FOOD GRAIN PRODUCTION TECHNOLOGY VERIFICATION PROJECT

PROGRESS REPORT

(FEBRUARY–OCTOBER 1990)

Supported through the Financial Assistance
Of the African Development Bank.

EXECUTIVE SUMMARY

Initially, an agronomic planning workshop was held from 19 to 22 February 1990, in Ouagadougou, Burkina Faso to assess the status of improved crop cultivation practices in semi-arid areas of West and Central Africa. Some of the important results of the workshop were a) the identification of biotic and abiotic constraints to the production of food grains; b) inventory of available and potential technologies; c) the exchange of technical information and experiences regarding the transformation of research results into extension recommendations and production and d) a review of proposals on on-farm verification trials. Nine sub-projects that received financial assistance from the African Development Bank were implemented in eight countries.

In Burkina Faso, six improved cowpea varieties and agronomic practices were evaluated in crop associations and in mono-culture, using plant protection measures in 13 districts in cooperation with rural development centres and 120 farmers.

In Cameroon and Mali, the project emphasis has been to develop packages of improved agronomic practices for the adoption of early (80-90 days) and extra-early (75-80 days) maturing maize cultivars in the Sudan and Sudano-Sahelian zones. These short cycle maize varieties have drought resistance characteristics which could enable the expansion of maize production in semi-arid zones with major emphasis to fill gaps of food shortages (for green maize available within 65 days) two to three months before the harvest of sorghum and millet.

In Senegal, the production of an improved cowpea variety designated as IS-86-275 was promoted in five villages since it has been accepted by farmers. The second sub-project support in Senegal is to enable researchers and farmers to develop appropriate millet-based farming systems in three villages (Diourbel, Thies and Kaolack-Fatick). The on-farm trials included the evaluation of improved agronomic practices to maximize the yield of improved and local varieties of millet and cowpea.

In Ghana, on-farm verification trials were conducted in the districts where fallow land (5-15 years) is still affordable (Birmilla district). This practice has virtually disappeared (Wa and Naduci districts) due to population pressure on the land. The packages of technology include cereal/cereal association with minimum doses of fertilizer application; cereal/legume rotation; and the promotion of improved cowpea varieties with good seed quality and acceptance by farmers.

In Nigeria, various technological options to enhance the performance and acceptibility of improved varieties of sorghum, maize, millet and cowpea under different land preparations, planting systems and fertility levels were evaluated.

In Niger, technology verification trials were conducted in three villages at Maradi (Kagadama, Tajaye and Takalmawa) with 200, 150 and 450 families, respectively. Some cowpea and millet varieties were evaluated with base application of fertilizer and under different agronomic practices. The second sub-project support is in Gaya area of Niger in Sokondii Birini village in the Sudanian zone involving close to 2000 farm families. Some of the agronomic practices evaluated were to develop appropriate intercropping (sorghum/millet/cowpea; millet/groundnut) systems and relay cropping systems with the application of minimum doses of inorganic fertilizer.

Furthermore, the farming practice of project sites in each country were documented. The purpose of this report is to update the status of project implementation. The annual technical report will soon be completed once data from the respective countries has been fully analyzed. The financial expenditure for project activities (as of November 1990) is reported elsewhere. In order to continue the on-farm and on-station food grain production verification trials, for the 1991 cropping season, a summary of the research grant proposal is provided in Annex 1.

INTRODUCTION

The crucial problem engulfing most countries in sub-Saharan Africa first and foremost is attaining food self-sufficiency and security. Agricultural practices need to be improved so that alternative systems that could accelerate food production can be adopted. Although some relevant technologies already exist in various research centres, the yield gap between on-station and on-farm needs to be narrowed.

The SAFGRAD mandated area is estimated to have a total population of 250 million inhabitants, about 80 per cent of whom are resource poor farmers, target of the project, producing most of the staple food supplies consumed in the region. Low resource agriculture is what farmers in semi-arid regions continue to practise. SAFGRAD's goal is therefore to increase the quantity and quality of staple food crops which can be made effectively available to the increasing population in semi-arid zones of Africa.

Through collaborative research networks (i.e. maize, sorghum, millet, cowpea and farming systems research) SAFGRAD has enabled the national research programmes to identify some relevant technologies that could enhance the production of food grain. The goal of this project is to speed up the process of technology verification and adoption by farmers.

Objectives

(i) To intensify the production of food grain through application of improved packages of technology.

(ii) To promote on-farm and on-station verificative trials and thereby identify suitable technologies that could enhance production of food grain.

(iii) To forge functional linkages between research agronomists and extension agents in order to narrow the yield gap between on-station and on-farm food grain production.

(iv) To facilitate the delivery of technology options that could minimize risks of crop failures due to environmental and socio-economic constraints.

(v) To improve on-farm research skills and consequently enhance the transformation of research results into extension recommendations and production.

Beginning of the Project

A proposal for the intensification of food grain research and production was submitted to the African Development Bank in 1989.

Since the financial support from the Bank was received in the middle of the cropping season, a decision was taken by SAFGRAD management to initiate project activities in 1990. Initially, an agronomic planning workshop was organized from 19-22 February, 1990. Participants from ten countries (Burkina Faso, Cameroon, Chad, Ghana, Guinea Bissau, Mali, Niger, Nigeria, Senegal, and Togo), regional and international organizations participated in the workshop.

The planning workshop addressed the following issues:

- Review of programmes of on-station and on-farm verification trials to be supported by the project;

- Development of an inventory of available and potential technologies in participating countries;

Finally some technologies were recommended for evaluation to fit existing farming practices such as cereal/legume associations, intercropping etc., cereal/legume rotation, application of some level of commercial fertilizers, compost, etc. to improve the fertility of the soil.

With regard to the management of agronomic practices, the participants of the above workshop stressed:

(i) The fact that unavailability of quality seed has been limiting good plant establishment (in addition to poor land preparation, soil fertility, insect pests, etc.).

(ii) The need to integrate the production of food crops with that of cash crops, such as cotton, in order to enhance both technical and economic complementarities.

