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Recherche et Développement des Cultures Vivrières dans les Zones Semi-Arides

1993/94 TECHNICAL REPORT OF THE FOOD GRAIN PRODUCTION VERIFICATION PROJECT

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

The 1993/94 food grain production technology verification project activities continued in Burkina Faso, Cameroon, Ghana, Mali, Nigeria, Senegal and Togo.

In the semi-arid lowlands of Northern Cameroon, the project successfully introduced two composite open pollinated early maturing cultivars for farmers use. These are DMR-ESRY released as CMS8806 and Pool 16 DR-SR released as CM9015. In the Extreme North Province of Cameroon, TZEE-SR, an extra-early maturing (80-90 days) maize cultivar was identified. Considering the removal of subsidies for fertilizer use and the need to build-up the soil organic matter, the on-farm trials focused on exploiting the use of cotton seed cake as a source of fertilizer. The study showed that, the application of cotton seed cake (800 kg/ha) alone did not substantially increase the yield of maize. However, combined application of cotton seed cake and reduced level of commercial fertilizer gave better yield of maize by more than 500 kg/ha than recommended rate of commercial fertilizer. Furthermore, seed of improved maize cultivars was distributed to more than 2000 farmers.

In Burkina Faso, the identification of new cowpea cultivars for high yield and pest resistance was carried out in the five regional agropastoral extension development zones. Among the promising cowpea cultivars, KVx-404-8-1 and KVx-414-22-72 gave more yield by 52 and 47% respectively than local cultivars. The potential fodder production of these cultivars have been above 4.5 tons/ha. Cultivars resistant to thrips (insect) were identified. Interestingly, the local cowpea cultivar referred as Moussa, has been observed as most tolerant to insect pests (thrips). Minimizing spray of insecticides not only can reduce cost of cowpea production, but also contribute to environmental protection. Furthermore, two early maturing maize cultivars were introduced. The on-farm trials were conducted in 41 sites in collaboration with 160 extension agents. The trial involved close to 800 farmers. A total of 136 tons of improved seed was produced by the farmers' cooperatives. The seed would be used by members of the cooperatives the following growing season.

In Northern Ghana, the yield performance of two extra-early maturing maize cultivars was evaluated. For example, NAES-EE-SR-W gave yield close to 2.6, 2.0 and 1.8 tons/ha in Damango, Tamale and Salaga respectively. On the other hand, the cultivar NAES Pool 16 DT gave yield of 3.0, 2.8, 2.9 and 1.4 tons/ha in Tamale, Damongo, Salaga and Yendi respectively. Furthermore, three improved cowpea cultivars were introduced in the same region where maize trials was undertaken. In general, there has not been significant difference in yield between test varieties and of previously released improved cowpea cultivars.

Based on the three years on-farm verification trials in Mali, the maize cultivars EV 8422 SR, DMR-ESRY and TZE-SRW have been well accepted by the national extension and regional development agencies and farmers. The relatively new maize variety, SWAN-1-SR, gave good yield (4 tons/ha) and it hygly accepted by farmers.

In Northern Nigeria (Sokoto, Katsina, Kaduna, Kano, Igawa, Kebbi and Bauchi States), the on-farm trials showed that the cultivation of improved cultivars of sorghum (SAMSORG 14), maize (TZBSR-W), millet (SAMMIL-6) and cowpea (SAMPEA-7) under improved agronomic practices resulted in higher financial returns. In maize/cowpea cropping systems, the application of 120 kg/ha N, 26 kg/ha P and 50 kg/ha K, resulted in higher yield of both crops.

In Senegal, combined application of organic and mineral fertilizer gave substantial yield of the millet based-cropping systems on-farmers'field than on research station. Reduction by 50% the recommended rate of fertilizer and the application of 2 to 5 tons/ha of manure improved millet grain yield on farmers yield by 30, 60, 84 and 40% than traditional agronomic practice in Thysse Kaymore, Diofior, Ndiemane and in Northern zone respectively. In Diofior and Ndiemane, the yield of millet straw was increased by 91 and 52% respectively with the application of 30 kg/ha P205 and 5 tons/ha organic manure. The application of organic manure alone increased yield of millet straw by 82%, and 32% in Diofior and Ndiemane respectively.

In the Kara and Savana regions of Northern Togo, the improved sorghum variety 27/TC out yielded local cultivar by 94 and 10%, respectively. There has not been significant yield difference in yield performance among the cowpea cultivars evaluated.

The 1994 annual review and planning workshop was attended by 20 participants from the eight countries, regional organizations and a consultant. Results of on-farm trials and programme for 1994/95 technology verification activities were reviewed. Furthermore, the workshop addressed issues and the need to simplify on-farm trials designs, to enhance farmers' participation in the evaluation of technologies; and to collaborate with other organizations in training of technicians and farmers.

ON-FARM VERIFICATION TRIALS.

1.0. BURKINA FASO.

i) Verification of Cowpea Production Technologies.

Cowpea is one of the principal grain legume that is being cultivated in association with sorghum, millet and maize. The average yield of cowpea is generally low (300 to 400 kg/ha) at on-farm level. The main objectives of the project are: i) the identification of suitable cultivars adapted to three main ecological zones and ii) to also identify cowpea cultivars resistant to insects, *Striga* and diseases.

The climatic zones of the study area include: i) The Sahel zone, which is characterized by monomodal rainfall June to October, with precipitation from under 300 to 600 mm/year and high daily temperature of about 40°C in May and April. ii) In the Sudanian zone, the mean rainfall ranges from 650 to 850 mm/year from May to October; with relatively warm temperatures (35-40°C) during the season. Periods of moisture stress are frequent and unpredictable. iii) The Northern Guinea savanna zone has relatively more dependable rainfall 850 to 1100 mm/year, with a growing season 4 to 6 month.

The on-farm trials comprised of five cowpea cultivars including local check. The trials were conducted in five provinces involving the National Agricultural Research Institute (INERA) and the Agropastoral Extension and Development Centre (CRPA).

As summarized in Table 1, the cowpea cultivar KVx 404-8-1, gave the highest average yield across locations including in the Hauts-Bassins Province. The variety KVx 414-22-72 performed better (800 kg/ha) than other cultivars in Bougouriba. These cultivars, are appreciated by farmers due to their short-cycle, seed size and colour. In Bougouriba Province, a total of 254 farmers (166 women and 88 men) visited the on-farm trials. More men farmers (478) than women (135) visited the various trials at the extension area (CRPA) of Hauts Bassins. The cowpea cultivars KVx 404-8-1 and IAR 7/180-4-5-1 gave the highest yield 825 and 634 kg/ha respectively in Hauts-Bassins. In the Fada region, yield of cowpea was generally low and the cultivars KVx 414-22-2 gave low yield 371 kg/ha slighly higher than traditional cultivar 345 kg/ha.

