OAU-SAFGRAD/KOREAN GOVERNMENT & UNIVERSITY OF KYUNG POOK

AFRICA INTEGRATED STRIGA CONTROL PROJECT

1999 ANNUAL REPORT

INTRODUCTION

The majority of rural population in SSA heavily depends on agriculture as a source of employment and income.

Sub-Saharan Africa (SSA) population is expected to reach 1.3 billion in 2025. Borlaug and Dowswell (1993) estimated that the production of cereal should reach 4 million metric tons in 2025 to meet food security. This represents more than the double of 1990 cereal production.

To meet this requirement, it was noted that 4% agricultural growth is needed to sustain food security, to end hunger and malnutrition. Otherwise, Africa will import 27 million tons from its current 12 million metric tons (IFPRI and World bank report 1995).

To enhance sustainable agriculture in Africa many solutions could be envisaged. Among them:

- increase in cultivated land area which will require the destruction of environment.
- Increase of productivity which will require the use of improved integrated production measures which include the use of improved stable cultivar along with good agronomic practices .
- reduction of losses after harvest.

Regardless of an impressive research effort and control measures to reduce striga incidence by farmers, extension NGOs, NARES and IARCS, this stress next to soil fertility remains one of the biological constraints that substantially reduce crop yields.

Yield losses due to striga is estimated by FAO to be 40% for cereal and 30% for cowpea. (Aggarwal and Ouedraogo 1999, Muleba et al 1997). Losses observed in countries involved in the integrated striga control project are presented in the table below.

Countries	Percent Infested	Averaged Losses (%)	Maximum Losses (%)	References
CAMROON	75	15-20	50-90	Lagoke, S.T. (1985)
GHANA	66.83	16	78-100	Sanuerborn (1991)
COTE D'IVOIRE	-	15	80-90	Thalouarn et Fer (1993)
BENIN	-	-	60-90	Gbehounou et al (1991)

Striga control could increase food production by at least 30% to 40% if an integrated striga control measures is used. Known striga control measures included.

1) Genetic control of damages : research efforts have yielded some varieties with horizontal resistance.

2) Agronomic control of losses, this included :

- the prevention of striga seed dispersal
- the production of maize seed on striga free plot.
- hand pulling of emerged striga plants
- transplanting
- seed treatment with ALS
- the eradication of striga seed bank by soil chemical fumigant such as ethelene gas or the application of post emergence herbicide (2-4 D).
- the use of trap crop in field rotation (cowpea), cotton, groundnut and soybean)
- the use of N fixing legume cover crop (Macuna, desmodium and stylosantes).
- The use of legume shrubs and tree (cassia, sesbania, crotalaria, pigeon pea etc.....)
- The improvement of soil fertility by the use or organic fertilizer.

3) Biological control.

4) Socio economic consideration.

Singlely, none of the above known striga control measures is 100% satisfactory.

II OBJECTIVES

Ultimate Goal

To control striga in order to enhance sustainable agriculture, to sustain food security, to end hunger and malnutrition.

Relative Objectives

- To evaluate at farmer level, maize varieties for tolerance to striga and to promote their adoption.
- To evaluate efficacy of integrating striga tolerant maize inter cropped with N fixing legume in reducing striga seed bank, level of infestation and improving soil fertility.
- To develop and promote appropriate integrate striga control technologies.

II – 1 Strategies

Progress achieved by individual sub-saharan African countries in striga control have been slow and non significant. This have been probably due to

- to the weak complementary and synergy among NARES, IARCs and other institutions engaged in striga research and control..

- to the fact that no single country in sub-saharan Africa has the scientific capacities and resources to effectively control striga infestation.

- to the non participation of farmers with multidisciplinary research teams engaged in improving agricultural production and productivity.

To achieve the above objectives, the following were done:

- the establishment of a collaborative programme by an African agricultural research co-ordination agency (here by OAU/CSTR-SAFRAD).
- The identification of a forum of donors, such as the Government of Korea through the University of Kyungpook, BAD, OAU, and participating countries.

The purposes of the collaborative programme were :

* To enhance partnership, complementary and synergy among stakeholders including farmers, extension agency, NGOs, NAREs, IARCs and other private institutions engaged in striga research and control.

* To establish a striga consultative group here called Striga task Force (STF).

