboinse joins these elements.

The Kamboinse Center

Headquarters for the SAFGRAD-IITA scientists is the Kamboinse Center, 15 km northwest of Ouagadougou, Upper Volta. It has an average annual rainfall of about 800 mm. The original seven hectares developed by the team were expanded by clearing ten hectares more at the start of the 1980 growing season. An additional ten hectares of irrigated land just northeast of Ouagadougou were acquired as an off-season breeding nursery.

SAFGRAD-IITA research projects also are conducted in three other ecological zones in Upper Volta, giving researchers a variety of moisture and soil conditions for their experiments. Both maize and cowpea studies are conducted at:

- Farako-Bâ in southwest Upper Volta. It has an average annual rainfall of 1,100 mm and the longest growing season of the SAFGRAD-IITA research sites in the country.
- Saria, 80 km west of Ouagadougou. It has an average rainfall of 800 mm annually.

In addition, cowpea research is conducted at Saouga in the extreme north of Upper Volta. Rainfall averages only 400 mm a year, making it a marginal area with a short growing season.

All of the research sites except Saouga have ferruginous tropical soils that predominate in the West African Savanna.

National scientists from Upper Volta are partners with IITA in this research at Kamboinse. U.S. Peace Corps volunteers and others also provide valuable assistance.

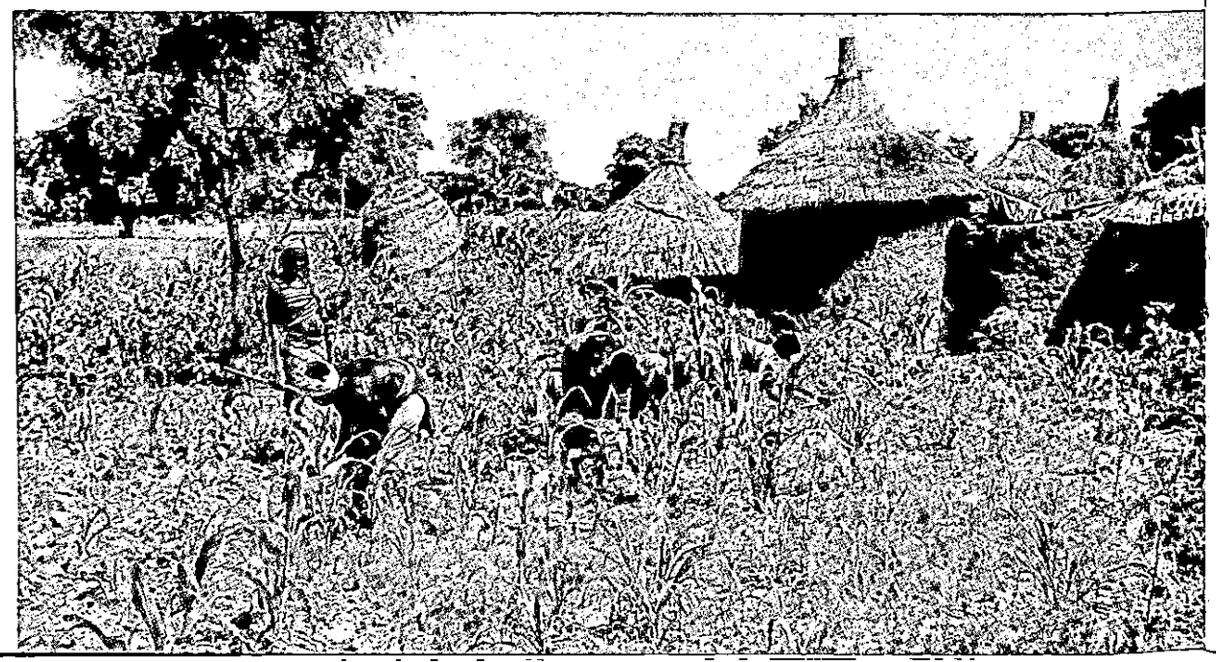
A U.S. Peace Peace Corps volunteer and a trainee from Upper Volta evaluate entomological studies in the screenhouse at Kamboinse. Scientists and technicians from many countries are taking part in the SAFGRAD project.

Maize

Growing maize in the semi-arid tropics is hard work. There is no more energy-sapping drudgery in all of agriculture than stooping under the hot African sun. The typical farmer in the 700 to 900 mm annual rainfall zone grows his maize as a garden or compound crop. Plots are small and soil conditions vary greatly within short distances. The plantings that do best are those adjacent to the huts where crop residues, kitchen wastes and animal manures have fertilized the soil, increasing organic matter and thus improving water penetration and the moisture-holding capacity. Maize is an important field crop in the 900 to 1,100 mm rainfall zone.

Conventional wisdom in the semi-arid region holds that maize requires more rainfall than sorghum and millet. However, many farmers plant maize adapted to the stressful conditions of the poor soils and limited moisture because it matures quickly and is used as a catch crop when the previous year's food supply is exhausted. Maize is eaten green and as a fully developed grain.

Maize cultivation is a family enterprise in the semi-arid region. Most food crops are grown on land around the family's dwellings.



Maize Breeding

The SAFGRAD-IITA maize breeding program has two goals:

- Conducting research to develop varieties that combine early maturity (85 to 90 days) with reasonable yield and drought resistance. Earliness is important as a drought escape measure although traditionally these varieties do not yield as well as medium maturing (110 days) varieties.
- Evaluating varieties developed by the national, regional and international programs so as to immediately have better materials available for the SAFGRAD countries.

An observation nursery was planted in 1978 which included germplasm used by IITA at Ibadan, plus that available from the various countries, and from IRAT and the International Maize and Wheat Improvement Center (CIMMYT), El Batan, Mexico.