The yield increase across locations of the new varieties compared to local cultivars has been 12, 47 and 52% more for IAR/7/180-4-1, KVx 414-22-72 and KVx 404-8-1 respectively. The variety KVx 414-22-2, which was evaluated in Fada region gave lower yield (by 8%) than local cultivar.

The on-farm level screening for resistance to thrips comprised of nine cowpea cultivars including two local checks. These cultivars were assessed in the low and moderate thrips pressure infestion zones in the Northern and Central region of Burkina Faso respectively. The average thrips infestation per flower was higher in the village of Kamboinse and Ziga.

In Kolbila village, the cowpea cultivars local Moussa, KVx 414-22-72 and KVx 404-8-1 gave the highest yield, about 695, 473 and 436 kg/ha respectively. The cultivars IT 85-D-3516-2 and KVx 404-22-2 gave better yield, about 412 and 330 kg/ha in Ziga village (Table 2).

As to fodder production, the cultivars KVx 414-22-72 and KVx 404-22-2 gave, about 4.9 and 4.5 tons/ha respectively in Kolbila village. Fodder yield in Ziga was generally low for all cultivars, except for vareity KVx 414-22-2, which gave yield about 1.2 tons/ha. In the Central zone, thrips pressure was relatively high (at Kamboinse), either grain nor fodder yield was obtained.

CONCLUSION.

Two promising cowpea cultivars KVx-404-8-1 and KVx 414-22-72 gave yield 617 and 596 kg/ha respectively across locations. This cultivars were appreciated by farmers due to their earliness and seed quality. Annual farmers' field day were organized in each provinces where trials were conducted. For example, in Bougouriba Province, about 254 farmer (65% women) visited the experimental sites. In Hauts-Bassins, more men farmers (478) than women (135) visited the on-farm trial sites.

Promising cowpea cultivars resistant to thrips were identified. In the central region of Burkina Faso, with relatively high thrips pressure zone, non of the cultivars assessed produced seed and the thrips susceptible cultivar such KN-1, did not even flower. At Kolbila village, the cultivars KVx 414-22-72 and KVx 404-22-

2 gave fodder yield of 4.9 and 4.5 tons/ha respectively.

The trials would be repeated in 1995/96 in order to determine the yield and thrips resistance performance of the above mentioned cowpea cultivars.

Table 1. Average yield of cowpea cultivars (kg/ha) grown in different provinces of Burkina Faso.

Provinces	Cowpea Cultivars				
	KVx414-22-72	KVx404-8-1	IAR 7/180-4-5-1	KVx414-22-2	Local
Bougouriba (6)	801	613	597	-	-
Mouhoun (3)	619	566	482	-	398
Fada (4)	354	-	215	371	345
Centre Nord (5)	413	466	336	-	337
Hauts-Bassins (6)	795	825	634	-	542
Average yield across locations	596.4	617.15	452.8	371	405.5
Percent increase of yield over local cultivars across locations	+47%	+52 %	+12%	-8%	

Figures in parenthesis indicate the number of sites in each province that cowpea cultivars were evaluated.

Table 2. Cowpea grain and fodder yield (kg/ha) (under thrips pressure) in Northern and Central zone of Burkina Faso.

Variety	CRPA of Northern Region						CRPA of Central Region Kamboinse [b]
	Kain		Kolbila		Ziga		Number Thrips/ Flower
	Yield	kg/ha	Yield	kg/ha	Yield	kg/ha	
	Grain	Fodder	Grain	Fodder	Grain	Fodder	
KVx404-8-1	63.4	1582 (17.1)[a]	435.54	2904.29(32.4)	303.8	173.6(18)	(42.8)
KVx404-22-2	48.8	1308.5 (13.4)	310.54	4511.71(25.9)	329.8	329.8(14.7)	(37.8)
KVx414-22-72	58.5	1464.8 (11.4)	472.65	4902.34(40.4)	308.2	850.6(25.6)	(36.0)
IT85D-3516-2	19.5	2562.5 (11.7)	83.98	2988.28(34.3)	412.3	538.1(13.7)	(19.5)
KVx414-22-2	73.2	2226.5 (16.7)	85.93	2246.09(26.1)	117.1	1215.2(25.5)	(38.4)
Locale Moussa	43.9	898.4 (19.8)	695.31	1621.09(35.5)	308.1	538.1(25.4)	(35.6)
KVx428-9	53.7	2187.5 (15.8)	335.25	2899.28(31.7)	303.8	451.3(17.9)	(50.4)
KVx165-14-1	58.5	1894.5 (14.2)	343.75	3281.25(41.9)	308.1	425.3(20.2)	WF [c]
KN-1	39.0	1933.5 (16.)	382.81	3613.28(44.8)	65.1	642.3(30.0)	WF
Average	50.94	1673.13(15.2)	349.52	3228.51(34.8)	272.91	573.81(22.2)	(37.2)

(a) Figures in parenthesis indicate number of thrips infestation per flower.

(b) In Central zone of Burkina Faso (example, Kamboinse) thrips infestation was relatively high, as result, grain yield was not obtained.

(c) WF - indicates thrips susceptible cultivars that did not flower.

ii) On-Farm Verification of the Performance of Improved Maize Cultivars.

Two early maturing maize cultivars (KPJ, yellow seed and KPB, white seed) were introduced to farmers. Furthermore, Pool 16 DT and Maka-SR are the two drought resistant cultivars that were identified. The on-farm trials were conducted on 4 sites involving 160 extension agents. The trials directly involved about 745 farmers among estimated population of 60,000 in the region. Basic seed of the improved maize cultivars was increased at Gampela. A total of 136 tons of improved seed was produced by farmers' cooperatives.

2.0. CAMEROON

i) Determining improved agronomic practices for the production of early and extra-early maize cultivars in low-land savannas.

In the past decade, there has been substantial increase of maize production in the semi-arid lowland savannas (North and Far North Provinces) of Cameroon. The project has successfully introduced two composite open pollinated early maturing maize cultivars with wide agroclimatic adaptation. These are DMR-ESRY (yellow seeded) and Pool 16 DTR (white seeded). Both DMR-ESR-Y (also known as CMS-8806) and Pool 16 DR-SR, also released as CMS 9015 in Cameroon mature within 90 to 95 days. TZEE-SR is an extra early maize cultivar (80-90 days) that is being introduced into the relatively low-rain fall areas of Extreme North Province of Cameroon.

The on-farm trials comprised of the effect of cotton seed cake and commercial fertilizer on the yield of early maturing maize (CMS 9055) and extra-early maize cultivar (TZEE-W-SR).