- To enhance on-farm adaptative evaluation of integrated Striga Control packages of technology at Focal countries in S.S.A.

- To serve as a forum of exchange of technical information as well as to articulate policy issues and to build awareness from community to government levels to facilitate support for research and control striga .

- To articulate the link between striga control and food security

II - 2 ACCOMPLISHMENTS

The Striga Task Force (STF) reviewed current state of striga research and co-operation. This task force identify the missing technical and institutional links, and put in place efficient mechanisms for striga control technology transfer. This included for the first year, the systematic on-farm adaptative evaluation of integrated striga control packages of technology at focal countries. This packages were made of 2 types of trials.

- On-farm striga tolerant maize variety trial .
- On-farm maize/legume inter cropped made of a striga trap crop (leguminous crop) and striga tolerant maize varieties.
- Rotation trial : maize/legume

Results obtained at focal countries in West and Central Africa are presented in this report.. The striga task force also identify as focal countries : Benin, Burkina-Faso, Cameroon, Côte d'Ivoire, Ghana, Mali, and Nigeria in West and Central Africa, Ethiopia Kenya and Tanzania in Eastern Africa and Malawi and Zimbabwe in Southern Africa. However, due to financial constraints, trials in Mali and Burkina-Faso in West Africa were not implemented during the first year.

A scientific monitoring tour comprised of researchers from IRAD-Cameroon, WECAMAN (West and Central Africa Maize Network). OAU/STRC-SAFRAD, IARI of the republic of Korea and IITA, visited Benin, Cameroon, Côte d'Ivoire, Ghana and Nigeria from 13 September to 10 October, 1999. Their findings were included in the implementation report : SAFGRAD No 001, of January 2000.

III MATERIALS AND METHOD

III – 1 Plant Materials

Plant materials used for on-farm adaptative evaluation in integrated striga control trial at each focal countries are presented in table 1 below, for the three types of trials conducted.

Expected for local check, all maize varieties used has been selected for tolerance to striga. In addition, except for Cameroon all tested striga tolerant varieties were developed at IITA

Leguminous crop used in the maize/legume inter-cropped were tested for trap cropping except for the one used in Cameroon.

Table 1 : Plant materials and trial type used in focal countries

Countries	Trial Types	Plant Materials	
		Maize Variety	**Leguminous Crop**
BENIN	Maize/Legume Intercropped	- Across 92 TZE Comp 5 W - DMRESR-W (check)	Youpi-youpi Yangalo (local cowpea)
CAMEROON	Variety Trial	- STR-Yellow - Oba-super - Oba-super - Cam-Inb STR - Advanced NCRE STR - K9351 STR - 87036 x 88094 - CMS 8501 (check)	
	Rotation trial (maize/legume)	- Cam Inb STR - STR-yellow - Advanced NCRE STR - CMS 8501 (check)	BR1 (Cowpea)
COTE D'IVOIRE	Variety Trial	- Across 94 TZE Comp 5-y - Across 94 TZE Comp 5-W - EVDT 97 STR Co - IWD STR Co - TZEE-W-SR-BC5 - TZEE-SR-W x Gua 314 BC1	
	Rotation trial (maize/legume)	- Across 94 TZE Comp 5-W	Local Cowpea
NIGERIA	Variety Trial Maize/Legume inter-cropped	- OBA-Super 1 STR - 9022-13 STR - TZE Comp 1 Co - IWD STR Co - Local check	Samsoy2 (Soybean) RMP 91 (Groundnut)
GHANA	Maize/Legume inter-cropped Rotation Trial (maize/legume)	- IWD STR Co - Across 92 TZE Comp-5-W - Dorke (local check)	Salintuya I (Soybean)

Table 2 : Plant materials, trial type number of participating farmer, treatment, design and plot size of on farm adaptative trial in focal countries

