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FOOD GRAIN PRODUCTION TECHNOLOGY PROJECT REPORT

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SAFGRAD

Semi-Arid Food Grain Research And Development
(SAFGRAD)

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ACKNOWLEDGMENTS

One of the major thrusts of SAFGRAD activities has been the strengthening of the technology transfer process of national agricultural research systems. The Food Grain Production Technology Verification Project was implemented through the genuine cooperation and partnership of the NARS of Burkina Faso, Cameroon, Ghana, Mali, Niger, Nigeria, Senegal and Togo. The project encompassed " research-extension-interphase" activities on narrowing the "yield gap" of the performance of crop production technologies between on-station research and that on farmers' fields. The collaboration and exchange of technologies among NARS has been a fruitful and productive exercise. In the total effort to speed up the process of transforming research results into extension recommendations and production, OAU/STRC-SAFGRAD wishes to express its appreciation to the African Development Bank for its financial assistance.

Dr. J.M. Menyonga
International Coordinator

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REMERCIEMENTS

L'un des principaux axes des activités du SAFGRAD a consisté à renforcer le processus de transfert de technologies des systèmes nationaux de recherche agricole. Le Projet de Vérification des Technologies de Cultures Vivrières a été exécuté grâce à la coopération sincère et au partenariat des SNRA du Burkina Faso, du Cameroun, du Ghana, du Mali, du Niger, du Nigeria, du Sénégal et du Togo. Ce projet a englobé les activités de recherche/vulgarisation visant à réduire le " fossé de rendement " observé dans la performance des technologies de production agricole en station et dans les champs des paysans. La collaboration et l'échange de technologies entre les SNRA ont été un mécanisme fructueux et productif. L'OUA/CSTR-SAFGRAD exprime sa profonde gratitude à la Banque Africaine de Développement pour son assistance financière à l'ensemble de ces efforts tendant à accélerer le processus de transformation des résultats de recherche en recommandations de vulgarisation et de production.

Dr. J.M. Menyonga
Coordinateur International

Novembre 1991.

EXECUTIVE SUMMARY

This report highlights the 1990/91 activities of on-farm verification trials carried out in eight countries, namely Burkina Faso, Cameroon, Ghana, Mali, Niger, Nigeria, Senegal and Togo, through the financial assistance of the African Development Bank.

The operational objective of the project is not only to improve the functional linkages between researchers and extension agents, but also to narrow the yield gap resulting from differences in the performance of similar technologies carried out on-station and on-farm.

In Burkina Faso, on-farm verification trials were conducted in 11 districts covering the three main ecological zones (Sahel, Sudan and Northern Guinea Savannas). With both improved and locally adapted cultivars, the trials showed that cowpea yield could substantially be increased.

The varieties KVx-396-4-4, TVx 3236, KVx 61-1 and KN-1, a locally improved cultivar, were found promising in different provinces of Burkina Faso. Furthermore, the advantages of insecticide application (to control cowpea pests) were established on most of the sites where trials were conducted.

In Cameroon, the project emphasis has been to develop packages of agronomic practice for early and extra-early maturing maize cultivars. Under the conditions in Northern Cameroon, the results obtained showed that the highest yield was obtained when 2/3 of the Nitrogen fertilizer was top dressed 20-25 days after plant emergence. In Northern Cameroon, the effect of plant population on maize yield was investigated. Higher plant density (80 x 20 cm) was recommended in order to compensate for poor stand due to poor germplasm, lodging, soil insect damage, etc. With an early maize cultivar (DMR-ES-R-Y), tied and simple ridges gave the highest

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Le présent rapport fait le point des essais de vérification en milieu paysan conduits en 1990/1991 dans huit pays, à savoir, Burkina Faso, Cameroun, Ghana, Mali, Niger, Nigeria, Senegal et Togo, grâce à l'assistance financière de la Banque Africaine de Développement.

En lançant ce projet, l'objectif n'était pas seulement d'améliorer les liens fonctionnels entre les chercheurs et les agents de la vulgarisation mais de réduire également le fossé de rendement résultant des differences de performance de technologies similaires appliquées en station et en milieu paysan.

Au Burkina Faso, les essais de vérification en milieu paysan ont été réalisés dans 11 districts représentant les trois principales zones écologiques (Savanes Sahélienne, Soudanienne et Nord Guinéenne). Les essais ont démontré qu'il était possible d'accroître considérablement les rendements du niébé avec des cultivars améliorés aussi bien qu'avec des cultivars localement adaptés.

Les variétés KVx 396-4-4, TVx 3236, KVx 61-1 et KN-1, un cultivar localement amélioré, se sont avérées prometteuses dans différentes provinces du Burkina Faso. Par ailleurs, dans la plupart des sites où les essais ont été menés il a été établi que l'application d'insecticide (pour éliminer les insectes nuisibles du niébé) présentait des avantages.

Au Cameroun, l'axe du projet a consisté à mettre au point des paquets de pratiques agronomiques pour les cultivars de maïs précoces et extra-précoces. Dans les conditions du Nord Cameroun, les résultats ont révélé que le rendement le plus élevé s'obtenait lorsque 2/3 de la dose d'engrais azoté étaient appliqués en surface 20-25 jours après l'émergence des plants. Dans le Nord Cameroun, l'effet de la population de plants sur le rendement du maïs a été étudié. Une densité plus forte (80 x 20 cm) a été recommandée pour compenser la faiblesse du peuplement due à la

yields of 6.6 and 6.0 tons/ha, respectively.

Various cropping systems were evaluated in Northern Ghana. The grain yield of alley-cropped maize under pigeon pea varied from 1626 to 2030 kg/ha in Nakpa and Binda villages, respectively.

In Mali, an agronomic evaluation on the adaptability of early and extra-early maize cultivars was investigated. Some promising cultivars were identified for different locations in the country.

In Niger, improved and traditional millet/sorghum-based cropping systems were evaluated. It was observed that the yields of improved varieties in sorghum/millet mixtures under improved management (with application of phosphorus fertilizer) gave higher yields than traditional practice.

