THE FOOD GRAIN PRODUCTION TECHNOLOGY VERIFICATION PROJECT

1993/94 IMPLEMENTATION REPORT

FUNDED BY: THE AFRICAN DEVELOPMENT BANK (ADB)

MAY, 1994

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A Consultant Report (K.A. Marfo, Agricultural Economist)

ACKNOWLEDGEMENT

The support provided by organizations and individuals who contributed to make the monitoring possible is acknowledged. Policy-makers, researchers, extension and rural development workers and farmers in the countries visited, and SAFGRAD and IITA staff based at Ouagadougou were very cooperative. The Agricultural Development Bank (ADB) provided funds for the monitoring.

The contribution of Dr. Taye Bezuneh, Director of Research, SAFGRAD, is particularly acknowledged. He took part in the field visits, and also provided very useful comments on the draft report. Mr. Denis Ouedraogo assisted as an interpreter during the field visits.

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I. INTRODUCTION

1. Background

The Semi-Arid Food Grain Research and Development (SAFGRAD) was created in 1977 by African Heads of State, following a resolution adopted by the 1976 Organization of African Unity (OAU) Council of Ministers meeting in Mauritius. It was established to promote and utilize scientific research for increased and sustained production of the staple food grains of the semi-arid zones of Africa, namely maize, cowpea, sorghum, millet and groundnuts.

The rationale behind SAFGRAD's establishment was that investment in supporting national agricultural research systems (NARS), and especially national food grain research scientists, would yield positive returns in terms of sustainable increases in food grain production and major improvements in the lifestyles of food grain farmers and their families.

During the period 1977-86, SAFGRAD concentrated its activities in the development of germplasm, training to improve professional skills, coordination of regional research, and the strengthening of the national capacity for technology generation and adoption.

One of the principal lessons realized from FSR Projects and the Accelerated Crop Production Programme of SAFGRAD, has been that the links between experimental station work and technology transfer activities must be dynamic and interactive if improved technologies are to be widely adopted by majority of farmers.

In 1990, the Food Grain Production Technology Verification

Project was initiated to speed up the process of moving technology from agricultural experiment stations to farmers' fields, with funds provided by the African Development Bank (ADB).

The Project encompasses a research-extension interphase activity, with major emphasis on narrowing the yield gap of technologies between research stations and farmers' fields. The main objectives, therefore, of the Project are as follows:

- To intensify the production of food grain through application of improved packages of technology.
- To promote on-farm and on-station verification trials and thereby identify suitable technologies that could enhance production of food grain.
- To forge functional linkages between research agronomists and extension agents in order to narrow the yield gap between on-station and on-farm food grain production.
- To facilitate the delivery of technology options that could minimize risks of crop failures due to environmental and socio-economic constraints.
- To improve on-farm research skills and consequently enhance the transformation of research results into extension recommendation and food production.

The number of village sites included in the trials and the extent of farmers' participation, as well as the technological options evaluated are summarized in Table 1.

Table 1 Project Sites, Farmers' Participation and Number of Technological Options Evaluated in the Participating Countries

Country	Project Sites (Villages) 1993	Number Farmers Managing Trials			Farmers with access to trials	Techno-logical options verified
		1990	1991	1992		
B. Faso	12 CRPA dist.	197	509	112	32,000	3
Cameroon	15	20	25	25	150,000	4
Ghana	32	70	70	650+	10,000	4
Mali	25	NA	19	25	40,000	2
Niger	2	10	15	NA	2,000	6
Nigeria	9	NA	30	93	20,000	4
Senegal	30	30	50	80	50,000	4
Togo	5	100	150	215	6,000	2
Total	130	428	873	1180	175,000	28

1.2 The Purpose of the Monitoring

The purpose of the monitoring was to assess the implementation of the Project in Ghana, Burkina Faso, Mali and Senegal to determine the extent to which the Project activities in these countries conformed to the objectives.

As indicated in Table 2, the focus of the project activities in the four countries varied from the verification of suitable cultivars to cropping systems, and to on-farm resource management.

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Table 2 Focus of Verification Activities.

	Crops	Themes
Burkina Faso	Cowpea, Maize	Improved varieties
Ghana	Cowpea, Maize	Improved varieties, cropping systems, resource management
Mali	Maize	Improved varieties
Senegal	Cowpea, Millet	Improved varieties. cropping systems, resource management

The terms of reference for the monitoring are presented in Appendix I.

3 Technology Generation and Transfer Framework

In examining the place of verification trials in the generation and transfer of technology, the framework described by Byerlee, Collinson, et al (1980) was adopted. It has on-farm research at the centre of activities, but integrated with on-station research. The stages of research are as follows:

a) Diagnosis

This involves the collection and analysis of information on farmers' circumstances and factors limiting productivity for the design of experiments. The activities may include review of secondary data, informal interviews and farm surveys, and formal surveys.

b) Planning

The planning stage involves using results of diagnostic studies and past experimentation to identify experimental factors to include in the research. The experimental factors are the possible solutions.

c) Experimentation

The trials are planted on representative fields to test possible solutions. There are different levels of experimentation. It starts with researcher-managed exploratory trials and ends with farmer-managed verification trials.

d) Assessment/Verification

This stage involves the assessment of farmers' reactions and opinions and agronomic, statistical and economic analysis of the research results. The results of the assessment are used to plan future research and to make recommendations for farmers.

e) Recommendation and Diffusion

Information generated through research in which researchers have confidence in is used to formulate recommendations. This information is then diffused to farmers through the established extension network.

4 Criteria and Methodology for the Assessment of the Implementation of SAFGRAD Technology Verification Project

For the purpose of the monitoring exercise, themes and their criteria were developed for the terms of reference. The different themes and criteria that were examined are interrelated, as summarized in Appendix II.

Field trips to the four countries were undertaken by the Consultant and the Director of Research, SAFGRAD during the period September 1-18, 1993. The schedule of visits is in Appendix III.

The following activities were carried out during the field trips:

a) Review of available documents (including research protocol) on research and extension activities.

b) Informal interviews and discussions with Project participants and relevant researchers within each country's research system with the purpose of obtaining information on:

(i) Research organization within the national research system, with particular emphasis on the participating institutions.

(ii) The thrust of research activities (commodities, themes).

(iii) Interaction among researchers and between researchers and extension agents.

c) Informal interviews and discussions with extension agents and rural development workers with the purpose of obtaining information on:

(i) Extension activities

(ii) Extension's links with research, with particular reference to activities being implemented under the SAFGRAD Technology Verification Project.

d) Informal interviews with farmers (individuals and groups) in some of the villages where verification trials were being implemented with the objective of:

(i) Assessing the appropriateness of technologies introduced under the Project, in relation to farmers' needs.

(ii) Assessing the number of farmers exposed to the activities of the Project.

(iii) Assessing farmers' understanding of the trials.

During the course of the field assessment, over 30 farmers were interviewed in the four countries.

The first section of each country's report provides an overview of the research and extension institutional linkages, followed by the assessment of the project implementations based on the general criteria and terms of reference. The third section of the report of each country visited contains the summary and recommendations for the implementation of the activities of the Project in future. Finally, a reporting format that would facilitate monitoring the implementation of project activities is presented in Appendix IV.

The number of districts, individual farmers and farmers' groups in each country that was covered during the field interviews is shown in Table 3.

Table 3 Coverage of Interviews with Farmers

Country	No. of Districts	No. of Individual Farmers	No. of Farmers' Groups
Ghana	2	5	1
Burkina Faso	3	16	1
Mali	1	3	1
Senegal	2	8	3

II. MONITORING AND IMPLEMENTATION OF PROJECT ACTIVITIES

A. BURKINA FASO

The Central Mossi Plateau, where the project activities are concentrated, is the most densely populated part of Burkina Faso. In some localities, the density nearly doubles the carrying capacity (40-60 inhabitants/km^2). As a result, there is migration from the Plateau to the Southern part of the country and to neighbouring countries. The region has few permanent water course.

There are three distinct agro-ecological zones which are defined by rainfall amounts, namely Northern Guinea Savanna (900-1200 mm), Sudan Savanna (600-900 mm) and Sahel (200-600 mm). Each zone runs across the country from the west to the east. The rainfall amount reduces from south to north.

Typically, the Sahel zone has limited surface water resources. Rainfall is monomodal in pattern, low in amount and poor in distribution. The total precipitation varies from under 300 mm/year in the northernmost parts to about 600 mm/year in the south. Relatively low temperatures (10-15 °C) characterize the period from November to February, whilst April and May record average day temperatures of 40 °C and over. The length of the growing season varies from two to four months (June to October), with the dry season lasting from October/November to May/June.

The Sudanian zone of Burkina Faso is characterized by three distinct seasons: warm and dry from November to March, hot and dry during March to May, and hot and moist from June to October. The mean annual rainfall ranges from 600 mm in the north,

bordering the Sahelian zone, to 1000 mm in the south, near the North Guinean zone with 4-5 months of rain. The rainy season starts between mid-May and mid-June and stops rather abruptly around early October. Temperatures are high, especially just before and right after the rainy season, with day-time values reaching up to 40 °C. The hot dry winds from the Sahara further aggravate the drought conditions. Potential evapotranspiration is high throughout the year, with a mean value of 1900 mm. Although rainfall exceeds evapotranspiration during some months, periods of moisture stress are frequent and unpredictable. The drought periods are pronounced during critical crop growth stages: seedling, flowering and grain formation.