Countries	Trial Type	Nbre of Farmers	Treatment	Design	Plot Size
BENIN	Maize/Legume inter cropped	15 20 Grand total 35	STR maize alone STR maize/cowpea Local maize/cowpea STR maize alone Local alone STR maize inter cropped Local inter cropped	RCBD 1 Rep/farmer	400 m^2
CAMEROON	Variety Trial	Total : 6 2 2 2	3 sets: Set 1: 88094 x 867036 Oba Super 1 STR yellow CMS 8501 Set 2 : Advanced NCRE STR Oba Super 1 STR yellow CMS 8501 Set 3 : Syn E1 Cam Inb STR 1 Oba Super 1 CMS 8501	RCBD 1 Rep/Farmer " "	12 m x 24 m = 288 m^2
	Rotation Trial (maize/legume)	Total : 10 Grand total 16	STR maize alone STR maize/cowpea Cowpea Local maize check (CMS 8501)	RCBD 1 Rep/farmer	12 m x 24 m = 288 m^2
COTE D'IVOIRE	Variety Trial	8	EVDT 97 STR Across 94 TZE Comp 5-W Across 94 TZE Comp 5-Y IWD STR Co Local Check	RCBD 1 rep/farmer	10 m x 2.25 m 22.5 m^2

Country	Trial Type	Nbre of Farmers	Treatment	Design	Size Plot
	Rotation Trial (Maize/legume)	8 Grand total 16	STR maize alone STR maize/cowpea Cowpea alone Local maize	RCBD 1 Rep/farmer	10 m x 10 m = 100 m^2
GHANA	Maize/legume Inter-cropped	9	STREC-WF TZL-Comp-1C[4] Dorke-SR Farmer maize		100m^2 to 280m^2
	Rotation Trial Maize/legume	8 Grand total 17	Soybean Cotton STR-maize		625m^2 25m x 25m
NIGERIA	Maize/Legume Inter-cropped	52	STR hybrid/legume STR maize/legume Farmer maize alone		150m^2
		126			

All participating countries were to use Oba Super 1 as across country check seed of Oba Super 1 were not available in some focal countries.

III – 2 METHOD

The type of trial, the number of farmers, treatment evaluated, the experimental design used as well as the plot size of technologies evaluated in each focal country are shown in table 2.

A total of 126 trials were conducted in focal countries. This trials were of three types : 14 varieties trials, (Cameroon; Côte d'Ivoire and Ghana) 86 maize/legume inter cropped trials Benin, Ghana, Nigeria), plot size varied from 22.5m2 observed in Côte d'Ivoire to 400 m2 in BENIN. The design used in all countries was a RCBD with one replication per farmer.

IV RESULTS

IV – 1 Benin Results (See Country Report Annex 1)

15 trials were planted in ZAPOTA area. 11 of them were good. Trials consisted of a tolerant striga variety Across 92 TZE Comp.5 W and a local maize called "jaune de Za" evaluated alone and inter cropped with cowpea or groundnut. In this zone, an average 1 striga plant per m^2 were observed in all trials. However, a good lineaire correlation was obtained ($r = 0.91$) between the number of striga plant emerged and the number of striga attachment non emerged. STR maize as yielded the same as local maize (664 kg ha^{-1}). This low yield was partially attributed to low fertilisation applied in a very degraded land. Cowpea yield inte-cropped with maize varied from 90.0 kg ha^{-1} to 166 kg ha^{-1}. Groundnut yield when intercropped with maize varied from 670 kg ha^{-1} to 121.3 kg ha^{-1}.

In OUAKE area, striga hermonthica infestation was observed in 11 trials out of 20. In general 0.5 striga plant per m2 were obtained in this zone which was very low. On infested field, Across 92 TZE yielded Comp.5-W yielded 1721.5 kg ha^{-1} as compared to 1525.1 kg ha-1 when inter cropped with leguminous crop. These yields were statistically superior to local maize yield (DMRESR) of 1297.6 kg ha^{-1} Maize yield obtained in non infested fields were statistically different from those obtained in infested fields.

Maize yield when inter cropped with the cowpea variety "YANKOLO" was 1333.1 kg ha^{-1} as compared to 1691.3 kg ha^{-1} obtained in plot inter cropped with cowpea variety "youpi-youpi". Across 92 TZE Comp.5-W yielded 1820.5 kg ha^{-1} as compared to 1769 kg when intercroped with "youpi-youpi" cowpea. The local variety yielded significantly lower (1483.kg ha^{-1}.

Cowpea yield in OUAKE varied from 27.0 kg ha^{-1} to 100.0 kg ha^{-1} for "youpi-youpi" cowpea variety.

Partial conclusion for Benin. striga infestation in tested plot was generally very low. This low infestation did not permit any grain yield differentiation.

