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SEMI-ARID FOOD GRAIN RESEARCH AND DEVELOPMENT
SAFGRAD

SHAPING AGRONOMIC RESEARCH IN WEST AND CENTRAL AFRICA

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Preface

THE human population of the West and Central African sub-region is increasing at the rate of about 3% per annum. The sub-region which was self-sufficient in food in the 1950s became a net food importer in the 1960s while it has been experiencing gross per capita food production decline since the mid-1970s. If self-sufficiency in food is to be attained in the next 20 years, the sub-region will have to increase its current food output by 80% in the year 2010 (this requires a minimum yearly increase of 4%).

Self-sufficiency in food could be achieved through the following three approaches, either separately or in combination: (a) expansion of crop land (b) irrigation and (c) intensification of food crop production.

Of these three, the most plausible approach appears to be intensification of food crop production. This requires agronomic research for the generation of appropriate technologies, i.e., crop varieties and agronomic practices that are not only within the reach of peasant farmers but suited to their conditions.

Due to financial, infrastructural and logistic problems, the massive utilization of modern inputs, such as chemical fertilizers, amendments and pesticides (as in the case of Europe and North America) may not be a viable option for West and Central Africa. It is, therefore, necessary to maximize the efficiency of the use of imported inputs through a series of appropriate agronomic practices. The basic concept of low input technology is to make the most efficient use of imported inputs by sowing those crop species and varieties that are most tolerant to existing environmental constraints, and thereby decreasing the rate of purchased inputs while attaining reasonable but not maximum yields (Sanchez and Salinas, 1981).

The West and Central Africa Sorghum, Maize and Cowpea Networks, being aware of the importance of the role of agronomy in the manipulation of environmental factors for creating new environments suitable for optimal resource utilization and/or sustainable agricultural production, organized a seminar for research agronomists. The seminar which was held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria from 7 to 19 January 1991 had as its objectives:

a. improving the research capacity of research agronomists through the exchange of ideas

b. highlighting the major constraints to agricultural production in the sub-region with a view to identifying areas that require research emphasis

c. explaining the concept of low input technology with a view to identifying appropriate, acceptable technologies for peasant farmers' requirements and a sustainable agricultural production and ecosystem

The seminar was organized in three parts as follows:

Part 1: General factors affecting crop productivity

Part 2: Low input technology strategy

Part 3: Agricultural experimentation and technology transfer

During the seminar, lectures were given by subject-matter specialists from both national and international agricultural research systems. An interesting feature of the seminar was that the emphasis was placed on discussion. This enabled participants and presenters to exchange views on new concepts and how to solve seemingly difficult agricultural problems in the sub-region. One thing that came out clearly was the similarity of problems across the sub-region.

This report is a summary of the lectures and discussions held at the seminar. It also includes a full list of participants.

NetworkCoordinators

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April, 1991

PART I

General Factors Affecting Crop Productivity

1.1 Identification of farmers' needs

1.2 Crop production constraints

1.3 Methodology for on-farm technology transfer.

1. General Factors Affecting Crop Productivity

1.1. Identification of Farmers' Needs

IN identifying farmers" needs, two approaches could be used: farmers' typology relevance and recommendation domain.

1.1.1 Typology

Farmers could be divided into four distinct groups based on their production objectives:

a. the subsistence group: production is intended to satisfy food security and the basic expenses requirements of ordinary peasant households

b. the consumer group: the standard of living is relatively high and commercial transactions are carried out mainly in local markets;

c. the prestige group: commercial transactions are of great importance and there is a product re-distribution system

d. the accumulation group: the principal activity lies in research for profitable production either as raw materials or finished products

About 60% of farmers belong to the subsistence category and this is generally made up of the native population. The accumulation group is often less than 10% and is usually made up of a group of immigrant farmers (i.e., farmers coming from other regions in or outside the country). The remaining 30% include the consumer and prestige groups.

1.1.2 Recommendation domain

This refers to all agro-economic conditions put together within a given group of farmers so that a new technology may have the chance of being successfully adopted in that region.

1.2 Agricultural Production Constraints

The factors can be identified as:

- abiotic and
- biotic

Among the abiotic factors, climatic and edaphic factors constitute the major constraints. Soils of the sub-region are low in fertility and subjected to erosion problems; and rainfall is often erratic. The frequent droughts are accompanied by dry, windy conditions, high air and soil temperatures.

The principal biotic factors are insect pests, diseases and parasitic weeds, causing considerable damage to crops. Yield losses may be up to 30-40%, and in some cases crops are completely destroyed.

1.3 Methodology of Technology Transfer to Farmers

Research under farmer's conditions is a new approach which is referred to as 'bottom up'. Four principal steps are involved:

a. Diagnosis: whereby one studies all the constraints, the objectives and farmers' needs and requirements
b. Elaboration of technologies from the research station and\or farmers' fields
c. Evaluation tests under farmers' conditions which constitutes a dynamic approach in liaison with farmers This could be done in two ways:
    - evaluation under scientists' management
    - evaluation under farmers' management
d. Transfer of new technologies: In order to make the transfer of new technologies effective, it is necessary to define the recommendation domain

The recommendation domain of a technology is composed of a group or groups of farmers amongst which existing agro-

economic conditions are similar in nature, so that any recommendation made is useful to the whole group.