The Northern Guinea Savanna has relatively more dependable rainfall of 850-1100 mm/year, spread over a four to six month period. Soils are largely alfisols and types similar to those of the Sudanian zone. Maize is the predominant cereal, with sorghum cultivated largely in the transitional Sudano-Guinean zone where the rainfall range is between 700 and 900 mm. Cowpeas and groundnuts are the important pulses, usually intercropped with cereals. Cotton is an important industrial crop in this zone.

The two main objectives of this project support have been to identify suitable cowpea cultivars adapted to the farming systems of the above mentioned ecological zones, and to determine the insecticide spray requirements in different regions of the country to control insect pests.

The Institut d'Etudes et de Recherche Agricoles (INERA), the participating research institution in the SAFGRAD Verification Project, has a national mandate for research on crops. The Institute has eight programmes organized along broad commodity lines (cereals, legumes, horticulture, oil crops, soil-water management, livestock etc.) and a strong FSR programme. Within the broad commodity groups, a multidisciplinary team of researchers are responsible for specific commodities.

Researchers in commodity programmes cooperate with FSR researchers (made up of social scientists, agronomists and soil scientists) in the planning and implementation of research. However, the FSR programme has not been well integrated into the research activities, but operate as a separate team.

Two IITA/SAFGRAD scientists are stationed at the Kamboinse Station of INERA. Their primary task is to coordinate the SAFGRAD cowpea and maize networks. They have additional responsibility to provide backstopping to the national research programme.

The training and visit (T&V) system of extension has been adopted in Burkina Faso with the support of the World Bank. This system of extension emphasizes on regular contacts with research and training of extension staff on recommended technologies.

The country has been divided into 12 CRPAs (zones) for the purpose of technology transfer. Each CRPA develops its own specific programme of activities on the basis of the specific problems identified.

The experimentation activities at INERA follow the following process:

- On-station: station trials
  multilocational trials
- PAPEM (joint research and extension trials)
- On-farm verification trials

The station and multilocational trials are conducted for a minimum period of two years to screen materials for their adaptability to the different zones. Promising materials identified in station and multilocational trials undergo further testing in what is called " PAPEM" under the joint management of research and extension staff. This enables extension officers to see the performance of the materials and participate in the selection of materials for recommendation to farmers. This testing is for a minimum period of two years. The final testing stage is managed by farmers. Normally, about three promising materials are verified under farmers' management. The feedback from farmers is important in determining the decision to recommend materials for planting.

ADB Funded SAFGRAD Technology Verification Project

1.0 Overview of Activities

INERA has participated actively in the activities of SAFGRAD. Through this collaboration, good varieties of cowpea and maize have been developed, but the adoption of these varieties is low. This is the motivating factor behind the Institute's participation in this technology verification trials.

The Project's activities have been integrated into on-going research. As such, one cannot distinguish between SAFGRAD and

non-SAFGRAD verification trials. Apart from the verification trials, seed production was identified as necessary to speed up adoption, and seed for verification trials. The national seed service is inactive. Thus, funds provided for verification trials have also been used for seed multiplication of cowpea and maize.

The verification trials conducted under the Technology Verification Project has focused on improved varieties of cowpea and maize. Cowpea had benefited from funding under the Project since 1990. In the case of maize, 1993 was the first year.

The activities of the Project is implemented by two different research teams on crop basis. A breeder and an entomologist are the core scientists for cowpea, and a breeder is the core scientist for maize.

The following themes/trials have been addressed under the Project:

Cowpea (1990-93)

- Monocropped cowpea with insecticide treatment
- Monocropped cowpea without insecticide treatment
- Millet-cowpea association with insecticide treatment
- Millet-cowpea association without insecticide treatment
- Cowpea seed multiplication

The objective of the trials was to evaluate varieties under different cropping and management systems for yield and other desirable characteristics. In these trials, one improved variety was tested against the farmers' variety.

The seed production activities covered breeder, basic (foundation) and commercial seed, and training farmers in seed production. Multiplication were at the station, PAPEM and farmers' fields.

Maize (1993)

- Extra-early (75-80 day) maturing variety trials
- Early (90 day) maturing variety trials
- Intermediate (105 day) maturing variety trials
- Maize seed production

The objective of the trials was to identify suitable varieties and improved agronomic practices for the different agro-ecological zones. The maturity groups were targeted for the three major agro-ecological zones: extra-early for Sahel, early for Sudan Savanna and intermediate for Northern Guinea Savanna. In each maturity group, two improved varieties were compared to the farmers' (local) variety.

2.0 Execution of Verification Trials in Relation to Research Protocol

As summarized in Table 4, the 12 CRPA districts or centres of extension activities were covered along the three agro-ecological zones discussed earlier.

Each one of the commodity programmes addressed varietal development, as contained in the country's research protocol. The evaluation of the cowpea varieties was carried out under different cropping system and management conditions of farmers in 50 villages involving 90 farmers. The maize trials focused on the identification of suitable cultivars within different

maturity groups. Maize seed production was carried out in 39 villages, mainly with farmers in cooperative associations.

Table 4 Spatial and Farmer Coverage of Verification Activities, Burkina Faso, 1993.

Activity	Number of Districts	Number of Villages	Number of Farmers	Reps/ Site
Cowpea trials/ seed production	12	50	90	1
Maize trials/ seed production	12	39	747	1

i) Appropriateness of Technology Introduced

Process of Diagnosis:

Studies by the FSR unit within INERA provide information on farmers bio-physical and socio-economic circumstances provide information that enables scientists to plan research to meet identified needs. In the verification trials in particular, feedback from farmers directly through PAPEM trials, and indirectly through extension provide the basis for the planning of trials.

Process of Planning:

There is an annual meeting of researchers and extension personnel at the regional level to discuss production constraints that could be addressed by research. Results of research

activities are also discussed at these meetings. Discussions at these meetings form the basis for planning joint research and extension activities, including verification trials. This has ensured that research responded to the needs of farmers. All the disciplines of research attend these meetings.

In the view of research and extension staff, it would be desirable to have these meetings at local levels, and that this possibility would be explored in future.

Cowpea has traditionally been an important crop in the farming system. The cowpea verification trials covered different technology options which conformed to the different bio-physical and socio-economic circumstances of the farmers. There were options for grain only or grain and fodder production, and insect control or no insect control, to accommodate farmers who would not be able to afford insecticides and the related costs. There was focus on the white and brown varieties, the most preferred colours. There were also options for monocropped cowpea or cowpea in association with millet.

Maize had traditionally been confined to compound fields but there is the trend towards expanding demand, especially the fresh (green) maize. Since it is mostly planted as a monocrop, the need to select varieties for different cropping systems did not arise.

Farmers' Opinions:

Responses to interviews with farmers showed that the trials were addressing their varietal and seed needs.

ii) Approaches to Enhance Diffusion of Technologies

Individual Versus Group Approach:

The maize programme as much as possible involved existing farmers' groups in the trials and seed production. However, the cowpea programme adopted individual farmers. The maize programme was, therefore, more successful in reaching many farmers with their activities.

It is recommended that the cowpea programme should follow the example of the maize programme.

Number of Trials/Villages/Replications:

In 1993, there were about 50 trials on cowpea and 39 in maize, directly covering 90 farmers in cowpea and 747 farmers in maize (Table 4). The number of villages covered by each crop corresponded to the number of trials (i.e. one trial in each village). To maximize the number of farmers directly involved, each trial had one replication per field.

Field Visits/Field Days:

Organized field days to expose other farmers to the new practices formed part of the defined activities. Such visits normally took place twice in a season. However, this activity had not been vigorously pursued in 1993. There were indications that some field days had been planned, but one would have expected that at least one field day should have already been organized for each trial since the crops were past the flowering stage. There is the need for a balance between the planting of trials and organizing field day.

Population of Surrounding Farm Families:

About 30,000 farmers had access to activities carried out

in 1993.

iii) Simplicity of the Verification Trials

The number of treatments under testing for each trial is presented in Table 5. The number of experimental variables did not exceed four (i.e. three, in addition to the farmers'), thus making the trials simple to follow. The farmers had good understanding of the treatments under testing.

Non-experimental Variables and Farmers' Practices:

For each of the crops, the non-experimental variables which were not practices common to all farmers were row planting/spatial arrangement and fertilizer application.

In the normal situation the non-experimental variables should approximate farmers' practices. It is understandable that in the prevailing soil conditions in the region, there is the need for the improvement of the fertility level before the potential of other improved practices could be realized. However, given the fact that some farmers were not applying any form of fertilizer, whether organic or inorganic, it would be desirable to carry out some of the trials under farmers' soil fertility conditions.

Row planting/spatial arrangement does not involve purchased inputs but more labour. That could more readily be adopted unless labour is a limiting factor. It does appear, however, that capital is the more limiting factor. In the analysis of the trial, farmers adopting similar practices could be considered as one set of trials, to overcome the problem of having to aggregate data for different non-experimental variables.