(iii) That on-farm verification trials should be simple with the main purpose of demonstrating improved agronomic practices to farmers i.e. the fewer the treatments in the trial, the more likely that farmers would adopt the technology.

(iv) That conventional research methods of replicated trials for on-station verification should be employed with major emphasis on finished research results or potential technologies.

While SAFGRAD provided the technical and administrative backstopping, projects in the eight countries involved were implemented by the following national institutions:

Table 1. Projects Implemented by Various Agricultural Research Institutions of Participating Countries.

	Country	Implementing Institution	Project Title
1.	Burkina Faso	Institut d'Etudes et de Recherches Agricoles (INERA)	Test en milieu paysan de paquets technologiques développés par la recherche agricole
2.	Sénégal	Institut Sénégalais de Recherche Agricole (ISRA)	a) Mise au point d'itinéraires techniques et amélioration des systèmes de production à base de mil. b) Paquet technologique minimum pour le milieu paysan.
3.	Niger	Institut de Recherche Agronomique du Niger (INRAN)	a) Test d'adaptation des nouvelles technologies en milieu paysan-culture associée Mil/Sorgho. b) Paquet sur l'association Mil/Arachide/Niébé.
4.	Mali	Institut d'Economie Rural (IER)	Improvement of Maize production in semi-arid regions of Mali.
5.	Cameroon	Institut de la Recherche Agronomique (IRA)	Developing agronomic packages of technology for early and extra-early maize cultivars in North and Far North Cameroon.

6.	Ghana	Crops Research Institute at Nyankpala Station (CRI)	On-farm agronomic research in Northern Ghana.
7.	Nigeria	Institute of Agricultural Research, Ahmadu Bello University (IAR/ABU)	On-station and on-farm agronomic testing of appropriate technology to increase yield of sorghum/millet/cowpea crop associations.
8.	Togo	Direction de la Recherche Agronomique (DRA) Antenne Régionale SAFGRAD/DRA.	Transfert de technologies en milieu paysan (sorgho, mil, maïs, niébé)

This progress report covers project activities implemented in the above mentioned countries, except Togo from which was not yet received (even though the project was implemented) at the time this document was compiled.

BURKINA FASO

Agricultural productivity decreases from the southern to the northern part of the country reflecting the relative amount of rainfall. Its climate is characterized by warm and dry seasons during November to March, hot and dry during March to May and hot and moist from June to October. The mean annual rainfall ranges from 400 mm in the Sahelian zone in the north, to an average of 1000 mm in the north Guinean zone in the south. Particularly in the Sahelian and Sudan savanna zones, the erratic rainfall pattern leads to a speculative type of farming which makes agricultural productivity rather risky. Temperatures are generally high before and just soon after the rainy season, reaching day time values of up to 40°C. The rainy season starts between mid-May and mid-June and stops abruptly around early October. Drought conditions are aggravated due to the hot dry winds from the Sahara. Because of relatively high evapotranspiration during most of the year (with a mean value of 1900 mm), periods of moisture stress are more frequent during critical crop growth stages (seedling, flowering and grain formation).

The land surface area of Burkina Faso is approximately 274,000 km2. Its population is estimated at about 8.9 million inhabitants. The Mossi Plateau is the most densely populated region (30 to 70/km2) of the country, covering an area of 94,000 km2. The mean density in the agricultural area, however, was estimated at 100/km2.

The problem of meeting the food requirements in the country is more crucial in the plateau (where most of the verification trials were conducted).

Implementation of the Project

On-farm verification trials were conducted in 13 districts covering the three ecological zones (Sahel, Sudan and Northern Guinea Savannas) in Burkina Faso. On the whole, close to 120 farmers were directly involved and one hundred and seventy (170) trials were conducted. Farmers were chosen by each extension and rural development centre.

Traditionally, the farmers grow their crops in cereal-based mixtures. Millet and sorghum are the predominant cereals while maize is ranked third, after millet and sorghum. Cowpea and/or several vegetable crops are grown as secondary crops in the cereal-dominated cropping system; occasionally cowpea is grown as sole crop. Groundnut and cotton are usually grown in pure stands.

The arable land is cultivated each growing season since fallowing the land is no longer affordable because of the population pressure on the land. Land is prepared manually with the aid

of family labour. Planting is usually on ridges, but quite a good number of farmers plant on flat land. Some farmers "tie" their ridges towards the end of the rains, to conserve moisture.

Soil fertility is sustained through application of organic manure (compost and/or animal manure) close to the homesteads. The main animals kept on-farm particularly in the Mossi Plateau are sheep, goats, poultry and pigs. These animals provide organic manure. In addition, donkeys are used mainly for transportation of farm produce and goods and, occasionally, for traction.

Delivery of Improved Technologies

Although farmers are aware of the benefits that can be accrued from the application of chemical fertilizers, only few can afford to buy such inputs. To implement the on-farm verification trials, each of the 13 cooperating centres was supplied with the following inputs:

Items	Amount delivered per centre
i) Fertilizer 50 kg	3
ii) Insecticides	4 liters
iii) Fuel expenses to facilitate mobility and supervision of plots	40,000 CFA

Table 2. Six Improved Cowpea Varieties Evaluated in Different Ecological Zones.

Cowpea variety	Suitable rainfall range (mm) for production	Recommended method of planting
KVx 30-309-6G	300-900	Pure or mixed
KVx 61-1	300-900	Pure stand
KVx 396-4-4	300-1200	Pure or mixed
KVx 396-18-10	300-1200	Pure stand
TVx 3236	300-1200	Pure or mixed
KN-1	700-1200	Pure

Mixed culture includes cowpea/millet/or sorghum.

Table 3. Distribution of the Cowpea Varieties Tested in Burkina Faso.

