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S A F G R A D

OAU STRC JP - 31

Semi Arid Food Grain
Research and Development



ORGANIZATION OF AFRICAN UNITY

SCIENTIFIC TECHNICAL AND RESEARCH COMMISSION

JOINT PROJECT-31

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ITS ROLE IN

S A F G R A D

Revised Paper presented by Dr. V. L. Asnani, Project Leader, IITA/SAFGRAD, at Consultation meeting with National, Regional and International Organisations operating in the member states of CILSS held at Ouagadougou, Upper Volta from December 10-15, 1980.

P R E F A C E

Several people representing many organisations interested in agricultural research and development visit Kamboinse and often like to know more about us and our work. This "hand-out" is primarily meant for such visitors. It attempts to briefly outline involvement of IITA scientists in trying to accomplish the objectives of maize and cowpea research and development in the SAFGRAD project.

Additional information may be obtained by writing to the International Co-ordinator, OAU/STRC JP - 31 or to the Project Leader, IITA/SAFGRAD B.P. 1783, OUAGADOUGOU, Upper Volta.

Ouagadougou
April 15, 1981.

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THE SEMI-ARID TROPICS OF AFRICA
A CHALLENGE FOR INCREASING FOOD PRODUCTION

The tropics is the largest underdeveloped region to which the world may look for increased food production. But in the semi-arid tropical regions, where the soil is often low in fertility and difficult to cultivate, the rainfall is low, erratic and highly seasonal, and the socio-economic resources are very much limited, increasing the production of food truly poses a great challenge.

INTERNATIONAL NETWORK-IITA

To help bring about a more equal balance in the food-population race, the Ford Foundation and the Rockefeller Foundation, in cooperation with the Government of Nigeria launched the International Institute of Tropical Agriculture (IITA) in Africa in 1967, and established it in Ibadan. It is one of nine major links in an International Network of Agricultural Research and Training Centers. Additional International Centers have been established with financial support from several organisations. In 1971, the Consultative Group on International Agricultural Research was formed which now coordinates the major financing of all these centers.

It is recognised that there are several constraints which farmers face to increase food production in tropics. Finding remedies to these constraints is the driving force behind the IITA's objectives which are :

1. To increase yields and improve the quality of food crops in the humid and sub-humid tropics through every available means, especially, the development of high yielding and insect and disease resistant varieties.
2. To distribute improved plant materials to national research centers where they can be of value to breeding or improvement programs.
3. To develop soil and crop management practices and farming systems for small farmers that will make possible a stable, permanent and productive agriculture.

4. To strengthen the capacity of developing countries through intensive training programs so that they will be able to solve their food production problems with their own expertise.
5. To publish and disseminate research findings to agricultural scientists throughout the world, to policy makers and to extension workers in national programs and, through them, to farmers.
6. Operate an information center and library with a collection of the world's literature on tropical agriculture in both English and French for the use of scientists and scholars.
7. Organise and conduct conferences, forums and seminars which review new research, consider current problems and discuss needs for the future.

Within the international net work, IITA has major world responsibility for :

1. Cowpea
2. Yams
- and
3. Sweet Potato

IITA has also the regional continental responsibilities within tropical and subtropical Africa for four crops namely :

1. Cassava
2. Maize
3. Rice
- and
4. Soybean

Three out of four of IITA's principal core programs are crop centered viz. Cereal Improvement, Grain Legume Improvement and Root and Tuber Improvement. The fourth, and heart of the total effort, is the Farming Systems program.

In addition to core programs IITA also has formal cooperative contracts and agreements with several nations and scientific organizations. Such cooperative programs are designed to help strengthen national research capabilities, to present opportunities for testing crop lines under different ecological conditions and to provide feedback on research problems. In addition to having staff members actually located in some countries, scientists at Ibadan headquarters are frequently involved in the cooperative programs. These programs are the vitally important outreach component, basic to the international character of the institute and become the link between research and reality.

In 1979-80, IITA's outreach programs in Africa are based in :

1. Cameroon,
2. Nigeria,
3. Sierra Leone,
4. Tanzania,
5. Zaire,
6. Ghana and
7. Upper Volta.

One of such cooperative programs in which IITA is a partner and on which it places great importance, is the SAFGRAD program which is based at Ouagadougou, Upper Volta.