Multilocation Recurrent Selection. The heart of the SAFGRAD maize breeding effort is the Multilocation Recurrent Selection (MLRS) program, a scientific approach to maize population improvement. It is based on work started by IITA in the mid-1970s to breed for earliness and high yield.

The concentration in MLRS is on two early maturing varieties for the 700 to 900 mm rainfall areas: one white grained variety, TZE-3, and one yellow grained variety, TZE-4, and two medium maturing varieties for the 900 to 1,100 mm rainfall zone: TZPB and TZSR. Early maturing maize is desirable for drier zones, but the makeup of the maize plant is such that medium maturing varieties are recommended whenever there is a sufficiently long growing season.

The first phase of the MLRS is conducted at Kamboinse by securing the potentially best materials, evaluating their usefulness under the semi-arid conditions, and then selecting the best plants of each population. Crosses are made to develop full-sib families.

The best 140 of the full-sib crosses are used during the next season for multilocational testing in countries with more advanced maize breeding programs: Senegal, Benin, Ivory Coast, Upper Volta and Nigeria. The objective is for a maize that performs well across a wide range of growing con-

ditions. The top 50% of the full-sib families performing best in all locations are recombined using the remnant seed, and a new testing cycle begins.

Better families that do well for earliness, drought resistance and yield in the various locations go through additional testing which generally improves yields by 8 to 10% each cycle. Any of the four populations in the MLRS can be replaced at any time as a new population develops which shows greater promise. This occurred in 1981 when POOL-16 replaced TZE-3.

The open pollinated varieties being developed by SAFGRAD are more useful to the small farmers of Africa than the newer hybrids as the seed does not have to be replaced each year. A farmer can plant an open pollinated variety from the previous year's crop for about four years before there is a significant reduction in yield.

A new maize variety is developed by recombining the top ten full-sib families, an even stricter selection than is used for the MLRS. The SAFGRAD-IITA program has developed SAFITA-2 from the POOL-16 material. (The name SAFITA is compounded from SAFGRAD and IITA and will be used to designate all maize varieties developed in this program.) POOL-16, selected from white dent material originally combined by CIMMYT, is early maturing and high yielding. As POOL-16 is maintained in the MLRS, it may become even better and could be the basis for future varieties.

While the initial success has been with early maturing varieties, the MLRS process is being used to improve the medium maturing varieties, TZPB and TZSR. There have been constant yield increases in the first three years of the program.

The MLRS process, in cooperation with the national programs, produces maize breeding materials adaptable to the broad semi-arid area. Each country then evaluates the results of the tests under its conditions. This is the way national scientists use the MLRS system to fit the needs of their own breeding programs.

Two new varieties — SAFITA-102 and SAFITA-104 — have been developed from crosses made with materials from several countries. SAFITA-102 is white grained, while SAFITA-104 is a yellow grained variety. Both are now in the Regional Uniform Variety Trials (RUVT). SAFITA-102 has been developed from downy mildew resistant materials originally from the Philippines. SAFITA-104 has a temperate material as a base.

The 13 to 15 other IITA early maturing materials in the TZE series not selected for the MLRS process remain a part of the SAFGRAD breeding program. The best full-sib families were recombined in 1981 to develop a single yellow grain population and a single white grain population. The top families will be selected from each with an eye toward future varieties.

Temperate x Tropical. Maize developed in the temperate regions tends to be more efficient in converting solar energy into grain production and has a large accumulation of genes for high yield. But transmitting temperate qualities to maize in the tropics has not been successful. IITA has sought ways to combine the qualities of temperate maize with the disease and insect resistance of tropical maize since the mid-1970s. Scientists found that temperate varieties changed their behavior under tropical conditions, becoming earlier maturing because of their response to differing day lengths and temperatures.

SAFGRAD-IITA is crossing temperate x tropical maize materials to combine their qualities into high yielding, disease resistant varieties for the semi-arid tropics. This promising research plot is at the Kamboinse Center.

Putting this discovery to work in the SAFGRAD breeding program, scientists collected all temperate x tropical materials available from CIMMYT. These, plus the materials of IITA, were planted and selections made in 1979 in Upper Volta. Mass selections of these were made in 1980 and promising materials were recombined in 1981.

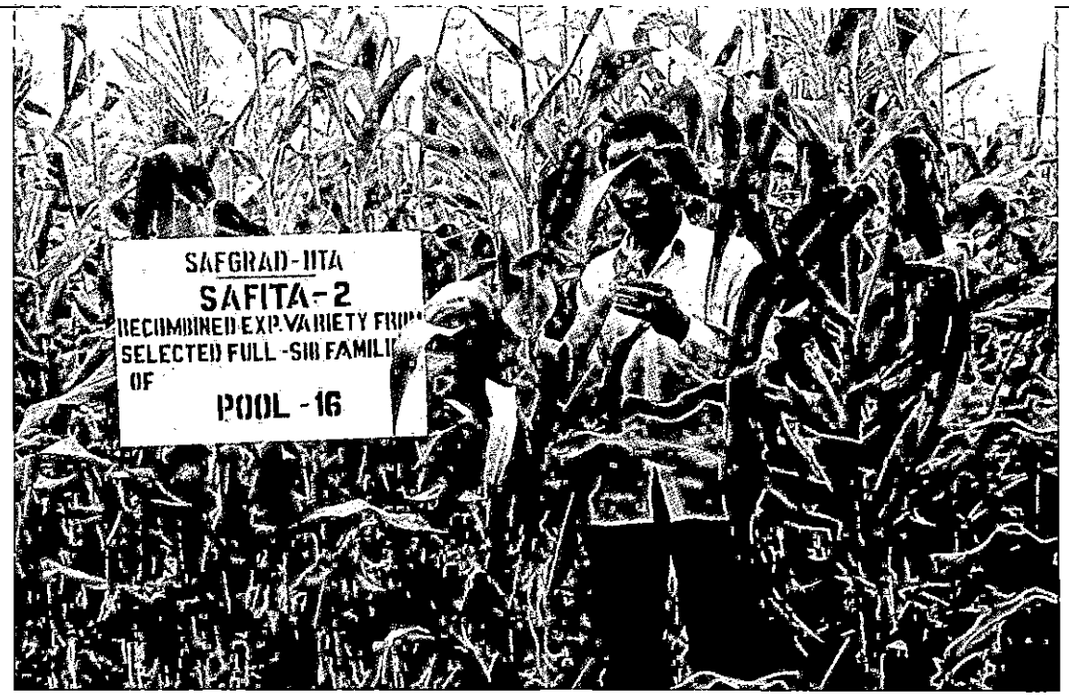
Another component of the SAFGRAD-IITA program is the use of local varieties in breeding work. These have been developed by farmers over the years by natural selection for resistance to the stresses of the region. Although they tend to be low yielding, the local varieties offer drought resistance breeding opportunities. A collection of local varieties has been started at Kamboinse and they are being tested at several locations. Their drought stress capabilities may be combined with high yielding materials to form improved varieties.

