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WEST AND CENTRAL AFRICA COLLABORATIVE MAIZE RESEARCH NETWORK

RESEAU MAÏS
SAFGRAD
MAIZE NETWORK

IMPACT ASSESSMENT STUDY

SYNTHESIS OF PRIMARY DATA

OCTOBER, 1992

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I. INTRODUCTION

The Phase I of the Semi-Arid Food Grain Research and Development (SAFGRAD) Project was launched in 1977 by the Scientific, Technical and Research Commission of the Organization of African Unity (OAU/STRC) and the US Agency for International Development (USAID). The Project's ultimate objective was to improve the production of maize, sorghum, millet and cowpea. The International Institute of Tropical Agriculture (IITA) accepted responsibility for undertaking regionally oriented research and training activities for maize and cowpea. The goal was to develop and promote maize and cowpea varieties, in addition to determining the cultural practices, for maize and cowpea production, that are compatible with small-scale farming systems in the semi-arid tropics (SAT). The Project was organized by the OAU/STRC Coordination Office in Ouagadougou, headed by the SAFGRAD International Coordinator.

The IITA/SAFGRAD Project became fully operational in June, 1979. From the start, there were five IITA scientists who worked as two teams: (a) a maize team, consisting of a breeder, an agronomist and an entomologist (25%); and (b) a cowpea team, also consisting of a breeder, an agronomist, and an entomologist (75%). Later, IITA was asked to assume responsibility for the soil and water management research previously contracted to ICRISAT/SAFGRAD. Consequently, in April, 1985, a sixth IITA/SAFGRAD scientist was added to the team.

The SAFGRAD Phase I of the Projet ended in 1986. During this phase, the resident maize research conducted by IITA/SAFGRAD in Burkina Faso resulted in the development of adapted early maturing maize varieties and management practices for soil-moisture conservation. Also, it was demonstrated during SAFGRAD I that regional commodity networks could help collaborating countries to develop and strengthen the capabilities of the national scientists and to share the technologies emanating from networks efforts. The Maize Network for West and Central Africa was therefore created during an assembly of maize scientists from the sub-region in March, 1987.

The first part of this synthesis report covers the activities of SAFGRAD I while the second part deals with the activities of SAFGRAD II.

SAFGRAD PHASE I

1.0. OVERALL OBJECTIVES AND STRATEGY OF SAFGRAD PHASE I

The major objectives of the IITA/SAFGRAD Phase I was:

a) To assist and strengthen national maize and cowpea programs in the semi-arid tropics of Africa.

b) To develop improved varieties and agronomic management practices capable of giving higher and more stable economic yields in semi-arid environments.

c) To organize and promote systematic regional testing of available genetic materials and technologies in the SAT.
d) To assist in the training and manpower development of African nationals at all levels.

The strategy followed to achieve these objectives included:

a) Resident research, i.e. research conducted directly by IITA/SAFGRAD staff at different locations in Burkina Faso.

b) Regional research conducted by and in collaboration with national programs in 26 SAFGRAD member countries.

c) Support and assistance to national programs through consultation visits, technical advice, encouragement and motivation, the provision of small research equipment, organization of annual maize and cowpea workshops, and annual maize and cowpea monitoring tours.

d) Training in Burkina and at IITA headquarters (Ibadan, Nigeria).

2.0. RESIDENT RESEARCH IN BURKINA FASO (1979-1986)

Maize Breeding

Objectives

Maize breeding program had three major objectives, namely the development of:

a) Early (90 days to maturity) high yielding varieties for the Sudan Savanna Zone.

b) Intermediate (105-110 day) high yielding varieties for the Northern Guinea Savanna Zone. These varieties could also be grown on lower slopes or hydromorphic soils of the Sudan Savanna.

c) Drought resistant varieties. Risk of drought stress is one of the major factors affecting yield stability in the SAT. Improving maize resistance to drought should enchance the well-being of small farmers in the region.

Testing of QPM materials developed by CIMMYT was carried out to identify the best populations/varieties for the Sudan Savanna.

Research results

a) Genetic improvement

TZESR-Y. This is an early streak resistant population developed at IITA/Ibadan. Two cycles of full-sib family selections were completed in 1984 at Kamboinse.

Pool 16. This early white dent CIMMYT pool has performed well in sAFGRADs' Regional Uniform Variety Trial (RUVT). The first cycle of selection was completed in 1982 and sent to IITA/Ibadan for further improvement in reistance to streak. Maize streak virus was a serious disease in Africa and was becoming more and more important in the Northern Guinea Savanna of West Africa. At Kamboinse, one selection cycle was completed in 1985 to incorporate drought resistance into this population.

TZUT-Y. This is a temperate x tropical intermediate maturity population which combines the efficient plant type of U.S. corn belt varieties with the disease tolerance/resistance of tropical germplasm. Since 1982, 305 S_1 lines of this population were combined twice at Kamboinse. In 1984, the first selection cycle of this new population was completed.

A cycle of selection TZE-3, TZE-4, and TZPB was carried out at SAFGRAD.

Through International Progeny Testing Trials (IPTT's), the Maize Breeding Program participated in the improvement of TZSR-Y, TZSR-W, TZUT-W, and TZESR-W (IITA populations); and Pop 33, Pop 70 and Pop 46 (CIMMYT populations).

210 local varieties from Burkina were collected and evaluated.

b) Varietal development

The following varieties were developed and tested:

24 experimental varieties from IITA's early maturing populations (TZE 7, TZE 8, TZE 9, TZE 12, TZE 14, TZE 15, TZE 16, TZE 17).

Four varieties from Pool 16 (CIMMYT Germplasm).

Four varieties from TZESR-Y (IITA Germplasm).

In addition, 72 crosses between tropical and temperate maize were advanced to F_4 and tested.

Of the above 104 varieties/crosses, six varieties (two intermediate and four early) showed good performance in the Regional Testing Program and some were adopted by national programs. The varieties developed by IITA/SAFGRAD which had shown the best performance were:

Early: Temp. x Trop. N°42, Tep. x Trop. N° 3
SAFITA-2 and SAFITA-104.

Intermediate: SAFITA-104 and Temp. x Trop. N° 27.

Controlled irrigation studies permitted identification of the best performing genotypes under drought stress. These were Pool 16 and Jaune Flint de Saria. A field methodology for identifying the best families under drought stress was developed. In 1985, experimental varieties were developed and tested using this methodology.

The program also developed a quality protein maize variety from QPM Pool 34 which was sent for regional testing and evaluation. It performed well in both Burkina and Cape Verde.

Maize Agronomy

Objectives

a) To assess the relative importance of the different soil, climatic, and management factors affecting maize production in the Northern Guinea and Sudan Savanna Zones.

b) To establish suitable management practices for the production of maize under low and high management conditions.

c) To participate in the formulation and execution of a Maize Improvement Program designed for growing conditions in the SAT, with particular emphasis on increasing maize drought resistance.

To accomplish these objectives, the program conducted more than 240 field trials between 1979 and 1985 under both low and high management conditions. These and other available research results together with the experience gained by the maize agronomist, have permitted the establishment of a broad data base of agronomic factors limiting maize production in the region.

Agronomic factors affecting maize production in the West African Northern Guinea and Sudan Savannas.

In the predominant soil types of the West African Savannas (ferruginous tropical soils or Alfisols and Inceptisols), soil fertility, soil compaction, and the risk of drought stress are the main agronomic factors affecting maize production. To this list, other factors of lesser importance or of a more localized nature may be added such as termites, maize streak virus, weeds (including *Striga*), soil acidity and lodging.

a) Soil fertility. Nitrogen and phosphorus deficiencies are most prevalent.

b) Soil compaction. This problem is mainly a function of:

- Mineralogy: high contents of quartz and kaolinite with low contents of amorphous iron and alluminum oxides.
- Low organic matter
- Crop residue removal.
- Lack of tillage.
- Impact from intense rainfall.

c) Drought stress. The risk of drought stress is often high due to:

- Erratic rainfall distribution patterns. Dry periods of one week or longer are common but unpredictable during the growing season. In addition, rains may be established late or cease earlier than expected.
- Surface sealing and/or surface crusting. The consequences are lower infiltration rates and increased run-off losses.
- Soil or subsoil compaction. As a result, percolation and infiltration rates decrease.

Agronomic solutions to major limiting factors.

Soil fertility.

a) Nitrogen: Grain yield response to nitrogen fertilizer was strongly dependent on the amount of rainfall received. Responses were found with up to 100 kg N/ha in the Sudan Savanna and up to 150 kg N/ha in the Northern, Guinea Savanna. Recommendations to farmers should, however, take into account soil type and management history, removal of crop residues, rainfall in the preceeding year, economic and other risk factors.

Timing of Nitrogen application: Experiments in the Sudan Savanna with ferriginous tropical soils showed no consistent difference in grain yield between one total and several split nitrogen applications. On ferrallitic soils in the Northern Guinea Savanna, split nitrogen applications generally produced better yield than one single nitrogen application at or soon after planting.

Legume-maize crop rotations: Maize grain yield was higher when maize followed cowpeas or groundnuts than when under continuous maize. However, the grain yield differences were small or modest (150 to 700 kg/ha) and could not be attributed solely to increased nitrogen fixation by the legume, implying that other factors were involved in the positive rotation effect.

b) Phosphorus: Phosphorus deficiencies are widespread in Burkina Faso and are a greater factor limiting yield than nitrogen. Deficiencies can be corrected, however, with moderate amounts of fertilizer application. Grain yield responses were found with up to 50-75 kg soluble P_2O_5/ha. In addition, marked residual effects of phosphorus on grain yield were measured several years after its initial application.

Use of local phosphatic rock: Experiments with the local phosphatic rock (Burkina phosphate) indicated that its effectiveness in increasing grain yield during the first two years of application was very minor due to the low solubility.

Soil compaction

Soil compaction affects maize growth and yield in at least two ways: 1) reduced root growth, with its related effects on water uptake and mineral nutrition, and 2) reduced water infiltration. Tillage and crop residue management were shown to reduce the negative effects of soil compaction on yield.

a) Soil tillage: In the absence of tied ridges, soil preparation by tractor, oxen, donkey, or hand-hoe always gave higher maize grain yields than zero-tillage. Generally, grain yield is positively correlated with depth of soil tillage. As such, tillage methods can be ranked as tractor > oxen > donkey = hand-hoe.

b) Residues: Crop residues help in maintaining soil organic matter and promote a higher level of biological activity. In particular, termite activity at or near the soil surface was found to be greatly enhanced by the presence of crop residues. As a result, infiltration rates and soil aeration are improved. When residues are kept as a mulch, there is an additional positive effect on maintaining lower soil temperatures and minimizing evaporative losses. Marked effects on maize grain yield were obtained only when the amount of residue was at least 3-4 tons of dry matter/ha. The amount of residue required was less when tied ridges were used. Under traditional (hand-hoeing) soil preparation methods, the systematic removal of crop residues leads to such low infiltration rates that grain yield response to fertilizer applications was very small or non-existent.

<u>Drought stress</u>

Alone or in combination, the following practices reduce the risk of drought stress.

a) Soil tillage: Tractor, oxen, donkey and hand-hoe tillage methods improve infiltration and soil water storage. Deep tillage was generally better than shallow tillage. The effect of soil tillage was only temporary and was not enough to ensure improved soil water infiltration rates throughout the growing season.

b) Tied ridges: Evaluation of tied ridges in the Sudan Savanna of Burkina Faso was initiated by the IITA/SAFGRAD Maize Agronomy Program in 1979. Tied ridges have been very effective in increasing infiltration and decreasing runoff losses. This is particularly true in those soils which have low infiltration rates due to surface sealing, crusting or compact subsoil layers. The yield response to tied ridges has been more consistent in the Sudan than in the Northern Guinea Savanna.

Tied ridges can be established at or before planting, or at the time of earthing (hilling) up. If farmers don't have the means to make tied ridges before planting, they may plant on the flat. Later, when plants reach a height of about 25 cm and when labor is less of a constraint, they can earth up and tie their ridges. Long term trials have also shown that it is profitable for farmers to plant directly on old tied ridges, without any prior soil preparation except weeding. The latter is a more viable option in the Sudan than in the Northern Guinea Savanna because the longer dry season lessens the problem of weed control.

Tests conducted directly by the Maize Agronomy Program and by other research agencies showed a yield response to tied ridges at most locations (maize and other crops) in Burkina Faso. However, no yield response was found in the weakly ferrallitic soils at Farako-Bâ. These soils were typical forest zone soils, however, which are not common in the West African Savanna. At Saria, only on poorly or imperfectly drained lower slope soils were there negative effects in most years of tied ridging on maize growth and yield.

The grain yield increase obtained on-station using tied ridges can be as high as 2000 kg/ha when soil fertility is not a yield limiting factor. Yield increases of 1 ton/ha are common. On-farm tests have shown yield increases of up to 500 kg/ha. The labor cost of making tied ridges by hand was estimated at 27 man-days/ha or 19.800 CFA/ha (ooportunity cost of labor at 50 CFA/hour). At a maize price of 90 CFA/kg, such labor cost equal 120 kg maize/ha, which is only a fraction of the potential yield increase.

c) Shallow ditches: Digging shallow ditches or small holes between the maize rows also increased soil water retention and decreased runoff. Experiments have shown large yield increases due to digging holes approximately 40 cm long x 20 cm wide x 10 cm deep. Such yield increases were usually smaller than those obtained by making tied ridges, due to the larger volume of water contained by the latter. If the farmer plants on the flat, he can dig small holes between rows any time after planting; whereas tied ridges can be established only after the plants reach a minimum height, usually 25 or more days after planting.

It has been concluded that the risk of drought stress can be reduced by any sort of small hole, catchment, basin, or terrain irregularity that slows down water runoff and conserves moisture.

d) Cultivations (scarifications) for breaking a sealed soil surface of crust: Crusting and/or surface sealing are soil characteristics frequently encountered in Burkina Faso. The results are poorer soil aeration and reduced water infiltration leading to a greater risk of drought stress. Even in the absence of weeds, cultivations after planting led to improved grain yields. In general, the greater the number of cultivations, the higher the yield. It was also shown that cultivars were not as effective as either digging small holes or as ridge tying in increasing maize yields. Moreover, cultivations can cause root prunning and/or exposure of moist soil to dessication, leading to increased drought stress and possibly reductions in yield.

e) Planting of maize on lower slope and hydromorphic soils: There was a very marked toposequence effect on maize grain yield. Yields were lowest on plateau soils and increased toward lower slopes and hydromorphic soils. The difference in grain yield was on the order of two to five fold, even when improved soil and water management practices such as tillage, tied ridges and fertilizer were used.

f) Use of residues as a mulch: Although farmers need crop residues for fuel, fodder and construction material, the current practice of systematic crop removal from the field is counter-productive in the long run and is one of the major factors responsible for the current degradation of the soil resource base.

g) Use of varieties whose maturity fits the length of the growing cycle: Under "average" rainfall conditions, varieties of the following maturities should be used in simple maize monocropping systems:-

Sudan Savanna - early varieties (82-95 days); Northern Guinea Savanna intermediate maturing varieties (96-110 days).

There is a demonstrated need to develop extra-early maize varieties (less than 82 days to maturity) to be used in the Sudan Savanna in those years when maize cannot be planted as soon as it should or has to be replanted when the remaining part of the growing season is too short for planting an early variety.

h) Appropriate planting dates: When rainfall conditions permit, it appears that the optimum planting dates for maize are June 16-30 in the Sudan Savanna and June 1-20 in the Northern Guinea Savanna. Nevertheless, given the high variability in the rainfall distribution pattern from year to year and the erratic occurrence of dry spells during the growing season, there were years when the highest maize grain yields were obtained when the planting date was earlier or later than the average optimum given above.

Results of other agronomic studies

a) Planting depth: In experiments where there was overplanting and thinning to one plant/hill, deep planting (8-10 cm depth) gave the same grain yield as shallow planting (3-5 cm). Nevertheless, deep planting reduced field germination and could lead to decreased stands and lower yields under farmers' conditions, where overplanting and thinning don't normaly occur.

b) Seedbed: Experiments in the Sudan and Northern Guinea Savannas showed no differences in maize grain yield between planting on the flat and planting on simple (non-tied) ridges.

c) Earthing up: When planting on the flat, there was no effect of simple earthing up (without ridge tying) on maize grain yield.

d) Plants/hill: Experiments in the Sudan Savanna showed that at the same plant density, there were no grain yield differences between one or two plants per hill. When the number of plants/hill increased to 3 or 4, grain yields decreased.

e) Seed size: There is a direct effect of seed size on field germination and seedling vigor, but its effect on yield has not been consistent over the years. A small seed size leads to lower field germination rates and can result in lower maize grain yields.

f) Plant density: The optimum plant density for maximum grain yield changes with soil fertility, planting date and number of days to maturity. When soil fertility is not a major limiting factor and the planting date is appropriate, optimum densities are similar to those found in more humid zones: Intermediate varieties: 50,000 to 65,000 plants/ha. Early varieties: 65,000 to 90,000 plants/ha. These optimum densities can be reduced by 20-30% with only a small (less than 10%) effect on grain yield. By using densities which are 20-30% below those which give the highest grain yields, the small farmer can decrease his/her planting and harvesting costs. Sub-optimal densities can also reduce the risk of crop failure if grain filling occurs during a very severe drought.