In Northern Nigeria, on-station agronomic trials included testing for appropriate varieties for sorghum/millet/cowpea mixtures; maize/cowpea cropping systems and determination of fertilizer rate (NPK) for maize/cowpea crop mixtures. The result indicated that cowpeas grown under KSU-8 (improved sorghum variety) yielded better than under a traditional variety, Farafara. Sorghum cultivar KSU.8 yielded significantly more than the local cultivar Farafara. In intercropping of maize/cowpea, the yield of the legume was reduced substantially mainly due to moisture stress. With regard to effect of fertilizer on maize/cowpea cropping system, the results showed that grain yield of maize was increased with increased Nitrogen. In contrast, increased application of N, depressed the grain yield of cowpea significantly while positive cowpea yield response to phosphorus (P), up to 80 kg P205/ha, was obtained.

In Senegal, verification trials on millet production technologies were carried out in the three regions, namely Kaolack, Fatick and Diourbel. Under farmers' management conditions, improved millet variety (Souna-3) yielded significantly more than *mauvaise qualité du germoplasme, à la verse, aux dégâts des insectes du sol etc. Avec un cultivar de maïs précoce (DMR-ES-R-Y) les billons cloisonnés et simples ont permis d'obtenir respectivement les rendements les plus élevés de 6,6 et 6 tonnes/ha.*

Differents systèmes culturaux ont été évalués dans le Nord Ghana. Le rendement en grain du maïs cultivé en couloirs sous le pois d'angole variait de 1626 à 2030 kg/ha respectivement dans les villages de Nakpa et Binda.

Au Mali, l'évaluation agronomique de l'adaptabilité des cultivars de maïs précoces et extra-précoces a été faite. Quelques cultivars prometteurs ont été identifiés pour différentes localités du pays.

Dans le Nord Nigéria les essais agronomiques conduits en station comportaient l'expérimentation de variétés appropriées pour les associations sorgho/mil/niébé, les systèmes d'association maïs/niébé et la détermination de la dose d'engrais (NPK) pour les associations maïs/niébé. Les résultats ont montré que le niébé cultivé sous KSU-8 (variété améliorée de sorgho) donnait un rendement meilleur à celui d'une variété traditionnelle, Farafara. Le rendement du cultivar de sorgho KSU-8 était significativement supérieur à celui du cultivar local Farafara. Dans l'association maïs/niébé, le rendement de la légumineuse était considérablement réduite surtout à cause du stress d'humidité. En ce qui concerne l'effet de l'engrais sur le système d'association maïs/niébé les résultats ont fait ressortir que le rendement en grain du maïs augmentait lorsque la dose d'azote était augmentée. Par contre, l'application d'une dose plus forte de N réduisait significativement le rendement en grain du niébé, tandis que la réponse de rendement du niébé au phosphore (P) jusqu'à 80 kg de P_2O_5/ha était positive.

Au Sénégal des essais de vérification des technologies de production du mil ont été conduits dans trois régions, à savoir Kaolack, Fatick et Diourbel. Dans les conditions paysannes, la variété de mil améliorée (Souna-3) a donné un rendement *the local cultivars. The verification trials on cowpea consisted of four varieties (IS-86-275, Ndiambour, 58-57 and Bambey 21) and plant protection measures to minimize damage caused by insects such as <u>Amsacta</u> <u>moloney</u> which cause severe damage in Louga. In Thilmakha and Sine, IS 86-275 yielded the highest, with an average grain yield of 757 and 675 kg/ha, respectively. Across the four villages evaluated, the mean yield of IS 86-275 was 512 kg/ha.*

In Northern Togo, trial results suggested that appropriate varieties of cowpea and sorghum for intercropping of these crops were identified as indicated in the value of the total Land Equivalent Ratio (LER) of 1.46 for the sorghum/cowpea mixture or intercropping. The cost benefit analysis, however, showed highest net income returns with pure or sole cowpea cultivation which was closely followed by the sorghum/cowpea mixture.

Furthermore, agronomic planning and review workshops were organized from 19-22 February, 1990 and on 29-31 May, 1991 where scientists and research managers from ten countries, regional and international organizations participated.

significativement supérieur à celui des cultivars locaux. Les essais de vérification pour le niébé comprenaient quatre variétés (IS-86-275, Ndiambour, 58-57 et Bambey 21) et des mesures de protection des plantes destinées à minimiser les dégâts provoqués par des insectes tels que Amsacta moloney qui sont très nuisibles à Louga. A Thilmakka et Sine, IS 86-275 a donné les rendements les plus élévés avec respectivement une moyenne de rendement en grain de 757 et 675 kg/ha. Sur l'ensemble des quatre villages où l'évaluation a été faite, la moyenne de rendement de IS 86-275 était de 512 kg/ha.

Dans le Nord Togo, les résultats des essais indiquent que des variétés de niébé et de sorgho appropriées pour l'association de ces cultures ont été identifiées comme l'atteste la valeur du Rapport Total Equivalent-Terre (LER) de 1:46 pour l'association sorgho/niébé. Cependant, l'analyse coût/bénéfice a fait ressortir des rapports nets plus élevés avec la culture pure du niébé, rapports suivis de près par ceux de l'association sorgho/niébé.

Des ateliers de programmation et d'évaluation agronomique ont en outre été organisés du 19 au 22 Février 1990 et du 29 au 31 Mai 1991. Des chercheurs et des administrateurs de la recherche de dix pays et d'organisations régionales et internationales ont pris part à ces ateliers.

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INTRODUCTION

The project activity was initiated following an agronomic planning workshop that was held from 19 to 22 February 1990, in Ouagadougou, Burkina Faso. The main achievements of the above mentioned workshop were:

a) *The inventory of available and potential technologies;*
b) *The identification of biotic and abiotic constraints to the production of food grains;*
c) *The exchange of technical information and experiences regarding the transfer and adoption of technologies and,*
d) *The review of the project proposals and planning on-farm verification trials for 1991 crop season.*

The project encompasses "a research-extension-interphase" activities. The major emphasis has been on narrowing the "yield gap" of the performance of crop production technologies between on research stations and on- farmers' fields. In this regard, the effort is to motivate agronomists to play a key role by working very closely with breeders, soil-fertility and management experts, plant protection specialists, etc. and concurrently liaise with the activities of extension agronomists.