Developing new maize varieties for the semi-arid tropics of Africa is an example of regional and national program cooperation at the practical level. Working together, these agencies accomplish what would be virtually impossible if relying on their own resources alone.

High Protein Maize. General availability of high protein maize could make a significant contribution to improved diets in the semi-arid region. The major work in high protein maize is being conducted by CIMMYT. SAFGRAD-IITA is cooperating by screening the high protein materials for their adaptation in the semi-arid tropics. Temperate White H.E. 0_2, a temperate, hard endosperm variety, looks promising. The seed is being multiplied, and if it continues to perform as expected, will be planted in the 1982 or 1983 regional trials.

Disease and Insect Resistance. Maize streak virus is a serious disease in the humid tropics, but has not been a threat in the semi-arid region. In 1980, however, it began appearing in northern Cameroon, Nigeria and Mali. In anticipation of the spread of the disease into the semi-arid tropics, SAFGRAD has started a breeding effort to develop lines for resistance to the disease. The resistance testing is done at IITA, with field tests for environmental conditions conducted in Upper Volta.

Surprisingly, insects are not a major maize problem in the semi-arid zone. Some scientists believe that when farmers multicrop maize it does not give insects sufficient opportunities to mount attacks. Termites, millipedes and army worms are the most serious maize insect pests. The extent of corn borer damage in the region is not fully known, but researchers are collecting data in regional trials to assess its seriousness.



SAFITA-2 is one of the first major results of the SAFGRAD–IITA maize breeding program. This Voltaic maize breeder is examining the flowering of the new crop.

Regional Testing. Regional maize trials are important for the SAFGRAD-IITA program. For many years there has been testing by IRAT in African French-speaking countries. An earlier OAU project had trials in some English-speaking countries. Now, as new varieties are developed, they are available for testing in all SAFGRAD countries. The effectiveness of the variety testing has been improved by the development of a uniform data recording system so all trial results are reported using the same standards.

Participating in regional trials — Maize

	1979	1980	1981
Benin	+ ✓	● +	+
Botswana		+	+
Cameroon	+	+ ✓	+
Gambia		+ ✓	+
Ghana	+ ✓	+ ✓	+
Guinea	+	+ ✓	+
Guinea Bissau			+
Ivory Coast	+ ✓	● + ✓	+
Kenya		+	
Mali	+ ✓	+ ✓	+
Mauritania	+	+	+
Niger			+
Nigeria	+	● +	+
Senegal	+ ✓	● +	+
Sierra Leone	+	+	
Somalia			+
Sudan	+		
Tanzania		+	
Togo			+
Upper Volta	+ ✓	● + ✓	+

● entered seed in regional trials

\+ materials for regional trials sent to country

✓ results of regional trials received by IITA-SAFGRAD

(Note: When this informaiton was gathered, it was too early to receive results from the 1981 trials.)

The national research programs are partners with SAFGRAD-IITA in groups of trials. As already mentioned, the more advanced programs cooperate in the MLRS testing. This includes the Regional Full-Sib Testing Trial (RFTT). In RFTT-1 and RFTT-2, attention is on the early maturing populations, TZE-3 and TZE-4, respectively. The POOL-16 selection has replaced TZE-3 in RFTT-1. The medium maturing populations are in RFTT-3 and RFTT-4: TZPB in the former and TZSR in the latter.

SAFGRAD also coordinates the RUVT. The RUVT-1 is for early maturing varieties and RUVT-2 for the medium maturing varieties. About 18 countries participate each year.

In the RUVT tests, the POOL-16 selection consistently flowered early (50 days) and was a high yielder. Its six-country average in 1980 was 3,438 kg/ha. Other promising early maturing varieties are BDS III from Senegal which averages 53 days to flowering and yielded 2,903 kg/ha, and Early Yellow from Ghana which also averaged 53 days and produced 2,836 kg/ha.

The tests in RUVT-2 have shown that IRAT-81 from the Ivory Coast has the best potential, flowering in 62 days and producing 3,589 kg/ha. TZPB, originally from IITA and selected in Upper Volta, required an average of 63 days to flowering and yielded 2,990 kg/ha.

BDS III and IRAT-81 are complex hybrids and so are difficult to adopt where there are no advanced seed production and distribution services. The open pollinated varieties continue to be more convenient in many countries.

The results of the RUVT-1 confirm that for most countries there already are available early maturing maize varieties producing about 15% better yields than the best available local varieties. The possibilities in the RUVT-2 range up to a 19% yield increase compared with the best yielding local medium maturing varieties.