SEMI-ARID FOOD GRAIN RESEARCH AND DEVELOPMENT PROJECT (SAFGRAD)

SAFGRAD also known as Joint Project-31 (JP 31) is a project of the Scientific and Technical Research Commission of the Organisation of African Unity (OAU/STRC) and is a multi-donor project. At present the major funding is provided by the USAID. The main theme of the project is to organize research and development efforts in the semi-arid tropics of Africa for three cereal crop-maize, sorghum and millet and two grain legumes -cowpea and groundnuts. IITA through a contract with USAID has taken up the responsibility to undertake and coordinate regional research and training activities for maize and cowpeas in this project.

Similarly, under a separate contract with USAID, the ICRISAT provides the necessary technical support for work on sorghum, millet and groundnuts. The third component of SAFGRAD research involves the work on Farming Systems for which University of Purdue (U.S.A.) provides the technical support also under a contract with USAID.

The headquarter for the maize and cowpea and farming systems portions of the project have been established at Ouagadougou, Upper Volta. IITA has placed four of its research scientists viz. Maize Breeder and project leader, Maize Agronomist, Soil Fertility Specialist (Cowpea Agronomist) and Entomologist to carry out the maize and cowpea components of the SAFGRAD project. In addition to these four positions, IITA has also placed one Cowpea Breeder in Upper Volta, under a separate bilateral contract with the Government of Upper Volta and IDRC-Canada to develop a national cowpea program. The cowpea breeder in this project provides the cowpea breeding support to the SAFGRAD project. All IITA scientists assigned to these projects are based at the National Agricultural Research Station at Kamboinse, about 15 km from Ouagadougou, which serves as the headquarter for IITA/SAFGRAD efforts.

OAU/STRC JP-31 also maintains a coordinating office which is located in Ouagadougou. The International Coordinator of OAU/STRC, the agricultural SAFGRAD liaison officer of USAID and their support staff are based here.

In addition to research components contracted to IITA, ICRISAT and University of Purdue, the SAFGRAD project also has placed production agronomists, known as Accelerated Crop Production Officers (ACPO) in several of SAFGRAD member countries. They provide the links between the SAFGRAD headquarter scientists and the national scientists on the one hand and between the research and extension agencies in a given country on the other hand. Financing for ACPOs is provided by several donors including USAID, FAC, FAD and ODI. At present, there are 25 countries who are members of SAFGRAD project and participate in its research and development activities.

SAFGRAD-LIWA EFFORTS

Under the auspices of OAU/STRC SAFGRAD JP-31 project, IITA has a contractual agreement with USAID to organise and coordinate the research, production and training activities on maize and cowpeas in the semi-arid tropics in Africa.

A strategy of team approach has been adopted and the five IITA scientists based at Kamboinse work as members of two teams : (1) A maize team -consisting of a breeder, an agronomist and an entomologist (30 %) and (2) a cowpea team -consisting also of a breeder, an agronomist and entomologist (70 %).

The overall objectives of the program are :

1. To assist and strengthen the national maize and cowpea improvement programs in the SAFGRAD member countries.
2. To develop improved genetic materials and improved agronomic practices capable of producing greater economic yield.
3. To organise a systematic testing and exchange of improved genetic materials and other improved technology among the SAFGRAD member countries.
4. To assist in man power development by arranging various types of training activities for national researchers and technicians.

The SAFGRAD/IITA team has been on site since May 1979 and the IDRC funded IITA cowpea breeder has been in Upper Volta since 1977.

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To fulfill the overall objectives enumerated above four major areas of work have been defined :

- A. Resident Research activity in Upper Volta at various experiment stations representing different ecological conditions of the semi-arid tropics.
- B. Regional Research and Production program in cooperation with the national programs of SAFGRAD member countries.
- C. Support and assistance to national maize and cowpea programs.
- D. Training

The Resident Research Program for maize is carried out at three locations -Kamboinse, Saria and Farako-Bâ, representing rainfall zones from 700 to 1100 mm rainfall. The cowpea research activities are carried out at the same three research stations and, in addition, at Gorom-Gorom, representing the 400 mm rainfall zone. The research programs in Upper Volta are conducted in collaboration with the national research workers of the Ministry of Rural Development, Govt. of Upper Volta. One Ingenior Agronom and one Technician from Govt. of Upper Volta have been assigned to work with the maize team and one Technician works with the cowpea team. Shortly, a national cowpea breeder will also be assigned to work with the IITA research team at Kamboinse.

Administrative and technical back-stopping is provided by IITA headquarter staff at Ibadan.

The actual work of the IITA/SAFGRAD project started in 1979. The immediate task was to develop the research facilities at Kamboinse. Seven hectares of land were cleared and developed in 1979 and another ten hectares has been acquired. A cold store for seed, two work sheds, a training laboratory, a screen house and an entomology laboratory (IDRC funded) have been developed.