Table 5. Number of Experimental Treatments, Verification Trials, Burkina Faso 1993

Trial	Factors	No. of Levels	No. of Treatments
Monocropped cowpea variety	Variety	2	4
	Insecticide	2	
Intercropped cowpea variety	Variety	2	4
	Insecticide	2	
Maize variety	Variety	3	3

iv) Improvement of Research-Extension Linkages

Role of Extension in Problem Diagnosis:

Within the research system, the FSR team is the main source of information relating to problem diagnosis. Extension provide some feedback to research. However, there is the limitation that research and extension does not work as a team to carry out diagnostic studies of the farming system.

Contribution of Extension to Research Planning:

There is in place joint research-extension planning meetings, through technical committees. These meetings precede the season's activities and are conducted at the regional level.

Role of Extension in Experimentation:

Extension is involved in research experimentation at two levels:

- joint research-extension trials in the "PAPEM", and
- verification trials.

In the verification trials, local extension personnel supervise and monitor the activities on a more regular basis than the researchers.

Role of Researchers Training Extension Staff:

The T&V system of extension adopted require that research provide training to extension. There is a unit within extension (Bureau Recherche Developpement) which liaises with research on training.

Contribution of Research to the Formulation of Extension Recommendations:

Extension recommendations of varieties and agronomic practices are based on results of research. Research results that could be passed on as recommendations are discussed in the technical committee meetings.

Contribution of Research to Planning of Extension Activities:

The joint technical committee meetings provide a forum for research to participate in the planning of extension activities.

Levels of Interaction:

There are interactions at the national and regional levels through committee meetings. Village and farm level interaction is provided by the joint research activities in the PAPEM, and the verification trials. The SAFGRAD Project has contributed towards increasing the village and farm level research-extension

(as well as research-farmer) interactions by enabling more verification trials to be carried out, and also more frequent farm visits by researchers.

v) Complementarity of Activities with FSR Programme

Activities under the SAFGRAD Verification Project are integrated into the activities of the cowpea and maize programmes of the national agricultural research system. However, the FSR unit has not been well integrated into the national research system. This has limited the capacity of the activities under the Project to complement FSR activities as desired.

A full integration of the FSR programme within the national research system is anticipated by the FSR scientists.

vi) Adequacy of Research

Stages of Research Prior to Verification and their Linkage:

The research system has a clearly defined process of generating technology. A minimum of four years of research is carried out with wide geographical distribution, prior to verification.

Involvement of Relevant Disciplines in Identifying Potential Treatments for Verification:

There is good interaction between the scientists within the commodity programmes. Poor links with the unit which has to provide social science input (i.e. the FSR team) limited the level of economic evaluation of the trials.

There is some level of economic evaluation prior to evaluation, but this is not adequate. For example, 300 kg/ha of cowpea has

been estimated as the additional yield required to cover cost of insecticide application. The costs of the higher level of accompanying management practices also have to be taken into consideration. The economic variable (eg. prices of inputs) change over time, requiring a continuous process of evaluation.

There is more room for increasing cooperation between the biological scientists and social scientists. This could be realized when FSR becomes fully integrated in the research programme.

vii) Conclusion

The national agricultural research system has a well defined process for developing improved technology for farmers. Links have been established between research and extension. The ADB-funded SAFGRAD Technology Verification Project has contributed positively to strengthen the process of generating and transferring technology by strengthening the research research at the verification stage. Verification trials which precede recommendations have been carried out on farmers' fields and, in the process, research-extension-farmer linkages have been strengthened. The linkages has increased the involvement of extension and farmers in developing recommendations. The activities of the project have focused on varietal development and seed production. Seed production is a vital link between research and the adoption of improved varieties.

Potential technologies do exist for transfer to farmers. The project, therefore, would continue to be relevant.

Farmers' perception of the activities of the project is positive.

In order to improve on the impact of the project activities, the following are recommended:

- The cowpea programme should follow the example of the maize programme by working more with farmers' groups rather than individuals.
- There is the need to maintain a balance between the number of trials planted and the organization of field days. Field days expose a lot more farmers to trials, and also provides the opportunity for researchers to obtain feedback from a large number of farmers.
- Non-experimental variables should as far as possible approximate farmers' practices.
- Cooperation between biological scientists and social scientists should be strengthened in all phases of the research process.

B. GHANA

The semi-arid zone of Ghana where the project activities are based covers the northern part of the country, encompassing three of the ten administrative regions of the country, namely Northern, Upper East and Upper West. The semi-arid zone is dominated by Northern Guinea Savanna agro-ecology, which covers about 80% of the area, with the remaining 20% being Sudan Savanna. There is a small coastal savanna belt along the southern-eastern coast which is also semi-arid.

Research services at this agro-ecological zone is provided by the Nyankpala Agricultural Research Station (NAES) which is part of the Crops Research Institute (CRI). The Institute has the mandate for research on all crops in Ghana, except cocoa, coffee, sheanut, oil palm and coconut. NAES has the mandate to improve the crop varieties grown in northern Ghana, and to develop adequate cropping systems adapted to the needs of farmers in the different zones of northern Ghana. Apart from Government of Ghana funding, the Federal Republic of Germany provides financial and technical support.

One farming systems research (FSR) team has been established for each of the three administrative regions of northern Ghana to ensure that results of research carried out by the station are transferred to farmers, while at the same time ensuring that research responds to the needs of farmers. The core staff in each team comprises of an agronomist, soil scientist, socio-economist and extension specialist. The extension specialist is a staff of the Department of Agricultural Extension Services of the Ministry of Food and Agriculture (MOFA).

With the support of the World Bank, the government established the National Agricultural Research Project in 1991 to oversee and coordinate the planning and implementation of agricultural research in Ghana. The Project is implementing commodity research programmes with farming systems research perspective. A counterpart project, the National Agricultural Extension Project, has been set up to implement a modified training and visit (T&V) system of extension. The two projects have established institutional structures to promote closer links between research and extension.

The research activities at NAES could be categorized broadly into commodity improvement/varietal development and farming systems improvement. The two are, however linked.

The process of experimentation is as follows:

- On-station: station trials
  multilocational trials
- On-farm/FSR: researcher-managed
  farmer-managed/verification

Extension links up with the researchers in all the stages of research through participation in FSR work, in addition to the institutional linkage structures that have been established.

The ADB-Funded SAFGRAD Technology Verification Project

1.0 Overview of Activities

NAES has been an active participant of SAFGRAD's networks on maize, cowpea, millet/sorghum and farming systems. A legume breeder and FRS agronomist are the core staff for the implementation of the ADB-funded SAFGRAD Verification Project.

The Technology Verification Project activities supplement the efforts of the station to provide farmers with improved technologies appropriate to their circumstances. Activities carried out under the Project have, therefore, been fully integrated into the overall research programme of NAES.

The Project was initiated in 1990. The three-year period 1990-1992 represented one phase, and a second phase started in 1993. The strategy is to focus on few specific technologies for a period of three years. After establishing the attractiveness of the technologies, appropriate extension recommendations are made.

The themes/trials addressed to date are as follows:

<u>1990-1992</u>

a) The effect of two cropping practices for maize, groundnut and sorghum.

   The objective of the trial was to compare the yields of these three important crops of the region in pigeon pea alleys to the traditional practice and to evaluate alley cropping under the farmers' own management.

b) Phosphorus fertilizer test on cereals (maize and sorghum) under different tillage methods.

   The objectives were to:

- evaluate different levels of phosphorus fertilizer on grain yield;
- determine the best tillage practice to incorporate phosphorus; and
- determine the availability of residual phosphorus for succeeding crops.

c) Cereal-legume rotation (maize or sorghum-groundnut rotation).

The objectives were to:

- demonstrate double cropping of short duration cowpea with early to medium maturity sorghum;
- introduce white seed coat variety of cowpea and test their performance under farmers' conditions; and
- assess the economic productivity of the system under farmers' conditions.

1993

a) Maize variety trial.

The objective was to evaluate the performance of extra-early maize varieties under farmers' conditions.

b) Cowpea variety trial.

The objective was to evaluate the performance of early maturing white cowpea varieties under farmers' conditions.

c) Community seed production

This activity was to enable farmers obtain seed of preferred (released) varieties which were not available for farmer's use, in order to improve adoption. It was also to demonstrate to farmers improved management practices, especially in relation to

seed production.

2.0 Execution of Verification Trials in Relation to Research Protocol

The spatial and farmer coverage of verification activities for the period 1990-1993 is summarized in Table 6.

During the period 1990-92, specific trials tended to be concentrated in a district, even though the themes addressed were relevant to other districts in the mandate area. This could limit the assessment of the adaptability of the technology under test and its potential spatial impact. In 1993, the coverage was better.

Four different types of trials were addressed in 1990-92, and three in 1993. The number of themes to address in a particular phase of verification activities was determined by the stage reached for each theme in the research process and available resources. The crop coverage (maize and cowpea) conformed to the research protocol for the country. However, cropping systems/resource management did not feature in the 1993 activities.

Within the limitation stated above, the number of themes addressed could be said to be adequate. However, given the fact that the spatial coverage for the cropping systems/ resource management trials that were conducted in the 1990-92 phase was low, the present phase could include some of these trials in districts with on-going verification activities that were not covered in the past.