Optimum densities decrease as soil fertility becomes a yield limiting factor. Under very low fertility, the optimum density for intermediate maturity varieties is about 25,000 plants/ha. The effect of planting date on stand density becomes very important when most of the grain filling period occurs under conditions of very low soil moisture. In this case, the optimum density should be drastically reduced from 50-65,000 to 20-25,000 plants/ha.

g) Thinning date: Results showed no effect of thinning between 12 and 25 days after planting on maize grain yield. Although thinning is not a practice normally followed by the maize farmer, overplanting and thinning late (20 days after planting) can increase a researchers' chance of obtaining desired stands and higher within-plot uniformity.

h) Spatial arrangement. There were no differences in maize grain yield between row spacings of 37.5 cm and 75 cm. At a row spacing of 112.5 cm, yields were the same as at 75 cm with a density of 40,000 plants/ha, but lower yields were obtained when the density was increased to 67,000 plants/ha.

i) Potassium fertilizer: Short term studies showed no grain yield increase due to the application of potassium fertilizers.

j) Zinc deficiencies: In some years, zinc deficiency symptoms have been observed in the Sudan Savanna, but no grain yield response to zinc application was found. Foliar sprays of zinc sulfate were effective in correcting the deficiency symptoms.

k) Effect of Furadan (Carbofuran): Soil applications of furadan 5G at or after planting and/or during the crop cycle often gave grain yield increases, sometimes as high as 1 ton/ha. The positive effect of furadan is due mostly to termite control in the Sudan Savanna, whereas it helps to control termites, stem borers, maize streak virus and some soil insects in the Northern Guinea Savanna.

l) Local varieties: Most if not all of the early (82-95 day) local varieties in the Sudan Savanna showed good yield potential (4-5 ton/ha) when properly managed. Some had good agronomic characteristics while others were too susceptible to lodging. Although foliar diseases are not a major problem in the Sudan Savanna, all local varieties appear to be highly susceptible to them.

m) Genotype x management interactions: Many trials were conducted to compare varieties under low fertility and/or drought stress. In general, local varieties did not perform better than improved varieties of the same maturity.

Development of a ridge-tier for animal traction.

Although tied ridges can be made by hand and still be economically profitable, a mechanical device adapted to animal traction has made tied ridging even more attractive. Two versions of such a device have been developed by the IITA/SAFGRAD Maize Agronomy Program; one designed for donkey and the second for oxen traction. The donkey model has shovels which are 16 cm wide at the outer edge, widening to 40 cm at the center. It weighs 11 kg and costs about 14,000 CFA to produce. The same parameters for the oxen model are 20 cm, 55 cm, 17 kg, and roughly 16,000 CFA. In 1985, more than 130 units of both ridge-tiers were built and widely distributed to farmers and cooperators in Burkina Faso.

Maize Entomology

Objectives

a) Identify principal insect pests and estimate associated yield losses to maize in the West African SAT.

b) Identify and evaluate chemical insecticides for pest suppression with emphasis on availability, cost and safety.

c) Develop and test integrated pest management (IPM) systems which are economically sound, ecologically balances, and agronomically feasible for increased stable maize production.

Research results

Millipedes, armyworms (*Mythimnia sp*), stem borers (*Sesamia, Eldana*), Cicadulina leafhoppers (streak virus vector) and termites were identified as the most important insect pests of maize in the West African SAT. Termites are the most serious pest because they attack all plant parts at all growth stages.

Furadan (Carbofuran) 5G (1-3 kg a.i./ha effectively controls termites and other maize pests (streak, borers, armyworms and millipedes), but large scale use is undesirable due to high toxicity and cost.

Work on screening maize for termite resistance was initiated. Given the non-uniform field distribution of termite populations, the major difficulty has been the lack of a reliable screening metholodoly. Thus, only preliminary observations have been made.

3.0. REGIONAL TESTING

Regional Uniform Variety Trials

Objectives

a) Provide elite maize germplasm to research workers in the African SAT for testing and use in their national programs.

b) Provide national scientists an opportunity to have their elite materials systematically evaluated over a wide range of environments.

c) Develop varieties possessing tolerance to problems in semi-arid areas for wider adaptation and stability.

e) Evaluate regional variation in disease and insect pests of maize.

d) Enhance the exchange of germplasm between national programs.

Results

Two Regional Uniform Variety Trials (RUVT), early (RUVT-1) and intermediate (RUVT-2) were prepared and coordinated by IITA/SAFGRAD. The RUVT entries were nominated by national programs, the IITA/SAFGRAD resident program, and other international organizations (CIMMYT-IITA). In addition, the program also prepared and coordinated four different Regional Family Testing Trials (RFTT) from 1989-1982. The RFTT's were composed of families generated from the IITA/SAFGRAD early and intermediate maturity populations. From 1979 to 1985, 192 sets of RUVT-1, 171 sets of RUVT-2 and 23 sets of RFTT were sent to national programs of SAFGRAD member countries as is shown below.

Distribution of regional trials by the IITA/SAFGRAD Maize Breeding Program, 1979-1985.

Year		RFTT's	RUVT-1	RUVT-2
1979	Sets	-	10	9
	Countries	-	10	9
1980	Sets	12	23	24
	Countries	4	14	13
1981	Sets	8	25	22
	Countries	4	17	17
1982	Sets	3	20	18
	Countries	3	20	18
1983	Sets	-	50	35
	Countries	-	24	24
1984	Sets	-	27	26
	Countries	-	17	15
1985	Sets	-	37	37
	Countries	-	18	16

A total of 44 varieties were tested in RUVT-1 and 42 varieties in RUVT-2. Six national programs participated in the nomination of varieties for these trials (Burkina Faso, Senegal, Ivory Coast, Ghana, Tanzania and Togo). Based on reports presented at the sAFGRAD/EEC Maize and Cowpea Workshop (Cotonou, 16-20 September, 1985), the following national programs were using varieties tested in RUVT's:

Togo: TZPB (IITA/Ibadan) was tested in RUVT-2 and advanced to on-farm testing.

Ghana: SAFITA-2 (developed by the IITA/SAFGRAD resident program from Pool 16 CIMMYT germplasm) had been released, and breeder seed provided to the Ghana Seed Company. This variety served the need for an early maturing white dent for the Guinea Savanna and Coastal Volta Regions.

Mali: SAFITA-2 (IITA/SAFGRAD) and TZE-4 (IITA/Ibadan; further improved by IITA/SAFGRAD) was in the process of release. Golden Crystal and Composite C4 (Ghana) were in multi-location testing for possible release. TZPB, TZSR-Y-1 (IITA/Ibadan), SAFITA-2 and SAFITA-104 (IITA/SAFGRAD) were being used in the National Maize Breeding Program.

Burkina Faso: SAFITA-2 was used in a top cross program by IBRAZ/IRAT at Farako-Bâ. SAFITA-2 had been proposed for release in Burkina, having been found very promising by SAFGRAD's cowpea agronomist for relay cropping with cowpeas in the Northern Guinea Savanna.

Benin: Synthetic C (Senegal) was to be tested in farmers' fields in 1986.

Cameroon: SAFITA-2 and Elite x Mexican Composite (Ghana) were in the process of release.

Maize Agronomy Trials

Objectives

The IITA/SAFGRAD Maize Agronomy Program first proposed regional trials in 1982 with the following general objectives:

a) To test at a regional level those cultural practices which had proven successful in Burkina Faso or other SAFGRAD member countries.

b) To evaluate the regional importance of other soil and crop management practices.

Results

Regional Maize Agronomy Trials (REMAT) were proposed in 1982. The trials were requested by the following countries, to which experimental plans and field books were sent.

a) REMAT-1 (Tied ridges trial): Ghana (1 set); Mali (3 sets).
b) REMAT-2 Legume-maize rotation trial): Gambia (1 set); Somalia (1 set).
c) REMAT-3 (Nitrogen and phosphorus response and residual fertilizer effect trial): (1 set); Guinea (1 set)

Experiments conducted in Mali at Katibougou and Tietiguila (Sudan Savanna) on ferruginous tropical soils (red, red-brown, and leached) showed very significant maize yield responses to tied ridges, similar to those obtained in Burkina Faso (Kamboinse). The yield response to tied ridges was present even without any fertilizer application at Katibougou, but only when fertilizer was applied at Tietiguila.

On fallowed soil at Nyankpala in the Northern Guinea Savanna of Ghana, there was no significant yield difference between the control and any treatment using tied ridges. Additionally, an experiment evaluating the response to N, P, and K showed that phosphorus was a greater yield limiting factor than nitrogen. No response to potassium was observed. Linear yield responses were found up to 120 and 75 kg/ha of N and P_2O_5, respectively (maximum rated used in the trial).

Maize Entomology Trials

Objectives

The objective of the entomology program was to stimulate collaboration and information exhange with national programs, thereby generating interest in entomology and crop protection research.

Results

A regional trial on the survey of maize arthropod pests was conducted in 1981 and 1982.

In 1981, two maize varieties, TZE-4 and a local check were grown for observation at two planting dates in Gambia, Mali, Senegal and Burkina Faso.

The trial was repeated in 1982 in Burkina, Gambia and Senegal using SAFITA-2 and local check varieties.

The results indicated that the principal pests of maize were termites and armyworms in Burkina Faso, stem borers in Gambia and millipedes in Senegal.

4.0. ANNUAL WORKSHOPS

The first SAFGRAD Workshop took place in Burkina Faso (Ouagadougou) in 1979. In each of the following years, Annual Maize and Cowpea workshops were organized by IITA/SAFGRAD and the OAU/STRC Coordination Office. Starting in 1984, the annual workshop was held jointly between SAFGRAD and the IITA/EEC (European Economic Community) High Yielding Varieties Technology Project.

The annual workshop permitted an evaluation of progress made by national maize programs, IITA/SAFGRAD and other participating institutions (EEC Project) as well as planning for future research activities. The workshops were held near March, so as to provide national programs the opportunity to nominate their own entries for regional testing and at the same time give seed of the nominated entries to the IITA/SAFGRAD team which was responsible for assembling and dispatching regional trials.

The annual workshops promoted an exchange of information and a sense of friendship and common purpose among national scientists and SAFGRAD researchers. Thus, a major accomplishment of the IITA/SAFGRAD project was the breaking of barriers between anglophone and francophone countries. As a result of these workshops and the annual monitoring tours, most of the leading maize researchers in the African SAT were able to interact more closely with each other.

Details on the annual workshops are presented below:

Year	Date	Location	Representation	
			Participants	Countries
1979	February 20-23	Ouagadougou	42	20
1980	February 12-15	Ouagadougou	63	19
1981	February 23-27	IITA, Ibadan	46	20
1982	February 28-March 2	Ouagadougou	47	15
1983	April 25-27	Ouagadougou	55	19
1984	March 5-9	IITA, Ibadan	70	26
1985	September 16-20	Cotonou	80	20

5.0. MONITORING TOURS

Under the coordination of IITA/SAFGRAD scientists, monitoring tours were conducted during each growing season, bringing together national scientists from up to 6 countries (per crop) to visit national maize or cowpea programs in as many as 6 countries. Scientists from CIMMYT and IITA/Ibadan were also invited. The monitoring tours promoted interaction among national programs in west, east and south African countries.

During monitoring tours, the relative performance of entries and/or management practices included in the regional testing were evaluated, as well as the performance of any other maize, cowpea or agronomic trial. In addition, the monitoring tours gave both national scientists and IITA/SAFGRAD staff a unique opportunity to learn about the problems limiting maize and cowpea production in the SAT.

The following table provides details on the to monitoring tours.

Year	Countries visited	Number of Participants: SAFGRAD Countries	IITA/SAFGRAD & IITA/CIMMYT	
1979 Sept.)	Senegal, Mali, Burkina, Ivory Coast, Ghana, Benin	3	(Burkina, Mali, Senegal)	3
1980 (Sept.)	Senegal, Burkina, Benin, Ghana, Cameroon.	3	(Senegal, Ghana, Cameroon)	2
1981 (Sept.)	Senegal, Gambia, Mali, Burkina, Togo.	5	(Senegal, Mali, Burkina, Togo, Tanzania).	1
1982 (Sept.)	Senegal, Burkina, Ghana, Nigeria, Guinea-Bissau.	5	(Ghana, C.A. Rep. Ethiopia, Somalia, Zimbabwe)	4
1983 (Feb.)	Botswana, Zimbabwe, Zambia Kenya, Somalia, Ethiopia.	3	(Nigeria, Senegal, Benin)	2 2
1984 (Sept.)	Burkina, Nigeria, Ghana, Mali, Cameroon, Senegal.	5	(Burkina, Nigeria, Ghana, Mali).	
1985 (Sept.)	Guinea, Senegal, Burkina, Nigeria.		-	2

6.0. VISITS TO NATIONAL PROGRAMS

In addition to the monitoring tours, IITA/SAFGRAD scientists paid about 25 visits to national programs in the following countries: Niger, Benin, Mali, Senegal, Gambia, Guinea, Nigeria, Togo, Ivory Coast, Ghana, Guinea-Bissau, and Mauritania.

7.0. TRAINING

In-Service Training

Every year national researchers and technicians from SAFGRAD member countries came to Burkina (Kamboinse) for in-service training in one or more disciplines of their choice. Participants in this training program worked closely with project scientists during the growing season for a period of 3 to 7 months in both field and laboratory activities.

The total number of trainees per discipline is given below:

Discipline	Number of trainees	Countries
Maize Breeding	4	Mali, guine, Burkina, Somalia
Maize Agronomy	4	Gambia, guinea, guinea-Bissau.
Maize Entomology	1	Burkina
Cowpea Breeding	8	Zambia, Guinea, Mali, Botswana, Benin, Burkina.
Cowpea Agronomy	3	Gambia, Chad, Botswana.
Cowpea Entomology	11	Senegal, Gambia, Burkina, Guinea, Botswana.

DEGREE-RELATED TRAINING

Students working towards a B.Sc. degree ("Ingénieur Agronome") can do their research work (thesis) under the guidance of IITA/SAFGRAD scientists. To date, a total of nine students from the University of Ouagadougou and the Katibougou Polytechnic Rural Institute (Mali) have done, or are presently completing their research under IITA/SAFGRAD. Student breakdown by disciplines is as follows: Maize Breeding, 2; Maize Agronomy, 1; Cowpea Breeding, 1; Cowpea Agronomy, 4; Cowpea Entomology, 1. These students have come from the following countries: Burkina, Chad, Zaïre, and the Central African Republic. In addition, two students did part of their Ph.D. thesis research at IITA/SAFGRAD: one in Cowpea Entomology (from Niger) and the other in Soil Fertility (from Burkina).

OTHER TRAINING

At the request of the National Seed Service in Ouagadougou, and with the help of the Training Office at IITA/Ibadan, IITA/SAFGRAD conducted a maize and cowpea production training course at Kamboinse from March 15 to April 9, 1982. Five trainees from Benin and 15 from Burkina participated in the training course.

SAFGRAD PHASE II

SAFGRAD MAIZE NETWORK FOR WEST AND CENTRAL AFRICA (1986-1992)

1. Objective of Maize Network

The Maize Network for West and Central Africa is one of the four collaborative Networks of SAFGRAD Phase II. Its purpose is to enable national maize programs of West and Central Africa to pool their resources to tackle production problems common to countries in the subregion through the development of appropriate technologies. The interaction in Networks is expected to help the NARS avoid unnecessary duplication and to focus their research priorities. The ultimate goal is to increase the productivity of maize in West and Central Africa.

2. Target Area

The maize collaborative research network targets the semi-arid zones of West and Central Africa.