Varieties/ Locations	KVx 30-309-6G	KVx 396-4-4	KVx 396-18-10	KVx 61-1	TVx 3236	KN-1	N°. of farmers
1. Central-South		x		x	x	-	5
2. Central-North		x		x			4
3. Central-East	x	x	x	x	x		
4. Central-West		x		x	x	-	7
5. East		x	x	x	x	-	10
6. North	x	x	-	x	x	x	5
7. Sahel	x	x	-	x	-	-	40
8. Mouhoun	x	x	x	-	x	x	5
9. Southern West	x	x	x	-	x	x	10
10. High Basins	-	x	x	-	x	x	5
11. Centre	x	x	-	x	x	-	5
12. UPI	x	x	x	x	x	-	8
13. Pobé		x				-	5
(Gorom as check)							3
Total for var.	7	13	6	9	10	4	117

Each farmer was allowed to decide which two of the above six improved cowpea varieties he wished to produce, in comparison with his local cowpea variety. The farmer was also allowed to decide whether or not he wished to grow the three cowpea varieties in pure stand or in mixture with millet or sorghum. The minimum plot size was 25 x 25 m (625 m2). Yields would be jointly estimated by the farmer and the technician.

For production of sole crop cowpea: Land was cultivated before planting, while 100 kg of Burkina phosphate was applied at planting. Planting in the zone with 300-600 mm rainfall was done during the end of June to early July. In the zone with 600-1200 mm rainfall, the sowing date was 15-25 July. Spacing between the rows was 75 cm, while the intra-row spacing was 20 cm. Two seeds were sown per hole; 14 days after planting, seedlings were thinned to 1 per hill.

Under normal conditions, farmers rarely apply specific crop protection measures. Farmers within the project applied two insecticide sprays. The first at flower bud formation (about 35 days after sowing) and the other at pod formation (about 14 days after the first application). A mixture of Decis and Rogor (1 litre of each product/ha or 40 ml of each product in 20 l of water). For the second application, a tank mixture of 20 ml of Decis and 20 ml of Rogor in 20 l of water could be used instead of the above, higher rates.

For cowpea/cereal mixture: Date of planting of the cereal was the date recommended for the respective ecological zones. In the zone with 300-900 mm rainfall, cowpea was planted at the same date as the cereal. In the higher rainfall zone (900-1200 mm), cowpea was sown 14-21 days after the cereal.

Mode of planting: Two rows of cereal were planted, alternating with one row of cowpea. Inter-row spacing was that recommended for the cereal component of the mixture. Within the row spacing for cowpea was 20 cm while within the row, spacing for the cereal was two thirds of the spacing recommended for the sole crop; for example, if the practice was to sow the cereal at 60 cm intra-row spacing for the pure stand, the spacing used in the trial was 40 cm.

Labour input: The family is the main source of labour; the effectiveness of labour is enhanced by the size and number of adults in the family in the rural areas. A common practice is that men from different families constitute themselves into a labour group that works in a systematic rotation from one family farm to another during the peak labour periods. The arrangement is popular with the men because they claim that the group is fed much better by the host farmer compared to the meals they are served when each member works on his own farm.

member works on his own farm.

Farmers' reaction to the project. All of the farmers visited during the study were extremely receptive of the sub-project. More of them had sprayed their cowpea crops twice, as recommended in the package being evaluated, and the differences in grain yields between sprayed and unsprayed cowpea were outstanding. (Failure to spray some farms was attributed to non-provision of insecticides by the supervising technician). The farmers were also convinced that some improved cowpea varieties (as indicated in Table 3) were preferred than the respective local varieties. Farmers were particularly pleased with the earliness of the improved varieties. The participating farmers are encouraged to use more of their land for testing of the improved packages in 1991 (if the inputs, especially insecticides, would be provided).

NIGERIA

Objectives

(i) To study the performance and farmers' acceptability of improved varieties of sorghum, millet and cowpea as compared to traditional farmers' varieties.

(ii) To validate, both on-station and on-farm:

(a) improved varieties for maize/cowpea mixture, and

(b) rate of fertilizer application in maize/cowpea mixture; in both cases, the ultimate objective is to study the acceptability of the technologies to farmers.

Description of Location

The on-station trials were located at the research farm of the Institute for Agricultural Research, Samaru (11° 11' N, 07° 38' E, 686 m above mean sea level) located in the Northern Guinea Savanna agro-ecological zone. The environment has a distinct wet season (May to September/October, with total annual precipitation averaging about 1,000 mm) and a dry season (which is cool in October to March but warm in March to May). The soil at the site is a well-drained ferroginous tropical soil that is characteristically sandy loam. Production constraints include pests and diseases, uneven distribution of rainfall, and unpredictable onset and cessation of the rains, non-availability of fertilizer at the appropriate time and labour bottlenecks, among others.

Trials Implemented

Production Inputs: The inputs varied with the type of trial.

For Trial I (Objective (i) above). Land preparation was by the local method, using traditional hand tools. Compound fertilizer (15:15:15) was applied only to the cereal at the rate of 30 kg/ha each of N, P205 and K20 (i.e., one half the recommended rate for sole crop sorghum or millet). On cowpea Cymbush (cypermethrin) and Rogor (dimethoate) were applied at 1.0 litre/ha each, at 14-day intervals, beginning at flower bud formation; three applications were given. Weeds were controlled mannually, using the hand-held hoe.

For Trial II (Objective (iia) above). Land preparation (ploughing, harrowing and ridging) was done with the tractor. Fertilizer was applied at 120 kg N/ha and 60 kg/ha each of P205 and K20 as NPK (22:13:13) and CAN. Cowpea seed was treated with benomyl at the rate of 1.0 g of product/1 kg of seed. Insect pests were controlled with three sprays of a mixture of Cymbush EC (cypermethrin) and Rogor (dimethoate) at the rate of 100 + 100 ml of products per ha. Weeds were controlled by three hoe-weedings.

For Trial III (Objective (ii b) above). Land preparation was done with the tractor. Cowpea seeds were sown between maize stands on 90-cm ridges at about 5 weeks after sowing of maize. Fertilization was the subject of the study; thus four levels of N, three of P205 and two of K20 were studied in all possible combinations (see materials and methods). The cowpea was sprayed with insecticides as described above for Trial I. Weeding was also done as described for Trial I.