Conclusion

It was noted that any increase in productivity is the result of a good manipulation of genotypes and environmental factors in a multidisciplinary team approach. This requires:

- varieties that are resistant to the major diseases, insect pests and parasitic weeds. The growth cycle of such varieties should match the cropping season.
- appropriate cultural practices for the conservation and maintenance of soil fertility:
    - application of organic matter (animal manure, compost, cover crops, incorporation of crop residues, etc.)
    - planting on tied ridges in low rainfall zones.
    - wind break devices
    - fertilization of crops with minimum inputs and the use of locally available cheap fertilizers, such as natural phosphates

PART II

Low Input Technology Strategy

2. Low Input Technology Strategy

2.1 Concept of Low Input Technology (LIT)

Farmers in the semi-arid zone are more concerned with risk minimization than production maximization. This imposes limitations on the use of modern inputs such as fertilizers and pesticides for increasing crop yields. There is, therefore, a need for a low input technology strategy to suit the farmers.

The objective of using LIT is to provide maximum returns to farmers by achieving yield increase with minimum inputs. To achieve this, a strong collaboration is required among different specialists, i.e., agronomists, breeders, pathologists, entomologists, economists and extension workers.

2.1.1 Components of LIT

The main components of the low input technology strategy are as follows:

- selection of appropriate land
- use of varieties that are resistant/tolerant to different environmental constraints
- use of available methods for soil and crop management
- use of minimum level of imported inputs
- maximum use of legume crops for symbiotic nitrogen fixation
- use of local rock phosphate

In view of the specificity of environmental constraints, approaches dealing with LIT should take into account the various economic and agro-socio-ecological features of an area.

2.2 Selection of Germplasm Resistant/Tolerant to Environmental Constraints

2.2.1 Cowpea

In West and Central Africa, drought is usually associated with high air and soil temperatures and these have been demonstrated to be the main constraints to cowpea production (Muleba 1988) and therefore resistance/tolerance to high temperatures is a prerequisite for breeding adapted cowpea cultivars.

In recommending cowpea varieties, emphasis should be placed on adapted and stable cultivars which react less than others to various conditions (particularly sowing dates in given areas).

The use of cultural practices like mulching and tied-ridging which increase soil water storage and reduce soil temperatures should be encouraged because they contribute significantly not only to yield increase but also to the prevention of severe yield losses during bad years.

In Sahelian areas where available mulch is scarce, appreciable amounts of mulch could be produced by rotating cereals with either cover crops such as *Crotalaria retusa* (L.), *Cassia occidentalis* (L.), *Styllosanthes* sp., etc.

2.2.2 Maize

Among the constraints limiting maize production are biotic (diseases, insects, parasites and weeds) and abiotic factors (drought, soil acidity, salinity, waterlogging, and mineral nutrient deficiencies)..

For effective breeding methods, screening techniques should be simple, quick and reliable; genetic variability should also be adequate and resistance\tolerance should not be associated with undesirable features.

In breeding for environmental constraints such as diseases, *Striga,* insects,etc., two main approaches are used:

a. hot spot technique
b. controlled inoculation\infestation

When breeding for drought resistance\tolerance, the use of irrigation or tied-ridges may well simulate conditions of adequate water availability. It is, however, important to note that the effect of tied-ridges will depend on soil, crop, climate and toposequence.

2.2.3 Basic agronomic principles

Crop yield can be expressed by a model of the form:

$$Y = C \times Dr \times P$$

where:

Y = grain yield
C = rate of crop growth
Dr = duration of the reproductive phase
P = fraction of the growth rate attributed to yield

In general, yield increases result more from changes in P or Dr than C. Consequently, a selection method focusing on a higher level of P would be more likely to increase yields.

2.2.4 Country reports on selection of germplasm resistant\tolerant to environmental constraints

a. ..BURKINA FASO

Collaborative agronomic research conducted by the national programs and international institutes has identified improved varieties resistant\tolerant to different environmental constraints as follows:

Crop/Variety	Characteristics
Sorghum	
ICSV-1049	• 105-110 days to maturity • resistant to foliar diseases • good tolerance to *Striga* • resistant to lodging • white grain and good palatability • yield potential 5 t/ha.
Framida	• 120 days to maturity • *Striga* tolerant • brown grain • yield potential 4 t/ha.
Millet	
IKMV-801	• 120 days to maturity • tolerant to mildew • yield potential 2 t/ha
IKMP5	• 110 days to maturity • low susceptibility to mildew, ergot and smut. • yield potential 1 t/ha.
Maize	
Kamboinse 86 Pool 16DR	• 90-95 days to maturity • drought resistant • white grain • yield potential 3-3.5 t/ha
KPB-1	• white grain • yield potential 3-3.5 t/ha
KEJ	• 70-80 days to maturity • yellow grain • yield potential 2-2.5 t/ha
KPJ-1 SR	• 90-95 days to maturity • streak resistant • yield potential 3-3.5 t/ha
KEB	• 70-80 days to maturity • streak resistant • yield potential 3-3.5 t/ha