Table 6 Spatial and Farmer Coverage of Verification Activities, Ghana 1990-93

Trial/ Activity	Year	Number of Districts	Villages	Farmers	Reps/ site
Cropping practices for maize, ground-nut and sorghum	90-92	1	10	40	1
Phosphorus ferti-lizer test	90-92	1	2	6	4
Cereal-legume rotation	90-92	1	3	12	1
Cowpea-sorghum relay	90-92	1	3	12	1
Maize variety	93	5	28	28	1
Cowpea variety	93	6	28	28	1
Seed production	93	1	1	20	-

i) Appropriateness of Technologies in Meeting Farmers' Needs

The appropriateness of a technology in meeting farmers' needs depends on the diagnosis and planning conducted prior to experimentation. Farmers' opinions on the technology is an important factor in assessing the appropriateness.

a) Process of Diagnosis:

The station engages in diagnostic activities to identify the

important factors influencing the productivity of farmers on a regular basis. The FSR teams play the leading role in this activity.

b) Process of Planning:

Planning sessions are held before the beginning of each season (normally in March) to plan the research activities, with emphasis on the on-farm/FSR trials. Researchers, extension officers, staff of the technical departments of MOFA and farmers meet to review previous research work and plan for the coming season. It is during such sessions that decisions are taken on what trials to carry out, and at what stage a particular trial should be carried out (eg. researcher-managed or verification). A clear set of criteria which combines technical feasibility with socio-economic feasibility has been established for the determination of the appropriateness of a particular technology. The planning sessions are carried out at the regional level.

With regards to the trials carried out under the SAFGRAD Technology Verification Project, emphasis was on technologies that required low level of purchased inputs. This conformed to the problem of high input prices that farmers had to pay in the face of withdrawal of subsidies on inputs and a depreciating currency. The unavailability of seed of improved variety limits the diffusion of the varieties.

c) Farmers' Opinions:

Interviews with farmers revealed that the importance of maize and cowpea in the farming system is in relation to their ability to bridge the hunger gap. This is because they mature earlier than the traditional staples of sorghum and millet.

Therefore, the focus on the promotion of extra-early maize and early cowpea varieties in the 1993 activities was in the right direction.

Maize is monocropped or intercropped. Monocropping of cowpea has rapidly taken over from the traditional practice of intercropping. Varietal testing at the verification stage should look at the effect of the intercropping systems.

ii) Approaches to Enhance the Diffusion of Technologies

Individual versus Group Approach:

Apart from community seed production, all the trials were conducted on the fields of individual farmers. This limited the potential impact.

Number of Trials/Villages/Replications:

The number of trials (farmers) and villages which were covered in 1990-93 is shown in Table 6. The 1993 activities covered 78 farmers.

It is commendable that in all the trials carried out in 1993, the option adopted was one replication per site. It was similar for the 1990-92 phase except in the case of the phosphorus fertilizer application on cereals under different tillage methods in which there were four replications per site. As expected, this limited the coverage of farmers.

Field visits/field days:

The number of farmers who visited each trial site ranged from five to fifteen. Some of these farmers visited the fields only once, and this meant that such farmers were not in a position to fully comprehend the new technology.

The researchers acknowledged the importance of field days in the verification activities, and they tried to incorporate them into their activities. However, there were few of such activities. It was obvious that in the allocation of resources for the verification activities, organization of field days was not given the necessary attention.

Field days provide cost effective means of reaching more farmers. It would therefore be desirable to organize field days in all the sites, even if it is at the cost of reducing the number of trials. They should be organized at crucial stages of the crops growth, and farmers should be encouraged to attend all the field days held at a particular site. The population of surrounding farmers who could benefit from the Project activities and potential economic impact was estimated to be 10,000.

iii) Simplicity of the Verification Trials

The number of treatments for verification trials carried out to date is presented in Table 7.

The six treatments for phosphorus fertilizer trial was rather too high. For on-farm trials, phosphorus levels could have been reduced to two or even one for any particular locality by adopting the most widely used practice. Alternatively, superior tillage practices (one or two) could have been compared with farmers' practice.

Therefore, there is the need to identify few superior alternative treatments, through agronomic, statistical and economic evaluation of the trials conducted at the stages preceding verification, for inclusion in the verification trials.

The trials conducted in 1990-92 all had farmer practices as non-experimental variables. In the maize and cowpea variety trials initiated in 1993, fertilizer application and insecticide application were non-experimental variables respectively.

Table 7 Treatments for Verification Trials in Ghana, 1990-1993.

Trial	Factors	No. of Levels	No. of Treatments
Cropping practices for maize, groundnut and sorghum	Cropping pattern	2	4
	Rotation	2	
Phosphorus fertilizer trial	Tillage	3	6
	Phosphorus	2	
Cereals-legume rotation	Rotation	2	2
Cowpea-sorghum relay	Cowpea variety	2	2
Maize variety	Maize variety	4	4
Cowpea variety	Cowpea variety	4	4

In the case of cowpea, farmers who planted improved varieties normally applied insecticides. This practice is in

line with research results which show that the improved varieties of cowpea do not give good yields without insecticide application. In the case of maize, not all the farmers apply fertilizer. It has been shown that the improved varieties performed better under all fertility levels. Thus, the number of varieties could have been reduced and an alternative fertilizer level (farmers practice, even if zero fertilizer) introduced. It should be demonstrated to farmers who do not apply fertilizer that in the absence of this input, they could still be better off planting the improved varieties of maize.

In all the trials, it was possible to show the contribution of the new technology. The limitation is imposed by the observations made in the discussion of non-experimental variables, in which case it would be difficult to separate the contribution of, say, new maize variety from fertilizer.

iv) Improvement of Research-Extension Linkages

a) Role of Extension in Research Problem Diagnosis:

Extension participates in research problem diagnosis through the following:

- Membership of FSR teams; and
- Bi-monthly technical review meetings attended by staff of NAES and representatives of the technical and extension departments of MOFA to identify farmers' problems and to discuss possible action plans.

b) Contribution of Extension to Research Planning:

The annual planning session provides the forum for extension to provide input in the planning of research.

c) Role of Extension in Experimentation:

With the exception of the extension specialists on the FSR teams, extension officers are not directly involved in the day-to-day implementation of trials. This role is played by the Department of Crop Services (DCS) of MOFA. The DCS in turn provide technical information to extension officers at monthly meetings. This arrangement is in line with the modified T&V system of extension that had been adopted in Ghana.

d) Role of research in training extension staff:

Researchers serve as resource persons during in-service training organized for extension staff. The training emphasis has been the correct application of new recommended technologies.

e) Contribution of research to formulation of extension recommendations:

All extension recommendations are based on research results. NAES cooperates with the Department of Agricultural Extension Services update recommendations on a regular basis.

f) Contribution of Research to Planning of Extension Activities:

The annual planning sessions and bi-monthly review meetings provide researchers the opportunity to participate in the planning of extension activities. During these meetings, farmers' problems requiring attention and for which improved practices had been developed are identified and plans of action drawn up.

The interaction at the regional level is through the joint planning sessions. Funds provided under the SAFGRAD Project have been important in improving links at the farm/village level.

This is through regular visits that scientists are now able to make to the verification trial sites, and the higher number of trial sites that have been made possible.

v) Complementarity with Farming System Research Programme

Funds provided for the SAFGRAD verification trials are used to expand planned verification trials to cover more villages and farmers. Part of the travel and transport expenses of the FSR team and on-station scientists are also covered from the SAFGRAD budget. Thus, there is no duplication of activities.

vi) Adequacy of Research

Stages of research prior to verification is summarized in Table 8. Trials do not necessarily go through the full process. In general, where to start technology testing depends on a number of factors, the major ones being the following:

a) Complexity of possible solutions: Where there are several possible solutions to a problem, the trial would necessarily start at the station. On-farm trials have few treatments.

b) Level of control required: In cases where a controlled environment is required, the station is the place for the initial screening of possible solutions.

c) Specificity of problem: where the problem is specific to sites or localities (eg. weed) the trial is initiated on-farm.

d) Urgency of the problem: In a situation where a problem requiring urgent attention emerges, the trial could start at the on-farm verification stage.

All the verification trials carried out under the Project had gone through adequate periods of testing before verification. As far back as the early 1980s, testing of alley cropping practices (in pigeon pea alleys), relay cropping, rotations, intercropping and phosphorus fertilizer had received attention in on-station and on-farm trials. These trials formed the basis of verification trials carried out in 1990-1992. The maize and cowpea varieties under verification testing had undergone two seasons of multilocational testing.

Due to the well-defined research process, the verification trials were not in isolation; they were linked to the other stages of research.

The methodology adopted by NAES requires that research themes are addressed by multidisciplinary teams. The links are strong at the pre-experimentation stage. However, in the experimentation and analysis of trials, the team approach tended to diminish. Analysis of trial data did not involve the socio-economist. Socio-economic evaluation should be conducted in addition to the agronomic and statistical analysis for the determination of the appropriate treatments for verification and, more importantly, the treatments to recommend.

Table 8 Stages of Experimentation, NAES, Ghana.