Data Collected by the Researchers

For Trials I and III, the data collected included number of days to 50% flowering, grain yield, yield components, and physico-chemical properties of the soil. For Trial II, the following data were collected: costs of labour and inputs, yields of the component crops, land equivalent ratios, yield components; in addition, an economic analysis of the cropping system was done.

Materials and Methods

Trial I (Objective (i) above): The second year of a two-year trial was conducted on-station in 1990 at Samaru to determine the varieties of the respective crops to be used in a sorghum/millet/cowpea mixture. This trial was designed to preceed another 2-year on-farm trial in 1991 and 1992.

The general cultural management practices of the local farmers for producing sorghum/millet/cowpea mixture were adopted to the on-station studies. The 1989 ridges were

split immediately after the first substantial rain of the season with the aid of the traditional hoe. This involved the cutting of heaps of soil from the top of a 1989 ridge into the adjacent furrow. Seeds of sorghum and millet were then planted immediately on this heap of soil in alternate, single hills, spaced 50 cm along the row. During the first manual weeding, 2-3 weeks after sowing, the old (1989) ridges were completely flatened in the process. After the weeding, fertilizer was applied to the cereal crops at the rate of 30 kg each of N, P205, and K20 per ha, using a compound fertilizer (15-15-15). Cowpea was interplanted near the millet stands shortly before millet was harvested.

One improved sorghum variety, KSV8, a medium maturing cultivar, was compared with Farafara (a local variety). Similarly, an improved millet variety (SE 13) was compared with a local variety, Zango. For cowpea, of three improved varieties, namely Kano 1696 (late maturing and white seeded), Sampea 7 (medium maturing and light brown seeded) and IT84S-2246-4 (medium maturing and light brown seeded) were compared with a local variety. Plot size was 6 x 7 m.

Trial II (Objective (ii a) above): Two varieties of maize, TZBSR and a hybrid (Ex-Kaduna), were intercropped with four cowpea varieties, namely Sampea 1 (IAR 339-1), Sampea 6 (Kano 1696), Sampea 7 (IAR 48), and one local variety. Sole plots of each component crop were included. In both sole and intercrop, maize and cowpea were established at 53,330 plants/ha on 90-cm ridges. Maize was sown on 16 June and cowpea on 10 August, 1990. In intercrops, maize and cowpea were sown on the same row. The gross plot size was 5.4 x 6 m. The experiment was laid out in randomized complete block with four replications.

Trial III (Objective (ii b) above): The second year of a two-year trial was executed on-station at Samaru in 1990 to determine the appropriate fertilizer practice for maize/cowpea mixture. The trial will be followed by a 2-year on-farm trial scheduled for 1991 and 1992.

A composite soil sample of the experimental site was taken before the trial was established. Maize variety, TZBSR, was sown at 60 cm spacing along ridges spaced 90 cm apart. Each was 5.4 m wide and 6 m long. The fertilizer treatments comprised four levels of nitrogen (0,75, 150 and 225 kg N/ha), three levels of phosphorous (0,40 and 80 kg P205/ha) and two levels of potassium (0 and 40 kg K20/ha). These were laid out in a randomized complete block design with four replications.

The maize was later thinned to three plants per stand while the cowpea was intersown into the maize stands at a spacing of 20 cm at two seeds per hole without subsequent thinning.

Status of Project Implementation

Trial I: The 1990 trial was an implementation of the approved proposal. This successful implementation of the approved second year's trial of the two-year, on-station sub-project means that the project is ready to go on-farm for the first time in 1991.

Trial II: The trial was executed in 1990 according to the approved proposal, with only minor but necessary modifications. Thus, the maize variety, EV8444SR, was replaced by hybrid maize (Ex-Kaduna) in view of the increasing popularity of hybrid maize in the Zaria area. Similarly, the cowpea variety Sampea I was added as an additional improved variety to satisfy the needs of farmers that may wish to produce white-seeded photoperiod-insensitive variety.

Trial III: The trial was implemented according to approved proposal with a minor modification; thus the fertilizer treatments were expanded to include all possible combinations of four levels of N, three levels of P205 and two levels of K20.

The principal problem encountered in implementing Trial II of the project was an end-of-season drought that adversely affected the relatively late-sown cowpea which was also attacked by Alectra vogelii, a parasitic weed. For all trials, the mobility of research staff is still a problem that will become more acute when the trials go on-farm in 1991 and 1992. Some amelioration is expected from the two motorcycles purchased for use by the technicians. Even here, the number of motorcycles will have to be increased to about five to ensure effective coverage of farmers fields as from 1991. The researchers believe that their effectiveness will be increased if they are provided with a Project vehicle, preferably a 4-wheel drive. Despite the above, the project objectives for 1990 were fully attained.

GHANA

Objectives:

i) To enable farmers evaluate available new crop varieties and improved agronomic practices;

ii) To develop adoptable recommendations for, and with, the Agricultural Extension Services in Ghana.

Trial Sites

a) Bimbilla District is located in the south eastern sector of Northern Ghana; 10 villages were used for the study, three farmers being selected from each village to give a total of 30 farmers. The total number of farm families is about 2,500. The soil type in Bimbilla District is clay-loam; soil fertility is somewhat better than that in Wa and Nadowli Districts. Because of the low population density, the pressure on the land is low; consequently the fallow period varies from 5 to 15 years. The District, with an annual rainfall of 1400 mm, is located in the northern Guinea savanna ecological zone.

b) Wa and Nadowli Districts are located in the upper west sector of Northern Ghana. There are five villages from which 22 farmers used in the study were pre-selected, with the help of the Crops Services Department of the Ministry of Agriculture. The soil type is sandy clay. Most of the soils in these districts are degraded. The population density is high; consequently, there is a great pressure on land. Fallow periods are virtually non-existent, the soil being cultivated successively each growing season. The two districts are located in the Sudan savanna and have an annual rainfall of about 800 mm.

Cropping system: Generally, intercropping is the predominant practice in both groups of farmers; the relative densities of the component crops are variable but they tend to depend on the quantity of seeds available for sowing during the planting season. However, sole cropping is the normal practice in the production of rice, cotton, soyabean and, sometimes, groundnut.