The application of cotton seed cake alone (800 kg/ha) did not increase the yield of both early and extra-early maize cultivars. However, combined application of cotton seed cake and reduced level of commercial fertilizer on extra early maize cultivar gave better yield by more than 500 kg/ha than traditional farmer practice. The recommended rate of fertilizer 100 kg/ha NPK of complete fertilizer (15-20-15) and 100 kg/ha urea application has improved the yield of CMS 9015, an early maturing maize cultivar.

In general, the application of cotton seed cake perhaps could contribute to the build-up of the soil organic matter in the long-run. The cultivar CMS9015 (Pool 16-DT), gave higher yield (5125 kg/ha) in Djalingo village with the application of recommended fertilizer rate. The average yield of CMS9015 across sites in Lokoro village with the four levels of fertilizer treatment was about 6 tons/ha, which has been 21 and 37% higher yield than in Djalingo and Lera villages respectively (Table 3). The cultivar TZEE-W-SR, an extra-early maize cultivar responded better to the combination of cotton seed cake and mineral fertilizer application with mean yield of 3.4 tons/ha compared to commercial fertilizer recommendation alone (2.8 tons/ha).

ii) Promotion of the production and use of the short-cycle maize cultivars.

This extension programme was initiated since 1990. It has been conducted in the North and Far North Provinces of Cameroon (and some locations in Chad). The maize varieties used were DMR-ESR-Y released as CMS 8806 and Pool 16-DR-SR released as CMS9015, TZEE-W-SR and CMS 8704. These varieties were accepted by farmers for their special attributes: (i) earliness to be used as "green maize" during the hunger period; (ii) the ability to withstand drought and dry spells and (iii) acceptable taste to the consumer.

In 1993/94, seed of the following maize cultivars were distributed to more than 2000 farmers supervised by SODECOTON. To enhance the dissemination and distribution of these new cultivars of maize, the following amount of seed was produced:

Variety	Parent seed increase on research station	Basic seed increase in collaboration with farmers
CMS 8501	6.5 kg	10,000 kg
CMS 8704	6 kg	3,000 kg
CMS 9015	6 kg	2,500 kg
CMS 8806	7 kg	1,400 kg
TZEE-W-SR	5 kg	50 kg

The parent seed were maintained for the 1994/95 trials. The basic seed were distributed to farmers for the production of certified seed.

Table 3. The effect of cotton seed cake and mineral fertilizer on the yield (kg/ha) of early and extra-early maize cultivars.

Treatment (T)	Maize cultivars							
	Pool 16 DT (MS 9015)				TZEE-W-SR			
	Villages				Villages			
	I kg/ha	III kg/ha	IV kg/ha	Mean kg/ha	II kg/ha	V kg/ha	VI kg/ha	Mean kg/ha
T-1	5.124	5.174	3.006	4.435 (B)	2.427	1.708	2.162	2.099 (B)
T-2	4.820	6.126	4.959	5.302 (A)	2.830	2.688	4.534	3.351 (A)
T-3	5.026	6.602	5.343	5.657 (A)	3.269	2.818	2.845	2.977 (A)
T-4	5.125	6.483	4.439	5.349 (A)	2.529	2.973	2.640	2.781(AB)
Average	5.023 (AB)	6.096 (A)	4.436 (B)	5.186	2.763 (A)	2.546 (A)	3.095 (A)	2.801

Villages : I = II = Djalingo; III = Lokoro; IV = Lera; V = Kourgui I; VI = Kourgui II.

The means followed by the same letters are not significant at 5% level.

* The data is an average of three trials per village.

3.0. GHANA

On-farm verification trials of maize and cowpea cultivars in Northern Ghana.

Low soil fertility, erratic rainfall, poor land use and lack of suitable crop varieties, incidence of *Striga,* and insect pests are among the major constraints to the production of food grains in Northern Ghana. The area is mostly semi-arid with a mono-modal pattern of rainfall. The dwindling rainfall in quantity and duration, has necessitated calls by farmers for cultivars of maize and cowpea that are early maturing and drought resistant. Maize and cowpea are important staple food crops and common ingredients in the diets of farm families. The 1993/94 project activities included the identification of suitable cultivars of maize and cowpea, as well as the promotion of "Community Seed Production" by farmers.

i) Maize varietal trial.

On-farm trial of extra-early maturing maize cultivars was carried out in nine villages namely, Salaga, Yendi, Bole, Damongo, Tamale, Gushiegu, Nakpanduri, Saboba and Walewale. Five farmers per village participated in this farmer managed trial. Unfortunately, usable data were obtained from four out of the nine villages. The two test varieties NAES Pool 16 DT and NAES-EE-SR-W matured to "green cob" stage within 70 and 57 days respectively, while the farmers' variety and improved cultivar Droke matured (green cob stage) within 80 and 76 days respectively.

As indicated in Fig. 1, the variety Droke (an intermediate maturing cultivar) gave yield of 3, 4.5, 4.5 about 3.8 tons/ha in Salaga, Yendi, Domongo and Tamale respectively. Similar yield performance was observed by farmers' variety. It is evident from similar performance, maize cultivars referred as local are perhaps those improved varieties introduced several years ago. The extra-early cultivars NAES-EE-SR-W gave close to 2.6 tons/ha in Damango, about 2.0 and 1.8 tons/ha in Tamale and Salanga respectively. The farmers cultivar showed better performance about 1.6 tons/ha in Yendi than other three improved maize cultivars evaluated.

The cultivar NAES Pool 16 DT, gave yield about 3.0, 2.8, 2.9 and 1.4 tons/ha in Tamale, Damongo, Salaga and Yendi respectively. In general, yields in

Yendi were generally low, due to the apparent mid-season drought. The NAES-EE-SR-W maize cultivars was chosen by farmers for its earliness to fill-gaps of food shortages before the long season maize cultivars, sorghum, millets etc. could be harvested.

ii) Cowpea varietal trials

Three improved cowpea cultivars (Bengpla, ValXBB, Valinga XBE) and farmers variety were evaluated in four villages. As summarized in Fig. 2, in Yendi, the three improved cultivars (above 1 ton/ha) out yielded the local cowpea cultivar. Similar yield trend was also observed in Damango and Tamale except that, the improved cultivars gave lower yield of about 800 kg/ha. In Salaga village, the local cowpea cultivar out yielded (about 900 kg/ha) improved varieties. In general, there is no difference in yield between the test varieties and released varieties across all locations.