Trial Stage	Management
On-station, exploratory	Researcher
On-station, levels	Researcher
On-farm, exploratory	Researcher
On-farm, levels	Researcher
On-farm, verification	Farmer

vii) Conclusion

The ADB-funded Technology Verification Project is well integrated into the activities of NAES, and the activities under the project have strengthened research-extension-farmer linkages. Technological components that have received attention are crop management, varietal improvement and seed production.

Verification trials carried out in 1991-92 appeared to be too complex, given the objectives of the project. However, this limitation was addressed in the 1993 activities; trials carried out in 1993 were simple in design.

Farmers were of the opinion that the activities of the project in terms of technology focus and crop focus were addressing their needs.

The project will continue to have role to play to facilitate the transfer of research results to farmers' fields.

Recommendations to strengthen project activities in Ghana are as follows:

- The geographical coverage of crop management trials has been very limited. Given the location-specific nature of crop management practices, there would be the need to address this technology component in future trials. The design for these trials should be simpler than they were in 1991-92.
- Varietal testing at the verification stage should be carried out under farmers' management practices. In the analysis of the results, trials with similar farmers' practices could be grouped together.
- The group approach had been adopted only for seed production. This should be extended to the other activities under the project.
- The organization of field days should receive more attention than it has received in the past.
- The multidisciplinary team approach, which is crucial for the methodology adopted by NAES, has to be strengthened at the stages of experimentation and the analysis of trial results.

C. MALI

The country has three agro-ecological regions: the Southern, Central and Northern zones. The annual rainfall amounts for these zones are 800-1200mm, 400-800mm and less than 300mm respectively.

The Insititut d'Economie Rurale (IER) is the institution responsible for agricultural research in Mali. The regional centre for agronomic research of IER, based in Sotuba is the participating research centre in the SAFGRAD Technology Verification Project.

The execution of research is the responsibility of six research centres distributed throughout the three agro-ecological zones. Each of these centres has a major research station. Other research stations and sub-stations within each area provide sites for testing of technologies for adaptability. There are commodity programmes and FSR unit within the research system.

A national agricultural research project has been set up with the objective of making research respond more to the needs of farmers. This objective is to be achieved through the improvement of linkages among different research disciplines, and between research extension and farmers. A bottom-up approach in which the review of on-going research and proposals for new research activities are carried out by local working groups. These working groups comprise of farmers, extension staff, production systems research scientists and commodity research scientists. Proposed activities would be reviewed at the regional level by regional technical committees. A committee of the national level would be responsible for balancing

agricultural research proposals with available resources. The National Agricultural Research Council (NARC) is the apex body established to oversee research in the country.

Agricultural extension activities in Mali are handled by three agricultural development organizations, namely Compagnie Malinne pour le Developpement des Textiles (CMDT), Office de la Haute Vallee du Niger (OHVN) and Office de Developpement Integre du Mali-Ouest (ODIMO). The government has entered into contracts with these organizations. All the three organizations are commercial parastatals.

ADB-Funded SAFGRAD Technology Verification Project

1.0 Overview of Activities

Maize is the third important cereal essentially used for human food in various forms. Over 50% of the maize is cultivated in the cotton production region. In the past ten years, there has been substantial increase in maize production in Mali from 38,000 ha in 1980 to 130,000 ha in 1992. Yield per unit of land has also increased by 52% during the same period. Under farmers' condition, maize is grown in association with millet and cowpea, or in rotation with cotton. Among the principal constraints to the production of maize are poor soil fertility, particularly the availability of nitrogen and phosphorus, and the lack of suitable varieties adapted to different ecological zones. The purpose of verification trials on maize has been to identify suitable early and extra-early maize cultivars and to develop improved agronomic packages for the semi-arid ecologies in the Sudano-Guinean zone.

Mali has participated in the Verification Project since 1990. The focus is on the development and diffusion of improved maize varieties. To achieve this objective, the technology verification activities are concentrated on varietal development and seed production. The activities are coordinated by an agronomist, who is the only scientist in the maize programme. Activities under the Project formed an integral part of the national research programme.

White and yellow maize cultivars are both developed to meet the needs of farmers and industry. This is in response to the fact that both colours are preferred. The yellow maize is particularly in demand by poultry farmers. The yellow, therefore, enjoys higher prices in the cities. The white is preferred for local food dishes. The testing process prior to verification are all carried out in research stations and sub-stations. The verification is carried out on farmers' fields in cooperation with CMDT. CMDT is basically a cotton development company. However, farmers have been encouraged to introduce other crops into the farming system, and maize is one preferred crop.

Farmers have adopted improved methods of production such as seed, row planting, fertilizer application and insect control in cotton production. This has spilled over to maize production, with the result that farmers have adopted improved cultural practices in maize production. The major role of research in maize, therefore, is to identify superior varieties which are adapted to the different agro-ecological environments.

Three maturity groups of maize required to meet the requirements of the different environments are the intermediate (105-day) for the south, the early (90-day) for the central and extra-early (75-80 day) for the north.

Activities under the Project, carried out for the period 1990-93 are as follows:

- Intermediate maturing variety trials
- Early maturing maize variety trials
- Extra-early maturing maize variety trials
- Seed production

2.0 Execution of Verification Trials in Relation to Research Protocol

In 1993, verification trials covering a total of 25 villages, with one farmer(field) per village were conducted. Both white and yellow maize in the different maturity groups were covered. The activities were in line with the research protocol.

The seed multiplication activities are carried out with the cooperation of CMDT. Varieties under verification tests were being multiplied in anticipation of their release.

i) Appropriateness of Technologies Introduced

Process of Diagnosis:

The maize programme's process of identifying farmers' need, involve the following:

- survey results of FSR team
- feedback from extension

- field interview, and observations by the researcher.

Process of Planning:

The planning of research is undertaken during annual technical committee meetings which precede the season. CMDT is represented at these meetings.

Farmers' Opinions:

Responses from farmers on the appropriateness of the varieties introduced were positive. Improved varieties of maize have become widely accepted in Mali.

ii) Approaches to Enhance the Diffusion of Technologies

Individual Versus Group Approach:

The trials were carried out with individual farmers; the group approach to reaching farmers has not been exploited by the Mali programme.

Number of Trials/Villages/Replications:

Trials were carried out in 25 villages, with one trial in each village. Each trial had one replication.

Field Visits/Field Days:

Extension staff and farmers were invited for regular visits to the research station at Sotuba to learn about new varieties. Field days for verification trials did not feature prominently. For the trials that were visited, at least 10 other farmers visited each trial.

Population of Surrounding Farm Families:

About 40,000 farmers had access to the trials carried out in 1993.

iii) Simplicity of the Verification Trials:

The verification trials had only one experimental factor (i.e. variety). There were three varieties in each trial, namely the farmers' (local) variety, best released improved variety and the test variety. In cases where the farmers' variety was the best released improved variety, the treatments reduced to two. In terms of the number of experimental treatments, therefore, the trial design was simple.

The non-experimental variables which are not traditional farmers' practices were row planting and fertilizer application. With the spill over of improved practices from cotton to maize production, the non-experimental treatments represented farmers' practices.

Farmers were able to tell of the contribution of the new technology introduced. This is not surprising since all that was required was to distinguish between the yields of the varieties.

iv) Improvement of Research-Extension Linkages

a) Role of Extension in Research Problem Diagnosis:

Extension provide feedback to research, based on observations made in the course of their duties. Information is provided by CMDT on the varietal requirements of farmers.

b) Contribution of Extension to Research Planning:

Extension participates in the annual technical meetings organized by the research centre to plan activities for the following season. In this way, extension has contributed to the planning of maize research activities. CMDT also provide some level of funding. This has enabled their views on what research

to be carried out to be treated seriously.

c) Role of Extension in Experimentation:

The verification and the seed production activities are implemented with extension staff. They supervise these activities.

d) Role of Research in Training Extension:

There is presently no major role played by the maize programme in the training of CMDT staff, except in maize seed production.

e) Contribution of Research to Formulation of Extension Recommendations:

All the varieties being promoted by extension are those that have been tested by research and recommended.

Contribution of Research to Planning Extension Activities: Due to the limited scope of the focus of the maize research programme, it has not been able to exercise any significant influence on extension activities.

There is interaction between research and extension at the farm/village, regional and national levels. However, it is only at the village/farm level that the contacts are regular. The verification activities have played a significant role in bringing about this interaction. The National Agricultural Research Project, when fully implemented, would improve upon interactions at all levels.

v) Complementarity of Activities with FSR Programme

The national maize research programme rely substantially on SAFGRAD at all levels of technology development. SAFGRAD assistance had been in the areas of germplasm, training and strengthening the national technology transfer process.