Specifically, in Bimbilla District, yams are grown in pure stands and are the first crop in the rotation after the fallow period, other crops in Bimbilla District are mixed. Tillage is by hoeing, while planting is on the ridge (groundnut is grown on top of the ridge, maize by the sides while sorghum is broadcast in the furrow, a practice that ensures good sorghum establishment since patridges eat a good proportion of the seeds). Maize and groundnut are simultaneously planted while sorghum is sown 3 weeks later. Sorghum is frequently adversely affected by mid-season drought. Cassava and pigeon pea are normally planted in the periphery of the farm; other minor crops are millet and bambara nuts.

In the Wa and Nadowli Districts, there are three tillage practices:

(i) ridging with ox-drawn plough; (ii) mounds made by hoe-farmers; and (iii) land clearing and subsequent planting on the flat. In the two districts, soyabean, cotton and, sometimes, cowpea are sole-cropped. The major cereals, in decreasing order of importance are sorghum, millet, maize and rice. The minor crop is bambara nuts, intercropped with other legumes or with cereal in cereals-dominated mixtures.

In Bimbilla District, farmers plant yam after the fallow, followed by maize/sorghum plus groundnut intercrop which is followed by sole crop sorghum or by sorghum/millet mixture.

In Wa and Nadowli Districts, farmers apply cow dung which is transported to the farm in ox-or donkey-drawn carts. Application of organic manure in Bimbilla District is rare, apparently because of the low population pressure on the land.

Land fallowing is rare in Wa-Nadowli sector; where fallowing is forced on the farmer, its period hardly exceeds two years. In Bimbilla District, the fallow period is between 5 to 15 years.

Livestock and crop integrated enterprises

In both areas, free-ranging of sheep and goats is the normal practice; however, the number of animals per farm-family is much lower in Bimbilla District than in Wa-Nadowli Districts. Cattle and donkey and used in Wa-Nadowli Sector for traction, transportation and for provision of farm-yard manure.

Land is prepared by hoeing in Bimbilla District and planting is done on the ridge (groundnut is sown on top of the ridge, maize by the sides and sorghum is broadcast on the furrow); maize and groundnut are planted simultaneously, while sorghum is sown 3 weeks after planting of maize and groundnut. In Wa and Nadowli Districts, land is prepared either by animal traction or by hoeing; planting is done on the ridge, mound or on the flat.

Fertilizer application: There is limited use of inorganic fertilizer, the quantities applied vary with the farmer's income. However, fertilizer application is restricted to cereals, especially maize. Indeed, fertilizers are not applied to sorghum/millet mixtures or to groundnuts. Cotton is sole-cropped and production inputs (including fertilizers and pesticides) are provided by the Cotton Development Board. On the whole, compound fertilizers are preferred, the following being the common (NPK) types: 15-15-15; 20-20-20 and 17-17-17 - being applied as basal treatments while suphate of ammonia is given as top dressing.

Crop protection measures: Generally, no specific crop protection measures are applied, except for cotton. A recent development in the Wa and Nadowli Districts is the spraying of sole-crop cowpea with insecticides by some farmers who have been convinced of the profitability of this input about 2 to 3 years ago.

Weed control is by hoeing and hand-pulling; herbicides are not applied. The Family is the main source of labour; when available, animal traction is used in Wa and Nabowli District. Hired labour is occasionally used during peak activities but costs are variable.

Labour costs. Very little hired labour is employed and costs vary a great deal. However, a common index is the cost of fertilizer required to produce 1 ha of maize; labourers (themselves farmers) charge the equivalent of the amount of money required to purchase fertilizers for 1 ha of maize in order to weed 1 ha of a crop.

Number of farmers within the project area: Data on the number of farmers in the project areas are available only for Bimbilla District which has about 2,500 farm families.

One of the relevant inputs here is artificial fertilizer which is sold to farmers through the Farmers' Services Supply Company as follows: NPK at 5,200 cedis/50 kg bag, and urea and (NH4)2S04 at 4,000 cedis/50 kg bag. The other inputs are insecticides for cowpea spraying, the common ones being Cymbush and Karate, each of which is sold at 6,000 cedis/litre.

Yields: The following yields are normally attainable at the farmer's level: maize - 3 tons/ha, using improved varieties and fertilizer; sorghum - 600 kg/ha; millet - 570 kg/ha; groundnut - 2 tons/ha of pods, using improved varieties at high crop density; cowpea 1.2 tons/ha, using insecticidal sprays (at least 2 sprays).

Implementation of Project Activities

The methodology used in the two sectors differed and, therefore, two separate accounts are given below.

In the Wa and Nadowli Districts: Farmers in these districts were asked to select any two of the three packages tested.

Package I. Objectives: (i) To test the feasibility of introducing millet as a third crop in an already existing system of sorghum/cowpea mixture, and (ii) to assess the economic feasibility of the cropping patterns.

There were three treatments, namely:

Treatment A: Farmers' current practice - sorghum (variety NSU-1) is sown on top of the mound while 4 hills of cowpea (Valenga variety) are planted halfway down the mound.

Treatment B: Same as treatment (A) but, in addition, local millet variety is planted between the mounds 2 weeks after cowpea.

Treatment C: Same as treatment (A) but with millet first planted in a nursery on the same day of planting cowpea and transplanted between the mounds 4 weeks later.

In each case, plot size was 5 x 3 m, with mounds spaced at 100 x 50 cm.

Five out of the 22 farmers accepted this trial, each farmer constituting a replicate, although the treatments were in replicates in each farm and the results will be analysed as a RCB design.

Package II: Cereal/legume Rotation

Objectives: (i) To demonstrate compatible cereal/cereal mixture (i.e. maize mixed with sorghum in a 1:1 ratio), and (ii) to demonstrate effects of legume/cereal rotations on soil fertility maintenance.

Each farmer constituted a treatment and results will be analysed as a RCB design. The following comprised the treatments:

Treatment A: Farmer's practice of mixing maize, sorghum and groundnut; they were mixed at random.