Cowpea

Drought and high temperature resistant varieties:

TN88-63	75 days; 1.5 t/ha
Gorom Local	70 days; 1.2 t/ha
KVx61-1	70 days; 1.2 t/ha
KVx396-4-2	65-70 days; 1.8 t/ha
KVx396-4-4	65-70 days; 1.8 t/ha

Varieties resistant to various diseases:

KN-1	75 days; 1.5 t/ha
TVx3236	75 days; 1.5 t/ha

Varieties resistant to aphids:

KVx165-15-1	75 days; 1.5 t/ha
KVx145-27-6	65 days; 1.2 t/ha

Varieties resistant to bruchids:

KVx30-G172	75 days; 1.5 t/ha
KVx295-2-121-99	75 days; 1.5 t/ha

b. NIGERIA

The fact that selection methods have, for a long time, not taken into consideration farmer's preference for different crop varieties has led to a low level of adoption, though some varieties showed a good level of resistance to environmental constraints. For example, the sorghum red grain and *Striga* resistant variety SRN48-41 was not accepted by farmers because of the grain colour.

However, drought resistant millet varieties SAMMIL-2 and 3 are available for cultivation. Also available are two early maturing millet varieties, SE13 and SE2124 which are resistant to ergot, smut and mildew. For maize, several varieties of various maturities that are streak resistant are available. They include TZESR-W, TZB-SR, TZSR-W and TZSR-Y.

For cowpea, the variety IAR 341 is moderately resistant to brown blotch.

c. SENEGAL

Millet and sorghum are the main staple food crops of the rural areas. Yield levels range between 375 and 750 kg/ha.

One of the difficulties faced by the millet program are the frequent changes in cultural practices due to ecological instability and the heterogeneity of the Sahelian environment.

Actions to be taken for short, medium and long-term yield improvement must include:

- selection of materials suitable for different agro-ecological zones
- development of improved cultural practices that might help achieve high yields under poor environmental conditions
- efficient crop protection measures

In the long term, hybrid production in potentially irrigable areas should be given attention.

d. MALI

Millet and sorghum are the main food crops with average yields of 800 kg/ha. Some varieties selected for resistance/tolerance to environmental constraints include: NKK for millet, Tiemarifing and CSM for sorghum. The varieties listed above are drought resistant but susceptible to *Striga*. The exotic sorghum variety IS-25108 is tolerant to anthracnose.

Maize comes after millet and sorghum in Mali and the average yield is 1.6 t/ha. Drought resistant varieties, TZESR-W and Ikenne-8149SR have been identified recently; these varieties are streak resistant and have proved to have potential for extension.

- Open pollinated varieties such as Poza Rica 8422 and Across 8464 also performed well in many locations.
- Particular emphasis should be placed on breeding for early and extra-early materials and further testing on farmers' fields.

Cowpea is mainly grown intercropped with millet, sorghum or maize and average yields range between 200 and 400 kg/ha. Yield potential may reach up to 2000 kg/ha. Varieties KN-1, Niban, Gorom-Gorom (Suvita-2), IAR-1696 and other higher yielding early and medium-cycle varieties that are resistant or tolerant to thrips have also been identified recently.

e. CAMEROON

Production constraints include drought, low soil fertility, *Striga*, lack of appropriate varieties and poor cultural practices.

Collaborative research between SAFGRAD and the national maize program has resulted in the identification of early (DMR-ESR-Y and Pool 16 DR SR) and extra early material (TZEF-Y) of 95 and 80-85 days respectively between the ishoyetes 700 and 900 mm. On and off station experiments show that the cultural practices listed below are very promising for both types of materials in the semi-arid lowland savanna:

- plant densities: 62500 plants/ha
- side dressing of urea 20 days after seed emergence in contrast to 30-35 days after emergence for medium to late maturities
- high yields may be achieved by combining 90 kg of N/ha with a population of 62500 plants/ha

Early and extra-early maturing cultivars DMS-ESR-Y, Pool 16 DR SR and TZEF-Y are very susceptible to environmental stresses such as soil fertility, *Striga* or weeds, but their shorter cycle gives them an appreciable yield advantage over longer maturity cycles as the growing season becomes shorter.

2.2.5 Conclusion

From the presentations on environmental constraints limiting maize, sorghum, millet and cowpea production, it was unanimously agreed that:

i. Strong collaboration among agronomists, breeders, extensionists and other scientists is necessary if farmers' needs are to be addressed.

ii. Selection under farmers' conditions, i.e., under no-tillage or minimum tillage and low soil fertility, needs to be given much thought, though in such conditions it is difficult to have a satisfactory level of homogeneity for objective and efficient selection. A plausible approach would be:

- to screen the parents used in a cross for their adaptation to farmers' and improved conditions
- to conduct progeny trials, which have large numbers of entries under improved conditions
- to conduct preliminary and/or advanced yield trials under farmers' and improved conditions
- to recommend for commercial purposes only cultivars performing better under farmers' as well as improved conditions

iii. When infrastructure is inadequate while breeding for drought tolerance/resistance, planting the varieties at different dates could be a satisfactory option.