The activities under the Project did not duplicate efforts. Rather, the funding had been used to implement important activities that would have otherwise not be implemented. In the absence of integration of FSR activities in the commodity programmes of the national research programme, the verification trials have encouraged the adoption of a farming systems perspective in the research programme.

vi) Adequacy of Research

Stages of Research Prior to Verification and their Linkage:

Varieties included in verification trials undergo on-station and multilocational testing for a total period of at least four years. At the on-farm level, no research is carried out prior to verification. This would have been a serious limitation if new cultural practices were part of the package. With the focus on only the identification and promotion of improved varieties, the research process on the field could be said to be adequate. Involvement of Relevant Disciplines in Identifying Potential Treatments for Verification:

The links between researchers of different disciplines in the execution of the verification trials was not strong. There is only one full scientist (agronomist) with no input from a breeder. There is some input from the FSR unit within the

research system. However, the links are not close. The FSR team operates separately from maize programme. The level of links are the feedback of information from FSR surveys to the maize programme and technical committee meeting.

vii) Conclusion

The development of improved practices for maize production in Mali has been very much dependent on SAFGRAD support. The Technology Verification Project has contributed to further strengthen this support.

The activities of the project are carried out in the cotton belt where maize production is concentrated. The use of improved crop management practices is not new to farmers in this area. What farmers lacked were good maize varieties. The focus on improved varieties has, therefore, been of relevance to the farmers.

The project has had a positive effect on research-extension-farmer linkages.

The design of the verification trials were simple and the farmers, therefore, had good understanding of the treatments.

As the research programme continues to develop improved varieties, there would be the need to speed up the process of recommending the most appropriate varieties to farmers through technology verification.

The following are recommended for the purpose of strengthening the implementation of the project:

- The group approach to reaching farmers should be exploited.
- Field days should be given much more prominence in future activities.
- Links between the maize agronomy programme and the FSR team has to be strengthened. This can be achieved through regular contacts in problem diagnosis, research planning, experimentation and analysis of trials.

D. SENEGAL

Senegal has predominantly Sahelian climate in the north, with annual rainfall of 300-600 mm, and Sudano-Guinean in the south, with annual rainfall of 700-1600 mm. The important crops include millet, groundnut (which accounts for 40% of the export revenue), rice, maize and cowpea.

The Centre National de Recherche Agronomiques de Bambey (CNRA) is the main national research station under the Institut Senegalais de Recherche Agricoles (ISRA), i.e. the Senegalese Institute for Agricultural Research. It is responsible for research on rainfed agriculture. There are other four research centres which are responsible for irrigated agriculture, forestry, livestock and fisheries respectively. Within each research centre, there is a technical committee which meets at the beginning of the year to plan activities. Extension staff and NGOs participate in these meetings. The major NGOs are Rodale International and World Vision International (WVI). The NGOs are encouraging a higher level of women in on-farm trials through the formation of cooperatives. The T&V system of extension is practised.

The process of experimentation is as follows:

- On-station trials at principal research centres
- Trials at secondary centres (PAPEM)
- Multilocational trials
- Verification trials

ADB-Funded SAFGRAD Technology Verification Project

1.0 Overview of Activities

The activities under the ADB-funded SAFGRAD Technology Verification Project covers millet and cowpea. The two crops are implemented by two separate teams. A breeder is the core scientist for millet verification trials, and a breeder/agronomist is the core scientist for cowpea verification trials.

The activities that have been on-going since 1990 are as follows:

Millet:

- Improved varieties
- Soil fertility
- Cropping system

Cowpea:

- Improved varieties:
  - 60-day (grain)
  - 70-day (grain)
  - 75-day (grain)
  - fodder cowpea

Research in millet on farmers' fields is concentrated in Central Senegal where millet is most important in the farming system. Technology verification activities on cowpea are concentrated in Northern Senegal. The objective is to promote early maturing varieties and as monocrops. The short season and low and erratic annual rainfall dispose longer maturing cultivars to drought stress. Cowpea varieties for grain and forage

respectively are being promoted.

The soil fertility trials have the objective of incorporating manure and compost into the system. It is part of a broad objective to integrate animal and crop farming.

The cropping systems trial covered millet/cowpea intercropping. Two types of cowpea (grain and fodder) were introduced into the system.

The different maturity groups of cowpea are being promoted for a purpose. The earliest maturing variety is important for bridging the hunger gap. Farmers' practice of reducing risk of crop failure associated with erratic rainfall is to grow varieties of different maturity periods. The research programme takes into consideration the colour preference (white mostly preferred), size of seed (large size) and coat texture (rough).

Work on forage cowpea is in line with the objective of integrating animal and crop production.

2.0 Execution of Verification Trials in Relation to Research Protocol

The trials were planted on farmers' fields in 30 villages which were widely distributed in millet and cowpea growing areas of the country, as planned.

The four major technologies covered in the trials conformed to the country's research protocol.

i) Appropriateness of Technologies Introduced

a) Process of Diagnosis:

The methods through which information for diagnosis is obtained are as follows:

- Results of studies by the Microeconomic Bureau of ISRA which is based in Dakar.
- Field interviews and observations made by researchers during field visits.
- Feedback from extension/rural development workers.

The extent of information obtained by researchers depends on the number and length of time of their visits to the fields. This is the area where funds provided by SAFGRAD had played a key role. More frequent visits by multidisciplinary teams of scientists (excluding social scientists) have led to regular contacts with farmers and extension workers.

b) Process of Planning:

Planning of research activities take place in annual technical committee meetings attended by researchers and extension/rural development workers, both governmental and non-governmental. Social scientists of the Microeconomics Bureau also attend these meetings.

At the village level, research, extension and farmers hold joint meetings to discuss the results of trials. Decisions are taken on what changes to effect on trial designs, and which technologies to advance.

c) Farmers' Opinions:

The farmers were of the view that the verification trials were addressing major production constraints, particularly the

risk of crop failure. For cowpea, the maturity of the crop, colour and texture was important for them. For millet, maintenance of soil fertility was critical due to the continuous cropping of the crop, especially on compound fields. The rotation system being encouraged on compound fields was compatible with their systems. Millet-groundnut rotation as already being practice on fields outside the compound.

The cowpea farmers, however, faced marketing problems. This was due to the fact that the crop had limited utilization. The possibility of linking up with an organization which could promote a higher level of utilization of the crop should be explored.

ii) Approaches to Enhance the Diffusion of Technologies

Individual Versus Group Approach:

Farmers' groups have been involved in the verification trials. The trials were carried out on the fields of a member of the group, but the other members joined in carrying out all the activities.

Number of Trials/Villages/Replications:

There was one trial in each of the 30 villages. There was one replication per site. With the adoption of group approach (with membership of 20-40 each), about 1,000 farmers could be reached directly in the 30 testing sites in 1993.

Field Visits/Field Days:

Other farmers got exposed to the trials through informal visits rather than field days. The option of field day has not been pursued aggressively.

Population of Surrounding Farm Families:

It was estimated that the potential number of farmers who could have indirect access to the trials was 50,000. SAFGRAD funding had been responsible for the number of trials carried out.

iii) Simplicity of the Verification Trials

As summarized in Table 9, the levels of treatments in the millet soil fertility studies were too many. The design seem to be complex for farmers to decide on technological options that could have been beneficial to them.

In the cowpea trials, three new varieties were tested against one farmers' variety.

In the millet trials, there were no non-experimental treatments which were not common practices of farmers. Row planting and insecticide application were non-experimental treatments in the cowpea trials. For insect control, farmers were advised to spray when insects became a problem. They had been trained to identify the major insects and their symptoms on the cowpea crop.

Table 9 Number of Experimental Treatments, Verification Trials, Senegal 1993

Trial	Factors	No. of Levels	No. of Treatments
Monocropped millet	Variety	2	4
	Management*	2	
Millet/cowpea intercrop	Variety	2	4
	Management*	2	
Millet soil fertility	Fertility	5	5
Millet rotation	Rotation	2	2
Cowpea variety	Variety	4	4

* Farmers: traditional practice
Improved: plant density (i.e. spatial arrangement and thinning)
fertilizer/compost/manure

For the cowpea trials, it was not difficult to tell the difference between the experimental treatments (i.e. the difference in the yields of the varieties).The millet trials, with the exception of the rotation trial, had a combination of factors that made it difficult to separate the effect of each one of them.

iv) Improvement of research-extension linkages

a) Role of Extension in Research Problem Diagnosis:

Extension workers provide feedback to researchers on constraints of farmers through informal channels.

b) Contribution of extension to research planning:

By participating in the joint research and extension technical committee meetings, extension workers contribute to the planning of research.

c) Role of Extension in Experimentation:

Extension workers are involved in the implementation of trials and sometimes provide funding for research technicians based at the trial sites. Extension personnel supervise farmers to plant trials. Technicians from the research centre follow up on the trials, but on a less regular basis than the extension personnel. Research scientists normally visit the trials to make observations and collect the necessary data on fortnightly basis.

d) Role of Research in Training Extension:

In the T&V system of extension being implemented, research is required to play a major role in training extension staff. In 1993, researchers provided training to extension personnel involved in the verification trials.

e) Contribution of Research to the Formulation of Extension Recommendations:

Extension recommendations have been developed with researchers.

f) Contribution of Research to Planning of Extension:

The researchers are involved in the planning of extension activities through the joint technical committee meetings.

g) Levels of Interaction:

Levels of interaction between research and extension exist at the farm/village level and national level. Verification activities have strengthened the interaction at the farm/village level.

v) Complementarity of Activities with FSR Programmes

In the absence of an active FSR programme within CNRA, the SAFGRAD Project has been useful in promoting FSR perspective in the organization of research through increased interaction among researchers of different disciplines and programmes, research and extension, and research and farmers.

vi) Adequacy of Research

Stages of Research Prior to Verification and their Linkage:

On-station trials at the principal and secondary centres take a total period of two to three years. Multilocational trials also take the same period. Thus, treatments for verification trials had gone through four to six years of testing. The verification takes about two years. The length of period of testing prior to verification is adequate.