A. RESIDENT RESEARCH

COMPEA :

In cowpea breeding program the emphasis is on :

1. Development of high yielding early maturing varieties for three ecological zones of the semi-arid tropics, viz. less than 500 mm rainfall, 500-800 mm and 800-1100 mm rainfall.
2. Improvement of local photosensitive varieties for the semi-arid tropics.

3. Incorporation of insect resistance into promising varieties.
4. Breeding for drought resistance
5. Improvement of the seed quality and acceptability of promising lines.

The cowpea entomology program works in collaboration with the breeding program to incorporate resistance to major insects into other-wise promising varieties. In addition, major areas of entomological research are :

1. To develop screening methodology for identifying tolerance to major cowpea insects.
2. Estimation of losses caused by major insect pests of cowpea.
3. Studies on population dynamics and seasonal abundances of 3 important insects viz. thrips, Haruca and pod bugs.
4. Studies on economic thresh-hold for thrips and Haruca and to develop suitable integrated pest management systems including minimum application of insecticides and other agronomic practices.
5. Comparison of synthetic pyrethroids with other commonly used insecticides.

Cowpea agronomic studies are designed to develop management practices for maximum economic yield of cowpeas in the semi-arid tropics.

Objectives of the work, presently underway, can be summarised as follows :

1. To determine factors limiting growth and yield of cowpea in the semi-arid zone.
2. To determine the response to various management factors (time of planting, soil fertility, density, land preparation, choice of soil, etc.) over the range of environments of the semi-arid zone.
3. To investigate management factors in a maize-cowpea relay cropping system for the Guinea Savanna.
4. To look for ways to improve cowpea yields in sorghum and millet inter-cropping for the Sudan and Sahel Savanna.
5. To study the characteristics of photoperiod sensitive cultivars and to determine their response to management factors.

MAIZE

The maize breeding program concentrates on :

1. Collection, evaluation and improvement of local varieties of maize in semi-arid areas.

2. *Breeding for high stable yield and wide adaptation.*
3. *Breeding for better plant type and high harvest index utilising Temperate x Tropical germplasm.*
4. *Development and improvement of early maturing populations.*
5. *Selection for drought resistance.*
6. *Development of maize populations tolerant to important diseases and insects of maize.*

Maize Agronomy work is oriented to understand and evaluate the relative importance of various soils, climatic and cultural factors limiting maize production in semi-arid tropics. Major objectives of the research program are to :

1. *Develop cultural practices which will reduce soil compaction, conserve soil moisture and maximise soil water utilisation.*
2. *Determine the potential of new improved varieties by manipulating various agronomic practices for low and medium level technology.*
3. *Study the role of various rotations with leguminous crops in increasing the production of maize.*
4. *Study and develop better crop residue management systems.*
5. *Participate in the selection program for developing drought resistant populations.*

It has been observed that insect pests are generally not a major problem in maize in the semi-arid tropics. Therefore, the entomologist spends only 25-30 % of his time on maize entomology and concentrates mainly on cowpea entomology research. For the maize entomology program, the major objectives are to :

1. *Develop integrated pest management systems for reducing yield losses due to insects.*

B. REGIONAL PROGRAM

Great importance is given to the regional program. It is carried out in partnership with the national research programs. Each year, a SAFGRAD maize and cowpea workshop is conducted in which researchers from member countries are invited to participate in a review of the results obtained during the past season and in the formulation of the next years regional research activities.

This regional activity has now been carried out for two years and has proved to be useful in accomplishing the following :

1. Providing elite maize and cowpea germplasm to research workers in the semi-arid region for testing and use in their national programs.
2. Providing national scientists an opportunity to have their elite materials systematically evaluated over a wide range of environments.
3. Developing varieties possessing tolerance to common problems in the semi-arid areas for wider adaptability and stability.
4. Evaluating variation in diseases and insect pests of maize and cowpeas and finding solutions to these problems.
5. Evaluating and developing cultural practices to overcome agronomic production constraints common in the semi-arid region.