The striga tolerant variety Across 92 TZE Comp 5-W yielded the same in pure stand as when intercropped with leguminous crop. However its performance was superior to the local check.

Cowpea variety "youpi-youpi" was better than Yankolo" in pure stand as when associated with maize.

IV-2 CAMEROON RESULTS (See Country Report in Annex 2)

IV-2-1 Variety Trial

6 variety trials consisting of 4 treatments each were conducted in 6 different farmer fields. Entries consisted of 2 single crosses/Oba Super 1 and 87036 x 88094), one three way crosses (Oba-Super 1 x $Exp_3 7$), 2 yellow intermediate (110 days) striga tolerant composite (STR yellow, Cam Inb. STR $_1$) 1 white intermediate striga tolerant composite (Advanced NCRE). 1 white synthetic (Syn E1). All these entries were divided in 3 sets. Each set was evaluated in 2 villages. Each trial consisted of 4 varieties (3 striga tolerant and the local check CMS 8501). Experimental plot was a 13 row plot $^{-1}$, 24 m long . Set 1 consisting of 86036 x 88094, Oba Super 1, STR-yellow and CMS 8501, were tested at Ngong and Sanguere Paul site all of which were infested with striga hermonthica, revealed No significant grain yield differences among the striga tolerant entries. However, Oba Super 1 (2484 kg ha^{-1}) showed a slight yield advantage over the two other STR maize. STR varieties yielded at least 7% more than the local check. Only Oba Super 1 out yielded the local check by 23%.

Set 2 consisting of Advanced NCRE STR, Oba Super 1, STR yellow and CMS 8501 (local check) were evaluated at Tcholiré and Guidiguis. These two sites had low striga infestation. No significant grain yield differences were observed at this 2 sites among the 4 varieties. However Oba Super 1 (1901 kg ha^{-1}) and Advanced NCRE STR (1823 kg ha –1) exhibited A 10% and 6% yield superiority, respectively over the local check CMS 8501.

Set 3 consisting of Syn E1, Cam Inb. STR 1, Cam. Inb. STR, Oba Super 1 x $Exp_3 7$, and CMS 8501 were tested in Sudan Savanna area (Guider and MORA). Significant yield differences were obtained between striga tolerant varieties and the local check. Oba Super 1 x $Exp_3 7$ (2836 kg ha^{-1}) out yielded the other entries and showed 56% yield superiority over the check. Syn E1 (2363 kg ha^{-1}) and Cam Inb STR 1 (2365kg ha-1) also exhibited 30% yield superiority of the local check.

In partial conclusion for variety trial in Cameroon , it was observed that striga tolerant varieties generally out yielded the local check under heavy striga infestation. These grain yield superiority was 56%, 30%, 30% and 23% for Oba Super 1 x Exp $_3 7$, Sy E1, Cam. Inb. STR_1, and Oba Super 1 respectively.

IV 2-2 Maize/Cowpea Association Trials

Treatments for this trials consisted of :

- Tolerant maize alone
- N. Fixing legume alone (cowpea)
- Tolerant maize and N. fixing legume inter-cropped.
- Farmer practice (local maize alone).

10 trails were conducted. Striga tolerant maize used varied from one farmer to the other and consisted of advanced NCRE STR for those farmers who preferred white maize and of Cam Inb STR 1 or STR yellow for those farmers who preferred yellow maize. The experimental plot consisted of a 13 rows plot^{-1} of 24 m.

Highly significantly differences ($p<0.01$) were detected among sites/farmers. The best treatment was striga tolerant maize in association with cowpea.. This treatment yielded an average of 2513 kg ha^{-1}. This represented 25% yield increase over the farmer practice. This treatment also exhibited the highest plant stand ear number at harvest and the lowest striga plant emerged per maize plant (0.7). Even though no significant grain yield, number of plant and ear at harvest

differences were observed between STR maize alone and the local check. The tolerant maize had significantly lower striga plant emerged per maize plant.

IV –3 CÔTE D'IVOIRE RESULTS (See Country Report in Annex 3)

IV 3-1 Variety Trial

8 variety trials were conducted in this country. Treatment consisted of 4 striga tolerant maize and a local check. Varieties used were EVDT 97 STR, Across 94 TZE Comp 5-W, Across 94 TZE Comp 5-Y and IWD STR Co. Each trial consisted of 4 row plot^{-1} of 10 m.