Once the research and testing have established the superiority of a particular material, the country ACPOs conduct on-farm trials and introduce the varieties to farmers. Pre-extension trials are presently underway in Mali and Cameroon, and the Farming Systems Unit has incorporated the new varieties into its village level trials throughout Upper Volta.

Maize Agronomy

Soil fertility, the risk of drought stress, and soil compaction are the most important agronomic factors limiting maize production in the semi-arid region. The predominant soils are low in phosphorus and nitrogen, and often have a very compacted subsoil and serious surface crusting. In many soils water does not infiltrate or readily percolate down the soil profile following the heavy tropical rainstorms. Little residual moisture is stored in the soil because of the high amounts of runoff. Erosion can be a serious problem.

The SAFGRAD maize agronomy research program is aimed at soil fertility problems and management practices that will increase the available soil moisture and crop yield. Soil fertility and soil moisture must interact at the same time. A moderately fertile soil will not produce a good maize crop if there is not enough available moisture, and vice versa. Most of the maize agronomy research is conducted at two fertility levels: a low level that will allow yields of 2 to 2.5 tons of grain/ha, and a high level for yields of 4 to 5 tons/ha. Using these levels it is possible to determine which management practices will work best under different fertility conditions.

Seven management practices can reduce the risk of drought stress in maize in the ferruginous tropical soils subject to poor water infiltration or storage problems. Each of these practices is effec-

tive in soils that have not received applications of animal manure.

Tied Ridges. A successful cultivation practice in East Africa a half a century ago with groundnuts and some food crops, tied ridges have been used more recently with several crops in Nigeria with significant yield increases. Tied ridges are earthed up rows with laterals built to connect the rows on which the maize is grown. The result is a series of miniature catch basins to hold rainfall around the maize.

There are two ways of using tied ridges. In one the maize is planted in rows on the ridges. The ridges can be tied or nontied. In another, maize is planted on the flat and then three to four weeks after planting, or later, the ridges are earthed up and tied.

Ridge tying adds to the labor cost of growing maize, but it reduces the risk of crop failure. An animal traction tie-ridger developed in Nigeria may be an answer in reducing the labor cost. Tied ridges will last more than one year in many soils, so a second maize crop can be grown without having to completely rebuild them. Tied ridges are most effective where the soils tend toward crusting, compaction, shallowness, steepness, and high runoff.

Tied ridges are recommended by the SAFGRAD-IITA maize agronomist as a rainfall conservation practice. They are most effective in the shallower soils with high rainfall runoff.

Tied ridges are not without problems. Holding the moisture within the ridges can waterlog a maize crop during heavy, extended rains. There are adaptations of the tie ridging system, such as tying the ridges between every other row of maize. This holds moisture on one side of the row while allowing normal runoff on the other.

Growing Maize on Deeper Soils. Maize yields improve the closer the crop is planted to the deeper soils at the bottom of the slopes. At a high level of fertilization, experiments produced about six times more maize on the lower, deeper soils than on the shallow soils of the upper slopes — a direct result of better moisture conditions and higher soil fertility. Planting early, planting early-maturing varieties, and planting on the lower slopes and deeper soils also reduce drought stress. There are, however, dangers of waterlogging and even flooding on some of the lower slope areas.

Deep cultivation is an important maize production practice in the region, according to SAFGRAD-IITA research. Hand hoeing (foreground) is inadequate, whereas deeper cultivation (rear) by oxen or tractors provides better soil water storage.

Tillage. Deep cultivation will significantly increase maize yields in the semi-arid region. Traditional hoeing barely scratches the surface. While this may be adequate for cultivating, it is not deep enough as a plowing method. Only by using oxen or tractors is it possible to reach the depth required for better storage of soil water.

Cultivation. Cultivating the crop to break the soil crust greatly improves rainfall infiltration. Experiments at Kamboinse show up to a 50% grain yield increase by cultivating.

Using Crop Residue as Mulch. Keeping crop residues on fields can protect the soil from the impact of rainfall and help to increase water infiltration and storage. Yield increases of 50 to 100% were observed in 1980 when using the maize crop residue as mulch. In addition to protecting the soil against rainfall impact, the mulch increases biological activity, mainly by termites. By partially decomposing and incorporating part of the crop residue, and by digging tunnels and galleries down the profile, termites greatly enhance water infiltration and percolation. The experiments also showed termite damage to the maize was no greater in mulched plots than in the unmulched.

Early Planting with Early Varieties. Early planting and the use of early maturing maize varieties reduce the risk of drought stress at the end of the rainy season. By planting early in the rainy season, a farmer more readily insures the minimum of 80 growing days with rain that is critical for maize to mature properly.

Legume-Maize Rotation. A rotation of cowpeas and maize produced significantly higher maize yields than continuous maize under high fertility levels. There are two possible explanations. One is that the legume contributes to improving the physical characteristics of the soil (such as tilth, structure and porosity) resulting in better water infiltration and storage. Another explanation is that the legume may reduce the severity of attacks on the roots by nematodes or pathogens.

Cowpeas

Cowpeas originated in Africa. Today, more cowpeas are produced in Africa than on any other continent, and their production is concentrated in the semi-arid region. Even though the cowpea is a major source of protein and a staple in the African diet, it has been one of the least-researched food crops. Traditionally, farmers grow cowpeas as a mixed crop with a cereal: maize, sorghum or millet. The common varieties are day-length sensitive, naturally adapted to flower toward the end of the rainy season. These varieties are susceptible to insects and diseases, though this often is not evident due to low planting density and escape mechanisms in the mixed-crop farming system. The average farmer yields are less than 500 kg/ha. Increasing planting densities, and using improved varieties and management practices can substantially increase yields.