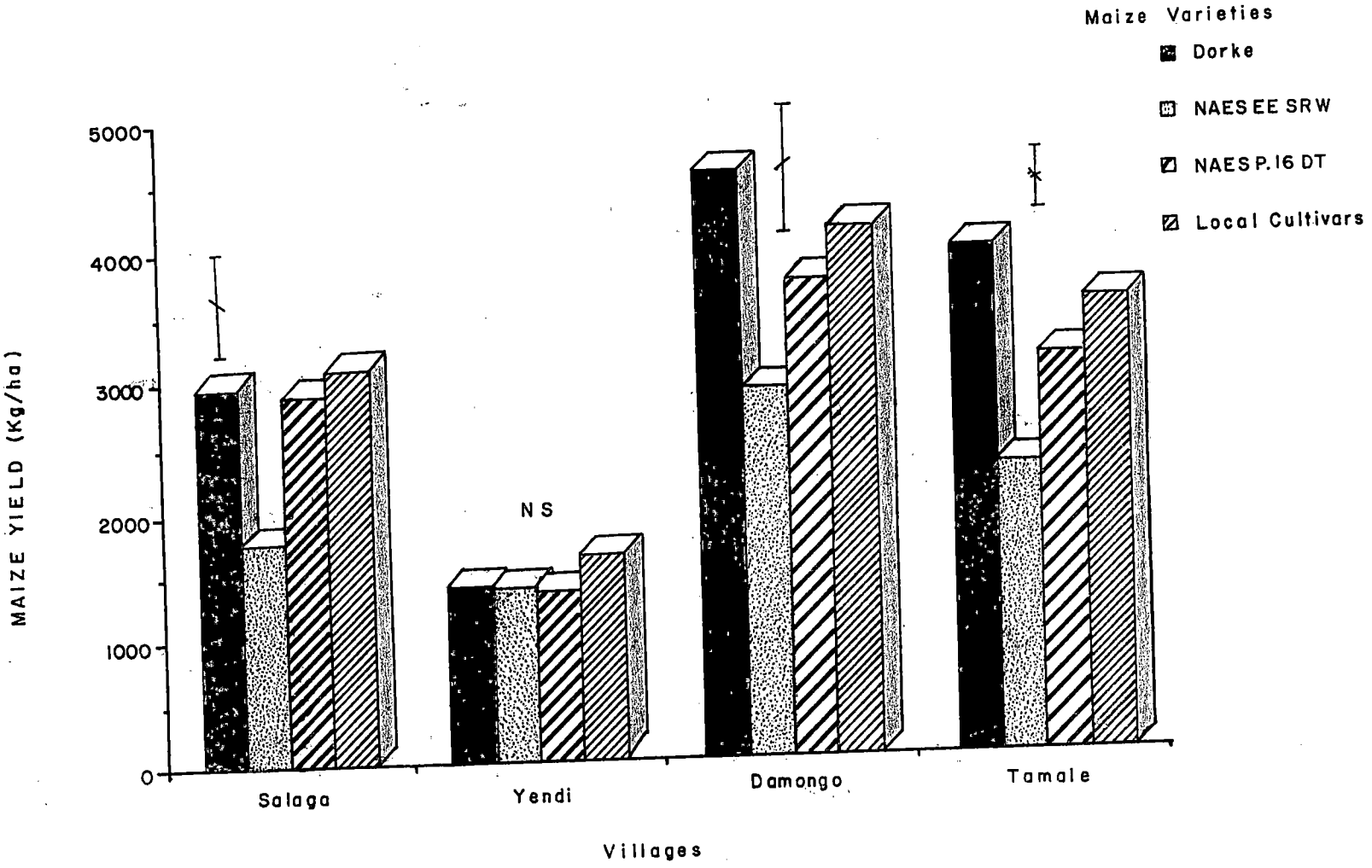

Fig. 1 Yield performance of maize cultivars across locations in northern Ghana

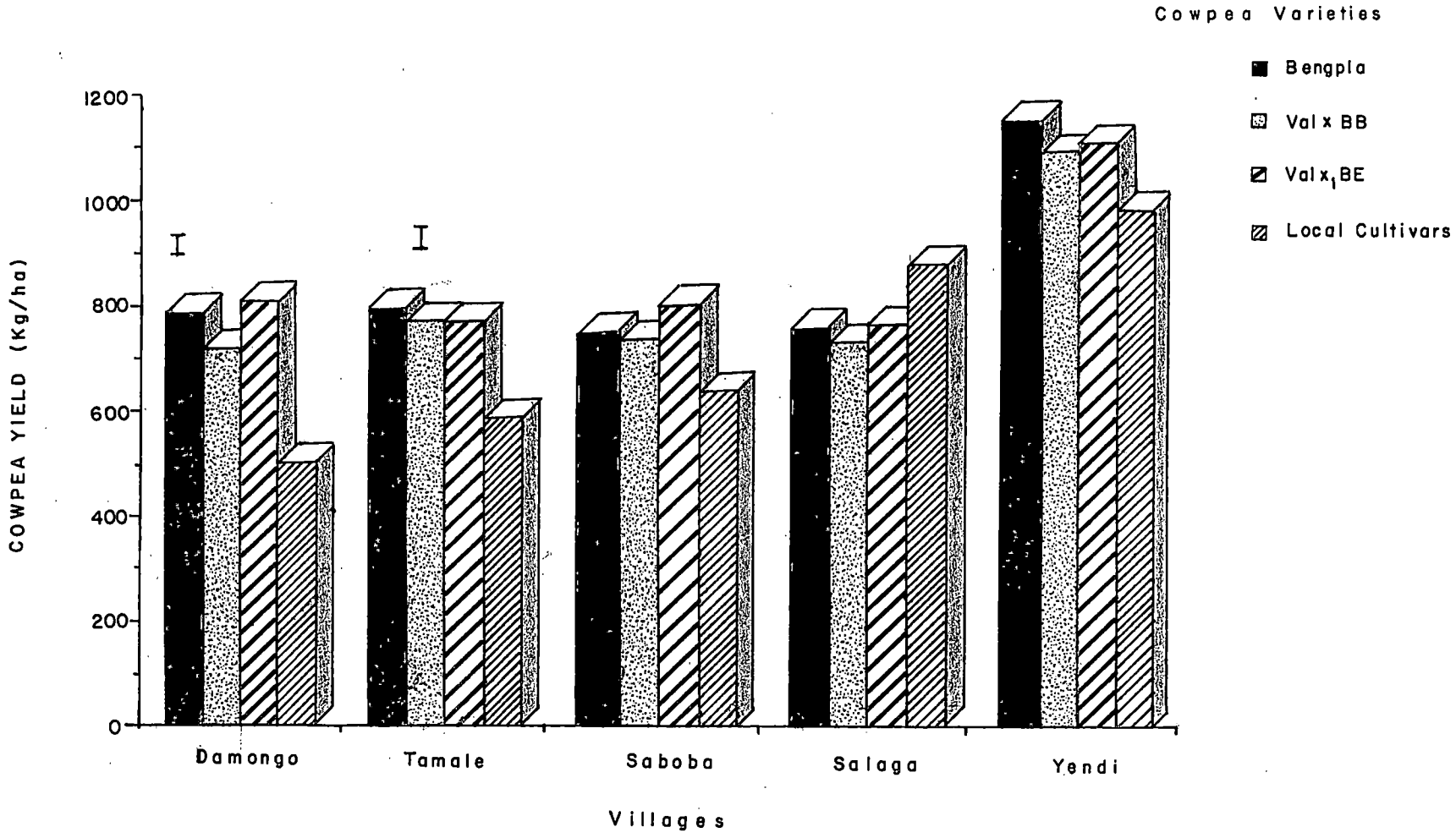

Fig. 2 The yield performance of cowpea varieties across locations

4.0. MALI

Agronomic evaluation of new maize cultivars in Semi-Arid Regions of Mali

The objective and purpose of the verification trials has been to identify suitable maize cultivars for semi-arid ecology and to develop agronomic practices that could minimize the effects of environmental and biotic constraints on the total maize production. The 1993/94 specific objective has been to undertake agronomic evaluation of the three improved maize cultivars compared to the performance previously introduced varieties.

Three improved maize cultivars (intermediate, early and extra-early maturing varieties) were evaluated. 57 farmers participated in the trials in the three ecological zones. The intermediate maturing maize cultivars evaluated particularly in southern region of Mali (Longorola) included Tiemantie, Tuxpeno n° 1, EV8422SR/IRAT 371. In Western zone of Mali (Kita), the on-farm verification trials consisted of early maturing maize cultivar such as DMR-ESRY, and TZESRW; and central region (Massantola) extra-early maturing maize cultivars such as Boni, Zanguereni; and TZEFY/CSPSR were evaluated.

As summarized in Table 4, the variety Tuxpeno, EV8422SR, and SWAN-SR had three years average yield 3.90, 4.20 and 4.20 and 4.17 tons/ha respectively. In 1993/94 the intermediate maturing maize cultivar SWAR-SR gave the highest yield in the Southern zone (Longorola).

In 1993, the variety CPSR was the highest yielder (2.83 t/ha) in Central zone of Mali (Massantola). The cultivar TZEFY was evaluated for three years and gave an average yield of 2.59 tons/ha. Two early maturing maize cultivars were compared with local cultivar in Western zone of Mali (Kita) between 1991 and 1993. The cultivar DMR-ESRY gave an average yield of 3.71 t/ha, slightly higher yield than local improved cultivar (3.29 tons/ha).

Based on the three years results, the varieties EV8422SR, DMR-ESRY and TZE-SRW have been taken up by the national extension and regional development agencies. The variety EV8422SR resistant to various diseases, confirmed its superiority compared to the cultivar Tiemantie and Tuxpeno n0. 1. SUWAN-1-SR is a recently introduced promising variety.

Table 4. Yield (tons/ha) of some maize cultivars under farmers' practice in the three ecological regions of Mali.

Variety	Southern zone Tongorola				Variety	Central zone Massantola				Variety	Western zone Kita			
	Year					Year					Year			
	1991	1992	1993	Average		1991	1992	1993	Average		1991	1992	1993	Average
Tiemantie	4.07	3.24	3.34	3.55	Local	2.4	2.08	2.65	2.38	Local	4.32	2.37	3.19	3.29
Tuxpeno	4.45	3.75	3.52	3.90	Longue-reni	2.2	1.93	-	2.07	TZESRW	3.42	2.24	3.08	2.91