In 1980, the following trials constituted the IITA/SAFGRAD regional program :

MAIZE BREEDING :

1. Regional Uniform Variety Trial-1 (RUVT-1) consisting of 11 early maturing varieties contributed by six national or international programs. 23 sets of this trial were sent out to 14 different countries.
2. Regional Uniform Variety Trial-2 (RUVT-2) consisting of 11 medium maturing varieties contributed by seven national or international programs. 24 sets of this trial were sent out to 13 different national programs.
3. Regional Full-sib Family Testing Trial-1 (RFTT-1) consisting of 140 full-sib families of early maturing population (TSE4) sent to four national programs.
4. Regional Full-sib Family Testing Trial-2 (RFTT-2) consisting of 140 full-sib families of early maturing population (TZE3) sent to four national programs.
5. Regional Full-sib Family Testing Trial-3 (RFTT-3) consisting of 140 full-sib families of medium maturing population (TZPB) sent to four national programs.
6. Regional Full-sib Family Testing Trial-4 (RFTT-4) consisting of 140 full-sib families of medium maturing streak resistant population (TZSR) sent to four national programs.

For four RFTT trials, the full-sibs are generated in four populations at Kamboinse and the selected full-sibs are recombined. A new set of full-sibs are developed during the dry season at Kamboinse.

COWPEA BREEDING :

1. Regional Cowpea Variety Trial (SRCVT-1) consisting of 20 entries contributed by seven national or international programs. 23 sets of this trial were sent to 13 SAFGRAD countries.

COWPEA AGRONOMY :

1. Cowpea Management Trial-1 (soil fertility) sent to ten locations in five countries.
2. Cowpea Management Trial-2 (planting date) sent to 13 locations in six countries.
3. Maize-Cowpea Relay Cropping Trial sent to 10 locations in five countries.

ENTOMOLOGY :

1. Survey trial for the insect pests of maize, eight trials sent to 8 countries.
2. Cowpea minimum insecticide trial including ten varieties. Nine sets of trial sent to 8 national programs.
3. Standardization of sampling procedures for cowpea pests ; nine sets of this trial were sent to six different national programs.

In the regional activity, IITA/SAFGRAD team organises and coordinates these trials. The trials are put-up, protocols and data sheets prepared and the trials sent out to the various national programs interested in conducting them. After the crop season, one copy of results is returned and the results are analyzed. The results are compiled and a report is prepared which is sent to all member countries for their information and use in their national programs.

MONITORING VISITS :

To monitor the regional trials and also to provide an opportunity for national researchers to evaluate the performance of various materials and techniques in different countries, a group visit of 6-8 national scientists is organized to visit 6-8 national programs during the crop season.

In 1980, 7 cowpea researchers were invited to visit the national programs in 5 countries. Likewise, 6 national maize researchers from 6 member countries were invited to visit six national programs. These visits provide an excellent opportunity for national scientists to exchange ideas and information in the field.

C. SUPPORT TO NATIONAL MAIZE AND COWPEA PROGRAMS

It involves the following :

- a) Resident research is focused on common problems generally found in the semi-arid region. The program is decided in collaboration with national scientists in the annual SAFGRAD workshop.
- b) Frequent visits to national programs and discussion on existing activities with Directors of Agricultural Research and scientists in various countries.
- c) Provide technical advice to assist the national programs.
- d) Assist in identifying the elite germplasm and to motivate the young national scientists.
- e) Provide assistance in terms of some modest logistic support.
- f) Provide an opportunity for exchange of ideas, results and other facilities among the member countries.
- g) Assist in identifying areas in which national programs need strengthening their technical man-power capabilities.
- h) Through SAFGRAD ACPO's based in different countries, maintain a close link among SAFGRAD scientists, researchers and national extension agencies for transfer of technology in the member countries.

D. TRAINING

Training is one of the important objectives of the SAFGRAD Program. To increase the technical competence of various national programs different types of training are organized for national scientists. Important types of training being offered are :

1. Formal maize production and cowpea production training courses at IITA Ibadan, Nigeria for research technicians and extension leader. These

- courses are for one to three months duration and involve class room instruction and field experience. In 1980, about 25 persons participated in the maize training course, and 20 completed the cowpea course.
2. Degree related training for the national maize and cowpea researchers. The selected candidates are sent to various universities in Africa, U.S.A., Canada or Europe for B. Sc., M. Sc. and Ph. D degree programs. Whenever possible, arrangements are made for them to complete their thesis research either at IITA, at SAFGRAD headquarter at Kamboinse, or at some university in Africa.
 3. Sabbatical leave research. An opportunity is provided to senior national scientists to gain additional research experience at Kamboinse and at the same time to contribute to the SAFGRAD program, by arranging with them to spend their sabbatical leave (10-12 months) at the SAFGRAD headquarters.
 4. Thesis research. An opportunity is also provided to students for M. Sc. degrees from various universities in Africa to conduct their thesis research at the research station at Kamboinse.
 5. On the job training. Young research technicians can obtain practical field experience in research methodology by spending about six months at Kamboinse where, as part of the IITA/SAFGRAD team, they work closely with one of the research scientists and participate in all field operations. Four technicians participated in this training in 1980 season.