2.3 Soil Conservation Measures

Alfisols and related soil groups are characterized by high temperature, soil compaction, soil surface sealing, low infiltration, low-capacity for water retention and poor fertility. Advocated methods for soil and water conservation include:

- tied ridging
- minimum level of mechanization
- use of manual tools for land clearing
- minimum or no tillage
- mulching
- improved fallow with legume crops
- methods ensuring a longer period of soil cover

Although, practices such as tied ridging have long been used by farmers in the Northern Guinea savanna and other areas, the level of adoption is still very low despite numerous efforts to further extend such practices. Thus, simple mechanization schemes for soil ridging and minimum or no-tillage conditions need to be given high research priority.

2.3.1 Selected country reports on soil and water conservation

a. BURKINA FASO

High rainfall intensity, conventional tillage and bush-burning tillage are the main factors causing intensification of water runoff and soil erosion. Control measures include tied ridging and sowing in large-sized mounds in which organic matter has previously been incorporated. In order to reduce destructive effects and to achieve desirable results, bush burning, where it has to be done as a soil conservation measure, should be done early, i.e., at the beginning of rather than late in the dry season.

The need to design erosion control methods for large areas rather than for small-sized individual plots was emphasized.

b. NIGER

Tied ridging used with other methods of land preparation, was reported to have significantly increased sorghum yield. The effect of tied ridging was more pronounced when fertilizer was applied.

2.3.2 Conclusion

The different presentations showed that tied ridging was an efficient method for soil and water management. It was noted, however, that its efficiency depends on the crop, rainfall intensity and pattern, climate and type of soil.

2.4 Phosphorus Management

It has been observed that most of the arable soils of the semi-arid zone of West Africa are deficient in phosphorus (P). This was well illustrated in the country reports of Burkina Faso, Mali, Niger and Senegal.

In Burkina Faso, a map showing phosphorus deficiency levels in the major soil types indicated that densely populated areas were most prone to P deficiency. This can be corrected by the annual addition of 25-30 kg P_2O_5/ha, depending on the type of crop. Results of research carried out on agricultural utilization of natural rock phosphates in some West African countries have demonstrated that their agronomic efficiency could be improved by partial acidification in combination with organic matter. However, some of the problems militating against the use of rock phosphates are their "powdery" form and their low positive effect on crop growth and development in the first year of application.

The International Fertilizer Development Center (IFDC) is, through its West African network, making efforts to solve the problems encountered in the utilization of rock phosphates. Studies carried out have revealed that aluminum and iron content in certain natural phosphates limit the effectiveness of the products obtained from partial acidification. This can be explained by the aluminum and/or iron content of such

natural phosphate fertilizers, which fix anew, in the soil, the soluble phosphorus resulting from acidification treatment.

It is important to note that in the sandy soils of Niger, a method was developed which permitted the determination of the most critical levels of assimilable phosphorus (Bray.1) in the soil according to a farmer's yield objective. Under this condition, it was observed that the total phosphorus of the soils contributed 69% to the assimilable P content of the soil and that 71% of the soil phosphorus absorption capacity is explained by their content of exchangeable aluminum.

Discussion on this topic focused on the basic concept of fertilizer use, since excessive use of rock phosphate can bring about a complex situation in calcium absorption, thereby reducing P availability to plants. It can also favour zinc deficiency due to a high level of P.

2.5 Nitrogen Management

Nitrogen, like phosphorus, is necessary for the growth and development of crops. Studies conducted using N15 isotope revealed that 50% of nitrogen applied to the soil is wasted in various forms. This is mainly related to the localized application of ammonium nitrogen as opposed to broadcasting and ploughing under. The high concentration of ammonium results in increased pH which favours nitrogen loss by volatilization. It is therefore necessary to search for other nitrogen sources which are less alkaline (i.e., calcium ammonium nitrate) and appropriate cultural practices. The following were discussed:

- maximum utilization of biological nitrogen fixation
- intercropping and cereal-legume rotation

2.5.1 Maximum utilization of biological nitrogen fixation

After reviewing the general principles and the micro-organisms (self or symbiotic) involved in biological nitrogen fixation (BNF), some methods of measuring BNF and factors influencing BNF were discussed. The presentation highlighted certain techniques/factors that can help improve the effectiveness of symbiotic nitrogen fixation.

- inoculation of seed with nitrogen fixing micro-organisms
- selection of promiscuous leguminous varieties
- favourable edaphic factors

2.5.2 Nitrogen management

The need to use grain legumes to improve soil nitrogen as an alternative to chemical fertilizer was emphasized.

Methods for estimating N_2-fixation were discussed and the use of different methods as alternatives to the N15 isotope method (most reliable but expensive) was recommended. Breeding for promiscuous nodulation in legumes was also recommended as an alternative to the use of inoculum to improve N_2-fixation.