EV8422SR	4.46	393	-	4.20	TZEFY	2.5	2.11	3.15	2.59	Niéleni	4.83	2.52	3.79	3.71
IRAT-374	-	-	3.84	3.84	CSPSR	-	-	2.83	2.83					
SWAN SR	-	-	4.17	4.17										
CV%	21.2	15.5	27.8	-	CV%	11.3	9.87	20.6		CV%	16.97	16.17	26.48	

5.0. NIGERIA.

i) On-farm verification trials with major emphasis to increase the productivity of sorghum/millet/maize/cowpea associations

The on-station study revealed that maize responded to nitrogen (N) and phosphorus (P) fertilizers up to 150 kg N and 17 kg P/ha, respectively. On the other hand, grain yield of cowpea was depressed by N fertilizer while P increased yield up to 35 kg P/ha. Grain yield of the two component crops was not affected by potassium fertilizer. It was also observed that, the cowpea variety SAMPEA-7 performed slightly better than the other improved cultivars. This report presents the results of on-farm trials conducted at two locations in 1993/94.

The project area comprised of Sokoto, Kebbi Katsina, Kaduna, Kano, Jigawa and Bauchi States. About 27 millions people inhabit in these states. The area is characterized by semi-arid environment with rainfall varying 600-1100 mm/year.

Thirteen farmers participated in the project at Daudawa and twenty farmers at Makarfi. The on-farm trials included:

(a) Farmers' local variety of maize and cowpea (one each) and NPK fertilization at 60 kg N, 13 kg P and 25 kg K/ha.

(b) Farmers' local variety of maize and cowpea (one each) and NPK fertilization at 120 kg N, 26 kg P and 50 kg K/ha.

(c) Improved maize variety TZBSR-W and cowpea variety SAMPEA-7 and NPK fertilization at 60 kg N, 13 kg P and 25 kg K/ha.

(d) Improved maize variety TZBSR-W and cowpea variety SAMPEA-7 and NPK fertilization at 120 kg N, 26 kg P and 50 kg K/ha.

Fertilizer was applied on maize in two split doses as NPK 21-13-13; half at two weeks after sowing and half at 6 weeks after sowing. Farmers managed trials including cultural management practices from land preparation to harvest and the only intervention by the researcher was the application of insecticide protection to

cowpea against insect pests. This involved two applications of a tank mixture of Karate EC and dimethoate - one application at flowering and the other at pod filling.

Data on the effects of variety and fertilizer on maize grain yield at Daudawa and Makarfi are contained in Table 4. At both locations, the improved maize variety TZBSR-W significantly outyielded the farmers cultivar. The magnitude of yield increase over the farmers variety was 17% and 33% at Daudawa and Makarfi, respectively. The difference in the magnitude of yield increase at the two locations may probably be attributed to the fact that farmers at Daudawa have been exposed to improved technologies for a greater number of years than those in Makarfi. Thus, the farmers maize variety at Daudawa was in fact an improved variety.