On-station verification trials focused on testing improved agronomic practices as well as on the identification of potential technologies.

In 1990/91, the on-farm food grain production technology verification trials supported through the African Development Bank were conducted in eight countries as summarized in Table 1.

Since the droughts of mid-1970's and 1980's, the crucial problem engulfing most countries in the sub-Saharan African has been the attaining of food self-sufficiency and security.

SAFGRAD's major thrust of activities has therefore been, to increase the production and productivity of food grains (i.e sorghum, millet, maize, cowpea, groundnuts etc) through improved agronomic practices.

The main objectives of the project are:

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

ii) To promote on-farm and on-station verification 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 production.

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

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 Rurale (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).

HIGHLIGHTS OF THE AGRONOMIC VERIFICATION TRIALS RESULTS.

1.0. Burkina Faso : On-Farm Evaluation of New Cowpea Varieties.

The 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 inhabitants/km² of the country, covering an area of 94,000 km². The mean density in the agricultural area, however, was estimated at 100 inhabitants/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.

On-farm verification trials were conducted in 11 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 ninenty seven

(197) 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. 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. In addition, donkeys are used mainly for transportation of farm produce and goods and, occasionally, for traction.

The following cowpea varieties were evaluated.

Table 2. Improved Cowpea Vaireites Evaluated in Different Ecological Zones of Burkina Faso.

Cowpea variety	Suitable rainfall range (mm) for production	Recommended method of planting
KVx 30-309-9G	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.

The trials had two main objectives: (i) to evaluate (under farmers' management practices) the performance of new varieties and (ii) to determine minimum insecticide spray requirements in different parts of the country so as to minimize frequency of spray and cost of cowpea production.

In general, the following on-farm verification trials substantiated that cowpea yield could be increased from 100% to 300%.

In the Sahel Province, Gorom, an improved check cultivar gave the highest yield 1792 kg/ha. It was followed by varieties, KVx 396-4-4, TVx 3236 and KVx 61-1 that produced 1704, 1544 and 901 kg/ha respectively.

In North Province, the result of 45 on-farm trials is summarized below. Cowpea varieties were grown in mixture with either sorghum or millet. KN-1 produced only 72% (256 kg/ha) of the grain yield of the local variety. The varieties TVx 3236, KVx 396-4-4 and KVx 61-1 gave yield of 537, 521 and 483 kg/ha respectively. The yield of local check was 493 kg/ha. The cereals mixed with KVx 61-1 and TVx 3236 produced 53% more grains than those under the local variety while those under KVx 396-4-4 produced 45% more grains and the largest quantity of fodder.

In Mouhoun Province, KN-1 was again the ckeck variety and varieties were grown in mixture with sorghum. The new varieties outyielded KN-1; KVx 396-4-4 outyielded it by 27%, compared to 13% and 12% for KVx 61-1 and TVx 3236 respectively. Sorghum in mixture with cowpea variety KVx 396-4-4 gave better yield 1300 and 322 kg/ha for the cereal and the legume respectively.

In Central Province (mean annual rainfall was 700 mm), only TVx 3236 and KVx 396-4-4 were evaluated together with the local check. The average yields of KVx 396-4-4 and TVx 3236 were 891 and 606 kg/ha compared to 555 kg/ha produced by the local check. In West-Central Province (average annual rainfall was 800 mm) the yields of KVx 396-4-4, TVx 3236 and KN-1 were not significantly different. The variety KVx 396-4-4 significantly outyield (800 kg/ha) the local check (588 kg/ha). In East-Central Province (mean annual rainfall was 900 mm), KVx 396-4-4 and KN-1 produced *significantly more grain yield 1271 and 1119 kg/ha respectively than TVx 3236 (which was severely damaged by Striga) and the local variety that gave yield of 763 and 410 kg/ha respectively. In fact, KVx 396-4-4 produced 210% more grain yield than the local check.*

In South-Central province (annual rainfall was 700-900 mm) the local cultivar gave yield of 577 kg/ha which was significantly lower than KVx 396-4-4, KVx 61-1 KN-1; TVx 3236 with mean yield of 918, 827 and 615 kg/ha respectively. In North-Central Province, KVx 396-4-4 and KVx 61-1 produced 692 and 611 kg/ha respectively which out yielded the local variety by 73% and 52%, respectively.

In Hauts Bassins province (annual rainfall was 800 mm), three improved varieties evaluated KVx 396-4-4, TVx 3236 and KN-1 gave better yield (640, 622 and 682 kg/ha respectively) compared to the local variety which had a mean grain yield of 440 kg/ha.

Results from the West-Central province showed again that, the grain yields of TVx 3236 (706 kg/ha), KN-1 (703 kg/ha) and KVx 396-4-4 (667 kg/ha) were not significantly different from each other, eventhough all the three varieties out-yielded the local check which had a mean grain yield of 495 kg/ha.

Insecticide Application Requirements for the Control of Insect Pests on Cowpea.

The tests were conducted in farmers' plots in the Sahel, East Central, Mouhoun and Hauts Bassins Provinces. In each village, 5 to 10 farms participated. In the Sahel, the yields of the unsprayed plots varied from 361 kg/ha to 2361 kg/ha for Pobe Mengao and Bani villages respectively. The yield of sprayed plots varied from 528 kg/ha for Pobe Mengao village to 3653 kg/ha for Bani village. Thus, the additional grain yield due to insecticide application varied from 167 kg/ha to 1292 kg/ha for Pobe Mengao and Bani village respectively.

In Hauts Bassins Province, in the other 12 sites (villages), the benefit from insecticidal spraying, expressed as a percentage of the yield of the non-sprayed plot varied from 34% for Sarkadiala village to 51% for Kourouma village. In the seven of the 12 villages, the yield advantage of the sprayed plots was less than 25% compared to unsprayed plots. More farmers trials on pest control would be necessary to further substantiate the results.