Cowpea Breeding

IITA began its cowpea work in Upper Volta in 1977 in the National Cowpea Improvement Program (NCIP), a joint project with the Government of Upper Volta and the International Development Research Center (IDRC) of Canada. The NCIP continues with the expanded outreach of SAFGRAD's regional activities.

The cowpea breeding program has three major objectives:

- Developing high yielding, insect and disease-resistant varieties with acceptable grain quality for different ecological zones.
- Evaluating and improving the existing local varieties for desirable agronomic traits.
- Providing technical support to the SAFGRAD program in evaluating varieties developed by national, regional and international programs for mobilizing the promising materials in SAFGRAD countries.

Thousands of early generation segregating progenies, as well as fixed lines from IITA in Ibadan, have been evaluated in the differing ecological conditions in Upper Volta. This effort identified such promising varieties as KN-1, TVx 1948-01F, TVx 1999-01F, TVx 1999-02E and TVx 309-1G that yield significantly better than the local materials. After three years of research, KN-1 was officially released in Upper Volta for areas with 700 mm or more annual rainfall. The seed is being distributed to the farmers for large scale cultivation. With good management conditions (particularly with insecticide application), KN-1 can yield 2,000 kg/ha of grain that is of a quality acceptable to consumers.

These regional maize trial plots are a cooperative effort of IRAT (Institut de Recherches Agronomiques Tropicales) and SAFGRAD-IITA. Many other institutions throughout the region also assist with the trials, effectively testing the materials over a wide range of conditions.

With the expanded responsibility to fulfill SAFGRAD objectives, a comprehensive cowpea breeding and selection program has been developed. The Semi-Arid Regional Cowpea Variety Trial (SARCVT) was started in 1980 to identify and evaluate promising varieties for the entire semi-arid region of Africa. Seventeen national cowpea programs are participating. A result of this cooperative effort is that Gorom-Gorom Local from Upper Volta and Mougne from Senegal have been identified as promising varieties for the drier areas, and KN-1 for the wetter areas in the semi-arid tropics. TVx 1948-01F and TVx 1999-01F from NCIP along with Kpodiguegue from Benin were identified as having wider adaptation.

These varieties have high yield potential but are susceptible to major insects; some of them do not have acceptable grain quality. As most farmers will not be able to provide insecticide protection, the breeding program is emphasizing the incorporation of insect resistance and better grain quality into the most promising of the recently identified varieties.

Insect Resistance. Aphids, flower thrips, *Maruca* and pod sucking bugs are a serious threat to cowpeas while in the field. In storage, a small weevil called bruchid (*Callosobruchus maculatus*) can cause significant damage within a few days. Developing insect resistance requires close cooperation between plant breeders and entomologists. This collaboration between scientists is one of the strengths of the SAFGRAD program.

Participation in regional trials — Cowpeas

	Benin	Botswana	Cameroon	Central African Republic	Chad	Gambia	Ghana	Guinea	Guinea Bissau	Kenya	Mali	Mauritania	Niger	Nigeria	Senegal	Togo	Upper Volta
1980	● +✓	● +	+✓		+	+✓	+	+			+✓	+	+✓	● +✓	● +		
1981	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

● = entered seed in regional trials
\+ = materials for regional trials sent to country
✓ = results of regional trials received by IITA-SAFGRAD

(Note: When this information was gathered, it was too early to receive results from the 1981 trials.)

Major efforts are underway to incorporate bruchid resistance in the promising materials. Progress is possible because a source of resistance was identified a few years ago at IITA in Ibadan. It is the TVu 2027 variety. Gorom-Gorom Local and KN-1 were crossed with TVu 2027 in 1979. The advanced generation breeding material is being tested at Saouga and Kamboinse to select desirable plants. The seeds of the selected plants are screened in the laboratory for bruchid resistance. In just a few more seasons, the SAFGRAD-IITA cowpea team expects to have the bruchid resistant Gorom-Gorom Local and KN-1 ready for farmers.

Maruca attacks cowpea stems, flowers and pods, causing them to wither and die. A Kamboinse local variety has been found to have *Maruca* resistance for pods, so it, too, has been crossed with Gorom-Gorom Local and KN-1. A total of 1,200 F_4 families of the cross of KN-1 and local Kamboinse are being field tested. The cross between Gorom-Gorom Local and a *Maruca* resistant variety is in the early stages of development.

When resistances to other insects are discovered, they will be crossed with the improved varieties. Likewise, promising varieties developed by national and international programs will be crossed to the known sources of resistance to different insects. Scientists are beginning to cross several of the insect resistant materials into a single cowpea variety. Eventually, bruchid, *Maruca,* aphids and other insect resistances will be combined with the desired characteristics of high yield and acceptable grain quality.

Grain Quality. Consumer preferences in cow-

Consumer preference is an important factor in developing varieties. A bold, wrinkled seed, either white or tan color, is the favorite for preparing family foods.

peas vary in different parts of Africa. However, the general preference is for a bold, wrinkled seed, either white or tan in color. The selection program is giving greater attention to those qualities. In a cooperative effort between IITA in Ibadan and SAFGRAD, the TVx 5048-01C-K and TVx 5050-012C-K varieties have been identified as having the desired grain quality characteristics. The TVu 2027, Gorom-Gorom Local, Mougne and Kamboinse Local possess the preferred grain types, too. These varieties are being crossed to select desirable plants which will combine high yield and desirable seed quality.

Improving Local Varieties. Local varieties have natural adaptation for the existing traditional farming systems, but produce low yields. Most are day-length sensitive, full season varieties. Usually they are planted at the time of the first rains. In contrast, the improved varieties are photo insensitive, early maturing and capable of high yields with good management. But, they do not fit into the mixed or relay cropping farming systems.