Grain yield of maize increased from 29 to 43% with application of 120 kg N, 26 kg P and 50 kg K/ha at Daudawa and Makarfi respectively.

Most of the soils of the savanna ecological zones are inherently low in native fertility, particularly nitrogen and phosphorus. The recommended rate of inorganic fertilizer for maize in most soils in the Nigerian Guinea and Sudan savannas is 120 kg N, 26 kg P and 50 kg K/ha. However, due to non-availability of and high cost of inorganic fertilizers, most farmers apply far less than the recommended rate of fertilizer to crops in general. Despite the fact that most farmers use farmyard manure, this study confirmed that maize yield will be reduced if the recommended rate of fertilizer is not applied.

Maize yield was higher at Daudawa compared with Makarfi mainly due to earlier planting (Table 5). Rainfall established early at Daudawa and farmers were able to plant maize in early-mid June whereas the erratic nature of rainfall at the onset of the season at Makarfi caused maize planting to be delayed till late - June/early-July.

Data on the effect of variety and fertilizer on grain yield of cowpea revealed that the improved variety SAMPEA-7 outyielded the farmers variety by 60 and 44% at Daudawa and Makarfi, respectively (Table 5). Cowpea grain yield also responded favourably to fertilizer application at both locations. Averaged over variety, the application of 120 kg N, 26 kg P, and 50 kg K/ha resulted in 25 and

35% increase in cowpea grain yield over 60 kg N, 13 kg P and 25 kg K/ha at Daudawa and Makarfi, respectively. Thus, the cowpea crop grown in relay with maize benefitted from the fertilizer applied to maize before cowpea was sown. The magnitude of response to fertilizer of both maize and cowpea was higher at Makarfi compared to Daudawa.

The cowpea grain yield was much higher at Daudawa compared with Makarfi. Average yield of the improved variety SAMPEA-7 in mixture with maize given 120 kg N, 26 kg P and 50 kg K/ha was 625 kg/ha (range of 340-1080 kg/ha). On the other hand, the average yield from a similar treatment at Makarfi was 191 kg/ha (range of 30-370 kg/ha). The better performance of cowpea crop at Daudawa compared to Makarfi could be associated with the relatively earlier planting and high rainfall received in the first and second weeks of October whereas the crop at Makarfi was adversely affected by end-of-season drought.

ii) Sorghum/millet/cowpea mixed cropping trials

Sorghum/millet/cowpea mixture is the most widespread cropping practice among peasant farmers in parts of the northern Guinea and Sudan savannas of Nigeria. The small-scale farmers who constitute the bulk of the producers cultivate mostly the traditional varieties. Improved varieties have been developed under sole cropping and the issues of varietal performance and acceptability in the farming system have not been properly elucidated. This study was therefore carried out to study the performance of improved varieties of sorghum, millet and cowpea as compared to farmers' cultivars, and to enhance the process of adoption of improved varieties, of sorghum, millet and cowpea as component technologies.

The project was located at Yandoto in Sokoto state in 1991-93, Makarfi in Kaduna state in 1991-92 and Zogarawa in Kano state in 1992-93. The two treatments included: (a) Farmer's local variety of sorghum, millet and cowpea (one for each crop), (b) Improved sorghum variety SAMSORG 14, millet variety SAMMIL-6 and cowpea variety SAMPEA-7. The trials were managed by 25 farmers who used their normal cultural management practices from land preparation to harvest. The researchers supervised the cowpea insecticide application and collected the data. An informal post-season technology evaluation exercise was carried out in the villages to monitor the preception of the farmers about the project.

Improved cowpea variety significantly outyielded the local while those of sorghum and millet were not significantly different (Table 6).

Grain yield of sorghum, millet and cowpea both for improved and local cultivars was higher in Yandoto than in Zogarawa, due to better rainfall and soil conditions in the former. Cowpea yield of improved variety over local cultivar increased by 93% in Zogarawa and by 25% in Yandoto. However, there was not significant yield difference between improved and local cultivars of millet and sorghum in above both locations (Table 6).

Problems faced by farmers appeared to be highly location specific. High labour cost ranked highest at Yandoto while insufficient fertilizer was noteworthy at Zogarawa. At Zogarawa, early maturity of the improved varieties ranked highest while at Yandoto, farmers believed more in the high yielding ability of the test entries.

At Zogarawa, about 92% of the farmers would like the introduction of extra-early maize, whereas 64% of the test farmers at Yandoto would want more fertilizer. All the farmers would like to cultivate the improved sorghum at Zogarawa. At both locations, all farmers would like to adopt Sampea-7.

CONCLUSION

Cultivation of improved varieties of sorghum, millet and cowpea resulted into higher financial returns than with local varieties. The cowpea variety sampea 7 consistently proved superior compared to the local cultivars in grain yield, taste, earlier maturity, and marketability. Although the grain yields of improved sorghum and millet were not higher than the local varieties, some farmers showed preference for the improved sorghum because of its early maturity, grain color, seed size and taste. The improved millet was the least acceptable to farmers. Analysis of labor usage showed that most of the labor demand went into harvesting the produce. In addition, more labor was used on land preparation and weeding in areas where use of hand hoe was predominant as compared to the use of oxen. Based on the findings, emphasis should be placed on the mass adoption of sampea 7 cowpea variety as it could lead to an overall yield increase from 25 to 93% over the local variety when insecticides are applied.

For the maize/cowpea/NPK fertilization, application of 120 kg N, 26 kg P and 50 kg K/ha resulted into higher maize, cowpea yields and gross margin (57%) than half this rate irrespective of variety. Improved maize variety TZBSR outyielded the local while improved cowpea sampea 7 consistently outyielded the local variety. Usage of improved varieties with 120 kg N, 26 kg P and 50 kg K/ha is strongly recommended for optimum grain yields and financial returns.

Table 5. Maize and cowpea grain yield as affected by variety and fertilizer in maize/cowpea relay crop (1993 wet season).

Treatment	Maize grain yield (kg/ha)		Cowpea grain yield (kg/ha)	
	Daudawa	Makarfi	Daudawa	Makarfi
TZBSR-W + 60-13-25 NP	2288	1796	537	148
TZBSR-W + 120-26-50 NPK	3042	2637	658	191
Farmers variety + 60-13 - 25 NP	2025	1353	325	96
Farmers variety + 120-26 - 50 NPK	2514	1969	422	139
SE	106.7	102.9	29.1	11.0
LSD (0.05)	306.3	291.2	83.4	31.0
CV (%)	15.6	23.8	21.6	34.2

Table 6. Grain yield of sorghum, millet and cowpea on farmers' helds at Zogarawa and Yandoto project sites (1993 wet season).