During the discussion, the lack of organic residue for recycling caused by the removal of stubble to feed livestock attracted much of the participants' attention. To address this problem, research on alley cropping was suggested.

It was also mentioned that since most farmlands are intercropped, legume cultivars adapted to intercropping should be developed. It was suggested that more work should be done on the use of fertilizers in intercropping.

2.6 Intercropping and Crop Rotation

About 75% of the area cultivated in the semi-arid zone of West Africa is intercropped. Some of the advantages of this practice are soil conservation, risk minimization, maximization of benefits and flexibility. Work carried out in Mali and Nigeria has yielded promising results. Considerable research has been conducted on crop rotation in Nigeria.

A number of questions were raised during this discussion, especially with regard to cereal/legume intercropping. Problems relating to the spatial arrangement of the component crops and methods of application of mineral fertilizer are yet to be solved.

2.7 Management of Crop Residues

One of the main characteristics of the soils of semi-arid West and Central Africa is the low content of organic matter. Organic matter plays an important role in the cation exchange capacity of soils. It is the mainstay of biological life and the backbone of physical soil properties, and provides a source of nutrients for the plant.

A soil without organic matter is a soil without life. Different modes of recycling exist. It is to be noted, however, that while bush burning solves the problem of potassium availability in the short term, it decreases both the nitrogenous and sulfur content. It also exposes the soil to erosion and the burning sun. Mulching appears to be effective in supplying organic matter in several situations (Niger and Burkina Faso).

Discussions on this subject were concentrated on the different experiences gained by the participants in coping with the problem of organic matter, especially in the recycling technique of crop residues (compost, night Kraal, etc.). In any case, the availability of crop residues remains a major constraint. Even when crop residues are available, they are either used for animal feed, fuel or domestic purposes.

2.8 Integrated Crop Management

This aspect can be defined as "any effort made on the basis of the best knowledge of factors limiting crop production and appropriate solutions, with a view not only to reducing yield losses, but also conserving the soil resource base through the adoption of most appropriate technologies ensuring sustainable crop production".

It is a system that requires direct collaboration among scientists working in various disciplines: agronomy, pathology, entomology, breeding, soil science, social sciences etc. Studies on this aspect were presented and useful discussions held on its basic concept. In conclusion, it was felt that prevailing conditions in each country (each ecological zone) should be considered when attempting this approach.

PART III
Agricultural Experimentation and Technology Transfer

3. Agricultural Experimentation and Technology Transfer

3.1 On-Farm Research

Applied research is based on the following principles:

a. Studies should be on the real constraints identified under farmers' conditions (i.e., on-the-spot), not isolated questions that the farmers might have generated.
b. Studies should be carried out under farmers' conditions unless there are tangible reasons for working in the research station.
c. On-station applied research is only relevant if the test conditions are representative of the target identified (physical conditions, crop management, etc.).

A study on the contribution of the plasticity of maize in intercropping was presented. From this presentation, it was obvious that before embarking on research, the researcher must ask a number of questions in relation to what operates under farmers' conditions and he must also take into account the production parameters in defining the type of data to be collected.

An example was also given of efforts being made to introduce pigeon pea into the maize/cassava cropping system of the humid forests of Nigeria. The choice of pigeon pea was justified by its rapid growth, and its ability to survive heavy pruning to avoid competition with cassava after the maize harvest and production of grains. Because of the lack of adequate information on the behaviour of pigeon pea under this type of cropping system, an on-station trial was conducted to define the appropriate technology to be tested under farmers' conditions.

From the discussions it was obvious, that after production constraints under farmers' conditions had been identified, it was necessary to ensure the success of the technology in the recommendation domain before experimenting in farmers' fields. On-station research is an important phase before going on-farm.

3.2 On-farm Experimentation

On-farm experimentation requires a multidisciplinary team to diagnose the problems and an interdisciplinary team for work in the field.

Agricultural experimentation under farmers' conditions relies on:

a. a rapid diagnosis to determine the major constraints of the area. Diagnosis is a continuous process and is needed throughout the experimentation period
b. choice of representative testing sites, geographically accessible, where production constraints to be addressed are common to a specified agro-ecology and/or a recommendation domain
c. choice of appropriate technologies in liaison with the farmers' needs and requirements
d. establishment of trials by the farmer, using a simple and comprehensive protocol. Experimental design must be appropriate. The number of farmers for the replications must not be less than 30
e. frequent visits to trials and nearby farmers' fields must be carried out. Field technicians and the scientist in charge of on-farm testing must interact frequently with the farmers to gather their reaction and opinion about the technology
f. an evaluation of the first harvest by the farmer and his impression should be recorded in the observation sheet
g. a rapid consultation on the observations made by the farmers will permit the scientist to make a pre-evaluation synthesis
h. group discussions with the farmers will permit an effective evaluation of the trials in order to draw up a conclusion. The evaluation period should not be too distant from harvest time, so that the farmers can still keep the expected results in mind
i. promising technologies should be passed on to pre-extension services and then extended on a large scale. In case of any inadequacy in the performance of the technology, a re-adjustment should be carried out at the station

During the discussion, it became obvious that active participation of farmers can only be guaranteed if they discover that the efforts being made are intended to solve their production problems. Encouragement to farmers should be limited to the supply of agricultural inputs.