Treatment B: The plot was divided into two; In 1990 one half was sole crop groundnut while the other half was a maize/sorghum mixture. Note that in 1991 maize/sorghum mixture will be planted in the 1990 groundnut plot while groundnut will be sown in the 1990 maize/sorghum plot. In 1990, 60:30:0 kg/ha of N, P205 and K20, respectively of compound fertilizer was applied, the plot size being 20 x 20 m.

Package III

Objectives: (i) To introduce white seed-coat cowpea into a system in which the red-testa cowpea (Vallenga) is already popular and to test farmers' response to the white seed-coat cowpea, and (ii) to assess the economics of their production under farmers' conditions.

Three cowpea varieties, namely, Vallenga (IT82E-16) IT821D-1137 and IT83S-818) were planted either as sole crops (density 88,000 plants/ha) or in mixture with two varieties of sorghum (i.e.

Nsu 1 and Naga white) both medium duration varieties; seed of a short duration variety (Belko) were not available in 1990 but will be included in the 1991 trials. Sole crop sorghum was planted at 53,300 plants/ha.

Cowpea was sprayed twice with Cymbush in 1990 (at pre-flowering and post-flowering stages of growth); in 1991 a mixture of cymbush and dimethoate will be used - dimethoate could not be purchased in 1990.

In the Bimbilla District: One package, consisting of two treatments, was being studied.

Treatment I: Farmers practice of mixing maize, sorghum and groundnut (groundnut on top of the ridge, maize on the sides and sorghum on the furrow).

Treatment II: Improved practice:

In 1990, three rows of maize/sorghum mixture or three rows of groundnut were alternated with one row of pigeon pea. Thus, 3 rows of either groundnut or maize/sorghum mixture were planted between two rows of pigeon pea. Plot size was 22 x 10 m, such that each plot contained two, three-row units of either groundnut or sorghum/maize mixture, the inter row spacing being 1.1 m. Fertilizer was applied as basal and top dressings only to maize in the maize/sorghum mixture.

In 1991, the pigeon pea will be pruned two weeks before planting but only into the plot in which groundnut was planted in 1990. Then maize/sorghum mixture will be planted in the plot in which groundnut was grown in 1990 while groundnut will be sown in the plot that contained maize/sorghum in 1990. Also only top dressing with urea would be applied to maize.

For groundnut, two rows were planted on top of each ridge at an inter-row spacing of 20 cm (on the ridge) while the intra-row spacing was 10 cm. The inter-ridge spacing was 1.1. m. Maize was planted in a single row on the top of the ridge of 60 cm intra-row spacing. Sorghum was broadcast in the furrow but was later thinned to 27 plants per furrow of 10 m. Each of the 30 farmers applied each of the two treatments.

NIGER

Niger is one of the largest countries in the Sahel covering an area of 1,267,000 km2. Only about 15,000,000 ha is considered suitable for agricultural production. Sorghum, millet and cowpea are cultivated on over 6,000,000 ha. The total area of pasture land was estimated at 9,700,000 ha. Its magnitude of the pasture

area indicates the extensive nature of livestock production in the country. Rural population accounts for 85% of its 7.5 million inhabitants.

Project Area

1.0. Maradi.

The 12 farmers who participated in the project activities were selected from three villages (Kagadama, Tajaye and Takalmawa) in the Madarounfa Local Government Area in the Atchidekofoto District near Maradi. The number of farm-families in the three villages were estimated at 200, 150 and 450 for Tajaye, Kagadama and Takalmawa, respectively. These villages are located in the Sahel-Sudanian zone with mean annual rainfall of 400 mm. The soils are predominantly sandy loam of average fertility.

Farming Practices

The farmers traditionally cultivate a mixture of cereals viz. millet/cowpea, sorghum/cowpea, millet/sorghum/cowpea, and millet/groundnut. In addition, some crops are occasionally grown in pure stands, e.g., groundnut, cowpea, millet, cyperus and sorghum. Some farmers practise crop rotation; an ideal rotation starts with millet, followed by cowpea or groundnut, while cowpea is planted in the third year before the cycle begins again with millet or sorghum, each of which is often mixed with one of the legumes.

Farmers apply organic manure derived from cattle, donkey, goat, sheep and poultry. Farmers without large numbers of livestock sometimes invite Fulani cattle rearers to settle in their fields during the dry season to ensure that dung is deposited on their farms. Farmers apply limited quantities of various fertilizers (e.g., NPK, SSP, and urea) to "gero" millet; single superphosphate is given as basal application while urea is given as top dressing. The amount of fertilizer used depends on the purchasing power of the farmer. Single superphosphate and compound fertilizer (NPK) cost 1,500 CFA/50 kg bag while urea (surprisingly) costs 3,500 CFA/50 kg bag.

Only farmers with large plots can afford to leave land fallow for 2-3 years. The vast majority of farmers cultivate their land every growing season. Animals (ruminants) feed on crop residue and produce organic manure. Bullocks and donkeys are used in land cultivation and in transportation of produce and people. An interesting point is the use of bulls to draw water from very deep wells. Labour is provided by members of the farmer's family. During peak periods, family labour is supplemented with hired labour.

Implementation of the On-Farm Trials

Objectives:

i) To identify technological options to increase the yield of millet/sorghum intercrop based on traditional farmers' practice;

ii) To introduce improved agronomic practices in order to improve productivity of farmers.

iii) To familiarize the Extension Service and farmers with improved technologies.

The following trials were carried out by the 12 participating farmers:

Trial one: The traditional system of planting local varieties of cowpea and millet.

Trial two: Improved varieties of millet (CVT) and cowpea variety TN-5-78; with basal application of 100 kg/ha of single superphosphate.

Trial three: The crop varieties and planting pattern were similar to those of treatment 2. An additional input was the insecticide Cymbush ED, sprayed on cowpea only twice during the season.

2.0. Gaya Area of Niger

Eleven volunteer farmers were identified following two meetings with peseant farmers and extension agent representatives. Discussion with the farmers centred on the traditional and improved technologies as well as developing awareness of farmers' responsibilities to conduct trials and the cultivation of fields following recommended practices.