The first step in improving local varieties is collection and evaluation. There is great variation in their maturity, yields and adaptability. The promising local varieties have been crossed with promising photo insensitive, early maturing varieties to create diversity. From these, lines are being selected which combine the adaptability of the local varieties along with the high yields of the improved varieties, plus the desirable maturity to fit into mixed or relay cropping systems. Scientists expect to develop varieties that can be grown with different cereal crops in the varying rainfall zones of the semi-arid tropics.

On-site visits give SAFGRAD-IITA scientists information on the field application of their research. This Cameroon farmer is discussing his cowpea mixed cropping with the SAFGRAD-IITA cowpea agronomist.

Cowpea Agronomy

Research to provide small farmers with better methods for producing cowpeas goes along with the development of improved varieties and entomological studies. The emphasis is on multiple cropping systems, management of photoperiod sensitive cultivars, and the identification of soil types and soil management methods which will produce the best yields.

Relay Cropping. A system of maize and cowpea relay cropping offers a potential for producing good yields of both crops from the same land in the same season. It involves planting cowpeas

The SAFGRAD-IITA research seeks practical answers to production problems for small farmers of the region. Intercropping can increase maize and cowpea yields when recommended practices are followed.

after the maize so there is only a partial overlap of the two crops and so the cowpeas mature after the maize is harvested. Planting both maize and cowpeas at the same time will seriously reduce the maize yield. And, the use of photoperiod insensitive cowpeas results in low cowpea yields because they must compete with the maize throughout their growth period. However, by proper choice of the planting dates and the varieties so that cowpea flowering occurs after maize harvest, a full crop of maize can be obtained along with close to a full crop of cowpeas. The package of management practices for this cropping system is being refined.

Timing of planting is critical in the relay system for there is a delicate balance between the adverse effects on cowpeas caused by competition with maize during the overlap period and the depletion of soil moisture at the end of the growing season. Regional trials in 1980 and 1981 provided data for developing planting date recommendations for different rainfall zones in the semi-arid tropics.

Relay cropping experiments in 1979 and 1980 concentrated on improved cowpea varieties which are photoperiod insensitive. These cannot be planted earlier than 40 to 45 days before the maize harvest or they will flower while still shaded by the maize. Trials are underway to determine if photoperiod sensitive cultivars may be better adapted to the system. They can be planted earlier and will make more growth by the time the maize is harvested, but will not flower until after the maize competition is removed.

Early maturing maize varieties have been used in most of the maize/cowpea relay cropping work. Now tests are studying the use of medium maturing maize — with its higher yield potential — in combination with photoperiod sensitive cowpeas. These cowpea varieties can be planted earlier, for they have a longer growing period, flower independent of planting date, and should provide a better yield.

Cowpeas yield better when maize is planted in wide rows, but this reduces maize yields. Another method being tried is to plant the maize in narrow rows, then harvest alternate rows early as a green crop to reduce the competition for the cowpeas. There is an expanding market near the urban centers for the green maize as well as for grain.

The cowpea plants tend to be smaller and yield less in relay cropping due to the maize competition. Scientists are trying to determine whether boosting the cowpea plant population to compensate for the smaller plant size will result in a higher cowpea yield per unit area.

The relay cropping work has been concentrated in the higher rainfall areas of the semi-arid zone. However, investigations are underway to determine if the practice can be extended into the drier areas. This may be possible with a proper choice

of soil and use of moisture-conserving practices such as tied ridges. Work on the relay cropping system has progressed to the point where preliminary on-farm tests are being carried out by the SAFGRAD Farming Systems Unit.

Intercropping with Sorghum and Millet. Better ways are being sought for managing cowpeas when intercropped with a full-season cereal. Insect damage to cowpeas usually is reduced when they are intercropped with sorghum. Scientists are determining if damage by flower thrips can be reduced further by using a cowpea variety having moderate resistance to the insect. Although this resistance may not be sufficient to be expressed under the heavy thrips attack that occurs in a pure crop, it may be adequate to give a real advantage over other varieties when intercropped.

Millet and cowpeas are intercropped in the lower rainfall zones. SAFGRAD-IITA experiments are studying a variety of management factors, including fertilizer response, planting densities for both crops, planting dates for the cowpeas, and the use of insecticides. The goal is a set of management practices for the small farmer.

Management of Photoperiod Sensitive Cultivars. Photoperiod sensitive cultivars have been neglected in most cowpea improvement research. However, there are local photoperiod sensitive cultivars with yield potentials close to those of improved photoperiod insensitive varieties. These local varieties appear to have such useful characteristics as flexibility in planting dates and a pattern of maturing which can help with insect control and ease of harvesting. But, these photoperiod sensitive cultivars often respond differently to management practices than do the improved varieties. Differences have been found in their response to phosphorus fertilization, date of planting, and plant population. A major thrust in both the resident and regional research programs is to learn how these cultivars respond to various management factors and to develop the proper agronomic practices.

Effect of Soil Type and Soil Preparation. Some of the most important soil variables in the Sudan Savanna are associated with position in the landscape from plateau to valley bottom. Large differences in cowpea yields are associated with posi-

tion on the slope as well as response to various management factors. The best methods for growing cowpeas on these different soil types are being determined. Soil preparation experiments have shown the desirability of plowing. The traditional method of land preparation with the hand hoe does not sufficiently till the soil for best yields. Plowing with oxen can increase yields by 40%.

Screening for Striga Resistance. A procedure has been developed to screen germplasm for resistance to cowpea striga (*Striga gesneroides*), a parasitic plant which can cause severe yield losses in the semi-arid zone. Preliminary results of this screening have indicated resistance in certain varieties. Further testing is now underway to verify these results.

Cowpea Entomology

Insects are the major problem in producing cowpeas. None of the available recommended varieties have an acceptable level of resistance to all the major insects. Insecticide protection can increase cowpea production, but there is little chance this practice will soon be adopted by the small farmers. Genetic resistance seems to be the answer, so the focus of the SAFGRAD entomology research is to work closely with the plant breeders to develop resistant varieties.