Collaborating Countries

The collaborating countries in the Networks are Benin, Burkina Faso, Cameroon, Cape Verde, Central African Republic, Chad, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Mali, Mauritania, Niger, Nigeria, Senegal, and Togo. There is enormous variability from country to country regarding the proportion of total land area occupied by the different semi-arid ecologies. The list of names of the maize scientists in the member countries is presented in Table 1.

Production Constraints

The production constraints as identified by NARS scientists during a workshop of the national scientists from West and Central Africa at Ouagadougou, Burkina Faso, 23-27 March, 1987, were as follows:

. Unavailability of maize varieties appropriate to the different ecologies and cropping systems or either.

. Biological stresses.

- diseases (maize streak, rust, blight, *Curvularia* leaf spot, stalk and ear rots)

- insect pests especially stem borers, termites, and storage insects

- parasitic weed, *Striga* spp.

. Drought stress

. Agronomic or crop management constraints

  - low soil fertility
  - soil-water management problems

. Socio-economic constraints

  - unavailable and expensive inputs, or either.
  - low and unstable prices of maize, or either.
  - inadequate or poor seed production and distribution, and
  - lack of or inappropriate on-farm testing.

. Inadequate number of trained research scientists, technicians and extension personnel.

Table 1. **West and Central Africa Maize Network : Collaborating scientists in Network member-countries (as of March, 1991).**

Country	Collaborating scientist	Qualification	Specialization	Location	% Time on maize
Benin	1. Yallou, Ch. G.	Ing. Agron.	Breeder	Niaouli	100
	2. Akomedi, T.M. (Mme)	M.S.	Seed Tech.	Niaouli	50
	3. Dossou, R.A.	Ing. Agron.	Breeder	Ina	100
	4. Adomou, M.	M.S.	Agronomist	Ina	25
Burkina Faso	1. Hema, I.	3e Cycle	Breeder	Kamboinse	100
	2. Konaté, G.	Ph.D.	Virologist	Kamboinse	30
	3. Sanou, J.	Ing. Agron.	Breeder	Farako-Bâ	100
	4. Traoré, S.	3e Cycle	Entomologist	Saria	50
	5. Paco Sereme	3e Cycle	Pathologist	Kamboinse	25
Cameroon	1. Ayuk-Takem, J.A.	Ph.D.	Breeder	Nkolbisson (IRA Director)	10
	2. Thé, Charles	Ph.D.	Breeder	Nkolbisson	100
	3. Zangue, J.B.	M.S.	Breeder	Nkolbisson	100
	4. Ngoumou, T.N.	M.S.	Agronomist	Garoua	40
	5. Ebete, A.M.	Ing. Agron.	Agronomist	Garoua	100
	6. Tchamo, P.	3e Cycle	Breeder	Bambui	60
	7. Eta-Ndu, J.T.	M.S.	Breeder	Bambui	100
	8. Nankam, C.	M.S.	Pathologist	Bambui	50
	9. Aroga, R. (Mme)	M.S.	Entomologist	Nkolbisson	50
	10. Fobasso, M.	M.S.	Extention Agronomist	Maroua	40
	11. Mongmong, B.	Ing.Agron.	Breeder	Garoua	100
	12. Ondoa, N.M.	Ing.Agron.	Breeder	Nkolbisson	100
Cape Verde	1. Silva, C.	Ing.Agron.	Agronomist	Praia	40
Cent. Af.Rep	1. Ganglaou, C.	Ing.Agron.	Agronomist	Bangui	60
Chad	1. Gaye-Sene, Y.	Ing.Agron.	Breeder	Gassi	
	2. Yagoua, R.	Ing.Agron.			
Côte d'Ivoire	1. Attiey, K.	M.S.	Breeder	Bouaké	100
	2. Acle Dadié	M.S.	Entomologist	Bouaké	60
	3. Akanvou, R.	M.S.	Agronomist	Ferke	50
	4. Akanvou, L. (Mme)	M.S.	Breeder	Ferke	50
	5. Ngoran, A (Mme)	M.S.	Breeder	Bouake	75
Gambia	1. Mbenga, M.S.	M.S.	Breeder	Sapu	75

Table 1. Cont'd

Country	Collaborating scientist	Qualification	Specialization	Location	% Time on maize
Ghana	1. Badu-Apraku, B.	Ph.D.	Breeder	Kumasi	100
	2. Twumasi-Afriyie, J.	Ph.D.	Breeder	Kumasi	100
	3. Sallah, P.Y.K.	Ph.D.	Breeder	Nyankpala	100
	4. Asiedu, E.A.	M.S.	Seed Tech.	Kumasi	75
	5. Owusu-Akyaw, M.	Ph.D.	Entomologist	Kumasi	25
	6. Bolfrey, G. (Mme)	M.S.	Agronomist	Kumasi	75
	7. Aflakpui, G.K.S.	M.S.	Agronomist	Nyankpala	75
	8. J.N. Asafu-Agyei	M.S.	Agronomist	Kumasi	40
	9. K.A. Marfo	M.S.	Ext. Agr.	Kumasi	50
	10. S. Ohemeng-Dapaah	M.S.	Agronomist/ Meteorologist	Kumasi	40
Guinea	1. Camara, S.	Ing.Agron.	Breeder	Kilissi	100
	2. Diallo, P.	Ing.Agron.	Agronomist	Kilissi	100
	3. Bah, I.	Ing.Agron.	Agronomist	Kilissi	100
Guinea Bissau	1. Domingo, F.	Ing.Agron.	Agronomist	Contobuel	100
Mali	1. Coulibaly, N.	M.S.	Agronomist	Sotuba	100
	2. Assa-Kanté, B. (Mme)	M.S.	Food Tech.	Sotuba	100
	3. Dolo, A.B.	Ing.Agron.	Agronomist	Bamako (CMDT)	75
Mauritania	1. Sidi R'Chid	3e Cycle	Agronome	Kaedi	30
Niger	1. Naino, J.	M.S.	Breeder	Kolo	40
Nigeria	1. Obajimi, A.O.	Ph.D.	Breeder	Ibadan	100
	2. Iken, J.E.	Ph.D.	Breeder	Ibadan	100
	3. Fakorede, M.A.B.	Ph.D.	Breeder	Ife	100
	4. Alofe, C.	Ph.D.	Agronomist	Ife	100
	5. Akintunde, Y.	Ph.D.	Agronomist	Ibadan	100
	6. Elemo, K.A.	Ph.D.	Agronomist	Zaria	60
	7. Iwuafor, E.N.O.	Ph.D.	Agronomist	Zaria	50
	8. Chude, V.O.	Ph.D.	Agronomist	Zaria	50
Senegal	1. Ndiaye, A.	3e Cycle	Breeder	St. Louis	100
Togo	1. Esseh-Yovo, M.	Ph.D.	Breeder	Lome	100
	2. Agbobli, C.A.	Ph.D.	Agronomist	Lome	60
	3. Adri, K.	3e Cycle	Agronomist	Lome	75
	4. Gumedzoe, M.	M.S.	Virologist	Lome	30

3. Strategy

Following a review of the production constraints, available research personnel, and infrastructure of the Network 17 member-countries, the problems of common interest to the participating countries and the areas of strength and weakness of each national program were identified. Based on the occurence of the constraints across countries within each network and the existence of strong and weak national programs within the subregion, the strategy of assigning technology development responsibilities to strong national programs (Lead Centers) was adopted. There was an understanding that each Lead Center would make available to other national programs the technologies forthcoming from its efforts. The topics below are the research responsibilities assigned to the Lead Centers.

i. Breeding varieties of different maturities for the semi-arid zone with emphasis on early and extra-early varieties : Burkina Faso, Cameroon, Côte d'Ivoire, Ghana and Togo;

ii. Breeding for drought tolerance : Burkina Faso and Cameroon;

iii. Breeding for streak resistance : Togo and Ghana;

iv. Stem borer control : Côte d'Ivoire;

v. *Striga* control : Cameroon;

vi. Agronomic research for maize varieties of different maturity groups : Cameroon and Nigeria.

4. Network Management and Scientific Leadership

The establishment of the Maize Collaborative Research Network for West and Central Africa and the coordination through the steering committee has facilitated the identification and promotion of research leadership among NARS scientists in the subregion. The steering committee of the Network met biannually, as stipulated in the Project Paper, from 1987 to date (Table 2). In all, nine meetings were held to date, four in Burkina Faso (Ouagadougou), two in Togo (Lome), and one each in Nigeria (Zaria), Benin (Cotonou) and Niger (Niamey). Deliberations at each meeting were promptly documented in the form of Meeting Reports which were distributed to national coordinators in all the network member countries.

The Steering Committee provided concerted leadership and direction to the Network by deciding agendas for meetings, monitoring tours, seminars and workshops as well as allocating research responsibilities among participating member countries. The Committee monitored the performance of member countries including sponsoring consultation visits by its members to assigned countries.

5. Collaborative Research

The progress made by the Lead Centers of each Network towards the generation of technologies that could be shared by other network member countries were the following:

Cameroon

Development of early maturing varieties. Through selection, line extraction, and crossing of promising early and intermediate germplasm, two early maturing synthetics have been created.

Table 2. Maize Network Steering Committee Meetings (March 1987 - March 1991).

No.	Date	Venue	Participants*	
			Members	Observers
1st	23-27 March, 1987	Ouagadougou, Burkina Faso	7	4
2nd	7-9 November, 1987	Ouagadougou, Burkina Faso	6	8
3rd	7-9 April, 1988	Lome, Togo	6	7
4th	8-10 November, 1988	Zaria, Nigeria	6	8
5th	23-24 March, 1989	Lome, Togo	7	8
6th	6-10 November, 1989	Ouagadougou, Burkina Faso	6	5
7th	26-30 March, 1990	Ouagadougou, Burkina Faso	6	4
8th	5-8 November, 1990	Cotonou, Benin	7	5
9th	13-14 March, 1991	Niamey, Niger	7	3

*The Committee consists of the 6 elected national maize scientists and the Network Coordinator; the observers are representatives of IITA, SCO, USAID.

Development of drought tolerant maize. Drought tolerant synthetics were created from a Drought tolerant pool developed from Pool 16 DR and Drought Resistant Synthetic obtained from SAFGRAD and IITA, respectively. Also, several other introductions have been used to form drought tolerant heterotic pools.

Development of *Striga* resistant maize. Inbred lines developed from IITA *Striga* tolerant germplasm were evaluated under *Striga* stress to form a *Striga* resistant population.

Seed treatment for improved plant establishment and yield. From results of over 20 on-station and on-farm trials, it was established that seed treatment with Marshall 25 ST (Carbosulfan) produced better emergence, improved seedling vigor, and 100% more grain yield than untreated seed. Economic analysis showed a 33:1 benefit/cost ratio in favor of the use of Marshal over that of Thioral (current recommendation) as seed treatment. The advantage of Marshal 25 ST has been attributed to its effect on soil insects, especially termites.

Contribution of technology components to maize performance. In the Sudan savana, the contributions of improved technological components to total maize yield were as follows : 5% for tillage, 27% for seed treatment and 38% for fertilization.

Management practices for early and extra-early maize. Across various locations, the highest yields of early (DMR-ESRY and Pool 16 DR) and extra-early (TZEF-Y) varieties were obtained when N was topdressed 20-25 days after plant emergence as compared with the 30-35 days, the current recommendation for medium to late varieties. A combination of 80 x 20 cm spacing and 90-135 kg N/ha was found necessary to allow the early and extra-maize to express their yield potential.

Ghana

Development of maize varieties of different maturities. For systematic, simultaneous population improvement and extraction of different varieties for the various ecological zones and grain color preferences, five breeding populations (120-day, 105-day, 95-day white dent, 120-day yellow flint/dent, and 95-day yellow flint populations and two back-up gene pools (120-day and 105-day white dent) were initiated in 1983 and have undergone several cycles of improvement. Also, the high yielding white dent maize, EV 8443-SR has been converted to yellow grain color through backcrossing using Golden crystal as the yellow-color donor.

Improvement of streak resistance levels of elite varieties. The streak resistance level of three elite maize varieties developed in Ghana was improved through evaluation and selection utilizing IITA streak resistance screening facilities during the 1-year visiting scientist tenure of Dr. Badu-Apraku at IITA. The varieties are (i) Dorke (early, white extracted from Pool 16 SR) (ii) Abeleehi (intermediate, white extracted from Ikenne 8149 SR) and (iii) GH 8363 SR (a high quality protein maize from EV 8363-SR BC4).

Inbred line and hybrid development. One hundred tropcially adapted, disease-resistant lines have been produced and 43 of the lines have been tested in hybrid combinations using elite inbreds from IITA. Hybrids GH 17 x 9071 and GH5 x B73 outyielded Okomasa, the best Ghanian open-pollinated varieties by 31 and 30%, respectively. Both hybrids yielded as much or higher than IITA hybrid 8321-21. Work was initiated in 1989 on the formation of two heterotic populations for systematic hybrid development. The male population has been constituted from CIMMYT Pop 42, TZb, Pop. 44 SR and Suwan I (white version developed by Cameroon Program). The female population is largely Tuxpeno based (i.e. Pop 43, TZPB and Pop 21).

Inheritance of floury endosperm in local maize. The inheritance of the soft and floury endosperm of some local maize varieties from Ghana, Togo and Cameroon was studied using five generations derived from a cross between each local variety and a normal endosperm variety (F1, F2, and the reciprocal backcrosses). Results showed that Ghana and Togo locals possess seemingly identical recessive gene for the floury endosperm. The Cameroon local, however, possesses a different single recessive gene for the floury endosperm.

Côte d'Ivoire

Local maize germplasm evaluation. One hundred and two maize accessions collected from the central region of Côte d'Ivoire, where farmers grow 90-day maize, were evaluated for twenty different characteristics. In addition to conserving these accessions, promising cultivars have been utilized in developing an early maturing maize population.

Stem borer control research. Three species of stem borers were identified in the central and northern parts of the country, namely *Eldana saccharina*, *Sesamia calamistis*, and *Busseola fusca*. Using insecticide control, yield losses of up to 56.9% were attributed to stem borer damage on maize sown in June in the central-south part of the country. A mass screening laboratory is under construction at Bouake to facilitate uniform and reliable screening of germplasm for stem borer resistance.

Togo

Development of streak resistant maize. Streak resistance screening facilities have been established at Ativeme near Lome, Togo. Over 24,000 *Cicadulina* leaf hoppers can be raised per week in the screenhouse, enough to infect about 5,000 plants. Two maize populations, AB12 (Togo local floury x Pop 49-SR) and AB13 (Togo floury x Pop 43-SR) are being improved for streak resistance, good husk cover, soft endosperm and prolificacy. ZL2-BD, another local-based maize population, is being improved for its preferred grain type. It has been crossed with Pool 16-SR for the generation of early maturing varieties.

Nigeria

Fertilizer requirement for maize/cowpea mixture. At Samaru (northern Guinea savanna), maize grain yield increased up to 75 kg N/ha. Maize responded significantly to P up to 40 kg P_2O_5 but there was no response to K. For cowpea, N application depressed grain yield significantly but there was a positive response to P at 80 kg P_2O_5/ha.

Response of maize to zinc. Field trials conducted at five locations in the semi-arid zone of Nigeria during 1988-90 showed that maize grain and dry matter yields increased with increasing zinc (1, 2, 3 kg Zn/ha) across all locations. The optimum Zn fertilizer rates for the soils studied ranged between 1-2 kg Zn/ha.

Field evaluation of Nigerian made granular urea. There were no significant differences among the sources of N at all the five semi-arid locations studied. Generally, the Nigerian made urea gave higher grain and straw dry matter yields than imported prilled urea but slightly lower yields than CAN at all locations. The optimum N requirement for maize in all the locations were between 100 and 150 kg/ha. All the three N fertilizer sources, at rates higher than 100 kg N/ha, had varying acidifying effects on the soil pH; the order of magnitude being CAN < granular urea < prilled urea.

Burkina Faso

The following activities were carried out by the Network Coordinator in collaboration with the National Program of Burkina Faso.

Development of drought resistant/tolerant maize. Pool 16 DR has been taken through three cycles of full-sib recurrent selection. Emphasis was placed on family selection under two levels of soil-moisture stresses created by planting in tied and simple (open) ridging systems at Kamboinse (Sudan savanna) at every cycle. Also, there was selection on the set of families subjected to high plant population (133,000 plants/ha) at Farako-Bâ (northern

Guinea savanna). Three sets of experimental varieties have been developed from the 1986, 1988 and 1990 full-sib family trials. The population and the 1988 varieties were subjected to improvement for streak resistance under controlled leaf hopper infestation at IITA, Ibadan. Pool 16 DR varieties performed very well in the 1987-1990 regional uniform variety trials. Many national programs are using this germplasm for release to farmers and/or for breeding purposes.