The farmers involved in the project are located in Sokondii Biirni village, 10 km off the town of Gaya (300 km south of Niamey). Situated in the Sudan-savanna, the village has an annual average rainfall of 750 mm. The soil is sandy. In the village, there are over 2000 farm families each with an average size of 7 members. Farm size varies from 3 to 4 ha.

Farming Practice

The dominant cereals are millet (the most important) and sorghum but there were small parcels of rice and maize. The main legume is groundnut grown in pure stand or in mixture with cereals. Cowpea is also grown as a secondary crop in the cereal-based

system. Yield of millet and sorghum (in mixture) average 700 and 250 kg/ha (i.e. total grain yield is 950 kg/ha).

Millet is frequently relay-cropped with sorghum but some farmers relay-crop early millet with late millet. There was no evidence of noticeable use of organic manure. Crop residue is used as animal feed or/and as construction materials. There was little evidence of land fallow around the homesteads. The main ruminant kept is cattle, oxen being used for carting of produce.

Traditionally the farmers do not apply any fertilizers, nor do they employ any crop protection measures, apart from hoeing and hand-pulling to remove Striga and other weeds. Labour is provided mostly by members of the family but some farmers hire labour at 750 CFA per day, with provision of meals, or 1,000 CFA per day, if meals are not provided. Bulls are used mostly for carting humans and produce.

As noted above, the number of farming-families within the project area is 1,996. Each family, on the average, comprises seven members (two parents plus five children).

Although farmers do not traditionally use fertilizers, the project provided fertilizers for the trials. As already noted, the average annual grain production per ha is 950 kg (700 kg of millet plus 250 kg of sorghum).

Implementation of On-Farm Trials

The study comprised five treatments (T1-T5) each of which was replicated 11 times (the farmers served as replicates, i.e., there were 11 farmers in the study). The treatments were as follows:

T1. Farmers' traditional practice of millet/sorghum intercropping, usually including intercropping of local varieties of millet and sorghum.

T2. Improved traditional method where mineral fertilizer: 20 kg P205 + 46 kg N/ha was applied on millet and sorghum.

T3. Intercropping of an improved millet (CIVT) and sorghum variety (BKC).

T4. Improved package with mineral fertilizer: 20 kg/ha P205 applied on sorghum and millet.

T5. Complete package: In addition to 20 kg/ha of P205 + 45 kg/ha of N was applied on millet and sorghum intercrops.

Status of Project Implementation

Both project activities in the Maradi and Gaya areas were

implemented according to the approved proposal, except that the treatments were not replicated in the 11 farms because the farmers were reluctant to commit more of their land to the trial. Being a new idea, they were not sure of its likely benefits. Instead of sowing two plots of each treatment in each farm, the researcher decided to sow only one plot. Since each farm constituted a replicate, this modification would not invalidate statistical analysis of the results of the trial.

Project objectives, in general, have been attained. The main lesson conveyed by the 1990 trial was that both millet and sorghum (both improved and local varieties) responded to N fertilizer application while there was no response to P205.

CAMEROON

The most important factor affecting crop yields in the lowland savanna is usually insufficient and/or erratic rainfall. In this region of Cameroon, sorghum is cultivated on about 400.000 ha while the area cultivated to maize covers nearly 42.000 ha. Both crops are grown by small farmers usually in rotation with cotton and legume crops. The major production constraints of food grain in the semi-arid zones of Northern Cameroon are low levels of soil fertility due to the apparent low content of soil organic matter, particularily on the sandy alfisols and low available phosphorus; poor crop stand establishment related to high levels of soil insect pest infestations and inadequate soil physical conditions.

The annual rainfall is quite variable from 573 mm (in 1987), to 1329 mm (in 1988), with a long-term average of 925 mm.

Project Implementation

The main purpose of the technology verification trials was to introduce extra-early (75-80 days) and early (80-90 days) maturing varieties of maize and improved agronomic practices to fill gaps of food shortage during certain months of the year.

A set of research activities on early maize were conducted both on-station and on farmers' fields. The objectives of these activities are:

1. To expose the farmers to early cycle materials,

2. To understand better various production constraints in growing early and extra-early maize on different agroecological zones of the semi-arid lowland savanna.

3. To improve our knowledge with the aim of making further valid recommendations to farmers on plant density, nitrogen requirements and on appropriate time of fer-

tilizer application on this early material (as actual recommendations were those developed for medium and late maturing maize cultivars).

Despite a late establishment of the rains and their very erratic nature, verificative trials were still carried out.

The project area covers the North and Far-North Provinces, within a range of rainfall between 500 and 1000 mm. A network of 20 experiments off-(6) and on station (14) was established between 4 July in the North Province and 16 July in the Far-North Province with the experimental unit being a quarter of an hectare. The themes under study were:

1) Plant density on early maize.

Three population levels, 42,000, 50,000 and 62,500 plants/ha were tested on early and extra early materials.

2) Timing of N side-dressing on early maize.

After a basal application of complete fertilizer, 5-8 days after emergence, maize performance was evaluated with the application of N at intervals of 20, 25, 30 and 35 days after plant emergence.

3) Demonstration and seed multiplication plots on early maize.

In addition to the pool of (20) experiments included under the themes above, 2 early-maize seed multiplication plots and 4 demonstration plots with early maize were set up.

Some of the objectives of these were:

- to deliver early maize varieties to farmers and to compare its performance to that of other materials used in different areas.
- to get some feedback from farmers on early or extra-early materials.
- to assess the main constraints (soils, climate, nutrients, pests or diseases,.) on early maize production in the area.
- to conserve enough seed to satisfy a further demand from farmers.