Analysis of variance computed on 6 trials showed no significant differences among tested varieties. In Ferke, IWD STR Co which was the best STR maize yielded 4% lower than the local check. At NIELLE, Across 94 TZE Comp 5-W yielded 3014 kg ha^{-1} which represented 10% yield increase over the local check. Across 94 TZE Comp 5-W and Across TZE Comp 5-Y exhibited less striga symptoms and less striga plant emerged as compared to the local check.. Except for on-station trial . Higher grain yield observed for the local check was partially due to their longer maturity cycle.

IV 3-2 Maize/Legume (Rotation Trial)

8 Maize/Legumes rotation trials were conducted. Results obtained in 6 trials revealed no significant maize grain yield differences between striga tolerant maize alone as compared to striga tolerant maize inter cropped with cowpea. Farmer practice consisting of local maize alone had more striga plant emerged.

IV - 4 GHANA RESULTS (See Country Report in Annex 4)

IV- 4-1 Maize/Legume Inter cropped.

9 farmers evaluated the continuous cropping of a mixed crop of striga tolerant maize varieties inter cropped with a N fixing trap crop (soybean). Four treatment made up of two striga tolerant maize varieties (STREC-WI, TZL Comp 1 C_4), a striga susceptible maize variety (Dorke SR) were inter-cropped with a N. fixing trap crop (soybean variety salintuya 5). These above treatments were tested against farmers practices. Plot size varied from 100 m^2 to 280 m^2

IV 4-2 Crop Rotation

8 farmers evaluated a crop rotational system. This trial was made of two treatments:

a) The continuous cultivation of striga trap crops and striga tolerant maize varieties as against b) farmer's practices. The sequence of the rotation for the 3 years duration was soybean (first year) followed by cotton (second year) and then a striga tolerant maize variety (third year). Plot size were 25 m x 25 m.

Results obtained in Ghana for both type of trials showed that :
1) Striga emergence was not only poor on both experimental and farmers' fields throughout northern Ghana, but was generally very erratic and variable. The number of emerged striga plant ha^{-1} did not vary significantly ($P<0.05$) among maize varieties. However, the striga susceptible

variety Dorke SR had higher striga plant population (3,326) than IWD STR Co (1,385) and Across 92 TZE Comp 5 W (408).

2) There was no statistical ($P<0.05$) differences in grain yield among the different maize varieties. Dorke-SR had the highest grain yield of 1.78 tons ha^{-1} which represented 16% grain superiority over IWD STR Co (1.53 ton ha^{-1}) and Across 92 TZE Comp 5 W (1.54 tons ha^{-1})

3) Soybean grain yield was not influenced by the different maize varieties.

IV – 5 NIGERIA RESULTS (See Country Report in Annex 5)

A total of 52 farmers conducted the maize/legume inter cropped trials in Nigeria. These demonstration trial consisted of inter-cropping an improved horizontally striga resistant maize hybrid (Oba Super 1) or (9022-13) an improved horizontally resistant open pollinated maize variety (Across 92 TZE Comp 5-W, IWD STR Co or TZL Comp 1 C4) with an improved Alectra tolerant groundnut (RMP 91) or soybean (Samsoy2). These technologies were compared with farmers local maize varieties planted sole. Plot size was 150 $m^{2.}$

IV - 5 –1 Guinea Savanna

At Bida, both striga infestation (shoot count) and incidence (crop plants infested) were significantly higher on farmers plots compared with those of improved technologies of inter crop of Oba Super 1 or TZL Comp 1 C4 with Groundnut. Oba Super 1 (4827 kg ha^{-1}) and of TZL Comp 1 C_4 (3592 kg ha^{-1}) significantly out yielded the farmer practices by 91% and 42%, respectively, Oba Super 1 and TZL Comp 1 C4 also showed fewer striga plant, better crop vigour score and higher cob number per hectare as compared to farmer's local maize.

At Beji-Minna, plots with Oba Super 1 and IWD STR Co exhibited lower striga infestation, less striga symptoms (crop reaction) and more than 29% grain yield superiority as compared to the local maize variety.