A drought resistant pool has been created from some local and introduced varieties previously identified to show good performance under drought stress. This pool will be used to create yellow drought resistant varieties and to widen the genetic base of Pool 16 DR.

Development of extra-early maize. Several extra-early maturing maize varieties (less than 82 days to maturity) were developed from crosses between locals and improved germplasm. In the past 4 years, emphasis had been placed on improved plants type and producing higher grain yield, while retaining the earliness trait and disease resistance. Susceptibility to foliar fungal diseases (*Helminthosporium* leaf blight and *Curvularia* leaf spot) has also been reduced.

Incorporation of streak resistance into some elite early varieties. Two early maturing local varieties, well appreciated for their grain type and/or adaptation, were converted to streak resistant forms. They are Blanc Deux Précoce (BDP) from Bénin Republic and Maka from Mauritania. The original crosses were made at Kamboinse (Burkina Faso) and advanced to BC1F2 before forwarding them to IITA, Ibadan, for selection under streak pressure and advancing them to BC3 F3. These are included in the 1991 regional variety trials.

6.0 RESIDENT RESEARCH IN BURKINA FASO (1987-1989)

Maize Breeding

During SAFGRAD Phase II, the sAFGRAD/IITA Maize Breeding Program aimed at developing four different types of varieties, namely: (1) early, drought resistant varieties, (2) extra-early varieties (82 days to maturity) (3) early varieties (82-95 days to maturity); and (4) intermediate (96-110 days to maturity), streak resistant varieties.

In addition, identification of good materials for relay cropping with cowpea was another, but less important, objective of the program.

Research Results

a) **Breeding for drought resistance**

Agronomic research work done since 1979 has shown a very marked response of maize to tied ridges on the ferruginous, tropical soils common in the Sudan savanna. By growing sets of varieties, using both simple and tied ridges, their performance under two drought stress conditions can be evaluated. Therefore, tied and simple ridges were used to simulate two levels of stress conditions in both population improvement and varietal evaluations.

b) **Population improvement**

In 1982, Pool 16 (early, white dent, tropical pool developed by CIMMYT) was identified as tolerant to drought stress. In 1983, a recurrent selection program using full sib selection scheme was employed to improve this pool for drought tolerance. Two cycles of selection were achieved and seven experimental varieties developed. New drought tolerant versions of this pool (pool 16 DR C1 and Pool 16 DR C2), with moderate resistance to maize streak virus, were developed.

A trend of improvement from cycle was observed. A mean of 7% progress was recorded from cycle to cycle under more drought stress conditions compared to a mean of 5% under medium stress conditions and a mean of 4.7% under less stress conditions.

At six locations in four SAFGRAD member countries, Pool 16 DR C2 outyielded Pool 16 DR C0 and SAFITA-2 by 8.7% and 7.7%, respectively. Pool 16 DR C2 yielded higher than SAFITA-2 by 28.9%, 15.5% and 14.4.% under three decreasing levels of drought stress designated as more, medium, and less stress conditions, respectively.

c) **Varietal evaluation**

From 1984 to 1987, more than 70 early maize materials, including local and improved, from CIMMYT, IITA and national programs of SAFGRAD member countries were evaluated under two stress levels at Kamboinse (Burkina Faso). In some cases, highly significant variety x stress level interactions were obtained.

Five materials (Temp x Tropical N° 42, SAFITA-104, Capinopolis 8245, Pool 16, and JFS) performed better than others under drought stress conditions, whereas four varieties (Local Kamboinse, Composite BD, Kito, and Synthetic C) were found to be susceptible to drought.

Among the five materials tolerant to drought, three (Temp. x Trop. 42, SAFITA-104, and Capinopolis 8245) had sub-tropical genetic background suggesting that sources of drought tolerance should be sought in temperate and sub-tropical germplasm.

Breeding for extra-early (drought escape) varieties

During the 1984 dry season, early and etra-early germplasm collected from Colombia, CIMMYT, India and Burkina Faso were grown for observation and seed increase. Out of 80 materials collected, 48 were selected and evaluated.

Two varieties, Bursanga Tollo or Kamandaogo Tollo (local yellow variety) and GUA 314 (white Colombian variety) which flowered, on the average, at 42-43 days after planting (7 days earlier than the local check) with mean yields of 2.4. and 2.5. t/ha, respectively, were crossed to other existing good, early white and yellow improved varieties, to develop composites combining extra-earliness and other useful agronomic characters.

Using population improvement schemes, the following varieties have been extracted from the crosses: TZEE-Y (Tropical Zea Extra-Early Yellow), TZEEW-1 (Tropical Zea Extra-Early White one), TZEEW-2 (Tropical Zea Extra-Early White Two), and TZEEW-3 (Tropical Zea Extra-Early White Three). These composites mature in 75-80 days after planting with 3 t/ha grain yield potential.

Breeding for early maturity

In 1984, the need to develop new early yellow flint population using local and improved germplasm was felt. Therefore 36 improved varieties of various origins (CIMMYT, IITA, national programs of SAFGRAD member countries) were crossed with Jaune Flint de Saria (JFS), a local improved variety well adapted to the Sudan savanna of Burkina Faso, in order to combine yield, earliness, resistance to lodging, and resistance to foliar diseases. In the 1985 dry season, these crosses were advanced to F2 and then tested in the rainy season at three lcoations. The best yellow crosses plus local Raytiri (a good local variety) were diallel crossed to make a new population, TZEF-Y (Tropical Zea, Early Flint, Yellow). At Kamboinse, TZEF-Y yielded 3.5. t/ha which compared favourably with 2.8 t/ha produced by JFS, the lcoal check. At Farako-Bâ, TZEF-Y and the local check yielded 3.8 and 2.7 t/ha, respectively. In five countries, TZEF-Y averaged 2.9 t/ha, with 45 days to 50% silking.

In collaboration with IITA and CIMMYT, three early varieties have been developed at Kamboinse: Kamboinse (1) 84 TZESR-W, Kamboinse (1) 8433, and Kamboinse 8546.

Two early materials (Capinopolis 8245 and Sids 8245) were identified and tested; both of them showed good performance in SAFGRAD member countries. Two local varieties (Local Koudougou and Local Raytiri) performed very well in the Sudan savanna of Burkina Faso.

TZESR-W, and EV8430 SR have been found to be adapted in the ORD of Koudougou where these two materials were being considered for formal release.

The new population, TZEF-Y, with a broad genetic base, population 45 (from CIMMYT), TZESR-W, and Pool 16 DR have been recommended for the Sudan savanna where maize diseases were not very important. Also Local Koudougou and Local Raytiri proved very well adapted in this environment and it was recommended that they should be given a high priority by breeders of Burkina Faso National Program.

Breeding for intermediate or late maturity

The intermediate and late varieties were intended for the northern Guinea savanna zone where maize streak virus is the major constraint to maize production. In collaboration with CIMMYT and IITA/Ibadan, three varieties (Ilonga 8032, Across 8149, and EV 8322 SR) were identified in 1984 and tested in Regional Uniform Intermediate Variety Trial (RUVT-2). The 1984 data were in agreement with those obtained by the national program of Burkina Faso in respect of EV 8322 SR, which, after further, detailed evaluation by the national program, was released in Burkina Faso under the name "SR-22".

In 1985, two other varieties, namely Ikenne 81 TZSR-Y-1 and EV 8428 SR BC4, were identified as good yellow germplasm for the northern Guinea savanna. Also, in collaboration with IITA/Ibadan, two varieties (Farako-Bâ 85 TZSR-Y-1 and Farako-Bâ 85 TZSR-W-1) were developed. An experimental, intermediate yellow variety (Loumbila (1) 84 TZUT-Y) was also developed and tested.

Improving yield stability through resistance breeding.

Disease resistance: Although diseases are usually not a serious problem in Sudan savanna, which is the target zone for early maturing varieties, certain climatic circumstances induce disease pressure of significant consequence on maize yields. For example, unsteady rainfall at the beginning of the season forces farmers to replant and/or plant late. Under such a situation, there is a build-up of foliar diseases. More importantly, the risk of maize streak virus (MSV) epidemic (*Cicadulina* leafhoppers) build-up under increased source of inoculum in the fields (Fajemisin et al 1987). This situation which has recurred many times in recent years in many countries in the semi-arid savanna, underscores not only the need for early maturing varieties but also varieties resistant to MSV and other important foliar diseases. This would reduce farmers' risks.

With the back-up support of the IITA Maize Program at Ibadan, maize cultivars and populations which are well appreciated by consumers and farmers in the sub-region were identified for conversion to streak resistant forms and/or for improvement for disease resistance.

The extra-early maize populations TZEE-W, TZEE-Y, were crossed in 1989 with appropriate sources of resistance. EV 8430 SR and EV 8432-SR for TZEE-W and TZEE-Y, respectively. These were also planted and selections carried out at Farako-Bâ under increased foliar fungal diseases (*Helminthosporium maydis* leaf blight and *Curvularia* leaf spot) enhanced by pre-planting of a susceptible variety as disease spreader.

The F2 families were later sent to IITA for planting under streak pressure for advancement to BC2 F1. Through this shuttle breeding, streak resistant as well as maydis and curvularia tolerant varieties (TZEE-WSR, CSP-early and TZEE-YSR) have been released and made available to NARS.

Simultaneously, varieties from the early maturing populations, Population 30 (white) and Population 31 (yellow) developed by CIMMYT have been identified as high yielding and consumer-acceptable by many national programs. These have been converted for streak resistance by backcrossing through a joint CIMMYT-IITA effort at IITA, Ibadan. Pool 16 has also been converted to streak resistant form.

<u>Drought resistance</u>: The effects of dry spell are felt more at either end of the rainy season emphasizing the need for early maturing varieties as a method of escaping drought. Unfortunately, drought can occur at any stage of crop growth; yield losses may be disastrously large if drought coincides with the period 1-2 weeks before or after flowering. Improvement of resistance to drought during this period will reduce farmers' risk. In Sudan Savanna zone, the risk of drought is accentuated by low water holding capacity of the predominant ferruginous tropical soils which are usually shallow, sandy, with low organic matter and low base exchange capacity and often with compact sub-soil.

Using two types of ridging systems, simple and tied ridges, to produce two levels of moisture stress under natural rainfed condition in the Sudan Savanna, Pool 16 has been improved for drought resistance. Selection was made on the basis of yield under the two levels of moisture and other characters such as synchronization between anthesis and silking, some Pool 16 Drought Resistant experimental varieties were developed and offered to national programs in 1988 through the Regional Uniform Variety Trial. The variety Across 86 Pool 16 DR was the most promising. It produced an average yield of 4.45 t/ha across 11 locations in 6 countries in West and Central Africa in 1988.

Early maturing drought resistant composites were initiated in 1988 from landraces that evolved in semi-arid West African countries and some improved varieties that have showed good performance under drought stress. These are DR early composite yellow (F2) and DR early composite white (F1).

<u>Evaluation of materials for relay cropping with cowpea</u>

In 1985, two experiments, namely EVT-ESR (including early, streak resistant varieties) and RUVT-1 (including varieties in SAFGRAD Regional Trials) were conducted at Farako-Bâ, in collaboration with the Cowpea Agronomist, to determine the effect of maize cultivars on relay-cropped cowpea and to identify maize cultivars that exert the least depressing effect on the yield of cowpeas. EV8431 SR was identified as a high yielding, early yellow variety which only slightly depresses the yield of relay cropped cowpeas.

Maize Agronomy

Objectives

a) To assess the relative importance of the different soil, climatic, and management factors affecting maize production in the northern Guinea and Sudan savanna zone.

b) To establish suitable management practices for the production of maize under low and high management conditions.

c) To participate in the formulation and execution of a maize improvement program, designed for the growing conditions in the semi-arid tropics (SAT), with particular emphasis on increasing the tolerance of maize to drought.

Research results

a) **Genotype x fertility level interactions**

The performance of 12 local and improved varieties was evaluated for three years under low and high levels of nitrogen and phsophorus. Results showed that local varieties were not necessarily better adapted to low P and/or low N conditions than improved varieties. For example, several improved IITA/SAFGRAD varieties and the hybrid, IRAT-178, performed better than the local varieties under low P, and to a lesser extent, under low N conditions. There were significant interactions between varieties and N level and between varieties and P level, i.e., the relative performance of varieties was affected by the N and/or P fertility levels. The variety, SAFITA-2, showed a consistently good performance under low P, whereas SAFITA-2, and TZE-4 were among the best performers under low N.

b) **Maize-cotton intercropping in the Sudan savanna**

A maize-cotton intercropping system was developed and tested for six years with good results in the Sudan savanna. The association often gave yields of 2 t/ha of maize and 1.5 t/ha of cotton. The inclusion of cotton, a cash crop, in the system appears to be a means of intensifying the use of fertilizer, an almost essential requirement for increasing maize productivity. The use of tied ridges was apparently a pre-requisite for the success of the association under the predominant Sudan savanna soils.

c) **Maize-cowpea rotation and relay-cropping systems**

Maize yields were consistently lower under continuous maize crop than when maize followed cowpea crop in a rotation. The increase in yield of maize grown in such a rotation with cowpea was as high as 1200 kg/ha.

Relay-cropping of cowpeas and maize did not significantly reduce yields of maize in the relay. However, the yield of monocropped maize in the year immediately after that of the maize-cowpea relay crop was either depressed or unaffected. Therefore, the production of cowpea as a relay crop with maize did not result in increase in yield of the succeeding monocrop of maize; this contrasts with significant increases in yield of maize monocrop grown immediately after a monocrop of cowpea.

d) **Surface management systems**

When compared with traditonal flat cultivation and planting, tied-earthing up by hand, or with the donkey ridge-tier, increased yields of monocropped sorghum and maize, as well as the productivity of a maize/cotton association. Likewise, digging small ditches between rows increased yields of monocropped maize and sorghum. These ditches could be dug either with a hand-hoe or with the oval wheel of a donkey and oxen traction implement developed by ICRISAT's Socio-economics program in Burkina Faso.

e) **Residual tillage effects**

There seemed to be a carry-over effect of tillage, but only in the absence of tied-ridges. Soil tillage by hand-hoe, oxen and tractor gave an average yield increase of 39%, in the second year, over zero-tillage.

f) **Residual effects and duration of tied-ridges**

There was no maize yield advantage, in most cases, of pre-planting hand cultivation with complete tied-ridge renovation over direct planting on old tied ridges in plots where there had not been systematic removal of crop residues.

Nevertheless, direct planting on old tied ridges, without previous tillage, can result in depressed maize growth if, during the first weeks of the crop, weather and soil conditions are such that there is excess moisture in the upper soil layer. Such a negative effect is more pronounced under very low fertility conditions, or when sub-surface termite activity results in severe damage to maize roots.

Results have shown that even without any maintenance at all, old tied ridges in the year immediately after that in which they were first established increased maize yields by about 1 t/ha compared to those of maize grown under the conventional flat cultivation and planting.

g) **Effect of maize crop residues**

The application of 4 or more t/ha of maize residue dry matter always gave large yield increases due, at least in part, to improved water infiltration.

h) **Residual Furadan effects**

Significant maize yield increases of around 0.5 t/ha were obtained in the second year after the application of Furadan 5 G at the rate of 1.5. kg a.i./ha.

i) **Residual N fertilizer effects**

Sorghum, maize, and cotton responded differently to residual N fertilizer. There were significant residual N fertilizer effects on sorghum and cotton yields.

J) **Soil cultivation (scarification)**

On crust-forming, dense soils, breaking the soil crust, even in the absence of weeds, improved water infiltration and soil aeration. Maize yield increases were very small, however, if the cultivations were shallow (1-2 cm); higher yields were obtained with deeper cultivations, 4-6 cm. However, inter-row ditches and tied ridges are much more effective than cultivations in increasing yields in such soils.

l) **Plants per hill**

Experiments in the Sudan savanna showed that in some years having four plants per hill resulted in lower maize yields than one to two plants per hill (at the same plant density/ha).

Improvement of the animal traction ridge-tiers

Major limitations of the ridge-tiers initially developed by the tied-ridging with animal power (TRAP) sub-project were the relatively large weight of the ridge-tiers and the need for proper adjustments of the cable and latch mechanisms.

Several modifications have been introduced in respect of: blade thickness and size; nature and size of the frame; a stabilizer to facilitate lifting of the implements; and a new tripping mechanism (for the donkey ridge-tier).