Involvement of Relevant Disciplines in Identifying Potential Treatments for Verification:

In the execution of the verification trials, researchers in different disciplines and commodity programmes cooperate on day-to-day basis in planning and execution. The only limitation was

the absence of social science input. Social scientists serving the national research system are based at the headquarters of ISRA and are, therefore, not well integrated into the research system. This limitation is, perhaps, one of the reasons why some of the verification trials had several treatments. Evaluation at earlier stages of the research process could have identified a few treatments for verification.

vii) Conclusion

Activities under the project have focused on the management of millet-based cropping systems and varietal development in millet and cowpea. The focus of activities under the project was perceived by farmers to be major production constraints. However, farmers were facing cowpea marketing problems, caused by the increasing production. Cowpea had limited utilization in household diets, and it faced limited demand in the market.

Participating scientists have developed more regular contacts with extension (both governmental and non-governmental), and the participation of women farmers in the activities has received special attention. Farmers' groups have been involved in the activities.

Potential technologies which receive adequate research at the pre-verification stages are being continuously developed. It would be necessary to carry out verification trials on these technologies prior to recommendation to farmers.

It is recommended that the following issues should be addressed in order to strengthen the process of technology verification:

- The project researchers should link up with institutions involved in food utilization with the view of promoting cowpea utilization to reduce marketing problems.
- The crop management verification trials should be made simpler by reducing the number of treatments. Agronomic, statistical and economic analyses of the results of trials carried out at preceding stages should provide a guide for the selection of few superior treatments for inclusion in verification trials.
- The social science input in the research process should be improved. Admittedly, the current structure of the national research system whereby the social scientists are based at ISRA headquarters, makes such a recommendation difficult to adopt. However, this is necessary.

III. CONCLUSION AND RECOMMENDATIONS

The purpose of the study was to monitor activities under the SAFGRAD Technology Verification Project and determine the extent to which the Project objectives were being met.

Recommendations in this report, based on observations made, are not aimed at defining the type of research systems that should be adopted by participating research centres. The summary and general recommendations are discussed in terms of the criteria developed for the monitoring.

Each participating country had well-focused themes that were being addressed. Proposals submitted for funding by SAFGRAD were all being implemented. The Project has led to more aggressiveness on the part of scientists to push their research findings to farmers, through partnership with extension.

The national agricultural research systems had the objective of making the needs of the farmers the basis of their research themes. In the absence of full integration of FSR teams in the activities of the national programmes, interactions between research, extension and farmers that the SAFGRAD Project had encouraged, had provided researchers with better opportunities to learn more about the farmers' systems and the constraints to production.

Each national research system plans the season's programme together with extension through annual meetings. These meetings are organized at the regional level only, except in the case of Senegal where planning is done at the local level as well.

Participating institutions have made efforts to spread their verification trials in the major areas of production for the

specific crops, and to reach as many sites as the resources at their disposal could support. The general trend was using different fields as replicates to maximize the number of farmers that could be reached with trials. One encouraging development is the use of farmers' groups for some of the activities in all the countries. There is, however, the need to improve on the involvement of farmers.

While the importance of field days as a means of exposing farmers to the technologies is recognized, they were not prominent in the activities. It is obvious that reaching farmers through field days are not as expensive as trials. The field days provide opportunity for researchers to obtain information on farmers impressions on the new technologies. Even in a situation where farmers groups are used, field days would still be important. That would be the opportunity to bring all the farmers in the group together to discuss crucial management practices.

For trials planted in 1993, the design was simple, with few experimental treatments (of up to three) except in the case of cropping system/resource management trials in Senegal. Farmers had good understanding of the objectives and management of the trials. The area of concern is the non-experimental variables. For verification trials, researchers should as much as possible adopt farmers practices as non-experimental variables, but this was not the case in some of the trials. Farmers management include the prevailing practices, and the objective is to measure how the new technology will perform under this management. The only exception is where researchers believe that on the basis of

past trial results, the only feasible way of promoting the technology is a package. It is recognized that some practices perform better when adopted together with other (eg. improved maize variety and fertilizer). However, it should also be noted that farmers may not be able to adopt the whole package because of the capital requirements.

One area that participating research institutions have made much success is the improvement of research-extension linkages. In all the countries, strengthening of research extension linkages stood out as an important activity to facilitate technology transfer.

The implementation of the T&V system of extension in the four countries calls for greater links between research and extension. The Project activities in all the four countries has succeeded in forging this link. The mobility of scientists and increased number of verification trials have increased the level of interaction.

Both research and extension interact in all the phases of the research process. The only difference is the varying responsibilities at each stage. The NGOs have come in as strong extension/rural development partners in Senegal.

The improved links, coupled with increased aggressiveness of researchers to move results to farmers have resulted in an improvement in the turn out of appropriate technologies. This has been particularly successful for improved varieties. The evidence is the demand for improved varieties for farmers. This development is not in isolation. Past research efforts, including networking in the sub-region have led to the

development of good adopted varieties that meet the preferences of farmers.

In general, FSR was yet to be institutionalized into national research systems. Given this weakness, the Project has contributed positively in the area of enhancing the level of FSR perspective in the research process. However, the links with FSR teams are weak.

All the research programmes have a well-defined research process. The weakness identified is the absence of vigorous socio-economic evaluation to select appropriate practices. In the case of varietal development, the evaluation might not be that critical, but even then there is still the need to assess the acceptability of the improved variety. For the cropping systems/resource management trials, socio-economic evaluation should be considered as equally important as the agronomic and statistical evaluation. This should apply to all the stages of experimentation.

The participation of other researchers and extension/ rural development workers was a priority to the core scientists involved in the Project. The limiting factor to the extent of involvement was the established research process. The weakest link among scientists that was observed throughout the four countries was the poor integration of social science in the research process. While acknowledging the fact that the institutional set up and staffing requirements are beyond the scope of the SAFGRAD Project, there was some room for the scientists to improve upon the process by improving day-to-day contacts with scientists in relevant disciplines in some of the

countries.

On the basis of the observations made in monitoring the implementation of the activities of the Technology Verification Project in the four countries that were visited, the following general recommendations are provided.

- The planning process should be improved through more localized planning. The planning process should involve researchers, extension and other rural development personnel (both governmental and non-governmental) and farmers. To accommodate the expenses in the budget provided, field days conducted at harvest could be a possible forum for such planning. Localised planning would provide greater participation by farmers.
- Participating research institutions should as much as possible adopt the group approach to the technology transfer activities under the SAFGRAD Project. The specific issues involved in group approach should depend on local experiences. The activities could be carried out on a community farm belonging to all members of the group; or they could be rotated on plots of members of the group but with the involvement of other members of the group.
- The level of field days should be raised. Project participants should determine the appropriate mix of trial sites and field days for each season and allocate the budget accordingly.
- Researchers should as much as possible adopt farmers

practices as non-experimental variables. Farmers could be grouped according to the uniformity of their non-experimental practices when the results are being analyzed.

- The number of experimental treatments should be few. Results of research carried out at stages preceding verification should guide researchers in deciding on the few treatments with the highest potential to improve productivity.
- There would be the need to continue with activities at the pre-verification stages to ensure the flow of potential technologies for verification. It is to be noted that it is the past research efforts, including networking in the sub-region which have led to the development of good adopted varieties that meet the preferences of farmers.
- Core scientists implementing the Project should strengthen linkages with the FSR programmes/teams in all the research stages, and not only at the planning phase, as seems to be the current practice. There could be joint activities in diagnosis, field visits and evaluation/assessment of technologies. This would require that technical scientists team up with FSR scientists in the planning and implementation of surveys. FSR scientists could be invited to join the other scientists during field visits.
- Related to the above is the need to improving on the input of social scientists. Socio-economic evaluation

is required to select appropriate practices, and it should be considered as equally important as the agronomic and statistical evaluation. This should apply to all the stages of experimentation.

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APPENDIX I TERMS OF REFERENCE

The terms of reference for the monitoring were as follows:

a) To assess the execution of verification trials in different villages according to the respective countries' research protocol of the Project.

b) To conduct interviews with some farmers:

(i) Survey if technologies introduced through the Project meet farmers' needs.

(ii) Assess the number of farmers exposed directly or indirectly to the verification trials.

(iii) Review the simplicity of the farm trials or 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.

c) To critically look into the following areas which relate to the research-extension interphase activity of the Project:

(i) Improved linkages between researchers and extension agents or rural development workers.

(ii) Project complementarity with FSR programmes in the particular country.

(iii) Packaging of technology (variety + fertilizer + plant population density + intercropping etc): The adequacy of agronomic research conducted on-station (before on-farm verification trials).

d) To submit a report on the status of Project implementation to the SAFGRAD Coordination Office.