Farmers were receptive to the innovations introduced to increase cowpea production. These include improved cowpea varieties and pest control. For example, farmers were extremly pleased with earliness and good yield of the improved varieties. The participating farmers had sprayed insecticides as recommended and also observed the substantial yield difference between sprayed and untreated cowpea plots.

2.0. Cameroon: *Development of Agronomic Packages for the short-cycle Maize Cultivars.*

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, particularly 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.

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 increase production in order to "fill gap" of food shortage during certain months of the year.

The main objectives of the study were: (i) To determine the appropriate rate and timing of Nitrogen (N) fertilization for these varieties; (ii) To determine the optimum plant populations for the *varieties; and (iii) To develop appropriate weed management practices for the short-cycle maize varieties.*

Results: The 1990 cropping season in the savanna ecological zones of Cameroon was characterized by insufficient, and erratic rainfall. Drought occurred at the begining of the third week of September and contributed to increased risk of crop failure, particularly in areas stretching from the isohyete 700 mm northwards where moisture stress occurred at the milky stage of the grain development. Results of the various trials are briefly discussed.

Time of Application of N Fertilizer. As summarized in Table 3, the results obtained accross various locations showed that, the highest yields were obtained when urea N was topdressed 20-25 days after plant emergence of early or extra-early maize varieties. For example, the yield of the maize var. DMR-ESR-Y was 4.9, 4.4 and 4.0 tons/ha by N fertilization after 20, 25 and 30 days of plant emergence. The results suggest that topdressing with nitrogen may be given earlier for early or extra-early maize than the present recommendation for medium or late maturing maize in which N top-dressing is given 30-35 days after emergence. On some relatively heavier soils with a relatively high humus content, delaying N topdressing up to 25-30 days after emergence may be advisable.

Table 3. Effect of different timings of N topdress application on grain yield of early maize variety in the semi-arid lowland savanna of North-Cameroon.

	Location		
Sites/ Treatments	Bokle (Var DMR.ESR-Y)	Soucoundou (Var. Pool 16 DR SR)	Mouda (Var. Pool 16 DR SR)
T1 (20 DAE)	4.860 kg/ha	2.852 kg/ha	1 872 kg/ha
T2 (25 DAE)	4.391 kg/ha	2.669 kg/ha	1.465 kg/ha
T3 (30 DAE)	4.070 kg/ha	2.226 kg/ha	1.784 kg/ha
T4 (35 DAE)	3.922 kg/ha	2.396 kg/ha	1.105 kg/ha
T5 (No N topdr.)	4.431 kg/ha	2.357 kg/ha	1.585 kg/ha
Note DAE = Days after emergence.	C.V. = 11.9%	C.V. = 16.2%	C.V. = 22.6%

The effect of plant population on the yield of an early and extra-early Maize Varieties was also studied. As indicated in Table 4, better yields were obtained at the highest plant population density (80 x 20 cm). Furthermore, it is also advisable to plant dense in order to compensate for poor plant stand establishment due to lodging, soil insect and disease damages.

Table 4. Effect of different plant population densities on the yield on two early maize varieties in the semi-arid lowland savanna of North-Cameroon (1990).

Treatm.	Varieties	Spacing	Location		
			Bokle kg/ha	Soucoundou kg/ha	Mouda kg/ha
T-1	DMR-ESR-Y	80x20 cm	4.221	3.283	2.226
T-2	DMR-ESR-Y	80x25 cm	4.277	3.165	2.426
T-3	DMR-ESR-Y	80x30 cm	4.184	3.030	2.064
T-4	Pool16DRSR	80x20 cm	2.972	2.810	2.625
T-5	Pool16DRSR	80x25 cm	2.893	3.114	2.611
T-6	Pool16DRSR	80x30 cm	2.464	2.708	2.609
			C.V. = 9.6%	C.V. = 18.7%	C.V. = 27%

Rates of 0, 45, 90 and 135 Nitrogen (N) were combined with plant spacing of 20, 25 and 30 cm in a randomized complete block design. In most trials, maize variety yields responded significantly to increase N and population rates.

The highest yields seem to be achieved when maize plants are 20 cm apart on the row with a fertilization rate of 90-135 N kg/ha. Trials in Soucoundou and Bokle had a high C.V. and that could mainly explain the failure of the test to reveal sometimes significant differences between N or population levels.

Table 5. Effect of N x population on grain yield of early and extra-early maize varieties (1990).

Treatm.	N rates	Spacing	Location: Bokle DMR ESR Y	Location: Bokle TZEF-Y	Location: Soucoundou DMR ESR-Y	Location: Soucoundou Pool16DRSR
1	0	20 cm	2.783	1.463	1.449	1.783
2	0	25 cm	2.366	1.037	1.525	1.624
3	0	30 cm	2.505	1.223	1.411	1.545
4	45	20 cm	3.626	1.596	1.868	2.219
5	45	25 cm	3.191	1.915	1.773	1.941
6	45	30 cm	2.931	1.383	1.506	1.922
7	90	20 cm	4.008	2.500	2.174	2.437
8	90	25 cm	4.137	2.261	1.983	2.358
9	90	30 cm	3.646	1.623	1.812	2.040
10	135	20 cm	4.370	3.006	2.536	2.873
11	135	25 cm	3.979	2.261	2.231	2.437
12	135	30 cm	3.683	2.048	2.193	2.338
			C.V.=15.8%	C.V.=18.8%	C.V.=45%	C.V.=37.5%

Studies on the effect of land preparation methods involving an early maturing maize variety, DMR-ESR-Y, was carried out in plots given different cultivation treatments, namely: conventional tillage (i.e. ploughing and harrowing), combined with simple or tied ridges; chiselling; and no-tillage. Plants grown in plots prepared by conventional tillage, be it combined with tied or simples ridges, yielded the highest, 6.6 and 6.0 t/ha at Djalingo area for tied and simple ridges, respectively at Djalingo area.