Maize Entomology

Objectives

a) To explore the potential for use of host plant resistance in the suppression of the major insect pests of the crop (termites and *Cicadulina* spp., maize streak virus vector).

b) To identify and evaluate insecticides for maize insect pest suppression, taking into consideration safety and cost of available materials.

c) To develop and test integrated insect pest management (IPM) systems, for increased and sustained grain yield, which are affordable, compatible with local farming practices, and environmentally safe.

Research results

Maize resistance to termites

Trials were conducted at Kamboinse and Farako-Bâ to assess performance of early (82-95 days maturity) and intermediate (96-110 days maturity) maize varieties for resistance to termites.

Results showed that termite feeding activity intensified with plant senescence, hence observed damage (lodging incidence and injury to roots, stems, cobs and grain) was invariably higher in earlier than later maturing cultivars; early varieties are thus, not necessarily more susceptible to termite infestation than later maturing ones.

Grain yield was satisfactory, but some varieties yielded significantly higher than others. Yields were similar between planting dates. However, highly significant variety x planting date interactions underlined the advantage of earliness as a drought escape mechanism; thus, earlier maturing varieties successfully produced a crop in contrast to later maturing varieties which succumbed to drought stress.

Insecticide application (Furadan 5G at 2.5 kg a.i./ha) significantly decreased lodging and termite damage (on roots, stems, cobs and grains) resulting in marked grain yield increase (14 and 35 per cent, respectively, in 1985 and 1986). Insecticide use also markedly reduced incidence of streak, armyworm (*Mithimnia* sp.) and lepidopterous borers.

Insecticidal control of maize insect pests

The efficacy of systematic insecticides for maize insect pest control was assessed. Two granular (5G) systemic compounds, carbofuran (Furadan^{R}) and fonofos (Dyfonate^{R}) were applied at three doses (0, 1, and 2 kg a.i./ha) at planting, and at 30 and 60 days after planting (DAP) to control termites and other insect pests in two early maize varieties : Jaune Flint de Saria (JFS) and SATITA-104, at Gampela. The following results were obtained.

i) Stand establishment improved significantly with increase in insecticide dose. Differences between varieties and between insecticides were negligible.

ii) Incidence of termite damage on stems of standing crop was significantly higher in SAFITA-104 (7 per cent) than in Jaune Flint de Saria (3 per cent), and was markedly reduced by insecticide dose (8, 6, and 1 per cent at 0, 1, and 2 kg a.i./ha). However, armyworm and lepidopterous borer infestations, termite damage on roots of standing crop, as well as damage on roots, stems, cobs, and grains of lodged maize were low and similar between varieties and insecticides, regardless of dose.

iii) Grain yields were moderate and comparable between varieties (JFS: 3.5 t/ha; SAFITA-104: 3.6 t/ha) and insecticides (carbofuran: 3.5 t/ha; fonofos: 3.6 t/ha), with marked differences between insecticide doses (3, 4, and 3.5. t/ha respectively at 0, 1 and 2 kg a.i./ha).

<u>Evaluation of three chemical insecticide compounds as seed treatments for improved stand establishment as well as reduced insect pest incidence in maize</u>.

Cabosulfan (Marshal[R]) at 1, 2, and 3 kg/100 kg seed, carbofuran (Furadan[R]) and fonofos (Dyfonate[R]) both at 1 kg a.i./ha were applied at planting on four local and improved early maize varieties: Jaune Flint de Saria (JFS), SAFITA-104, SAFITA-2, and TZESR-W, at Kamboinse; each treatment was supplemented by a single application of carbofuran (0, or 0.5 kg a.i./ha at 30 to 35 DAP. The results showed that:

i) Plant establishment was good and was clearly improved by insecticide protection in all varieties. Incidence of root lodging was consistently lowest in TZESR-W compared to the other varieties.

ii) Grain yield was low (400 to 1200 kg/ha), presumably because of severe drought stress, as well as soil and nutrient problems, during the season. Nevertheless, significant varietal differences emerged: TZESR-W produced the highest yield (1.2 t/ha), followed by Jaune Flint de Saria (JFS) and SAFITA-104 (1,0 t/ha) while SAFITA-2 yielded least (0.4 t/ha).

Soil-water Management

Objectives

In general, the objective of the soil-water management program was to develop and define crop and soil management systems capable of optimizing the available soil and water resources in the Alfisols of the Sudan savanna of the West African semi-arid tropics (WASAT). More specifically, the program had two major research thrusts:

a) Characterization of tied ridges, in terms of soil physical, chemical, and hydrological properties; and quantification of responses of the major crops of the West African Sudan savanna to tied-ridges, in terms of water use, crop and root growth, and yield.

b) Development of a minimum or zero tillage system, which would alternate with periods of grass or leguminous leys, for the West African Sudan savanna. Emphasis was on minimizing herbicide use.

Research results

Tied ridges

Tied ridges caused large yield increases in many crops of the West African semi-arid tropics. This was primarily due to reduction of water runoff, increased infiltration and, consequently, greater water storage compared with either open ridging or flat planting. Soil chemical properties of tied ridging resulted in greater levels of soil OM, exhangeable Ca, Mg, K, and total CEC.

Depth of rooting and subsoil root densities of cowpea (*Vigna unguiculata*), maize (*Zea mays*), millet (*Pennisetum americanum*) and cotton (*Gossypium hirsutum*) under tied ridging were superior to those under either open ridging or flat planting in dry years, although cowpea root growth was reduced by tied ridging in wet years, due to high frequency of transient waterlogging.

Minimum tillage systems

In relation to maize monoculture, sowing of *Macroptilium artropurpureum* and *M. lathyroides*, as cover crops under a minimum tillage system, where cover crop residue was retained as in situ mulch, resulted in reduction of topsoil loss; increases in soil OM, C, C/N, exchangeable K, infiltration rate, soil matric potential and proportion of macropores (pore radius > 14.3/mm; and decreases in soil temperature and proportion of micropores (pore radius < 2/mm). These changes resulted in large increases in subsoil root growth, grain and dry matter yields of the succeeding maize crop. It was concluded, that among the cover crops studied, *M. artropurpureum* and *M. Lathyroides* are the most appropriate for the Alfisols of the West African Sudan savanna.

7.O. REGIONAL TRIALS

The Maize Network offered three types of regional uniform variety trials to the network-member countries from 1987 to 1989 namely: (i) RUVT 1 comprising early maturing, drought resistant/tolerant varieties (85-90 days) (ii) RUVT 2 consisting of late and intermediate maturing varieties (105-120 days) and (iii) RUVT-3, the extra-early varieties (less than 82 days).

The composition of each trial varied from year to year (Table 3A) by introducing promising varieties from the NARS and IITA and eliminating the least performing ones. Generally, a variety was tested for two years before it was withdrawn. In 1990, following an arrangement with the IITA Maize Program to harmonize germplasm delivery to NARS to prevent duplication and overburdening of the national scientists, the coordination of the late/intermediate variety trials was left with IITA. IITA also handed over to SAFGRAD the organization of the international testing of all early and extra-early maturing varieties in the subregion.

In Tables 3B, 3C and 4 are presented information on the sets of regional maize trials that were sent, on request, to the member-countries of the SAFGRAD between 1979 and 1991. It is evident from Tables 3B and 3C that the number of sets of trials dispatached by SAFGRAD to NARS have increased since the inception of the Network (1987-1991). Three hundred and fifty-two sets of the regional maize trials were sent to SAFGRAD member countries between 1987 and 1991 while four hundred and sixty-two sets were dispatched during the period 1979-1986. It is evident from Table 4 that the data recovery rates of the trials also improved considerably between 1987 and 1991 compared to 1979-1986. The data received each year were quickly analyzed and a compilation of the summary of the analyzed data across locations and countries was prepared by the Network Coordinator and mailed.

Table 3A. Entries in Regional Uniform Variety Trials 1982-1992

Year	RUVT-1	Origin	RUVT-2	Origin	RUVT-3	Origin
1982	TXTrop No. 42	IITA/SAFGRAD	IRAT 178	IRAT/Côte d'Ivoire		
	TZESR-W	IITA/Ibadan	Comp. 4.	Ghana		
	TXTrop No.3	IITA/SAFGRAD	SAFITA-1O2	IITA/SAFGRAD		
	Pirsa back(1)					
	793O	CIMMYT/Ibadan	TZPB	SAFGRAD-UV		
	SAFITA-2	IITA/SAFGRAD	Elite x E. Mex	Ghana		
	7/8 Con x 1/8					
	Comp. D		TZSR-1 (Y)	IITA/Nigeria		
	MST	IRAT/Côte d'Ivoire	POZARICA 7843	CIMMYT/Nigeria		
	SAFITA-1O4	IITA/SAFGRAD	Fereke 7622	IRAT C.I.		
	EV 7982	Tanzania	Golden Crystal	Ghana		
	Comp. 77 BD		TXTrop.27	IITA/SAFGRAD		
	Pool 27	CIMMYT	Comp.Y	IRAT Côte d'Ivore		
1983	Synth.C	Senegal	IRAT-178	IRAT Côte d'Ivoire		
	SAFITA-1O4	IITA/SAFGRAD	SAFITA-1O2	IITA/SAFGRAD		
	Pop. Senegal		Elite x E.M.X.			
	Oriental	Senegal	Comp.	Ghana		
	TXTrop No. 42	IITA/SAFGRAD	TZSR-1	IITA Ibadan		
	Pirsaback (1)					
	793O	CIMMYT Ibadan	POZARICA Rica	CIMMYT IITA		
			7843			
	EV Gusao 81	IITA Ibadan	Fereke(1) 7622	IRAT Côte d'Ivoire		
	Pool 16					
	EV 8188	Tanzania	TXTrop. No. 27	IITA/SAFGRAD		
	TXTrop. No. 3	IITA/SAFGRAD	ATK 82 ZR	Togo		
	SAFITA-2	IITA/SAFGRAD	EV 8176	Tanzania		
	TZESR-W	IITA Ibadan	TZPB (Onne)	IITA Ibadan		
	EV 7982	Talzania	BAKO Comp.	Senegal		
	MTS	IRAT/Côte d'Ivoire				

Table 3A cont'd. Entries in Regional Uniform Variety Trials 1982-1992

Year	RUVT-1	Origin	RUVT-2	Origin	RUVT-3	Origin
1984	Pop Senegal					
	Oriental	Senegal	TZB Gusau	IITA-Ibadan		
	Synth C	Senegal	IRA 178	IRAT/Côte d'Ivoire		
	EV Kamb TZE.12	IITA-SAFGRAD	Elite x E.Mex			
			Comp.	Ghana		
	Pirsa(1)793O	CIMMYT Ibadan	Tuxpeno DR	CIMMYT-SAFGRAD		
	TXTrop. No. 42	IITA/SAFGRAD	TXTrop No. 27	IITA/SAFGRAD		
	EV Pool 34 QPM	CIMMYT	TZSR-1 (Y)	IITA Ibadan		
	EV 8188	Tanzania	Pozari Rica			
			7843	CIMMYT-Ibadan		
	EV Gusao 81					
	Pool 16	IITA Ibadan	Fereke 7622	Côte d'Ivoire		
	TZESR-W	IITA Ibadan	SAFITA-1O2	ITTA/SAFGRAD		
	SAFITA-2	IITA/SAFGRAD	EV 8176	Tanzania		
	SAFITA-1O4	"	ATK 82ZR	Togo		
	TXTrop No. 3	"				
	EV833OSR	IITA/Ibadan				
	TZE16 Across(W)	SAFGRAD				
1985	Capino. 8245	CIMMYT	8321-18	IITA Ibadan		
	Synth C	Senegal	8423-18	IITA Ibadan		
	SIDS 8245	IITA/SAFGRAD	Acr 83 TZUT-W	IITA Ibadan		
	SAFITA-2	IITA/SAFGRAD	Ilonga 8O32	CIMMYT		
	EV8431 SR	IITA-CIMMYT	Acr. 8149	IITA Ibadan		
	EV Gusao 81					

Table 3A cont'd. Entries in Regional Uniform Variety Trials 1982-1991

Year	RUVT-1	Origin	RUVT-2	Origin	RUVT-3	Origin
	Pool 16	IITA Ibadan	SAFITA-102	IITA-SAFGRAD		
	CSP	CIMMYT	EV8435 SR	CIMMYT-IITA		
	Jaune Denté de Bambey	Senegal	ATK 82 ZR	Togo		
	M.G.82 TZESR-W	IITA Ibadan	Tuxpeno DR	CIMMYT-SAFGRAD		
	EV Pool 34 QPM	CIMMYT	Kamb. (2) 83 TZUT-W	IITA Ibadan		
	SAFITA-104	IITA-SAFGRAD	TXTrop. No. 27	IITA-SAFGRAD		
	8346-3 (Hybrid)	IITA-Ibadan	PR 7822	CIMMYT Ibadan		
			TZPB (Onne)	IITA		
1986	EV8431 SR	IITA-CIMMYT	Acr. 83 TZUT-W	IITA-Ibadan	Kito	Tanzania
	SAFITA-2	IITA SAFGRAD	Kamb.(2) 83 TZUT-W	IITA Ibadan	Pop CSP	IITA-SAFGRAD
	Capino. 8245	CIMMYT	EV 8422 SR	Burkina Faso	Pop 31 Early	IITA-SAFGRAD
	SIDS 8245	IITA SAFGRAD	EV8443 SR	CIMMYT-IITA	SAFITA-104	IITA-SAFGRAD
	Jaune Denté de Bambey	Senegal	EV8449 SR	CIMMYT-IITA	Kaïchan Jaune	IITA-SAFGRAD
	D.822	India	EV8435 SR	IITA-Ibadan	Comp. D	Côte d'Ivoire
	Pop 30 SR	IITA-SAFGRAD	SAFITA-102	IITA-SAFGRAD	L. Raytiri	IITA-SAFGRAD
	CSP	CIMMYT	STAHA	Tanzania	L. Koudougou	IITA-SAFGRAD
	Early 84 TZESR-W	IITA-Ibadan	Ilonga 8032	CIMMYT	Gua 314 x	IITA-SAFGRAD
	D765	India	Latente x Latente	IITA-SAFGRAD	Ven 389	IITA-SAFGRAD
1987	Capino. 8245	IITA-SAFGRAD	SAMARU 83 TZSR-Y-1	IITA-SAFGRAD	CSPXL.Raytiri	IITA-SAFGRAD
	Kawanzie	CRI-Ghana	EV8443-SR	"	(Acr8131xJFS)xL.R	"
	Early 84 TZESR-W	IITA-SAFGRAD	EV8428-SR	"	(DMR-ESR-YxJFS) x Kamandaogo Tollo	"
	Kamb.(1)84TZESR-W	"	Kamb.(2)83TZUT-W	"	Pop 46xK.Tollo	"
	Kamb.(1)8433	"	Acr.83TZUT-W	"	Pool 29x K. Tollo	"
	Pool 16 DR CO	"	Aburotia	Ghana	Pool 28x K. Tollo	"
	Pool 16 DR C1	"	EV8422-SR	Burkina Faso	Early 84TZESR-W x GUA 314	