3.3 Technology Transfer

The Accelerated Crop Production Officer (ACPO) Program was used as a case study. Its roles and objectives were:

a. to develop a multilocational trial network
b. establish direct liaison between research stations and farmers' conditions
c. develop a mechanism for transfer of technologies to farmers

After 8-10 years of this activity, SAFGRAD learnt the following:

i. that even though improved agronomic practices are known to benefit yield, emphasis was laid on varietal evaluation
ii. farmers in the semi-arid zone practise low-input agriculture
iii. technology transfer is a difficult and long-term process which requires resources
iv. in order to obtain a rapid feedback from farmers to researchers, it is necessary to involve farmers as early as possible in the experimentation process

The lessons have permitted SAFGRAD to change its strategy in order to help scientists work under the farmers' real conditions and in direct collaboration with them and with extension workers for the enhancement of an effective feedback system.

The principal tool used in technology transfer is agricultural demonstration involving producers of agricultural products and all workers concerned with the agricultural development process.

There are two kinds of demonstration techniques:

- agronomic research field day carried out at the research station
- on-farm demonstration (either production package or diamond type demonstration)

This type of demonstration is carried out under the supervision of a scientist in collaboration with the extension workers.

It became clear from the discussions that many factors hamper the activities of agronomists. Among them are:

- lack of training and information
- lack of adequate working infrastructures
- lack of adequate financial support
- research stations are sometimes badly situated and poorly managed or maintained

PART IV

RECOMMENDATIONS

4. Recommendations

The following recommendations were drawn up arising from issues in the presentations and discussions.

a. In view of SAFGRAD's determination to improve food grain production and productivity in the sub-region, it is strongly recommended that agronomists should be more involved in its activities.

b. Since agronomists serve as a pivot for technology generation and verification both on-station and on-farm, researchers and policy makers should allow agronomists to lead the interdisciplinary research team in order to make it more possible for them to address the real constraints of farmers. This would ensure the generation and verification of relevant technologies for adoption.

c. More research agronomists should be trained to improve the research capability of National Agricultural Research System (NARS) scientists.

d. In view of the poor research infrastructure in the sub-region, it is recommended that governments should commit more funds to research. SAFGRAD should play a catalystic role in sensitizing policy makers to the importance of research in the attainment of sustained food self sufficiency.

e. It is recognized that research should be further intensified in the following areas:

- on-farm experimentation
- maintenance of soil fertility
- water conservation
- effective utilization of rock phosphate
- breeding crops for stress resistance

f. The agronomy seminar was identified as being of immense significance, particularly in bringing together practitioners from the sub-region to update their knowledge on the constraints of farmers and agronomists in the mandate area. The need to hold such a seminar frequently is strongly recommended.

References

Sanchez, P.A. and J. G. Salinas. 1981. Low-input technology for managing oxisols and ultisols in tropical America. *Advances in Agronomy* 34:279-406.

Muleba, N. 1988. Responses of cowpea to high soil temperature and drought, pp 331-349. In: *Food Grain Production in Semi-arid Africa.* J. M. Menyonga, T. Bezuneh & A. Youdeowei, eds. Proceedings of an international drought symposium. Redwood Burn Ltd. Trowbridge, U.K. OAU/STRC-SAFGRAD.

ANNEXES

ANNEX I List of Resource Persons

Bationo, A.	Soil Scientist	IFDC/ICRISAT BP 12404 I.S.C., Niamey Niger
Bezuneh, T.	Physiologist	OAU/SAFGRAD Ouagadougou
Dembele, B.	Weed Scientist	IER/DRA/SRCVO BP 438, Bamako Mali
Emechebe, A. M.	Pathologist	Dept. of Crop Protection, Faculty of Agric., Institute for Agricultural Research, Ahmadu Bello University PMB 1044, Zaria Nigeria
Hulugalle, N.	Soil Scientist	Humid Forest Zone Station, BP 2008 Messa, Yaounde Cameroon
Fajemisin, J. M.	Pathologist and Breeder	IITA/SAFGRAD 01 BP 1495 Ouagadougou 01 Burkina Faso
Muleba, N.	Agronomist, Breeder and Pathologist	IITA/SAFGRAD 01 BP 1495 Ouagadougou 01 Burkina Faso

List of Resource Persons (cont'd)

Prudencio, Y. C.	Agric. Economist	IITA (RCMP) PMB 5320, Ibadan Nigeria
Ratnadass, A.	Entomologist	ICRISAT/CIRAD BP 320, Bamako Mali
Sorgho, M. C.	Sociologist	INERA/Kamboinse 03 BP 7192 Ouagadougou 03 Burkina Faso
Suh, J. B.	Entomologist	ICP/IITA PMB 5320 Ibadan, Nigeria
Thomas, M.	Pathologist	ICRISAT, BP 320 Bamako, Mali
Versteeg, M. N.	Agronomist	IITA/Benin Res. Station BP 06-2523 Cotonou, Benin
Williams J.H.	Physiologist	ICRISAT BP 12404 Niamey, Niger