APPENDIX II FRAMEWORK FOR MONITORING THE IMPLEMENTATION OF THE FOOD GRAIN PRODUCTION TECHNOLOGY VERIFICATION PROJECT

a) The execution of the verification trials in relation to the research protocol of each country.

(i) Coverage of villages: Verification trials should aim at a wider spatial and farmer coverage to assess adaptability.

(ii) Number of technologies

b) The appropriateness of the technologies introduced in meeting farmers' needs.

(i) Process of diagnosis.

(ii) Process of planning.

(iii) Farmers' opinions

c) The number of farmers exposed directly or indirectly to the verification trials.

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

(ii) Number of trials/villages/replications:

Replication across farmers (i.e. one replication per site), while possibly reducing statistical precision, compared to increased replications 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 would be a preferred option.

(iii) Field visits/field days: Organized field visits and field days should form part of the methodology of technology transfer. Such visits have to coincide with critical activities/stages of the crop's growth/management, namely planting, fertilizer (or insecticide application), flowering and harvesting (when yields could be compared).

(iv) Population of surrounding farm families likely to benefit from a spill over.

d) The simplicity of the on-farm trials or design, and the effective demonstration to farmers the yield increase and economic advantage of the new technology.

(i) Number of treatments: The number of treatments is determined by combination of the number of factors under test and the number of levels for each factor.

(ii) Non-experimental variables and farmers practice: In verification trials, it is more appropriate to adopt farmers practices as the non-experimental variables. This ensures that the new technologies give the responses that would be obtained when adopted by farmers. The exception would be in a situation when it is realized that the new option alone could not provide any advantages unless adopted together with an existing improved practice (eg. improved

cowpea and insecticide use), in which case the technology is introduced as a package. The evidence, however, is that farmers adopt technologies in a step wise manner. It is important to think of farmers' management not only in terms of carrying out the activities, but also adopting the practices in the non-experimental variables.

(iii) Separation of effects of each treatment.

e) The contribution to improved linkages between researchers and extension agents or rural development workers.

(i) Role of extension in research problem diagnosis

(ii) Contribution of extension to research planning

(iii) Role of extension in experimentation

(iv) Role of research in training extension staff

(v) Contribution of research to the formulation of extension recommendations

(vi) Contribution of research to planning of extension activities

(vii) Levels of interaction (farm, village, regional, national).

f) The complementarity of activities under the Project with Farming System Research (FSR) programmes.

(i) Avoidance of duplication/clear delineation of activities

(ii) Interaction with FSR staff in problem diagnosis, planning and experimentation

(iii) Integration of FSR activities within the national agricultural research system

g) The adequacy of research carried out on the technology packages prior to the on-farm verification.

(i) Stages of research prior to verification and their linkage

(ii) Involvement of relevant disciplines in identifying potential treatments for verification.

APPENDIX III ITINERARY FOR SAFGRAD CONSULTANT, MR. KOFI AMOAKO MARFO, AGRICULTURAL ECONOMIST

OBJECTIVE: To assess the implementation of Food Grain Production Technology Verification Project (FTVP)

1-4 September, 1993

Evaluation FTVP - In Northern Ghana, the project is implemented under the management of Nyankpala Agricultural Experiment Station.

Sunday, 5 September, 1993

Travel to Ouagadougou, SAFGRAD would arrange transport.

Monday, 6 September, 1993

08:00-10:00	Discussion, SAFGRAD Coordination Office
10:30-10:45	Visit, Director, Kamboinse Station
10:45-11:00	Visit, IITA/Programme
11:00-11:40	Discussion, Project participants INERA/Kamboinse Station
11:40-12:40	Visit, INERA/FSR Programme
15:00-16:00	Visit, Director CRPA
16:00-17:00	Visit, Extension Department, Ministry of Agriculture

Tuesday, 7 September, 1993

Field Visit- Cowpea on-farm verification trials

Wednesday, 8 September, 1993

Field Visit- Cowpea on-farm verification trials

Thursday, 9 September, 1993

Field Visit- Maize seed production. Travel to Bobo

Friday, 10 September, 1993

Travel Bobo - Bamako

Saturday, 11 September, 1993

Field Visit- Maize on-farm verification trials (Mali).

Sunday, 12 September, 1993

Field Visit- Maize on-farm verification trials (Mali).

Monday, 13 September, 1993

Visit Sotuba Station

08:00-08:30 Visit, D.G. IER

08:30-12:30 Sotuba Station including FSR

Tuesday, 14 September, 1993

08:00-10:00 Visit, Agricultural Extension Unit, Ministry of Agriculture, (Mali)

Afternoon Travel Bamako-Dakar

Wednesday, 15 September, 1993

09:00-10:00 Visit, D.G. ISRA (Senegal)

Afternoon Travel to Bambey Station

Thursday and Friday 16-17 September, 1993 Bambey Station

Field Visits - On-farm verification trials

Afternoon 18 September - Return to Dakar

Sunday, 19 September, 1993

Dakar - Abidjan

Monday, 20 September, 1993

Abidjan - Accra

21-25 September, 1993

Preparation of the report in Ghana.

APPENDIX IV REPORTING FORMAT

To facilitate a better understanding of activities and how they conform to the objectives of the Project, the following format for reporting research activities/results is proposed.

1. Introduction:

The country - Bio-physical setting
- Economic setting
- Agriculture policy: new developments
- Performance of agriculture.
- National agricultural research system, with emphasis on new developments, and the role of the participating institution in the system.

- National agricultural extension system, with emphasis on links with the research system.

2. The SAFGRAD Technology Verification Project

- Choice of technologies for verification
  . criteria
  . history of research on the technologies
  . evidence of yield and economic advantage of new technology over farmers practice
  . the number (or percentage) of farmers affected by the problem which the technology is proposed as solution.

- Number of years of testing at verification stage

- Trial distribution

. Number of testing sites (fields) for each trial type

. Number of treatments and replications per site

. Number of field days per site

. Number of farmers involved directly and indirectly.

- Extension involvement

- For each trial:

  . Objectives

  . Methodology (materials and methods)

  . Results: agronomic, statistical economic

- Conclusion

  researchers decision (i.e. to continue, discontinue or recommend, and the reasons).

APPENDIX V PERSONS AND ORGANIZATIONS CONTACTED.

1.0 BURKINA FASO

OAU/SAFGRAD

J.M. Menyonga	International Director
Taye Bezuneh	Director of Research
E. Adanlete	Chief Accountant
Denis E. Ouedraogo	Documentalist

IITA/SAFGRAD

N. Muleba	Team Leader
B. Badu-Apraku	Coordinator, Maize Network

INERA

Roger Zangre	Chief, Kamboinse Research St.
C. Dabire (Mme)	Cowpea Entomologist
Issa Drabo	Cowpea Breeder
Idrissa Hema	Maize Breeder
M. Bertelssen	Agric Economist, FSR/INERA
J. Dicken	Agronomist, FSR/INERA
E. Robins	Sociologist, FSR/INERA

CRPA

Ouedraogo Nabyoure	Director-General
M. Puahoukiga	Director, Research and Devt.
M.M. Fofana	Extension Department, Ministry of Agriculture
Dianda Nini Pascal	Extension Department, Ministry of Agriculture.
Badiara Leon	CRPA/Sahel
Nacro Souleymane	CRPA/Sahel

Diallo Oumarou	CRPA/Sahel
Dicko Issiaka	CRPA/Sahel

2.0 GHANA

NAES

H. Mercer-Quarshie	Station Manager
L.O. Tetebo	Agronomist
K.O. Marfo	Grain Legume Breeder
P.Y.K. Sallah	Maize Breeder
J. von Bargen	Head, Research-Extension Liaison

MINISTRY OF FOOD AND AGRICULTURE

E.K.T. Frempong	Head, Crop Services, Northern Region
A. Adam	Head, Extension Services, Northern Region
F. Adongo	Extension Officer

3.0 MALI

IER

Oumar Niangado	Director-General, Institute of Rural Economy (IER)
Yacouba O. Doumbia	Director, Sotuba Station
N'Tji Coulibally	Maize Agronomist, IER

CMDT

M. Nedelec Gabriel	Director, DTDR/CMDT
Sidibe Seydou	CMDT
Abdoulaye Dolo	Adjoint DTDR/CMDT

WORLD BANK

Office of Representative

ICRISAT/MALI

Samanko Station

USAID/MALI

Tadesse Kibreab	Research Advisor

4.0 SENEGAL

ISRA

Habib Ly	Director-General, ISRA and Acting Director, Bambey Research Station
Saliou Diangar	Millet Agronomist
Samba Thiaw	Cowpea Agronomist

RODALE INTERNATIONAL

Country Representative

5.0 FARMERS' INTERVIEW

As summarized in Table 3.

AFRICAN UNION UNION AFRICAINE

African Union Common Repository **http://archives.au.int**

Department of Rural Economy and Agriculture (DREA) African Union Specialized Technical Office on Research and Developmer

1994-05

THE FOOD GRAIN PRODUCTION TECHNOLOGY VERIFICATION PROJECT, 1993/94 IMPLEMENTATION REPORT

Marfo, K.A.

AU-SAFGRAD

http://archives.au.int/handle/123456789/2550

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