Table 3A cont'd. Entries in Regional Uniform Variety Trials 1982-1991

Year	RUVT-1	Origin	RUVT-2	Origin	RUVT-3	Origin
	SAFITA-2	"	Loumbila 84TZUT-Y	IITA-SAFGRAD	Pop 30 x Gua 314	"
	Pop CSP	"	EV 8449-SR	IITA-SAFGRAD	Pool 27 x Gua 314	"
	Pop 30 SR Early	"	SAFITA-102	IITA-SAFGRAD	Wir 17215 x K. Tollo	"
	TZEF-Y	"	FBA 85TZSR-W-1	IITA SAFGRAD	Pop CSP	"
	EV8431-SR	"				
1988	SAFITA-2	SAFGRAD	Loumb.84 TZUT-Y	SAFGRAD	Pop 30 x Gua 314	IITA-SAFGRD
	Kawanzie	Ghana	Acr.85TZSR-W-1	IITA-Ibadan	CSP x L. Raytiri	"
	Pool 16 DR CO	SAFGRAD	EV8343 SR	CIMMYT-Ibadan	TZEE-Y	"
	Pool 16 DR C2	"	Movacay 7921-SR	CIMMYT-Ibadan	Pop CSP Early	"
	Early 86 Pool 16 DR	"	Aburotia	Ghana	TZEE-W-1	"
	Across 86 Pool 16 DR	"	EV8422-SR	Burkina Faso	TZEE-W-2	"
	FBA 86 Pool 16 DR	"	TZPB SR	IITA-Ibadan	Pool 27 x Gua 314	"
	Kamb. 86 Pool 16 DR	"	EV 8428	CIMMYT-IITA	TZEF-Y	"
	Across 86 Pool 16	IITA-Ibadan	EV8444 SR	CIMMYT-IITA	Acr.8131xJFS xL.R	"
	AB22	Togo	FBA85 TZSR-W-1	IITA-Ibadan	Pool 28xGua 314	"
	Pool 16 DR C1	SAFGRAD	FBA85 TZSR-Y-1	IITA-Ibadan	TZESR-WxGua 314	"
1989	Across 86 Pool 16 DR	"	AB 22	Togo	(Across8131xJFS)x Local Raytiri	IITA-SAFGRAD
	Early 86 Pool 16 DR	"	Acr. 85 TZSR-W-1	IITA-Ibadan	CSP Early	"
	FBA 86 Pool 16 DR HD	"	CMS 8710	Cameroon	CSPxL.Raytiri	"
	Kamb. 86 Pool 16 DR	"	EV8422 SR	Burkina Faso	Pool 27xGua 314	"
	Pool 16 DR CO	IITA-SAFGRAD	EV8428 SR	CIMMYT-IITA	Pop 30xGua 314	"
	Pool 16 DR C1	"	EV8444 SR	CIMMYT-IITA	TZESR-WxGua 314	"
	Pool 16 DR C2	"	FBA 85TZSR-Y-1	IITA-Ibadan		
	Kamb(1)84 TZESR-W	IITA-SAFGRAD	Loumb.84 TZUT-Y	SAFGRAD	TZEE-W-1	"
	Kanwanzie	Ghana	Maracay 7921 SR	CIMMYT-IITA	TZEE-2	"
	DMR-ESR-Y	IITA-Ibadan	Ndock 8701	Cameroon	TZEE White Pool	"
	TZEE Comp. 3x4	IITA-Ibadan	Okomasa	Ghana	TZEE-Y	"
	SAFITA-2	SAFGRAD			TZEF-Y	"

Table 3A cont'd. Entries in Regional Uniform Variety Trials 1982-1991

Year	RUVT-1	Origin	RUVT-2	Origin	RUVT-3	Origin
1990	Acr.86 Pool 16 DR	SAFGRAD			(Acr.8131xJFS)x L.Ray.	"
	Acr.86 Pool 16 DR	"			CSP Early	"
	FBA.88 Pool 16 DR	"			CSP x L. Raytiri	"
	Kamb. 88 Pool 16 DR	"			Pool 27 x Gua 314	"
	DR Comp Early	IITA-SAFGRAD			Pop 30 x Gua 314	"
	TZE Comp. 3 x 4	IITA-Ibadan			TZESR-W x Gua	"
	DMR-ESR-W	"			TZEE-W-1	"
	DMR-ESR-Y	"			TZEE-W-2	"
	TZESR-W SE	"			TZEE-W Pool	"
	EV8730 SR BC6	"			TZEE-Y	"
	EV8731-SR BC5	"			TZEE-Y Pool	"
	Acr.87 Pool 16 SR	IITA-Ibadan			TZEF-Y	"
	SAFITA-2	SAFGRAD				
1991	Acr. 86 Pool 16 DR	SAFGRAD			CSP-SR BC3	"
	Acr. 88 Pool 16 DR	"			TZEE-W SR BC3	"
	FBA 88 Pool 16 DR	"			TZEE-Y SR BC3	"
	Kamb.88 Pool 16 DR	"			TZESR-W x Gua 314	"
	TZE Comp. 3 x 4	IITA			CSP	"
	TZESR-W SE	"			TZEE-W	"
	Ikenne 88 BU-ESR-W	"			TZEE-Y	"
	EV8731 SR BC6	"			CSP x L. Raytiri	"
	MAKA-SR BC3	SAFGRAD				
	BDP-SR BC3	SAFGRAD				
	FBC6	Burkina Faso				
	SAFITA-2	SAFGRAD				

Table 3A cont'd. Entries in Regional Uniform Variety Trials 1982-1991

Year	RUVT-1	Origin	RUVT-2	Origin	RUVT-3	Origin
1992	FBA 88 Pool 16 DR	SAFGRAD			CSP-SR BC3	SAFGRAD
	Kamb.88 Pool 16 DR	"			TZEE-W SR BC3	SAFGRAD
	FBA 90 Pool 16 DR	"			TZEE-Y SR BC3	"
	INA 90 Pool 16 DR	"			TZESR-WxGua 314	"
	Kamb. 90 Pool 16 DR	"			CSP	"
	Maroua 90 Pool 16 DR	"			TZEE-W	"
	NKPALA 90 Pool 16 DR	"			TZEE-Y	"
	BDP-SR BC3	"			CSPxL. Raytiri	"
	FBC6	Burkina Faso			TZEF-Y	"
	Ikenne 88 BU-ESR-W	IITA				
	MAKA-SR BC3	SAFGRAD				
	TZESR-W SE	IITA				
	SAFITA-2	SAFGRAD				

Table 3B. **Number of regional maize trials whose data were returned to SAFGRAD by collaborating countries 1979-1986.**

Country	RUVT-1								RUVT-2								RUVT-3	Total/ country
	79	80	81	82	83	84	85	86	79	80	81	82	83	83	85	86	86	
Benin	1	-	-	-	-	1	4	-	-	-	1	1	-	-	5	-	-	13
Burkina Faso	2	2	3	1	2	2	1	3	1	2	3	3	2	3	2	1	4	37
Cameroon	-	1	3	2	-	-	1	2	-	2	2	2	-	2	-	-	2	19
Cape Verde	-	-	-	-	-	-	1	1	-	-	-	-	1	-	1	1	-	4
Cent. Afr. Rep.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Chad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
Côte d'Ivoire	1	1	-	-	-	-	-	-	1	1	-	-	-	-	1	-	-	5
Ethiopia	-	-	-	-	1	-	2	-	-	-	-	-	-	-	2	-	-	5
Gambia	1	1	-	2	-	-	1	-	-	1	-	-	1	-	1	-	1	9
Ghana	-	1	1	1	-	-	1	1	-	1	1	1	-	-	1	1	1	11
Guinea	-	1	1	1	1	-	1	-	-	-	1	-	2	-	2	-	1	11
Guinea Bissau	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Mali	2	2	2	-	2	-	3	-	1	-	1	-	2	-	2	-	-	17
Mauritania	-	-	-	1	-	1	1	-	-	-	-	-	1	1	1	-	-	6
Niger	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Nigeria	-	-	2	2	1	-	-	-	-	-	2	1	2	-	-	-	-	10
Senegal	1	-	2	1	1	-	2	3	1	-	2	1	2	-	3	2	2	23
Togo	-	-	-	-	1	1	2	2	-	-	1	-	1	1	2	2	2	15
Total returned	8	9	16	11	9	5	20	12	4	7	14	9	14	7	23	8	13	188
Total dispatched	10	23	25	20	50	27	37	33	9	24	22	18	35	26	37	33	33	462

RUVT-1 = Early maturing drought tolerant variety trial
RUVT-2 = Full season/intermediate maturing variety trial
RUVT-3 = Extra-early maturing variety trial.

Table 3C. Number of regional maize trials whose data were returned to SAFGRAD by the collaborating countries (1987-1991).

Country	RUVT-1					RUVT-2**			RUVT-3					Total per country
	87	88	89	90	91	87	88	89	87	88	89	90	91	
Benin	O	2	2	4	3	O	1	2	O	3	2	2	2	23
Burkina Faso	2	3	2	3	3	1	2	2	1	3	3	3	4	32
Cameroon	O	2	3	3	3	O	2	2	O	2	3	3	3	26
Cape Verde	–	–	O	–	O	–	–	–	O	O	O	O	O	O
Cent.Afr. Rep.	O	1	1	1	2	O	O	O	–	O	1	1	1	8
Chad	O	O	1	2	1	–	O	–	O	O	1	2	1	8
Côte d'Ivoire	O	O	1	1	2	–	O	O	–	O	1	1	2	8
Gambia	1	O	O	1	2	–	–	–	1	O	O	1	1	7
Ghana	1	1	3	2	3	1	1	2	–	O	1	1	3	19
Guinea	3	–	1	2	2	2	O	1	–	–	O	1	1	13
Guinea Bissau	–	O	O	O	O	–	O	O	O	O	O	–	O	O
Mali	–	–	1	2	2	1	–	O	O	–	2	2	2	12
Mauritania	–	–	1	1	1	–	–	–	–	–	1	1	1	6
Niger	1	O	O	1	2	–	1	1	–	O	1	1	1	9
Nigeria	1	1	1	2	3	1	1	1	–	1	1	2	3	18
Senegal	2	O	2	–	2	2	O	2	1	O	1	–	1	13
Togo	1	2	2	2	2	1	2	2	1	2	2	2	2	23
Sierra Leone					1								1	2
TOTAL RETURNED	12	12	21	27	34	9	10	15	4	11	20	23	29	227
TOTAL DISPATCH.	23	28	32	33	38	15	25	23	15	29	30	27	34	352

** In 1990, there was an arrangement between IITA and SAFGRAD to harmonize trials (germplasm) delivery to NARS. SAFGRAD handed over late variety trials (RUVT 2) to IITA and IITA has stopped delivering early variety trials (RUVT 1).

** "-" represents no set of that particular trial was requested/received by the collaborating country; O means data were not returned for any trial(s) received.

Table 4 Number of Regional Uniform Maize Variety Trials requested by NARS and data recovery (1979-1991).

Country	No. of Trials conducted												
	79	80	81	82	83	84	85	86	87	88	89	90	91
Benin	1	–	1	1	–	1	9	–	0	6	6	6	5
Burkina Faso	3	4	6	4	4	5	3	8	4	8	7	6	6
Cameroon	–	3	5	4	–	2	1	4	0	6	8	6	6
Cape Verde	–	–	–	–	1	–	2	2	0	0	0	0	1
Centr. Afr. Rep.	–	–	–	–	–	–	–	–	0	2	2	2	4
Chad	–	–	–	–	–	–	–	1	0	0	2	4	4
Côte d'Ivoire	2	2	–	–	–	–	1	–	0	0	2	2	5
Ethiopia	–	–	–	–	1	–	4	–	0	0	0	0	0
Gambia	1	2	–	2	1	–	2	1	2	0	4	2	4
Ghana	–	2	2	2	–	–	2	3	2	0	6	3	6
Guinea	–	1	2	1	3	–	3	1	5	2	2	3	3
Guinea Bissau	–	–	1	–	–	–	–	–	0	0	0	0	4
Mali	3	2	3	–	4	–	5	–	1	–	3	4	5
Mauritania	–	–	–	1	1	2	2	–	–	–	2	2	2
Niger	–	–	1	–	–	–	–	–	1	1	2	2	3
Nigeria	–	–	4	3	3	–	–	–	2	3	3	4	6
Senegal	2	–	4	2	3	–	5	7	5	0	5	–	4
Togo	–	–	1	–	2	2	4	6	3	6	6	4	4
Total returned	12	16	30	20	23	12	43	33	25	34	56	50	63
Total dispatched	14	47	47	38	85	53	74	99	53	82	85	60	76
Recovery rate (%)	63	34	64	53	27	23	58	33	47	42	66	83	83

Results from the RUVT-early over the past 4 years showed that there were Pool 16 DT SR varieties which significantly outyielded SAFITA-2. Pool 16 DT SR varieties were, in addition streak resistant whereas SAFITA-2 was not. It has therefore been recommended that all countries that have released SAFITA-2 should consider replacing it with either Kamboinse 88 Pool 16 DT SR or Farako-Ba 88 Pool 16 DT SR (HD) in order to insure yield stability. Results of the RUVT-Extra-Early have also revealed that the streak resistant varieties are significantly higher yielding than their non-resistant counterparts. Furthermore, the SR versions are more vigorous and more resistant to other foliar diseases (rust, blight and *Curvularia* leaf spot) than their non-SR counterparts. For instance, in 1991, TZEE-WSR was the highest yielding entry (5.25 t/ha even though it was only 5 days later in flowering. The improvement of the extra-early varieties in plant type, and resistance to fungal foliar diseases and streak virus has enlarged their area of adaptation and possible adoption to include the humid forest zone. At the same time, they remain an attractive option in the semi-arid zone as a result of their extra-earliness.

Two-year data from two Regional Uniform Variety trials, RUVT Extra-Early and RUVT Early (involving extra-early and early varieties, respectively) conducted from 1989-1991 at several locations within West and Central Africa were studied by Fajemisin and Badu-Apraku (un published data), using yield stability analyses in order to determine the adaptation of the varieties.

The results of the stability analyses of the extra-early varieties revealed that the variety TZEE-Y had a b-value which was substantially greater than 1.0 and produced above average grain yield, indicating that it is well adapted to favorable environments and less stable. In constrast, the varieties TZEE-W-1 and TZEE-Y had b-values which were significantly less that 1.0 (P=.05) and produced below average grain yield indicating that they are relatively better adapted to less favorable growing conditions. The varieties, Across 8131 x JFS x L. Raytiri F4, CSP Early, CSP x Local Raytiri F4, Pool 27 x Gua 314 BC1 F4, Pop 30 x Gua 314 BC1 F4, TZESR-W x Gua 314 BC1 F4, TZEE-Yellow Pool and TZEF-Y F4 had regresssion coefficients which were not significantly (P.< 05) different from 1.0, suggesting good stability over environments. Stability analyses of grain yield of the early varieties showed that none of the varieties tested had a b-value significantly (P<.05) different from 1.0, implying that all the early varieties have good stability over the test environments.

8. Workshops and Seminars

The maize network organized many workshops, seminars and in-service training to strengthen the research capabilities of the NARS and promote an exchange of information and a sense of friendship and common purpose among the national scientists. Thus, a major accomplishment of the Project has been the breaking of barriers between anglophone and francophone NARS scientists. This has allowed for closer interaction.

Joint Workshops and Seminars

Three biennial joint workshops and one special purpose seminar were organized jointly for the maize and cowpea scientists from the national programs in West and Central Africa.

The 1987 Workshop permitted the national scientists to assemble and to (i) check-list and prioritize the constraints to the successful production of maize and cowpea and the resources and needs of the different NARS to carry out effective research, (ii) develop strategy for the networks, and (iii) elect the first steering committee for each network.

One of the major achievements of the Project is that the 1989 and 1991 Workshops emphasized the presentation of original scientific papers and discussions on collaborative research (Table 5). This is a progressive step in professionalism compared with the workshops during SAFGRAD Phase I which were limited to country reports. In 1989, the Workshop was a joint effort of both the Maize and Cowpea Networks. In 1991, the SAFGRAD Coordination Office got involved and included the Sorghum Network for West and Central Africa and representation from the East African Sorghum and Millet Network. Most of the scientific papers derived from the three West and Central African Networks, were presented in joint plenary sessions. Other activities carried out during the 1989 and 1991 biennial workshops (in separate sessions for each network),

Table 5. **Joint Biennial Workshops (1987, 1989, 1991): some important statistics.**

	1987	1989	1991
Date	March 23-27	March 20-24	March 8-14
Venue	Ouagadougou, Burkina Faso	Lome, Togo	Niamey, Niger
Maize Network			
- No. NARS Scientists	18	22	40
- No. of countries	15	15	17
- Scientific papers	-	20	20
Cowpea Network			
- No. NARS Scientists	19	30	49
- No. countries	15	16	17
- Scientific papers	-	15	15
No. General Papers	10	10	13
International Organizations (Scientists/Representatives)	17	19	37
West & Central Sorghum Network			12
East Africa Sorghum & Millet Network			2

were presentation of country reports, review of work on collaborative research, formulation of regional trials and the re-constitution of steering committees. From the number and quality of papers presented by the NARS maize, sorghum and cowpea scientists and the great interaction generated among the networks, the participants were unanimous in advocating that the biennial inter-network workshops should be encouraged.

A seminar for research agronomists was organized jointly by the SAFGRAD maize, cowpea and sorghum networks from 7 to 19 January, 1991 at IITA, Ibadan, Nigeria. The objectives of the seminar were:

(i) improvement of research capabilities of research agronomists through exchange of ideas.

(ii) elucidation of the major constraints to agricultural production in the subregion to identify areas that require research emphasis, and

(iii) understanding of the concept of low input technology to identify appropriate technologies compatible with farmers' needs and requirements and the sustainability of agricultural production and the ecosystem.