ANNEX 2 List of Participants

Country	Name of Participant	Address
BENIN	1. M. Amidou	Station de recherches sur les cultures vivrieres d'Ina, BP 03, N'Dali
	2. M. Adomou	"
BURKINA FASO	3. Hien Victor	INERA, 03 BF 7192, Ouagadougou 03
	4. Lompo Francois	"
CAMEROON	5. Ebete Anatole	IRA/MESIRES, Box 415 Garoua
	6. Ngoumou Nga Titus	"
CENTRAL AFRICAN REPUBLIC	7. Yandia Abel	Entomologist, Direction de la Recherche SOCADA, BP 997 Bangui
GHANA	8. L.O. Tetebo	CRI, NAES, Box 52, Tamale
	9. Patterson Osei Bonsu	Crops Research Institute Box 3785, Kumasi
GUINEA CONAKRY	10. Ibrahima Bah	CRA Kilisssi BP 163 Kindia
MALI	11. N'dri Coulibaly	IER/SRCVO, BP. 438, BAMAKO
	12. Diakalia Sogodogo	"
MAURITANIA	13. Sidi R'Chid	CNRADA, BP 22, Kaedi
NIGER	14. Cherif Ari Oumarou	INRAN, BP 429, Niamey
NIGERIA	15. O. O. Olufajo	IAR/ABU, PMB 1044, Zaria, Nigeria
	16. K. A. Elemo	"

List of Participants (cont'd)

Country	Name of Participant	Address
NIGERIA	17. A. Y. Akintunde	Nat. Rice/Maize Centre PMB 5042, Moor Plantation, Ibadan
SENEGAL	18. Sene Manievel	ISRA-CNRA, BP 53, Bambey
	19. Saliou Diangar	"
TCHAD	20. Gaye Sena Yassine	StationExperimentale de Gassi, BP 101, N' Djamena

ANNEX 3

1. The Seminar Organization

The seminar was organized in three sessions as follows:

Session 1: General Factors Affecting Crop Productivity
Session 2: Low-input Technology Strategy
Session 3: Agricultural Experimentation and Technology Transfer

There was an overall chairman for the seminar and a chairman and two rapporteurs for each session.
Overall chairman: Dr. O.O. Olufajo

Session 1

Chairman: Mr. Sherif Ari
Rapporteurs: Mr. L. O. Tetebo
Mr. M. Sene

Topics

Identification of Farmers' Needs
Crop Production Constraints
Methodology for On-farm Technology Transfer

Session 2 Part 1

Chairman: Dr. V. Hien
Rapporteurs: Mr. T. Ngoumou
Mr. M. Amidou

Topics

Concept of Low Input Technology Strategy
Selection of Germplasm Resistant and Tolerant to Environmental Constraints
Soil Conservation Measures

Session 2 Part 2

Chairman: Mr. F. Lompo
Rapporteurs: Mr. P. O. Bonsu
Mr. N. Coulibaly

Topics

Management of Soil Acidity
Phosphorus Management
Nitrogen Management
Management of Low Native Soil Fertility
Integrated Crop Management

Session 3

Chairman: Dr. K. A. Elemo
Rapporteurs: Mr. M. Adomou
Mr. D. Sogodogo

Topics

On-farm Research
On-farm Experimentation
Technology Transfer

During the seminar, the chairman of the session introduced the different speakers making sure that the presentations were made within the time limit and that the topic was thoroughly covered. If any aspect was missing he requested the speaker to briefly cover it during discussion time. He also presided over the discussions and the writing of the sessions' reports.

2. The Seminar Collective Output

The overall chairman of the seminar presided over the writing of the seminar's brief report. He was assisted by the chairmen of the various sessions and other participants.

3. The Seminar Work Program

SUNDAY 6 JANUARY 1991
Arrival of participants

MONDAY 7 JANUARY 1991

- Registration (Training Bldg Rm #2)
- Opening ceremony
- Welcome address by IITA Director of Training
- Opening remarks by Deputy Director-General, International Cooperation, IITA
- Group photograph
- Introduction to the seminar by **Dr. N. Muleba**

SESSION I: GENERAL FACTORS AFFECTING CROP PRODUCTION

Peasant farmers' needs and requirements
Mrs. M.C. Sorgho
Factors affecting crop production: General aspects
Dr. N. Muleba

TUESDAY 8 JANUARY 1991
Factors affecting crop production (cont'd)
Rainfall characteristics **Dr. N. Muleba**
Biological constraints of some major food crops in West and Central Africa
Insect pests, diseases and parasitic weeds of sorghum
Dr. M. D. Thomas
Dr. B. Dembele
Dr. A. Ratnadass