The differential response of an early maize variety, DMR-ESR-Y, and a medium variety, CMS 8501 to weed control management *practices was also evaluated. For the early maize variety, higher yields were obtained with two hoe-weedings at 2 and 4-5 weeks after emergence, or herbicide application (Lasso GD at 4 liters/ha) at planting time followed by one hoe weeding at 4 weeks after emergence. For the medium variety, hoe weeding at 3 weeks after emergence or two hoe weedings at 2 and 4-5 weeks after emergence appeared to be the most appropriate weed management practices.*

Furthermore, survey of 800 farm families indicated very good acceptance of the short cycle maize varieties for their earliness to maturity and "taste" preference as green maize to fill "gaps of food shortages" during hunger period before the harvest of main crops such as sorghum and millets. Because of the acceptance of early maturing maize cultivars, seed has been increased to meet the demand of several farmers.

3.0. Ghana.

The trial sites included:

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 Nodowli Districts. Because of the low *population density, 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.

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. 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.*

The aim of on-farm verificative trials in northern Ghana was to enhance the adoption of technologies developed at the agricultural research stations. In 1990, with the financial assistance of the African Development Bank through SAFGRAD, the team extended their work on alley cropping from just one village in the Bimbilla district to 10, the number of contact farmers increasing from 10 to 35. Also the funds facilitated commencement of on-farm studies on inorganic fertilizer use, cropping patterns and tillage practices in the Upper West region. However, due to severe drought last year, sorghum yields were very poor and there was a wide variation among yields in the fields managed by the farmers.

The objectives of the study were to: (i) compare the yields of maize, groundnut and sorghum in the alleys of pigeon peas (<u>Cajanus cajan</u>) with those of the traditional practice; and (ii) evaluate alley cropping under farmers own management.

In general, plant stand and densities varied greatly in farmers' fields, although the ratio of the component crops depended on the preferred crops of the farmer. Due to the low and varied densities of maize planted by the farmers, yield was very low. For example, as summarized in Table 6, the grain yield of alley-cropped maize varied from 1626 kg/ha (in Nakpa village) to 2032 kg/ha (in Binda village) while those of maize in farmers' fields ranged from 293 kg/ha (in Nakpa village) to 852 kg/ha (in Dabole village). Sorghum, being the preferred food crop, the densities planted were quite adequate, although very little fertilizer was applied. Since 1990 was the first year of the study, neither the effect of rotation nor that of alley cropping was expected.

Table 6. The Effect of Alley Cropping on Maize Grain Yield (kg/ha)

	Dipa	Dabole	Binda	Juanayili	Nakpa
Alley cropping	1909	1693	2032	1801	1626
Farmers' practice	712	852	773	412	293
Trial mean	1310.6	1272.8	1402.5	1106.1	959.9
C.V.%	27.48	65.7	81.8	22.8	42.2
L.S.D. (05)	632.4	1878.1	2578.1	879.6	711.2

The effect of phosphorus (P) level under different tillage practices on maize yield in the upper Western Region of Ghana was investigated. Sorghum planted two weeks after the maize suffered from drought. Germination was poor, despite efforts to refill the gaps. However, crops grown on mounds yielded significantly more *than those planted on ridges or on the flat. Due to the low amounts of rainfall, the addition of phosphorus had no significant effect on grain yield of any of the crops.*

The cereal-legume rotation trial was conducted in order to: (i) demonstrate the agronomic and economic compatibility of cereal-cereal crop association; (ii) demonstrate rotational effects on soil fertility maintenance; and (iii) demonstrate the effect of rotation on weed control. Since this was the first year of the study, there could not have been any effects due to the rotation practice. Consequently, grain yields of all the crops under the different practices were not significantly different from each other.

The cowpea-sorghum relay trial showed that, the brown seeded Vallenga variety cowpea appeared to be more drought tolerant than the white seeded IT81D-1137. Flower abortion reduced the yield of IT81D-1137 significantly but, with the farmers' preference for white varieties, the yields were still acceptable.

4.0. Mali.

Maize production in Mali was estimated at 153,000 metric tons on 129,000 ha in 1989. Improved maize varieties including Tuxpeno 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.

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

<u>Agronomic evaluation on the adaptability of early maturing maize cultivars</u>.

The first phase of the verificative trials consists of testing maize varieties under the conditions that exist in research stations and sub-stations in the zones suitable for maize production. The second phase consists mostly of evaluation of varieties (selected in the first phase) and production technologies under farmers' conditions.

Trials conducted in the research station and sub-stations in 1990 included maize varieties of three different maturity periods, namely: extra-early maturity varieties (less than 82 days to maturity); early maturity varieties (90-95 days to maturity); and intermediate maturity varieties (96-120 days to maturity).

The 13 extra-early maturity varieties were evaluated at two locations (Katibougou and Massantola). At Katibougou, the total rainfall in 1990 was 762.4 mm in 76 days. The three highest yielders in descending order were Kogoni (1.7 t/ha), CSP Early (1.7 t/ha) and TZESRW x GUA 314 (1.6 t/ha). The lowest yielders were TZEE Yellow Pool (0.7 t/ha) and Pool 30 x GUA 314 BCIF3 (1.0 t/ha).

At Massantola, the total rainfall in 1990 was 591.5 mm in 41 days. The three best yielders were Across 8131 X TES X LEF3 (3.9 t/ha), TZEE W2 (3.4 t/ha) and CSP Early (3.2. t/ha). The lowest yielders were TZEE W1 (1.9 t/ha) and Pool 27 x GUA 314 BC1F3 (2.0 t/ha).

One local check and 13 early maturity varieties were evaluated at Sotuba and Kita. At Sotuba, the total rainfall in 1990 was 827.2 mm in 57 days. The varieties DR. Comp. Early, TZE Comp 3X4 F3 and Kamb 88 Pool 16 DR gave the highest yield of 3.64, 3.33 and 3.17 t/ha, respectively. The Local Check (2.6 t/ha) and DMR-ESRY (2.77 t/ha) yielded lowest. At Kita, the total rainfall in 1990 was 766 mm in 51 days. The top yielders were DMR-ESRW (4.8 t/ha), Across 87 Pool 16 SR (4.77 t/ha) and DMR-ESR Y (4.63 t/ha); the lowest yielders being Across 86 Pool 16 DR (2.4 t/ha) and Across 88 Pool 16 DR (3.03 t/ha).