	Grain yield (kg/ha)	
	Zogarawa	Yandoto
Sorghum		
Improved	956	1867
Local	924	1598
SE+	115.6	125.7
t (0.05)	not significant	not significant
Millet		
Improved	597	1512
Local	519	1560
ΣE	110.1	118.1
t (0.05)	not significant	not significant
Cowpea		
Improved	454	1325
Local	235	1060
SE+	38.4	84.9
t (0.05)	significant	significant

6.0. SENEGAL

Improving the productivity of millet-based cropping systems

Poor soil fertility, cost of inputs erratic rainfall, and lack of improved cultivars have been the major constraints to increase the production of food grain (i.e. millet, sorghum, maize, groundnut, cowpea, etc.) in Senegal. Through the support of this project, verification trials to improve the productivity of millet-based cropping systems were conducted since 1990 in various regions of Senegal. In 1993/94, the following technological options were evaluated:

i) Assessment of inorganic fertilizer and organic manure requirements.

The trials were carried out in four major ecological zones: Centre South (Thysse Kaymore); Central region (Diofior); Centre Nord (Ndiemane) and Northern region (Thilmakka). Three improved millet varieties, Souna-3 and IBMV 8402 and IBMV 8004 were evaluated in Centre South and Central zone, Central North and Northern regions respectively.

The application of 100 kg/ha of complete of fertilizer (14-7-7) plus 100 kg/ha urea increased yield across locations (Table 7). The yield of millet was generally low when organic manure was used alone except in Central zone (Diofior village) and Centre North region (Ndiemane village) where yield increased over the traditional practice (without organic manure) by 41% and 28% respectively. The application of 30 kg/P_2O_5 and 5 tons/ha organic manure improved yield by 41% in Thysse Kaymore; 68% in Diofior; 36% in Ndiemane. On the other hand, the application of 50 kg/ha of complete fertilizer and 5 tons/ha organic matter increased millet yield by 60 and 83% over traditional practice in central zone (Diofior) and central north zone (Ndiemane) respectively. In general, the Centre North region with low soil fertility responded well to the increased application of organic matter. The yield gap of the performance of technologies between on-station and on-farmers' field is evident. In the Thysse Kaymore, Centre South zone, the mean yield of all treatments on-station has been 2033 kg/ha compared to 829 kg/ha on-farmers' fields, which represents 59% of the yield obtained on station.

In the Centre North region, at Bambey Station, the average yield of millet has been 1519 kg/ha compared to 943 kg/ha on farmers' fields, which represents 62% of the yield on-research station.

ii) Productivity of the millet/cowpea mixed cropping systems

The mixed cropping systems in the Centre South Centre region comprised of the millet variety Souna-3 and cowpea cultivar 58-74 grown in association and monoculture. In the Centre North region, the millet cultivar IBMV8402 and IBMV8404 were grown in association and pure stand with cowpea cultivar 58-74. The purpose of the study has been also to produce forage for livestock. As indicated in Table 7, the yield of the millet cultivar Souna 3 was increased by 1214 kg/ha with application of 5 tons/ha organic matter and 50% of the recommende rate of commercial fertilizer. This has been about 84% yield increase over farmers practice (i.e. no fertilizer application).

With regard to millet/cowpea mixed cropping systems, the cultivation of the millet variety such as Souna-3 alone gave the highest yield, compared to millet/cowpea mixed cropping systems in Thysse, Diofior, Ndiemane and Ndiasil. Millet association with cowpea reduced the yield of cereal by 73 and 66% in Thysse Kaymore; and Diofor respectively. Cowpea yield has been reduced from 35 to 45% when grown in association with millet. The fourage types of cowpea such as 58-74 seem to reduce the yield of millet than grain type cowpea cultivars. In North region, the application of 100 kg/ha NPK (14-7-7) and 100 kg/ha urea gave over 65% yield increase of millet compared to farmers practice.

As indicated in Table 8, the application of 50 kg/ha of complete fertilizer (14-7-7) and 5 tons or 2 tons/ha of organic manure gave the highest millet straw production 3.4 and 2.1 tons/ha in Diofior and Ndiemane respectively. Millet straw yield was increased to level of 2.4 and 1.7 tons/ha in North region and Thysse Kaymore respectively (Table 8).

iii) Training

In collaboration with national extension systems and non-governmentagents more than 50 farmers were trained in the construction and preparation of compost

in Diofior, Ndiemane, Bambey and Thilmakha. Another important topic of discussion with farmers has been the management of natural resources.

Table 7. Effect of mineral fertilizer and organic manure on the grain yield (kg/ha) of millet in some villages of Senegal.

Treatment (T)	Centre South		Central Zone	Centre North		North		% increase or decrease
	Thysse Kaymor		Diofior farmers field	Bambey CNRA Research Station	Ndiémane Farmers Field	Research Station	Farmers field	
	Research Station %	Farmers Field %	%	%	%	%		
T_0: Without fertilizer	1713c	627c	959 c	1283 a	661 c	548 b	365 c	
T_1: 150 kg/ha of NPK (14-7-7) + 100 kg/ha of urea	2256a +32	1133a +81	1618 a +69	2052 a +60	1095 ab +66	725 a +32	787 a	+65
T_2: 5 t/ha organic manure (OM)	1836bc + 7	610c - 3	1358 b +42	1389 a + 8	845 c +28	438 b -21	337 c	+ 7
T_3: 30 kg de P205 + 5 t/ha of organic manure	2215a +29	919b +47	1616 a +68	1471 a +15	898 bc +36	560 b + 2	372 c	+28
T_4: 50 kg/ha of NPK 14-7-7 + 5 t/ha organic manure 2 t/ha organic manure	2146ab +25	855b +36	1540 ab +60	1401 a + 9	1214 a +84	666 b +50	548 b	+40
Average	2033	829	1418	1519	943	588	484	
CV %	12	30	22	31	30	32	25	
L.S.D. 05	373	211	258	727	238	290	117	

% = percent increase or decrease in yield compared to traditional agronomic practice (T_0).

Table 8. Effect of mineral fertilizer and organic matter application on millet straw yield.