Sites for SAFGRAD Experiments

Sites	Trials
1. Sanguere on-farm trial (OFT) (Farmer NYA)	Population on early maize Timing N side-dressing on early maize
2. Djalingo (11) OFT (Farmer CYNFAY)	Timing N side-dressing on early maize Demonstration of early maize
3. Mayo Dadi OFT (Farmer BALE)	Timing of N side-dressing on early maize Demonstration of early maize
4. IRA Sanguere	N x population on early maize Timing of N side-dress on early maize Seed multiplication of early maize
5. IRA Bokle	Demonstration of early maize
6. IRA Pitoa	Demonstration of early maize
7. NCRE Djalingo	N x population on early maize Seed multiplication of early maize Demonstration of early maize

Trials in LANAVET (BOKLE)

8. Plant populations
9. Timing of N application
10. Nitrogen x population
11. Soucoundou
    - plant populations
    - Timing of Nitrogen application
    - Nitrogen x population
12. Mouda
    - plant populations
    - timing of N application.

SENEGAL

The climate in Senegal is predominantly Sahelian in the North (300-600 mm annual rainfall) and Sudano-Guinean in the South (700-1600 mm in Casamance). It covers an area of 196,860 km² with an estimated population of 7.6 million inhabitants of which 65% are in rural areas. Estimated cultivable land in Senegal is in the range of 3,750,000 ha.

The major crops cultivated are groundnuts, which accounts for more than 40 percent of export revenue, occuping close to 50 percent of the cultivated land. Other important crops include millet, sorghum, rice, maize, cowpea, etc.

Some progress has been made in the identification of improved cultivars of cowpea at Bambey Research Station. Through the financial assistance of the project, on-farm trials were conducted in four villages namely: Bambey, Louga, Thilmaka and Ndiol with an average rainfall of 410, 287, 277 and 154 mm, respectively.

The verification trials comprised four cowpea varieties (IS-86-275, Ndiambour 58-57 and Bambey 21) and plant protection measures to minimize damage caused by insects such as Amsacta moloney which had caused severe damages in Louga. Other insects that were observed in Bambey and nearby sites included aphids (Aphis craccivora) and thrips (Megalurotrip sjostedti). Virus and bacterial diseases (Xanthomonas vignicola) were observed on the varieties 58-57 and Bambey 21, respectively.

The yield performance of cowpea varieties during the 1990 growing season was generally low due to the apparent moisture stress. The variety IS-86-275 was the highest yielder, revealing its adaptation to drought conditions. It was also found to be tolerant to bruchids, resistant to bacterial blight and viruses. Furthermore, preliminary socio-economic investigations revealed that farmers prefer this variety for its grain quality.

MALI

Millet, sorghum, rice, maize, groundnut, cowpea and bambara nut are the major food grains cultivated in Mali. Millet and sorghum constitute 72% (1,800,000 ha) of the area cultivated to cereals. During the last few years, however, the production of maize has increased due to its high yield potential among the cereals. The development of early and extra early maturing cultivars of maize has shown good promise for the expansion of its production in the Sudano-Guinean zone. It is mainly used in the staple diet and as "green maize" during periods of food shortage.

Maize production in Mali was estimated at 153,000 metric tons on 129,000 ha in 1989. Improved maize varieties including Tuxpeno NO. I and Tiémantié, have been adapted to the Sudano-Guinean zone by farmers where more than 50% of the maize is produced. In the Central and Western region, including the semi-arid area of Mali, the area under maize production has increased significantly. This region is characterized by a low and irregular rainfall and low input farming conditions. The purpose of the verification trials on maize was to package technologies suitable to the environmental and economic conditions of farmers. The principal objectives were:

- To test local and introduced improved maize varieties from SAFGRAD and other sources under different agroecological conditions;
- To minimize the effects of environmental and biotic constraints to maize production in the region;
- To identify and develop suitable maize varieties for the Sudanian zone.

Five locations representing major recommendation domains have been identified. Researcher-managed trials including local improved maize cultivars and varieties from SAFGRAD have been tested in each of the 5 locations (Sotuba, Longorola, Kita, Katibougou and Massantola) to cover a range of the environmental characteristics including rainfall pattern, soil moisture, soil nutrient levels, etc. (Table 4).

The material tested included varieties with different cycles (intermediate, early and extra early), different grain colours (yellow and white), etc.

The 1990 growing season has been characterized by a low rainfall and poor atmospheric conditions. The low moisture distribution might have contributed to the apparently low yields.

Table 4. Environmental Characteristics of the Different Test Locations in Mali.

Experimental Sites/Station	Longorola	Sotuba	Kita	Katibou-gou	Mas-santola
Latitude	11:21	12:39	13:04	12:56	13:30
Longitude	5:41	7:56	9:27	7:32	7:48
Varieties tested	Inter.	All	Early	E-early	E-early
Annual rainfall (mm)	997.9	827.2	758.7	762.4	591.5
Number of rainy days	86	57	50	67	14

During the growing season, farmers and extension agents were invited to visit the experimental fields across locations. The data on grain yield and other growth characteristics is being analyzed for the annual report. Three potential out-yielding varieties have been identified within each set of trials (early and extra-early materials). These varieties included:

DMRESR-Y (early), TZEF-Y (extra early), TZPBSR (intermediate).

The three varieties out-yielded local varieties with similar growth cycles. In 1991 these best performing varieties would be compared to local maize varieties under farmers' agricultural practices.

Seeds of the best performing varieties will be multiplied during the off-season (December-April) under irrigation at the Cinzana Research Station, located 265 km north of Bamako. Five farms will be identified within each of the five recommendation domains within the region (April-May 1991). Short training sessions will be organized within each recommendation zone for extension agents and farmers to introduce the packages of technologies on maize production. Adaptive varietal trials will be conducted on each of the 25 farms identified within the project area to cover a cross-section of the environmental variabilities.

Expected Output of the Project would be to:

(i) Enhance the availability of suitable crop production technologies for resource poor farmers in semi-arid regions;

(ii) Strengthen technical linkages and feedback between on-station and on-farm extension research to adapt technologies in order to fit farmers' needs and resources;

(iii) To improve on-farm verification skills and methods in order to enable participating national programmes evaluate and adopt technologies to their environmental and socio-economic conditions;

(iv) To facilitate farmers' participation in the evaluation of technologies;

(v) Contribute towards food self-sufficiency and security.

1990

FOOD GRAIN PRODUCTION TECHNOLOGY VERIFICATION PROJECT

AU-SAFGRAD

AU-SAFGRAD