Ten intermediate maturing maize varieties were evaluated at Longorola and Sotuba. At Longorola, the total rainfall in 1990 was 997.9 mm in 86 days. The best yielding maize varieties were DR Synt IITA (5.8 t/ha), EV 84-28 SR (5.7 t/ha) and EV 84 22 SR (5.7 t/ha), while TZPB (4.0 t/ha) and Tiemantie (4.1 t/ha) yielded least. At Sotuba, DR Synt IITA (4.7 t/ha) again yielded highest, being followed by EV 84 22 SR (4.3 t/ha), EV 84 28 SR (4.2 t/ha), and Tiemantie (4.2 t/ha).

5.0. Niger.

Niger is one of the largest countries in the Sahel covering an area of 1,267,000 km^2. 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. The 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.

In 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' participation to conduct trials and the cultivation of fields following recommended practices.

The farmers involved in the project are located in Sokondjii 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.

Maize and rice are also cultivated to some extent. 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) respectively.

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.

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. Oxen are used mostly for carting humans and farm produce. As noted above, the number of farming-families within the project area is 1,996. Each family, on the average, comprises of seven members. The trials consisted mixed planting of traditional sorghum and millet cultivars (T_1), cultivation of same cultivars with the application of fertilizer 20 kg P_2O_5 and 46 kg N/ha (T_2), mixed planting of improved cultivars of sorghum and millet without fertilizer (T_3) and with the application of the above rate of phosphate fertilizer (T_4) and with the application of both nitrogen and phosphate fertilizer on improved cultivars (T_5).

Results

In general, the response to fertilizer of both local and improved cultivars of millet and sorghum was positive. Millet and sorghum were cultivated in mixture. As indicated in Table 7, yield of traditional millet and sorghum cultivars on-farmers' field was 860 and 280 kg/ha respectively.

The application of 20 kg/ha P_2O_5 and 46 kg N/ha increased the yield of local cultivars of millet and sorghum significantly. In Tara research station, millet yield almost tripled from 390 to 1150 kg/ha; while that of sorghum also increased from 240 to 720 kg/ha. The on-farmers field, the same rate of fertilizer application increased yield of millet from 860 to 1200 kg/ha; and that of sorghum from 280 to 630 kg/ha. It is important to note however, the improved millet variety (CIVT) and sorghum (BKC) gave lower yields than local cultivars without fertilizer application.

The results of this verification trials indicate:

- *The yield response of sorghum and millet to phosphate and nitrogen fertilization has been positive. Yield of these crops on-farmers field both with local and improved cultivars either doubled or tripled.*

- *Intercropping of millet and sorghum or legume could also improve the productivity per unit area by 50 to 75 percent.*

Table 7 The Effect of Agronomic Practices on the Yield of Millet and Sorghum (on-Station and on-Farm Trials) 1990.

YIELD GRAIN Kg / ha

Treatments	TARA / Station			OFT		
	Millet	Sorghum	Millet/Sorghum	Millet	Sorghum	Millet/Sorghum
T_1	390	240	630	860	280	1140
T_2	1150	720	1870	1200	630	1830
T_3	540	330	870	600	420	1020
T_4	1400	670	2070	740	580	1320
T_5	1600	940	2540	1080	715	1795
CV%	15.93	23.18	—	14.84	25.15	—
LSD (5%)	249.46	207.68	—	120.53	119.97	—

M = Millet S = Sorghum M/S = Association Millet/Sorghum

OFT = On-Farm Trials (mean yield of 10 farmers)

6.0. Nigeria.

The verification trials on food grain production were conducted at 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.

The following three trials were carried out:

Trial One: Agronomic testing for determining NPK ferrilizer requirements in Maize/Cowpea Association.

Maize/cowpea mixture is a popular cropping practice among small scale farmers in the northern Guinea savanna agroecological zone of Nigeria. Presently, appropriate NPK fertilization has not been identified. This study started on-station at Samaru during the 1990 wet season.

All fertilizer treatments were applied only to maize and none to cowpea. Four levels of nitrogen (0, 75, 150 and 225 kg N/ha) using calcium ammonium nitrate as source, three levels of phosphorus (0, 40 and 80 kg P^2O^5/ha) using single superphosphate as source were tested with two levels of potassium (0 and 60 kg K^2O/ha) using muriate of potash as source in all possible combinations.

Results

Nitrogen application of 75 kg/ha increased maize yield (C.V. TZBSRW) from 545 to 3710 kg/ha. Further increase of nitrogen more or less depressed the yield of the crop. Maize also responded positively to phosphorus fertilization up to 40 kg/h P^2O^5 where yield improved from 2747 (without P) to 3160 kg/ha (with P application). Increasing potassium (K) level up to 60 kg/ha K^2O inpact decreased yield of maize from 3155 to 2890 kg/ha.

With regard to cowpea (cultivar Kananado) N application depressed the grain yield substantially (from 535 (without N) to 369 kg/ha (with N 75 kg/ha).

There was positive response to phosphorus application where cowpea yield improved from 386 (without P) to 508 kg/ha (with 80 kg/ha P^2O^5). Application of K only increased cowpea grain size.

Trial Two : Agronomic Testing for Determining Appropriate Variety Combination in Sorghum/Millet/Cowpea Association.

Sorghum/millet/cowpea mixture is the most widespread cropping practice among small-scale farmers in the northern Guniea and parts of the Sudan Savanna agroecological zones of Nigeria. Until recently, the agricultural research approach never considered the small-scale farmers as client of research. Improved varieties have been developed under sole cropping system with the expectations that the small scale farmers would adopt for their multiple cropping system.

Previous studies on-farm have indicated the lack of yield superiority of improved cowpea varieties over those of the local.

The main objective of this investigation therefore, is to study the performance and acceptability of improved varieties of sorghum, millet and cowpea as compared to the traditional local varieties of farmers.