The seminar was attended by 20 national program research agronomists from 12 countries (Table 6) and 13 resource persons from IITA, ICRISAT and some national research institutions. Papers were presented by subject-matter specialists from both the national and international research systems. An interesting feature of the seminar was that emphasis was placed on discussions. This enabled participants and presenters to exchange views on new concepts and how to approach seemingly difficult problems in the subregion.

Table 6. List of Participants to the Joint Networks' Seminar for Research Agronomists, IITA/Ibadan, Nigeria, 7-19 January, 1991

Name of Participant	Country	Address
1. M. Amidou	Benin	Station de recherches sur les cultures vivrières d'INA, BP 03, N'Dali
2. M. Adomou	"	Station de Recherches sur les cultures vivrières d'INA, BP 03, N'Dali
3. Hien Victor	Burkina Faso	INERA, 03 BP 7192, Ouagadougou 03
4. Lompo François	"	INERA, 03 BP 7192, Ouagadougou 03
5. Ebete Anatole	Cameroon	IRA, Box 2123, Yaounde
6. Ngoumou Nga Titus	"	IRA/MESIRES, Box 415, Garoua
7. Yandia Abel	Cent. Afr. Rep.	Direction de la Recherche SOCADA, BP 997, Bangui
8. Gayesena Yassine	Chad	Station Expérimentale de Gassi, BP 101, N'Djamena
9. L.O.Tetebo	Ghana	Crops Research Institute, N.A.E.S., Box 52, Tamale
10. Patterson Osei Bonsu	"	Crops Research Institute Box 3785, Kumasi
11. Ibrahima Bah	Guinea Conakry	C.R.A. Kilissi, BP 163, Kindia
12. N'Tji Coulibaly	Mali	IER, BP 438, Bamako
13. Diakalia Sogodogo	"	IER, BP 438, Bamako
14. Sidi R'Chid	Mauritania	CNRADA, BP 22, Kaedi
15. Cherif Ari Oumarou	Niger	INRAN, BP 429, Niamey
16. O.O. Olufajo	Nigeria	IAR/ABU, PMB 1044, Zaria
17. K.A. Elemo	"	IAR/ABU, PMB 1044, Zaria
18. A.Y. Akintunde	"	National Rice/maize Centre PMB 5042, Moor Plantation Ibadan
19. Sene Manievel	Senegal	SRA-CNRA, BP 53, Bambey
20. Saliou Diangar	"	ISRA-CNRA, BP 53, Bambey

9. Training

Realizing that inadequacy of skilled research workers is one of the major constraints to the production of maize and cowpea in the subregion, each Network designed appropriate training programs from the rather limited training funds.

From 1988 to 1990, the Network organized a 5-month residential training annually at Kamboinse for technicians. The course was practical-oriented lasting the whole planting season and emphasizing field plot techniques, trial management, variety maintenance, seed multiplication, statistical analysis, data interpretation and report writing. Fifteen technicians (Table 7) were trained. These technicians have been contributing effectively to their respective national programs. For example, Dr. Charles Thé of Cameroon observed, during his visit to the Central African Republic and Benin Republic, tremendous improvement in seed multiplication and trial management by former trainees. Dr. Fajemisin, the Network Coordinator, made similar observations in Mali in 1989 and Guinea in 1990 on former trainees from these two countries. Mr. Dossou of Benin commended the impressive way that a former trainee, Mr. Mohammed Soumanou, managed his trials when he was away to Yugoslavia for a course to the extent that his country (Benin) made a request to nominate a second technician for training by the network.

1O. Provision Of Research Materials And Funds

The Maize Network supplied several national programs with some small but essential equipment such as moisture testers, balances, measuring tapes, sprayers, pesticides, pollination bags etc. Funds were provided to supplement national budget to Lead Centers for collaborative research and to technology adapting NARS for essential activities like variety maintenance and seed production. The assistance given to the various national programs is summarized in Table 8.

Table 7. List of Participants at Training Course for Maize Research Technicians (1988, 1989 and 1990)

1988 Participants	Country
1. Soumanou Mohammed	Benin
2. Zouré Grégoire	Burkina Faso
3. Badahoro-Zaromo, A.	Central Afr. Republic
4. Romtitingar Djidinray	Chad
5. Sow Abdoulaye	Guinea
6. Sidibe Issa	Mali

1989 Participants	Country
1 Ali Imam Abacar	Chad
2. Dawuni Ahmed	Ghana
3. Fernandez Augusto	Guinea-Bissau

1990 Participants	Country
1. Denangnon Gangbo	Benin
2. Noba Raymond	Burkina Faso
3. Faikreo Jean	Cameroon
4. Bojang Abdoulaye	Gambia
5. Maïga D. Mohamadou	Mali
6. Attiley Kossi	Togo

Table 8. Financial assistance to National Maize programs ($) (1987-91).

Countries	1987*	1988	1989	1990	1991**	Total
Benin	180	4,000	4,000	3,000	2,000	13,180
Burkina Faso	2,223	4,000	4,000	3,000	2,000	15,223
Cameroon	-	-	3,000	3,000	2,000	8,000
Cape Verde	180	-	-	-	1,000	1,180
Central Afr.Rep	1,540	-	-	2,000	2,000	5,540
Chad	180	4,000	-	2,000	1,000	7,180
Côte d'Ivoire	-	-	3,000	-	2,000	5,000
Gambia	-	-	-	1,000	1,000	2,000
Ghana	-	-	-	3,000	2,000	5,000
Guinea	1,037	4,000	-	2,000	1,000	8,037
Guinea Bissau	180	-	-	-	1,000	1,180
Mali	1,577	-	3,000	3,000	2,000	9,577
Mauritania	-	-	-	-	1,000	1,000
Niger	-	-	-	-	1,000	1,000
Nigeria	-	-	3,000	3,000	2,000	8,000
Senegal	180	4,000	3,000	-	2,000	9,180
Togo	-	-	3,000	3,000	2,000	8,000
Total	7,277	20,000	26,000	28,000	27,000	108,277

* In 1987, the assistance was in kind through provision of research materials and equipment.
** Funds planned for release in 1991.

10. Improvement Of Linkages Among National Programs

The Maize Network sponsored several activities to promote the development of linkages among NARS scientists and with scientists from IITA.

Monitoring Tours

The primary purpose of monitoring tours, usually conducted during the growing season, is to bring together national scientists from 5-8 countries (per crop) and IITA scientists to visit national maize or cowpea programs in 2-3 countries. Such tours allow the scientists to interact on the field with regard to production constraints, research methodologies and appropriate new technologies. During monitoring tours, the relative performance of entries and/or management practices included in the regional testing are evaluated, as well as the performance of any other maize, or agronomic trial. The tour enables participants to gain experience on how research activities are linked with development agencies.

Monitoring tours were organized in 1988 and 1990 (that is, years alternating with the biennial workshops) to selected countries in the subregion. Scientists from two different sets of 7 countries visited Burkina Faso and Ghana in 1988 and Cameroon and Nigeria in 1990 (Tables 9 and 10).

Visits to National Programs

In order to increase the chances for increased interaction and follow-up activities, visits were undertaken by the Coordinators and members of the steering committees to many countries yearly. The objectives of the visits were (i) to assess the activities of the various national programs and thus increase the effectiveness of their participation in the network, (ii) to assess training needs in order to promote the development of

Table 9: Maize Monitoring Tour to Burkina Faso and Ghana, 12-20 September, 1988.

Participants	Country	Address
1. Mr. Ch. Gouro Yallou	Benin	Maize Breeder DRA, BP 884 Cotonou
2. Mr. Jacob Sanou	Burkina Faso	Maize Breeder INERA, Farako-Bâ BP 910 Bobo-Dioulasso
3. Mr. Alloudoumyngue Nadingar	Chad	Research Administrator Bureau de Recherche Agronomique BP 441, N'Djamena
4. Mr. Lansana Touré	Guinea	Maize Agronomist IRAG, Bordo-Kankan BP 576, Conakry
5. Dr. N.U.A. Idem	Nigeria	Maize Agronomist IAR/ABU BP 1044, Zaria
6. Mr. Abdou Ndiaye	Senegal	Maize Breeder CRA/Fleuve BP 240, Saint Louis
7. Mr. Payaro Toky	Togo	Maize Agronomist RPAA BP 218, Kara
8. Dr. J.M. Fajemisin	Network Coordinator	Pathologist/Breeder IITA/SAFGRAD 01 B.P. 1495 Ouagadougou 01

Table 10. Maize Monitoring Tour to Cameroon and Nigeria 8-22 September, 1990.

Participants	Country/position	Address
1. Dr. Charles Thé	Cameroon	Maize Breeder IRA/NCRE BP 2067, Yaoundé
2. Mr. Clément Ganglaou	Central Afr. Republic	Maize Agronomist Direction de la Coordination Agricole BP 786, Bangui
3. Mr. Koffi Attiey	Côte d'Ivoire	Maize Breeder IDESSA, 01 BP 635, Bouake
4. Mr. M.S. Mbenga	Gambia	Maize Agronomist/Breeder Dept of Agricultural Research Station Ministry of Agric. Yundum Agric. Station, Yundum
5. Mr. G.K.S. Aflakpui	Ghana	Maize Agronomist CRI, P.O. Box 3785 Kumasi
6. Mr. NTji Coulibaly	Mali	Maize Agronomist IER-SRCVO, BP 438 Bamako
7. Mr. Naino Jika	Niger	Cereal Breeder INRAN, BP 429, Niamey
8. Dr. J.M. Fajemisin	Network Coordinator	Pathologist/Breeder IITA/SAFGRAD, 01 BP 1495 Ouagadougou 01
9. Dr. Taye Bezuneh	SAFGRAD Director of Research	Research Administrator OAU/STRC/SAFGRAD 01 BP 1783, Ouagadougou 01
10. Dr. S.K. Kim	IITA Maize Breeder	Maize Breeder IITA, PMB 5320 Ibadan, Nigeria
11. Dr. J. Kling	IITA Maize Breeder	Maize Breeder IITA, PMB 5320 Ibadan, Nigeria

effective and sustainable national maize programs, (iii) to find out how maize produce is utilized locally and, where necessary, advise on how to increase consumption/utilization and therefore enhance farmers' incentive to produce, and (iv) to promote interaction between research institutions and development agencies including small scale farmers for realistic conception and implementation of research goals.

The involvement of members of the steering committees in visits to assigned countries enabled them to learn more about the subregion and enhanced the gradual development of self-driven and sustainable networks. Other objectives were (i) to share experience with the scientists of the host countries, and (ii) to promote exchange of technologies, ideas and visits among national scientists in the subregion.

The countries visited are listed below.

1987: Coordinator: Burkina Faso, Central African Republic, Guinea, Mali.

1988: Coordinator: Benin, Burkina Faso, Central African Republic, Ghana, Guinea, Nigeria, Senegal, Togo.

Steering Committee:

- Esseh-Yovo Mawule (Togo) : Senegal
- Hema Idrissa (Burkina Faso): Cape Verde and Guinea Bissau
- Charles Thé (Cameroun): Chad and Central African Republic
- Badu-Apraku (Ghana): Gambia

1989: Coordinator: Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Gambia, Guinea-Bissau, Chad, Togo.

Steering Committee:

- Attiey Koffi (Côte d'Ivoire): Cape Verde
- Charles Thé (Cameroon): Chad, Central African Republic.
- Esseh-Yovo Mawule (Togo): Senegal

1990: Coordinator: Burkina Faso, Cameroon, Côte d'Ivoire, The Gambia, Guinea, Mali, Nigeria.

Steering Committee:

- Badu-Apraku (Ghana): Togo
- Charles Thé (Cameroon): Benin

1991 (Planned): Coordinator: Burkina Faso, Cape Verde, Côte d'Ivoire, Ghana, Mauritania, Togo

Steering Committee:

- Romuald Dossou (Benin): IITA & Nigeria
- Abdou Ndiaye (Senegal): Mali
- Charles Thé (Cameroon): Ghana.

11. NETWORK IMPACT

The Maize Network has significantly influenced the scope and quality of maize research in regional and national terms with some obvious or potential impact in terms of diffusion of improved production technologies at farm level.

Management Of Research Activities

A strong link has been established between the SAFGRAD Coordination Office (SCO) and the Directors of Agricultural Research of the participating countries.This has facilitated the mobility of germplasm and scientists in the subregion. The Council of Directors meets biennially and the Oversight Committee of proven research administrators, academicians and researchers set up by the Council provides policy direction for all the SAFGRAD Networks; it also monitors and evaluates their activities regularly. The directors have thus been very active and responsive to the activities of the network by encouraging the contribution and participation of their scientists and/or hosting such activities (steering committee meetings, monitoring tours, workshops, training and regional trials). The Network activities and the benefits derived by the participating countries have reduced linguistic barrier to scientific interaction in the subregion.

Maize Research

The Maize Network has promoted interest in maize research and the linkages developed within and among NARS scientists have greatly increased the morale of individual scientists. The enhanced interaction coupled with the training activities organized by the network and the technical back-stopping by IITA scientists and resource persons from Lead NARS have increased the efficiency and effectiveness of research within individual national programs through sharper focusing on major constraints and better utilization of resources. The collaborative research activities initiated and coordinated by the Maize Network has resulted in the development of new technologies which are subsequently exchanged within the Network. An indicator of this impact is the progressive increase in the number of improved varieties and technologies contributed by national programs into the Networks' regional trials. In the past, these trials were composed of only entries from international research centers (IITA and CIMMYT).

Diffusion And Adoption Of Varieties

The collaborative research and regional trials coordinated by the Maize Network have allowed national programs to identify promising varieties and technologies. From the request for seed and further testing of these selected varieties in several locations across each country, new varieties have been proposed to and adopted by farmers.

The improved technologies available to farmers have helped in extending maize hectarage in all the 17 Network-member countries (Table 11). The savanna belt across West Africa has witnessed tremendous increase in maize production. The early and extra-early varieties promoted by the Network have contributed significantly through movement of maize into new frontiers ; they escape drought and help to break the hunger period since they mature before any grains or root crop in any given year.

In Cameroon, the total maize production has doubled in 10 years. Over 60% of this increase is attributable to increase in maize area in the savanna which is planted almost exclusively to improved varieties. The intensity of maize cultivation in the savanna is also true of Benin. Data from a 1986-1989 survey showed that there has been a 3.4% increase in land area/year under maize production in the southern province and a 10% increase in the northern province. It further revealed a replacement rate of 1.0% local with improved varieties for the south and 4.8% for the north per year.In a survey on diffusion of maize technology of all the major maize producing areas in Ghana in 1990, it was found that 57.8% of the farmers used improved varieties, 52.6% practised row-planting, 26.8% applied fertilizer and 19.0% protected their stored maize against weevils.

Table 11. Maize production trends in some selected countries of West and Central Africa

	Production area (ha)		Grain production (tons)		% of total maize area under improved varieties in 1988	Technologies adopted by NARS through SAFGRAD
	1986	1989	1986	1989		
Benin	442,785	478,995	352,849	424,042	41	Pirsabak 30 SR,Sekou 81
Burkina	165,000	206,000	155,000	171,000	27	TZSR-W1,DMR-ESRW,TZESR-W SR-22,KPB,KPJ KEB,KEJ, SAFITA-2, Pool 16 DR, Tied-ridging, Ridge tying implement.
Cameroon	-	500,000	-	600,000	18	CMS 8602, CMS 8806, SAFITA-2, Pool 16 DR, Mexican 17 Early and Tied ridging, seed treament with ST 25.
Chad	32,419	45,292	25,293	41,000	-	Gusau82 TZESR-W,CMS 8501, CMS 8507.
Côte d'Ivoire	468,000	600,000	361,000	450,000	10	ZSR-Y-1,Maka,Pool 16 DR
Ghana	472,000	567,000	560,000	750,000	43	SAFITA-2,Okomasa, Abeleehi,Dorke SR, Streak screning techniques.
Mali	-	126,000	-	228,000	36	Golden Crystal, SAFITA-2, DMR-ESRY, TZEE-Y.
Mauritania	2,624	11,303	1,150	3,104*	-	Maka, CSP Early.
Niger	2,194	3,047	4,735	4,776	-	TZESR-W, Maka, Pop 31-SR, JF de Saria.
Nigeria	-	3,5 m	-	4,4m	40-50	DMR-ESRW,DMR-ESR,TZESR-W
Senegal	95,000	105,000	100,000	133,000*	100	Pool 16 DR, Tocumen 7835, Maka.
Togo	-	258,000	-	245,000	15	TZESR-W x Gua 314, Maka, Streak screeing t techniques.

* 1990 Figures. ** Production under irrigation

Source: 1989/90 CIMMYT World Maize Facts and Trends.
Outline of National Maize Research Systems in West and Central Africa.