The cowpea entomology program has these major objectives:

- Finding out the relative importance of major cowpea insects, determining the economic losses caused by them, and developing an integrated pest management program for the semi-arid tropics.
- Developing field techniques for screening cowpea germplasm and identifying sources of resistance to major insect pests.
- Providing technical support to the breeding program for insect resistance work.

Among the general cowpea pests in the semi-arid tropics, the cowpea aphid is the first to appear in the season. It not only feeds on the leaves, buds, flowers and pods, but also transmits the aphid-borne mosaic virus. Flower thrips, the most serious cowpea pest, feeds on the flower buds and flowers which then fail to produce pods. An infestation can

mean a total crop failure. *Maruca,* the legume pod borer, is a widely distributed pest in the region. It feeds on the young shoots, stalks, reproductive parts, and pods. Other parts of the plant are vulnerable when they touch the infested pods. Pod sucking bugs take the sap from the green pods. With severe infestation, the pods shrivel and dry prematurely resulting in seed loss.

Bruchid infestation begins in the field and is carried into storage where it multiplies generation after generation.

Some countries have specific cowpea pest problems. In Senegal, for example, the hairy caterpillar (*Amsaeta spp.*) is a serious pest in the seedling stage. In Upper Volta, the flowers and pods of the late planted crop of early maturing varieties often are seriously damaged by the Egyptian leaf worm (*Spodoptera littoralis*).

Sources of Resistance. Reliable screening techniques are the first step in identifying sources of resistance. A prerequisite is to accurately determine the population levels of the insect pests. Uniform procedures for data collection and screening were developed by entomologists of the SAFGRAD region. Several member countries take part in a regional trials system to collect this information.

Sources of resistance to the cowpea aphid that were identified at IITA were then tested in Upper Volta. Some of these were found to be susceptible to a new K-biotype. TVu 36, TVu 1037, TVu 2896 and TVu 3000 have resistance to the K-biotype. Studies are underway to combine the resistances to aphid and the cowpea aphid-borne mosaic virus with cultivars having high yield and good seed quality.

No single resistant source is available for flower thrips. However, TVx 3236 has been a moderately resistant variety at IITA in Ibadan. Its value as a resistant source in the semi-arid zone is being evaluated.

A cowpea variety with a long peduncle and widely separated pods escapes the damage by *Maruca*. At IITA, TVu 946 and VITA-5 have been identified as resistant sources. These and other promising lines are being tested for their resistance in the semi-arid region. One local variety, Kamboinse Local, has a good level of *Maruca* re-

sistance in pods and is being used to incorporate this quality in various agronomically superior varieties.

No variety has been identified as resistant to pod sucking bugs. Laboratory tests at IITA have found few lines that are less preferred by these insects, but their levels of resistance need confirmation under field conditions. A good source of bruchid resistance in seed has been confirmed in TVu 2027 and is being used in the SAFGRAD-IITA cowpea breeding program. Bruchid resistance in pods is being confirmed in a variety called Worthmore, also identified at IITA.

Integrated Pest Management. These are promising components for an integrated pest management control program:

- Planting improved photo insensitive varieties around mid-July at Kamboinse, where the average annual rainfall is 700 to 800 mm, gave maximum yield with insecticide protection.
- Insecticide treatment at the flower bud formation stage was found to be the most crucial, followed by additional treatment at the post-flowering stage.
- Synthetic pyrethroid insecticides such as Decis and Cymbush are very effective, relatively inexpensive, and safe to use in controlling cowpea insects. It is safe to eat all parts of the cowpea plant in three to four days after treatment with synthetic pyrethroids.
- The populations of important cowpea insects are relatively lower in intercropping compared with monocropping.
- Mixing a small quantity of groundnut oil with the grain was found by IITA scientists to be effective in reducing the bruchid damage in storage. SAFGRAD scientists are experimenting with local oils as alternatives, such as the oil from the butter tree in Upper Volta.

Training

IITA devotes considerable attention to building the capabilities of professional scientists and technicians in the SAFGRAD countries. The goal for these countries is to be able to use their expertise to conduct research to solve their food production problems. SAFGRAD-IITA training is increasing the number of competent agricultural scientists and technicians, thus strengthening the research capability in the semi-arid tropics.

Five training opportunities are integrated into the regional maize and cowpea improvement program:

- Maize and cowpea production courses of one to three months each are conducted by IITA at Ibadan for research technicians and extension leaders. They combine classroom instruction with field experience. In three years, 53 cowpea researchers and 43 maize researchers from 17 SAFGRAD countries have attended courses

SAFGRAD-IITA training provides national researchers with opportunities to learn by observation and by hands-on experience with guidance by the scientists at Kamboinse.

funded by the governments of The Netherlands and Belgium, Ford Foundation, Arab Bank, IDRC, USAID, CIMMYT, IITA, International Agricultural Development Service (IADS), Food and Agriculture Organization of the UN (FAO) and their national programs, as well as SAFGRAD.

- Degree related training is offered for national researchers seeking bachelor's, master's, and doctoral degrees. Selected candidates are encouraged to do their thesis research at IITA, Kamboinse, or an African university.
- Sabbatical leave taken at Kamboinse offers research experience to senior national scientists and an opportunity to contribute to the SAFGRAD program. They spend 10 to 12 months at SAFGRAD-IITA.
- Thesis research may be conducted at Kamboinse by university students studying for agricultural science degrees. Four students of the University of Ouagadougou have completed their thesis research. A Voltaic doctoral candidate of the University of Laval in Canada conducted research on soil fertility. A graduate student from Niger studied cowpea entomology at Kamboinse.