Treatment (T)	Centre South		Central Zone	Centre North		North		% increase decrease
	Thysse Kaymor		Diofior farmers field	Bambey CNRA Research Station	Ndiémane Farmers Field	Research Station	Farmers field	
	Research Station %	Farmers Field %	%	%	%	%		
T_0: Without fertilizer	3079 a	1048 c	1569 b	2864 a	1281	1800 cd	1502 c	
T_1: 150 kg/ha of NPK (14-7-7) + 100 kg/ha of urea	3278 a + 6	1660 a +58	3261 a +108	3407 a +19	2079 +62	2782 ab +55	2390 a	+59
T_2: 5 t/ha organic manure (OM)	3611 a +17	1066 c + 2	2861 a + 82	3768 a +32	1695 +32	2128bcd +18	1263 c	-16
T_3: 30 kg de P205 + 5 t/ha of organic manure	3540 a +15	1381 b +32	3000 a + 91	3619 a +26	1951 +52	2315 bc +29	1460 c	- 3
T_4: 50 kg/ha of NPK 14-7-7 + 5 t/ha organic manure 2 t/ha organic manure	2717 a -12	1435 ab+37	3496 a +123	3832 a +34	2172 +70	3098 a +12	2042 b	+36
Average	3245	1318	2837	3498	1836	2425	1731	
CV %	21	21	29	10	20	14	18	
L.S.D. 05	1039	226	691	516	396	508	310	

% = percent increase or decrease in yield compared to traditional agronomic practice (T_0).

CONCLUSION

Mineral fertilizer and organic manure application showed substantial yield increase on-farmers field than on-research station, even the yield level on the latter, has been two to three times more. Fertilization with 100 kg/ha NPK (14-7-7) and 100 kg/ha urea increased yield on farmers field in Diofor (69%), Thysse Kaymore (81%), Ndiemane (66%) and in Northern zone (65%) with same level of fertilizer application the millet grain increase varied from 32 to 60% compared to traditional practice. Reduction of mineral fertilizer to 50 kg/ha NPK (14-7-7) plus 5 or 2 ton/ha of manure improved millet grain yield on-farmers field by 36, 60, 84 and 40% in Thysse Kaymore, Diofior, Ndiemane and in Northern zone respectively. The application of organic manure alone did not substantially increase grain yield of millet.

With regard to straw production of millet, the use of complete fertilizer and urea increased yield from 58 to 108 percent compared to traditional practice in Thysse Kaymore and Diofior respectively. The application of 30 kg/ha P_2O_5 plus 5 ton/ha organic matter in Central and Centre North zone increased yield millet straw in Diofior by 91%; and Ndiemane by 52%. The application of organic matter alone increased yield of millet straw by 82% in Diofior; 32% in Ndiemane and decrease yield by 16% in the Northern zone. Further study is planned (1995/96) to substantiate these findings.

7.0. TOGO

Identification of suitable sorghum and cowpea cultivars for Northern Savanna Zone

The project is based in the Kara region, Northern Guinea savanna zone, where the yearly average rainfall is 1100-1300 mm. The estimated population of Northern Togo is about 430,000 inhabitants with a density of about 37/km^2. Sorghum, millet, groundnut and cowpea are important staple food crops, but the production and use of maize has substantially increased in the past 20 years. Agriculture is the major occupation for 75% of the population in Togo.

The main objectives of the project are: to determine the adaptability of two improved sorghum cultivars under farmers' conditions in Northern Togo; to evaluate the adaptability and acceptability of new (white seeded) early-maturing cowpea cultivars; to identify the best combinations of varieties and improved agronomic practices for sorghum/cowpea mixed cropping systems and to assess the economic feasibility of cropping systems under consideration.

In both Kara and Savanna regions, the on-farm verification trials of sorghum and cowpea involved 24 and 33 farmers respectively. Furthermore, 16 farmers participated in the the Maize *Striga* resistance field level observation trials.

As summarized in Table 9, sorghum variety 27/TC outyielded local cultivar by 94% in the Kara region and only by 10% in the Savanna region. Variety 288/TC outyielded local cultivar in Kara by 48%. In general, sorghum yield is relatively higher in savanna region, eventhough the performance of elite varieties over local cultivar was not impressive. Since the cowpea cultivars used as local check was introduced the previous years, there was no significant difference in yield performance among the varieties evaluated.

Table 9. Yield (kg/ha) of sorghum and cowpea (monoculture) cultivars in Kara and Savanna regions.

Variety	Kara Region				Savanna Region			
	Sorghum		Cowpea		Sorghum		Cowpea	
	Yield kg/ha	Percent increase over local	Yield kg/ha	Percent increase over local	Yield kg/ha	Percent increase over local	Yield kg/ha	Percent increase over local
(Sorghum)								
27/TC	908	94			1345	10		
288/TC	694	48						
331/TC					1507	24		
Local	468				1218			
(Cowpea)								
IT83-S-742-2			458	13			701	5
IT83-S-962			424	4				
58-146 (local)			406				667	
KVx396-4-4							828	24

ANNUAL REVIEW AND PLANNING WORKSHOP

A review and planning workshop was held 11 to 31 May, 1994. Project participants from 8 countries and senior consultant and Director of Research of SAFGRAD attended the workshop.

The 1993 results of on-farm verification trials were discussed and the objectives of the project were revisited. The following issues that could influence project achievements were discussed.

It was noted that specific achievements of the project activities in participating countries seem to vary considerably. Some of the important elements that influenced success of the project activities are:

(i) Simplicity of the on-farm trials design - the main purpose being to effectively demonstrate that the technology under consideration not only could increase yield but also could be advantageous to farmers. In general, project design in most of the participating countries need to be simplified focusing on few factors.

(ii) Appropriateness of technologies.
Farmers' opinions and participation in assessing the appropriateness of technology is crucial. Researchers, extension workers and farmers should meet not only to plan on-farm trials activities, but also to review results of previous seasons. A clear cut set of criteria which combines technical feasibility with socio-economic feasibility (i.e., social benefits and economic returns) need to be carried out to determine the appropriateness of particular technology.

(iii) Adequacy of research.
Technologies included in verification trials under the project should go through adequate periods of testing on-station and multilocation trials. Multidisciplinary research team should be involved at various levels of experimentation and analysis of trials socio-economic evaluation should be conducted to determine the cost effectiveness and feasibility of the technology and its acceptance.

(iv) Access of technology to farmers.
Farmers can be exposed directly (those involved in managing trials) and indirectly to the verification trials.

(a) Individual versus group approach: The group approach has proved to be an effective means of directly involving many farmers at the same time.

(b) Replication across farmers (i.e., one replication per site), while possibly reducing statistical precision, compared to increased replication per site, allows more farmers to be reached with given amount of resources. Considering the objective of verification trials, reduced replication per site, if even it leads to some loss in statistical precision may be preferred option.

(c) Farmers' Field Days (FFD).
Organized field visits and field days of demonstration sites by farmers should be part of the methodology of the technology transfer process. Unfortunately, the project activities in most of the countries did not report of such undertakings. Furthermore, FFD provides opportunity for researchers to obtain feed-back information of farmers acceptance of new technologies.

1994

1993/94 TECHNICAL REPORT OF THE FOOD GRAIN PRODUCTION VERIFICATION PROJECT

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