For sorghum, the improved variety used was KSV8 a medium maturing cultivar from the Institute for Agricultural Research Samaru (IAR) while the local cultivar Farafara was used for comparison. For millet, Samaru Early 13 (SE 13) was the improved variety compared with the local cultivar Zango. Three improved *cowpea varieties were used - late maturing white seeded Kano 1696 and light brown seeded Sampea 7 obtained from IAR and the dark-brown seeded IT 845-2246-4, a multiple pest and disease resistant variety obtained from the International Institute of Tropical Agricultural (IITA). The cowpea varieties were protected with insecticides and the trial was laid out in a randomized complete block design with four replications.*

Results

Farmer's local variety produced the highest grain yields (433 kg/ha) together with Sampea 7 (392 kg/ha). Kano 1696 and IT 84S-2246-4 were inferior in yield to the Farmer's local variety and Sampea 7 with IT 84S-2246-4 producing the least yield. This result is in agreement with last year's observation. This result is in agreement with last year's observation. Cowpeas under KSV8 yielded (427 kg/ha) more than under farafara (237 kg/ha). Sampea 7 grew tallest while the spreading Kano 1696 and farmer's local were shortest in height. Kano 1696 produced the largest grain sizes while those of IT 84S-2246-4 were the smallest.

Sorghum cultivar KSV8 significantly outyielded (1379 kg/ha) the local farafara (1189 kg/ha) while the main effects of cowpea variety and millet variety were not significant. Farafara grew taller than KSV8.

For millet, the local variety Zango outyield similar to the improved cultivars. However, millet grown with KSV8 sorghum appeared to have yielded (1184 kg/ha) significantly higher than with farafara (1052 kg/ha).

Trial Three: Agronomic Testing of Improved Varieties in Maize/Cowpea Mixed Cropping System.

Most of the maize currently produced in Nigeria come from the fields of small-scale farmers where maize/cowpea mixture is one of the popular maize-based cropping system. In this mixture, cowpea yields are always reduced by the dominant maize crop. Although nearly all farmers grow improved maize varieties, most of them are yet to adopt the cultivation of newly recommended improve cowpea varieties.

Studies on-station have shown a lot of variation in the yield of cowpea varieties while findings on-farm have indicated the yield superiority of traditional cowpea cultivars over some improved varieties in the traditional cropping system.

The field trial was conducted during the 1990 wet season at the Institute for Agricultural Research, Samaru, in the northern Guinea savanna ecological zone of Nigeria on a well-drained ferruginous tropical soil. Two varieties of maize (TZBSR and Ag-Kaduna 'hybrid) and four of cowpea (SAMPEA 1 - IAR 339-1, SAMPEA 6

- IAR 1696, SAMPEA 7 - IAR 48' and Farmer's variety) were compared in all possible combinations. SAMPEA 1 and SAMPEA 7 are photo-insensitive white and brown seeded, respectively while SAMPEA 6 and Farmer's variety are photo-sensitive and white seeded types. The Farmer's variety was obtained from a village around Samaru.

Two weeks after sowing, maize received 60 kg N, 60 kg P^2O^5 and 60 kg K20/ha as NPK (15-15-15) compound fertilizer. A top dressing of 60 kg N/ha as calcium ammonium nitrate (26% N) was applied to maize plants at six weeks after sowing. Fertilizer was applied by placement alongside stands of maize. No fertilizer was applied directly to inter-cropped cowpea while sole cowpea received 36 kg P^2O^5/ha as single super phosphate (18% P^2O^5). In sole and intercrops, cowpea insect pests were controlled with three applications of a tank mixture of 50 a.i./ha cypermethrin (Cymbush 10EC) with 250 g a.i./ha dimethoate (Perfekthion 40EC).

<u>Results</u>

In both sole and intercrops, hybrid maize, Ag-Kaduna significantly outyielded the open pollinated variety, TZB-SR. Grain yield of the hybrid maize was above 5 ton/ha and that of TZBSR varied from 3.6 to 4.5 t/ha for sole and intercropping systems respectively.

Sole cropped cowpea for SAMPEA 6, farmers' local, SAMPEA 7 and 1 was 1024, 826, 823 and 738 kg/ha respectively. Intercropping markedly reduced cowpea yield relative to the sole crop; mean reduction in cowpea yield being 81%. In both monocropping and intercropping, none of the three improved cowpea varieties tested significantly outyielded the farmers' variety. The number of pods per plant was not affected by either maize or cowpea varieties. The photosensitive cowpea varieties, SAMPEA 6 and Farmer's variety had heavier seeds compared with the photo-insensitive varieties, SAMPEA 1 and 7.

Cowpea yields were generally low due to abrupt cessation of rains in September coupled with infestation by Alectra vogelli. Moisture stress was particularly severe in intercrop plots where many cowpea plants dried up.

These preliminary results tend to suggest that the farmer's cowpea variety is as productive as the improved varieties. The investigation will continue in 1991.

7.0. Senegal

Verification of Millet Production Technologies under Farmers' Conditions.

The climate in Senegal is predominantly Sahelian in North (300-600 mm rainfall) and Sudano-Guinean in the South (700-1600 mm in Casamance). The land surface area of Senegal is approximatly 196,850 km² with an estimated population of 7.8 million of which 65% are in the rural areas. Estimated cultivated land is in the range of 3,750,000 hectares. The major crops cultivated are groundnuts (which accounts for more than 40 percent export revenue), millet, sorghum, rice, maize and cowpea. Millet, the principale cereal is cultivated within isohyetes 250 to 900 mm.

The verification trials on-farmers' field consisted of the evaluation of the performance of two improvement millet cultivars namely, Souna-3, in the Kaolack, Fatick region; and IBV 8004 in the Diourbel province Central North region. These varieties were compared with local cultivars under improved agronomic practices and traditional both farming systems.

The improved agronomic practice included initial and split application of 100 kg/ha urea at plant density of 0.90 x 0.90 m. After 12 and 15 days after emergence, each hill was thinned to 3 plants.