On-the-job experience at Kamboinse gives technicians from the SAFGRAD countries practical knowledge in research methods, thus building important human resources for agricultural development in the region.

Participation in training courses at IITA-Ibadan in SAFGRAD

	Maize Production		Cowpea Production		
	1978	1980	1978	1979	1980
Benin	1	1	1	1	
Botswana			1		
Cameroon	1		1	1	
Gambia	1				1
Ghana			2	2	2
Guinea Bissau		1			
Ivory Coast	1		1		
Kenya		1	2	2	3
Mali	1	1	1		1
Niger				1	2
Nigeria	8	5	2	2	1
Senegal	2	1			1
Sierra Leone	1	1			
Somalia		1			
Tanzania	6	4	8	3	
Togo		2	1	2	
Upper Volta	2	1	4	3	1
Totals	24	19	24	17	12

Training at Kamboinse

1980: 1 each: Mali (maize), Gambia (maize), Mauritania (cowpeas)

1981: 1 each: Chad (cowpeas), Senegal (cowpeas entomology), Guinea (maize)

- On-the-job training offers technicians practical experience in research methodology. They spend six months during the cropping season working at Kamboinse with SAFGRAD-IITA scientists. Four technicians from three countries were trained in 1980 and three more from three SAFGRAD countries participated in 1981. These scientists are a valuable resource for building increased research competence in the semi-arid region of Africa.

The candidates for these training activities must be nominated by their national governments. SAFGRAD provides scholarships and logistical support for those selected.

Key Personnel

- Organization of African Unity, Scientific, Technical and Research Commission.
  Prof. A.O. Williams, Executive Secretary, Lagos, Nigeria.
  Dr. K. O. Akadiri-Soumaïla, International Coordinator, OAU/STRC JP 31,Ouagadougou, Upper Volta.

- U.S. Agency for International Development.
  Mr. Herbert Hughes, Project Officer, JP 31, Ouagadougou, Upper Volta (from August 1981).

- International Institute of Tropical Agriculture, Ibadan, Nigeria.
  Dr. E. H. Hartmans, Director-General.
  Dr. S.V.S. Shastry, Director of Research.
  Dr. Y. Efron, Assistant Director, Cereal Improvement Program.
  Dr. P.R. Goldsworthy, Assistant Director, Grain Legume Improvement Program (to December 1981).
  Dr. S. R. Singh, Acting Assistant Director, Grain Legume Improvement Program (from December 1981).
  Dr. E. R. Terry, Assistant Director, International Programs.

- SAFGRAD-IITA, Ouagadougou, Upper Volta.
  Dr. V. L. Asnani, Project Leader and maize breeder.
  Dr. V. D. Aggarwal, IDRC-Government of Upper Volta, cowpea breeder.
  Dr. F. E. Brockman, soil fertility specialist/cowpea agronomist.
  Dr. Y. S. Rathore, entomologist.
  Dr. M. S. Rodriguez, maize agronomist.

SAFGRAD-IITA Personnel Profiles

V. L. Asnani, Project Leader and maize breeder, holds a Ph.D. degree from the Indian Agricultural Research Institute. Following his studies, he was a maize breeder in his native India for ten years during which time he was closely associated with another regional project, the Inter-Asian Maize Improvement Program. Asnani did postdoctoral work at CIMMYT in Mexico before joining IITA's Cereal Improvement Program in 1974.

V. D. Aggarwal, cowpea breeder, received his Ph.D. degree from the University of Missouri in the United States after accumulating many years of experience as a grain legume breeder in his native India. He came to IITA in 1977 and worked in the National Cowpea Improvement Program in Upper Volta.

F. E. Brockman, cowpea agronomist and soil fertility specialist, received his Ph.D. degree from Cornell University in his native United States. He joined IITA in 1974 and worked in a legume improvement program in Tanzania before coming to the project.

Y. S. Rathore, entomologist, received his Ph.D. degree from Iowa State University in the United States under a Rockefeller Foundation fellowship. Rathore was a crop entomologist in India for nearly 15 years before joining SAFGRAD-IITA.

M. S. Rodriguez, maize agronomist, earned his Ph.D. degree from Cornell University. A native of Colombia, he conducted research at CIMMYT and the International Center for Tropical Agriculture (CIAT) in Colombia before joining the SAFGRAD-IITA project.

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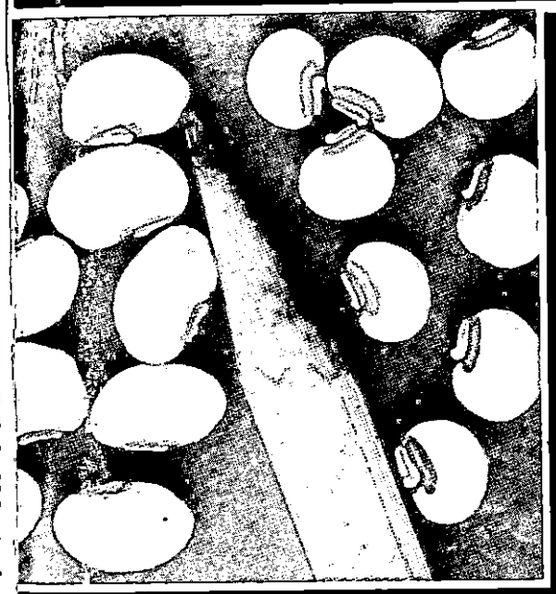
Scientific Technical and Research Commission
Joint Project 31 Semi-Arid Food Grain Research and Development



Maize and Cowpea Improvement in Semi-Arid Africa

The Contribution of the International Institute of Tropical Agriculture in Semi-Arid Food Grain Research and Development (SAFGRAD)

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Maize and Cowpea Improvement in Semi-Arid Africa

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