At Gwagwalada in Abuja, no grain yield difference were observed between the two improved (9022-13 and TZL Comp. 1 C_4) maize varieties. However, this two entries yielded at least 235% better than the local check and they exhibited better crop syndrome reaction .

IV-5-2 Northern Guinea Savanna

19 farmers conducted this trial in this zone. At Detu when RMP 91 was used as leguminous crop, in spite of the similar striga incidences and infestation observed on the plots, 9022-13 exhibited lower striga symptoms and produced significantly more cobs and 42% grain yield superiority over the farmers' practice. IWD STR Co had only 10% yield advantage over the farmers' practices.

When at Detu, soybean Samsoy 2 was used as leguminous crop, yield increased of Oba super 1 and TZL Comp. C4 was 6% and 15% superior to the farmer practice, respectively. Striga infestation at this site was also low.

At Sakaru, 9022-13 and IWD STR Co had a non significant lower striga infestation and incidence but significant lower striga syndrome, higher crop vigour and produced 17% and 26% more grain yield than the farmers varieties.

IV – 5-3 Sudan Savanna

10 trials were conducted in this zone. At Yandoto-Daji, treatments did not have significant effect on all the striga crop parameters even though slightly lower cob and grain yield were produced by farmers varieties as compared with the improved Oba super 1 and TZL Comp 1 C_4.

IV - 5-3 Correlations

Correlations coefficient computed between striga parameters and grain yield showed that the number of infested maize stand (NIS), striga count at 9 WAS (SSC), Striga symptoms rating (CRS), were negatively correlated with grain yield in all tested zone. Higher negative correlation values were obtained in all tested sites between striga symptoms rating and grain yield. In the northern Guinea and Sudan Savanna zone, these correlations were not significant and ranged from r=O.43 at Detu to r=-0.71 at Sakaru. In the Southern Guinea Savanna zone, significant negative correlations were obtained between grain yield and the number of infested maize stands at 9WAS and between grain yield and striga shoot count at 9 WAS at Gwagwalada and Bida. Highest significant values was obtained at Gwagwalada between grain yield and number of infested maize stands at 9 WAS (r=-0.81**) and between grain yield and striga rating damages (r=-0.81).

Correlations values between soil characteristics and grain yield were also computed results are presented in Annex 5.

Finally Socio-Economic Analysis of Striga Control Technologies was computed and results are presented in Annex 5.

IV CONCLUSIONS

At all focal countries striga tolerant maize general out yielded the local maize . In Benin, Côte d'Ivoire and Cameroon, variety trial allowed identification of new striga tolerant maize for release. However, much progress could be achieved by testing the appropriate technologies in the adequate zone i.e the use of intermediate maturing varieties (110 days) at area with more than 1000 mm of rainfall in Benin and Côte d'Ivoire . The identification and dissemination of striga tolerant varieties by itself could permit 20-30% grain maize production increase in tested countries.

Maize/legume inter-cropped trial as well as rotation trial revealed.

- No yield losses between treatment consisting of striga tolerant maize alone, and striga tolerant maize inter cropped with legume.
- Significant striga infestation and striga damages on maize when tolerant maize was inter cropped with legumes.

VI FIELD DAYS

Field days were conducted in Cameroon (3 sites) and Nigeria. The objectives were :

1) to show and disseminate promising technologies to farmers

2) To facilitate further interaction among researchers, extensionists as well as participating and non-participating farmers in the community.

Farmers were allowed to ask questions based on their observation. They were also presented with questions to enable researchers to have feed back about the new technologies and to access the rate of acceptability of the technologies.

In general farmers appreciated the improved technologies over the farmer practices and most of them indicated their willingness to participate in the next trial.

RECOMMENDATIONS

1) Progress achieved in one year at focal countries were encouraging. It was recommended that more countries be included in the on-farm adaptative evaluation of integrated striga control packages.

2) In most countries, the trial did not cover all zones infested by striga hermonthica and except for Nigeria, the number of trials conducted was small. It is recommended that the level of funding be increased so that each country could adequately cover all striga infested zones.

3) Besides the monitoring tour, they were not enough interactions between researchers from different focal countries. It is then recommended that annual workshop be organised to allowed for such interaction and exchange of ideas.

4) In view of the impact obtained during the field days, it is recommended that all participating countries should organise field days in selected areas of their countries.

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