The results of the on-farm trials showed that in the Soulkouloyen in Kaolack region, both Souna-3 and local variety gave yield of 1106 and 888 kg/ha respectively under improved agronomic practices. Under the traditional practice, the yield of the variety Souna-3 and local cultivar was 725 and 434 kg/ha respectively. It is evident that the yield of millet could significantly increase providing seed of the improved cultivars, fertilizer and other inputs are made available to farmers. As summarized in Table 8, the yield of Souna-3 was significantly higher than under farmers management practices, with mean yield of 1489 and 1033 kg/ha respectively across all locations. The local cultivars of millet, also responded to improved agronomic techniques than traditional farming practices, with mean yield of 1181 and 792 kg/ha respectively. The results of this verification trials substantiates that the yield of millets cultivars can be increased by 30 to 70 percent using improved agronomic practice.

On-farm Evaluation of Cowpea Varieties.

The trials were conducted in five villages, namely Thilmakha, Sine Dieng, Gatt, Lampt Sarr and Sakal. The new cowpea line IS 86-275 was evaluated together with three cowpea varieties 58-57, Ndiambour and Bambey 21 in four of the villages while in Gatt Bambey 21 was replaced by the variety Mougne. These varieties were evaluated on five farms in each village, i.e., 25 farmers participated in the trial.

As indicated in Table 9, in Thilmakha, IS 86-275 yielded highest, with an average grain yield of 757 kg/ha (range 622-850 kg/ha) while Bambeyi 21 yielded least with a mean of 451 kg/ha (range 376-520 kg/ha). Ndiambour (mean yield, 597 kg/ha) ranked next to IS 86-275.

In Sine Dieng, IS 86-275, with mean yield of 675 kg/ha, yielded highest while Bambey 21 with an average yield, 244 kg/ha produced the lowest. The variety 58-57 with an average yield of 627 kg/ha ranked second in this village.

In Gatt, the cowpea variety Mougne produced 441 kg/ha to outyield IS 86-275 436 kg/ha, 58-57 403 kg/ha and Ndiambour 350 kg/ha. The highest yielder in Lamp Sarr was IS 86-275 436 kg/ha; it was followed by 58-57 296 kg/ha, Ndiambour 168 kg/ha and Bambey 21 135 kg/ha. In Sakal cowpea yield was generally low. IS 86-275, Ndiambour, 58-57 and Bambey 21 yielded 255, 273, 224 and 114 kg/ha respectively. As summarized in Table 9, accross the five villages, the mean yields of the four varieties were 512 kg/ha (IS 86-275), 410 kg/ha (58-57), 380 kg/ha (Ndiambour) and 236 kg/ha (Bambey 21).

Table 8. The effect of improved agronomic practices on the yield (kg/ha) of millet.

Location	Var. Souna-3		Local Cultivar		
	IP	TP	IP	TP	Mean Yield
Soulkou Loyen	1106	725	888	434	788.2
Darou	1816	1463	1730	1511	1630
Paoskoto	1325	852	1175	804	1039
Diofior	2100	1455	1623	926	1526
Niakhar	1099	671	491	285	636.5
Mean Yield across location	1489	1033	1181	792	1123.9

IP = Improved Agronomic Practices
TP = Traditional Farming Practices.

Table 9. Grain yield of cowpea varieties (kg/ha) evaluated in different villages of Senegal.

Location	Cowpea Varieties			
	IS86-275	58-57	Ndiambour	Bambey-21
Thimakha	757.2	485.4	596.4	450.8
Sine Dieng	675.2	626.8	510.0	244.2
Gatt	435.5	403.2	350.0	-
Lamp Saar	435.5	295	168.0	134.7
Sakal	254.7	223.5	273.2	113.5
Mean Yield	511.6	406.9	379.5	235.5

8.0. Togo

Evaluation of Sorghum/Cowpea Cropping Systems

Objectives. (i) To determine the adaptibility of Framida, an early maturing sorghum variety, under conditions of Northern Togo; (ii) to test the adaptability and acceptability of the new, white-seeded, early maturing cowpea variety the KVx 396-4-4; and (iii) to demonstrate the productivity of sorghum/cowpea mixture using these varieties.

The adaptability of an early maturing sorghum, (Framida in sole culture and in mixture with white seeded cowpea cultivar KVX 396-4-4 was evaluated. The improved agronomic practices included fertilizer application of 150 kg/ha NPK (15:15:15) and 5 t/ha manure. In sole cowpea cultivation, three sprays were applied to control insects.

The study was carried out in four villages. Mixed cropping of Framida sorghum (50,000 plants/ha) with above mentioned cowpea cultivar (25,000 plants/ha) gave yield of 1015, 865, 797 and 328 kg/ha in Bidjande, Misseouta, Agounde and Broukou respectively. Under sole cropping, the yield of sorghum varied from 408 to 1145 in the villages of Broukou and Bidjande respectively.

As shown in Table 10, the cost-benefit analysis was compared for the three systems (pure crop sorghum, pure crop cowpea, and sorghum/cowpea mixture). The highest net income, about 116,000 CFA/ha was realized with pure crop cowpea which was closely followed by sorghum/cowpea mixture about 108,000 CFA/ha. The sole crop sorghum gave the lowest economic return of about 54,000 CFA/ha. The costs taken into account include insecticides, sprayers, labour and three sprays for the sole cropping of cowpea.

Table 10. Estimated net return of sorghum and cowpea cropping systems.

Cropping System	Yield kg/ha Sorghum	Yield kg/ha Cowpea	Net return CFA/ha
i) Sorghum (50,000 plants/ha cultivated with cowpea (25,000 plants/ha)	906	583	108020
ii) Sorghum (65,000 plants/ha) pure	946	-	53667
iii) Cowpea (100,000 plants/ha) pure	-	1164	115876

Average price in 1990 in Northern Togo was as follows:

Cowpea	118 CFA/kg
Sorghum	67 CFA/kg
Fertilizer	65 CFA/kg
Insecticides	1800 CFA/kg

Source: Toky Payaro (1990) Technical Report on-farm evaluation of sorghum and cowpea association in Northern Togo.

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