WEDNESDAY 9 JANUARY 1991
Biological constraints of some major food crops in West and Central Africa (cont'd)
Major insects, diseases and parasitic weeds of maize
Dr. J. M. Fajemisin
Major diseases and parasitic weeds of cowpea **Prof. A. M. Emechebe**
Insect pests of cowpea **Dr. J. B. Suh**

Development of technologies relevant to farmers' conditions
Dr. Y. C. Prudencio

SESSION II: LOW INPUT TECHNOLOGY STRATEGY

THURSDAY 10 JANUARY 1991
Concept of low input technology strategy **Dr. N. Muleba**

Selection of germplasm resistant or tolerant to environmental constraints

cowpea	**Dr. N. Muleba**
maize	**Dr. J. M. Fajemisin**
sorghum	**Dr. J. Williams**
millet	**Dr. J. Williams**

FRIDAY 11 JANUARY 1991

Selected country reports on maize, cowpea, sorghum and millet germplasm resistant or tolerant to environmental constraints.

Burkina Faso	**Mr. F. Lompo**
Niger	**Mr. Ari Sherif**
Nigeria	**Dr. O.O. Olufajo**
Cameroon	**Mr. T. Ngoumou**
Mali	**Mr. N. Coulibaly**
Senegal	**Mr. Saliou Diangar**

Discussion on maize, cowpea, sorguhm and millet germplasm resistant or tolerant to environmental constraints.

Soil conservation measures

Soils of West and Central Africa:

Prototype management systems for upland soils of the West African semi-arid tropics. **Dr. N. Hulugalle**

Soil conservation measures (field work and discussion) **Dr. N. Hulugalle**

SATURDAY 12 JANUARY 1991 VISIT IBADAN

MONDAY 14 JANUARY 1991

Selected country reports on soil conservation measures:

Burkina Faso	**Mr. F. Lompo**
Niger	**Mr. Ari Sherif**

Management of soil acidity **Dr. A. Bationo**

Phosphorus Management **Dr. A. Bationo**

TUESDAY 15 JANUARY 1991

Selected country reports on phosphorus management:

Burkina Faso	**Dr. Victor Hien**
Mali	**Mr. N. Coulibaly**
Senegal	**Mr. Manievel Sene**

Discussion on management of soil acidity and phosphorus.

Nitrogen management

Maximum use of biological nitrogen fixation **Dr. K. Mulongoy**

Cereal-grain legume intercropping and legume-cereal rotation **Dr. A Bationo**

Management of low native soil fertility (N, K, S, Ca, Mg, Zn, Cu) **Dr. A. Bationo**

WEDNESDAY 16 JANUARY 1991

Selected country reports on management of low native soil fertility

Nigeria	**Dr. K.A. Elemo**
Mali	**Mr. D. Sogodogo**

Discussion on management of low native soil fertility

Integrated Crop Management **Dr. N. Muleba**

SESSION III: AGRICULTURAL EXPERIMENTATION AND TECHNOLOGY TRANSFER

Technology development

Experimentation on-station (zonal) **Dr. H. Mutsaers**

Multilocation testing on-station (sub-zonal) **Dr. G. Weber**

THURSDAY 17 JANUARY 1991

Verificative research:

Research-managed on-farm testing
Farmer-managed on-farm testing
Analysis of data from on-farm testing

Dr. M. N. Versteeg

Technology Transfer
ACPO case study — **Dr. T. Bezuneh**
Technology transfer (cont'd) — **Dr. N. Muleba**

Drafting of seminar report

FRIDAY 18 JANUARY 1991

Drafting of seminar report
Luncheon and closing ceremony
Summary of report by Rapportuer
Vote of thanks

Closing remarks — **Director, IITA Training Program**
Deputy Director General, IITA/ICP
International Coordinator, SAFGRAD

SUNDAY 19 JANUARY 1991

Departure

Annexe 4

ABBREVIATIONS

CARDER	Centre d'Action Régionale pour le Développement Rural (Regional Action Centre for Rural Development)
CRPA	Centre Régional de Promotion Agropastorale (Regional Centre for the Promotion of Agropastoral Farming)
HYV	high yielding varieties
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
IITA	International Institute of Tropical Agriculture
INERA	Institut d'Etudes et de Recherches Agricoles (Institute of Agricultural Study and Research)
INRAN	Institut National de Recherches Agronomiques du Niger National Agricultural Research Institute of the Niger
NARS	National Agricultural Research Systems
OAU/STRC	Organisation of African Unity/Scientific and Technical Research Commission
PAPEM	Points d'Appui à la Prévulgarisation et l'Experimentation Multilocale (Support Points for Pre-extension and Multilocational Experimentation)
RENACO	Réseau Niébé de l'Afrique Centrale et Occidentale (Cowpea Network for Central and West Africa)
SAFGRAD	Semi-Arid Food Grains Research and Development
Six S	Savoir se Servir de la Saison Sèche en Savane et au Sahel (know how to make use of the dry season in the Savanna and the Sahel)
USAID	United States Agency for International Development

1991

SHAPING AGRONOMIC RESEARCH IN WEST AND CENTRAL AFRICA

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