12. MAIZE NETWORK IMPACT INDICATORS

LEVEL I. Strengthening of NARS' Technology Development Base and Generation of Appropriate Technologies.

1.1. Conception of Appropriate Research Objectives

Impact Indicators	Supporting documents/ references
1. Constraints to increased maize productivity and production identified and prioritized.	- Proc. Network Estab. Workshop.
2. Resources --human, infrastructure-- inventorized.	- Proc. Network Estab. Workshop.
3. Research objectives formulated and prioritized.	- Proc. Network Estab. - St. Comm. Rept. N°. 2.

1.2. Development and Implementation of Collaborative Research Strategy.

Impact Indicators	Supporting documents/ references
1. Establishment of a Network Steering Committee of elected, active national scientists to plan, and monitor network activities.	- Proc. Network Estab. Workshop.
2. Lead Centre approach used to obtain and mobilize 'critical mass' for addressing region-wide researchable issues.	- St. Comm. Rept. No. 2.
3. Implementation of Collaborative research to generate maize production technologies.	- St. Comm. Rept. No.2-10.

1.3. Enhancing the capability and capacity of National Programs.

Impact Indicators	Supporting documents/ references
1. Restructured national maize programs as evidenced by institutionalization of National Variety Trials, prudent varietal and germplasm maintenance, and seed production in many countries.	- Special Publ. No.3 - St. Comm Rept No.2-10
2. Fifteen (15) maize research technicians from 11 countries received 5-month intensive training of trial management, variety maintenance, seed production, data analysis and interpretation.	- Trainees' Rept for 1988(6), 1989(3), 1990(6).
3. Improved implementation and efficacy of research trials.	- Coordinators Trip Reports - Reg. Trials' Rept: 1987, 1988, 1989, 1990, 1991.
4. Increase in number of NARS developed varieties in regional uniform variety trials.	- Reg. Trials Rept: 1987, 1988, 1989, 1990, 1991.
5. Increase in the number of papers presented by NARS scientists at Network -organized workshops indicating increased research activities.	- Special Publ. No. 1 - Special Publ. No. 6
6. Increased avenues for scientist-to-scientist contact resulting from Network activities.	- SAFGRAD II Final Rept. - Special Publ. No.3
7. Progressively diversified research program.	- Special Publ. No. 3 - St. Comm. Rept. No.4-10 - Special Publ. No.5
8. Research problems once reserved for International Centers now gradually being addressed by some NARS programs.	- St. Comm. Rept No.1-10 - Special Publ. No.3

9. Increased research activities as a result of provision of additional funds, research equipment/materials, and documents.	- SAFGRAD II Final Rept. - St. Comm. Rept No. 1-10 - Special Publ. No. 3.
10. Increased types of maize germplasm to suit needs of farmers and consumers.	- Reg. Trials' Rept. 1987, 1988, 1989, 1990, 1991. - Special Publ. No. 2.

1.4. Improved linkage with extension agents

1. More national programs have extension departments/unit within or closely linked with research system.	- Special Publ. No. 3 - Steering Comm. Repts.
2. National programs organize joint annual workshops attended by researchers, extension agents and farmers for review and planning.	
3. More countries have seed production decentralized to include farming groups or private organizations.	

1.5 Increased scientific leadership to direct sustained collaborative regional research network.

1. Exchange visits between scientists from different national programs for technological information.
2. Experienced scientists visit weaker national programs to offer on-the-spot advice.
3. Spill-over of research technologies to other countries.
4. SAFGRAD Strategic plan developed by Network scientists after program review and appraisal.

LEVEL II. Changes in Output from Research and Development Agents

2.1. Technology Menu

(a) Maize Varieties made available to NARS by the Network.

1) Late and intermediate maturing varieties (110-120 days) for Northern Guinea Savanna Zone.

Impact indicators — Supporting documents/references

Variety	Origin	
Abeleehi	Ghana	- Special Publ. No.2,
Aburotia	Ghana	- reg. Trials Repts.
AB 22	Togo	1987, 1988, 1989, 1990,
CSM 8710	Cameroon	1991.
Okomasa	Ghana	
Dobidi	Ghana	
EV 8422-SR	CIMMYT-IITA	
EV 8428-SR	CIMMYT-IITA	
EV 8435-SR	CIMMYT-IITA	
EV 8443-SR	CIMMYT-IITA	
EV 8444-SR	CIMMYT-IITA	
EV 8449-SR	CIMMYT-IITA	
FARAKO-BA 85 TZSR-W-1	IITA	
FARAKO-BA 85 TZSR-Y-1	IITA	
NDOCK 8701	Cameroon	
LOUMBILA 84 TZUT-Y	IITA & Burkina	
TZB-SR	IITA	
TZPB-SR	IITA	
Golden Crystal	Ghana	
Composite 4	Ghana	
Zm10	Senegal	
Synthetic C	Senegal	
BDS	IRAT/Senegal	
AB22	Togo	
CJ1	IRAT/Benin	
Composite 4	IRAT/Côte d'Ivoire	
Staha	Tanzania	
IRAT 100	IRAT/Burkina Faso	
IRAT 102	IRAT/Burkina Faso	
IRAT 178	IRAT/Côte d'Ivoire	
NH2	IRAT/Benin	
Elite x Early Mexican Composite	Ghana	

2) Early maturing (90-100 days) and/or drought tolerant varieties for Sudan savanna.

Impact indicators		Supporting documents/ references
Variety	Origin	
Across 86 Pool 16 DR	IITA-SAFGRAD	- Special Publ. No.2,
Across 87 Pool 16 SR	IITA	- Reg. Trials Repts:
Across 88 Pool 16 DR	IITA-SAFGRAD	1987, 1988, 1989,
BDP-SR BC3 F3	Benin-SAFGRAD	1990, 1991.
DMR-ESRW	IITA	
DMR-ESRY	IITA	
DR Comp. Early	IITA-SAFGRAD	
Early 86 Pool 16 DR	IITA-SAFGRAD	
EV 8730-SR	CIMMYT-IITA	
EV 8731-SR	CIMMYT-IITA	
Farako-Bâ 86 Pool 16 DR	IITA-SAFGRAD	
Farako-Bâ 88 Pool 16 DR	IITA-SAFGRAD	
FBC 6	Burkina Faso	
Ikenne 88 BU-ESRW	IITA	
Kamboinse 88 Pool 16 DR	IITA-SAFGRAD	
Kawanzie	Ghana	
Maka-SR	Mauritania-SAFGRAD	
SAFITA-2	IITA-SAFGRAD	
TZE Comp. 3 x 4	IITA	
TZESR-W	IITA	
TZESRW-SE	IITA	
Mexican 17 Early	Ghana	
Jaune Dente de Bambey	Senegal	
MTS	IRAT/Côte d'Ivoire	

3) Extra-early maturing varieties for Sahel savanna and to bridge hunger gap in other zones. No international centre worked on this maturing group.

Impact indicators		Supporting documents/ references
Variety	Origin	
(Across 8131 x JFS) x Local Raytiri	IITA-SAFGRAD	- Special publ. No.2,
CSP	CIMMYT	- Reg. Trials Repts.
CSP-SR	IITA-SAFGRAD	1987, 1988, 1989,
CSP x Local Raytiri	IITA-SAFGRAD	1990, 1991.
Pool 27 x Gua 314	IITA-SAFGRAD	
Pool 28 x Gua 314	IITA-SAFGRAD	
Pool 30 x Gua 314	IITA-SAFGRAD	
TZEE-W1	IITA-SAFGRAD	
TZEE-W2	IITA-SAFGRAD	
TZEE-White Pool	IITA-SAFGRAD	
TZEE-WSR	IITA-SAFGRAD	
TZEE-Y	IITA-SAFGRAD	

TZEE-Yellow Pool	IITA-SAFGRAD
TZEE-YSR	IITA-SAFGRAD
TZEF-Y	IITA-SAFGRAD
TZESR-W x Gua 314	IITA-SAFGRAD

(b) Improved agronomic practices

Impact indicators	Supporting documents/ references
1. Tied ridges for soil moisture conservation in Sudan savanna	- Special Publ. No.3
2. Better seed treatment chemicals for improved plant establishment and grain yield.	- Special Publ. No.3
3. Increased plant population for higher grain yield of early and extra-early varieties.	- Special Publ. No.3
4. Earlier date of fertilizer application (top dressing) for increased yield of early and extra-early varieties.	- Special Publ. No.3

2.2. Technologies Released by Individual National Programs for use by their Farmers.

Country Name of technology	Remarks	Supporting documents/ references
BENIN		
Pirsaback 30-SR	Version of EV 8430-SR	- SAFGRAD II Final Rept
Sekou 81 TZSR-W-1	Well accepted for local dishes	- Special Publ. No.4
DMR-ESRW	Noted for wide adaptability across the country	
TZESR-W	For green maize	
TZB/TZB-SR	High yield in northern Guinea savanna	
Poza Rica 7843-SR	Version of EV 43-SR	

BURKINA FASO

SR 22	Local name of EV 8322-SR
KPB	Local name for EV 30-SR
KPJ	Local name for EV 31-SR
KEB	Local name for TZEE-WSR
KEJ	Local name for TZEE-YSR
Maka	-
SAFITA-2	A variety from Pool 16
Pool 16 DR	Streak resistant and drought tolerant variety replacing SAFITA-2.
Tied ridging	Adopted by farmers to conserve soil moisture in the Sudan savanna
Ridge tying implement	Accepted and fabricated for use with donkey or cow.

CAMEROON

TZB-SR	Wide adaptability in Guinea savanna
CMS 8602	Local name for EV 31-SR
CMS 8806	Local name for DMR-ESRY
SAFITA-2	A variety from Pool 16
Pool 16 DR	Streak resistant and drought tolerant.
Mex. 17 Early	Ghanaian variety

Country/Name of technology	Remarks	Supporting documents/ references
Marshall ST 25 as seed treatment	Replaces Thioral because it has a 33:1 benefit/cost ratio over use of Thioral.	- Special Publ. No.3
Tied ridging	Adopted as a methodology for simulating 2 levels of soil moisture for breeding for drought tolerance.	- Special Publ. No.3

CENTRAL AFRICAN REPUBLIC

CMS 8505	A Cameroonian variety; now in on-farm trial.
CMS 8710	A Cameroonian variety; now in on-farm trial.

COTE D'IVOIRE

TZSR-Y-1		- SAFGRAD II Final Rept. - Special Publ. No. 4
Maka		
Pool 16 DR		

GHANA

Kawanzie	
Dobidi	
Composite 4	
Elite x Early Mexican Composite	
Mexican 17 Early	
Aburotia	
Golden Crystal	
La Posta	
SAFITA-2	A variety from Pool 16
Okomasa	Derived from EV 43-SR
Abeleehi	Derived from EV 49-SR
Dorke-SR	Derived from EV 31-SR
Obatanpa	Derived from GH 8363 SR
Streak screening technique	For development of varieties resistant to maize streak virus.

GUINEA

Ikenne 83 TZSR-Y-1	On-farm trial
DMR-ESRY	On-farm trial
EV 8428-SR	On-farm trial

GUINEA BISSAU

TZESR-W
TZESR-Y

MALI

Golden Crystal	A Ghanaian variety
SAFITA-2	
DMR-ESRY	
TZEF-Y	On-farm trial

MAURITANIA

Maka	Tolerant to drought
CSP Early	

NIGER

TZESR-W
Maka
Pop 31-SR
J.F. Saria

NIGERIA

TZB-SR
TZPB-SR
TZESR-W
TZSR-W-1
TZSR-Y-1
DMR-ESRW
DMR-ESRY

SENEGAL

Maka	
Ikenne(1) 8149-SR	
Pool 16 DR	
JDB	Local name for Tocumen 78

TCHAD

Gusau 82 TZESR-W	
CMS 8501	Developed in Cameroon
CMS 8507	Developed in Cameroon

TOGO

EV 8443-SR	
Ikenne 8149-SR	
TZESR-W x Gua 314	
Maka	
Streak screening techniques	For development of varieties reistant to maize streak virus

LEVEL III: Technology adoption

3.1. Variety Adoption Profile

Country/Name of variety	% of total maize area	Remarks	supporting documents/ references
BENIN			
TZB and TZB-SR	22	North	- SAFGRAD II Final Rept.
TZSR-W	5	North	
TZESR-W	5	North	
Poza Rica 7843-SR	7	South	
Pirsaback 7930-SR	2	South	
BURKINA FASO			
SR22 (=EV 8322-SR)	25	Northern Guinea Sav.	
Maka	1	Sudan Sav.	
KPB (=8330-SR)	0.5	Northern Guinea Sav.	
8321-18	0.5	Northern Guinea Sav.	
TCHAD			
Gusau 82 TZESR-W	n.a.	Lake Chad area	
CMS 8501	n.a.		
CMS 8507	n.a.		
COTE D'IVOIRE			
TZSR-Y	10	Center-North	
MAKA			
Pool 16 DT			
GHANA			
Okomasa/Dobidi	28	Throughout country	
Aburotia/Abeleehi	10	" "	
Safita-2	3	North	

MALI

TZEE-Y		
DMR-ESRY	36	
Safita-2		
Golden crystal		

CAMEROON

CMS 8602		
CMS 8806		
Safita-2	18	
Pool 16 DR		
Mexican 17 Early		

NIGERIA

TZB/TZB-SR	20	Throughout country
TZPB/TZPB-SR		" "
TZSR-W		" "
TZSR-Y		" "
TZESR-W	20	" "
DMR-ESRW		Downy mildew zone
DMR-ESRY		" "
EV 8443-SR		South
EV 8428-SR		Throughout country

SENEGAL

JDB (=Tocumen 7835)	40	Kaolack-Casamance
Synthetic C	20	" "
Maka	5	Fleuve
Pool 16 DR	5	Center
ZM 10	5	Casamance

TOGO

Ikenne 8149-SR	6	
EV 8443-SR		

3.2. Maize Production Trends

Country	Maize production trends	Remarks	Supporting documents/ references
BENIN	442,785 ha (352,849 t) in 1986 to 478,995 ha (424,042 t) in 1990.	Most of this increase is in the north	- Special Publ. No.3
BURKINA FASO	165,000 ha (155,000 t) in 1986 to 206,000 ha (171,000 t).	Most of the increase is in the northern Guinea savanna.	"
CAMEROON	Total maize production is 600.000 from 500,000 ha.	The land cultivated to maize in northern Cameroon increased from 3,000 ha in 1980 to 70,000 ha in 1989. About 30,000 ha of this increase occured after 1986.	"
TCHAD	32,419 ha (25,293 t) in 1986 to 45,292 ha (31,000 t) in 1990.		"
COTE D'IVOIRE	468,000 ha (361,000 t) to 600,000 ha (400.000 t) in the 1980's.		

GAMBIA	A surge in production from 1987 to 16,000 t from 17.500 ha.	Increase to meet demand for livestock feed and green maize.	"
GHANA	472,000 ha (560,000 t) 1986 to 567,000 ha (750,000 t) in 1989.	Large increase in the Guinea savanna. Clear trend in increase of national yield average.	"
GUINEA	Maize fast replacing millet and sorghum. Current production is 100,000 t.		"
MALI	Production 228,000 t from 126,000 ha.	Over 50% of the maize is produced in the south (northern Guinea savanna)	"
MAURITANIA	2,624 ha (1,150 t) in 1986 to 11,303 ha (3,104 t) in 1990.	Fluctuaction in yield due due to grossly insufficient and irregular rainfall.	"
NIGER	Rainfed maize increased from 2571 t 7728 t over the period 1986-89. Area under irrigation increased from 2194 to 3,047 ha.	Attack by streak virus is a major source of production instability. Spread of streak resistant varieties pursued.	"

NIGERIA	Ban on imported maize in 1985 stimulated increased production to the present estimate of 5.4 million tons from 3.5 million hectares.	Most of the increase is is from the Guinea savanna. Increased privatization of seed production, grain production and diversified utilization are key factors.
SENEGAL	95,000 ha (100,000 t) in 1986 to 105,000 ha 133,000 t) in 1990.	Maize replacing sorghum and millet in areas over 700 mm rainfall.
TOGO	Maize production has rapidly increased over the years to 245,000 t from 258,000 ha (1989).	

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4. Sidibé Issa (Mali)
5. Zouré Grégoire (Burkina Faso)
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1992-10

IMPACT ASSESSMENT STUDY SYNTHESIS OF PRIMARY DATA (WECAMAN)

AU-SAFGRAD

AU-SAFGRAD