For these training facilities the SAFGRAD program provides the scholarships and other logistic support to the candidates who are nominated by their national Governments.

MAJOR RESEARCH RESULTS

The IITA/SAFGRAD program has completed only two crop seasons so far, and it should be recognised that it is a very short period to list major research accomplishments. In addition, the results obtained will need further confirmation in a wider range of environments. However, the major results obtained so far, are summarised below. It should be emphasised that these results have been obtained through a joint effort of IITA/SAFGRAD scientists and cooperators in various national programs :

MAIZE PROGRAM :

1. Over the last two years, the promising varieties which already exist and were developed by national or international institutions have been systematically tested across the semi-arid zone of tropical Africa. This effort provided the needed vehicle for exchange of genetic material particularly between English and French speaking countries.
2. Through this regional testing, it has been found that BDS III and Pool-16 are two promising early maturing varieties of maize which have performed very well in several SAFGRAL member countries. Similarly, among the medium maturing varieties IRAT-81 and TEPB have shown good promise in different countries.
3. In several countries, new varieties yielding 15 to 20 % more than the local varieties have been identified. The national programs are being encouraged to have these varieties tested in on-farm trials and, if found suitable, to launch a production program with them.
4. Two cycles of recurrent selection to combine yield and early maturity have been accomplished and the better varieties from improved populations are now in the pipe line.
5. Other medium maturing promising populations which have been developed or identified are : Phil. DMR Comp., Hungarian Composite and BIU Yellow.
6. It has been demonstrated that for the semi-arid tropics the Temperate and Temperate X Tropical germplasm holds great promise. Several populations of this origin have been obtained from various sources for further selection and breeding efforts.

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7. Yield increases of about 50 % (15 to 300 %) have been obtained by the tying of ridges. The proportion of ridges to be tied and the timing of tying operation are a function of crop position on the toposequence and rainfall distribution pattern.
8. Plowing with oxen or tractor has given higher yields than either the farmers conventional hand-hoe cultivation or zero-tillage.
9. In the absence of weeds, cultivation, with the sole purpose of breaking the soil can increase yields by up to 50 %.
10. Yield increases of 50 to 100 % have been obtained using crop residues as mulch.
11. Substantial higher maize yields were obtained from maize planted after cowpeas than from maize planted after maize even under high fertility levels.
12. Except in a few countries where maize borers are important, termites and millipedes seem to be the two most important insect pests of maize in the semi-arid regions.
13. Soil application of appropriate insecticides can substantially reduce the damage caused by the two insects.

COWPEA PROGRAM

1. For the areas with the rainfall of 700 mm or more, at least one promising variety, namely KN-1 (TVx 289-4G) has been identified. In the SAFGRAD regional cowpea variety trial initiated in 1980, KN-1 and Kpodigueue have been identified as promising varieties in several countries.
2. In the drier areas, a local variety, called Gorom-Gorom local, has consistently given good performance in comparison with other varieties.
3. Substantial progress has been made in incorporating bruchid resistance in high yielding varieties.
4. Efforts have been made to improve the seed quality (size and color) of the high yielding varieties.
5. Good progress has been made in screening the cowpea germplasm for adaptation to moisture stress.
6. TVx 1193-7D, TVx 309-1G, TVx 1999-01F, TVx 1999-02E are promising lines in the pipe line.

7. The response of cowpeas to various management factors has been studied and salient findings are :
 - a) Time of planting. Optimum time of planting appears to be 2 1/2 months before the end of the rains.
 - b) Soil fertility. Phosphorus deficiency has been shown to be a common factor limiting yield. Moderate rates of phosphorus application can result in yield increases of 50 % or more. The response to phosphorus has been found to differ with plant type : erect varieties giving the most pronounced and prostrate, photo-period sensitive varieties, the least.
 - c) Land preparation. Plowing with oxen or tractor has given higher yields than preparation with the conventional hand hoe.
 - d) Choice of soil. Within the same toposequence, yield differences of 300 % have been observed between upper and lower slope sites.
8. Management practices for a maize-cowpea relay cropping system are being developed. It has been shown that, in the Guinea savanna such a system can give good yields of both crops in one growing season.
9. It has been shown that among local cultivars, there are varieties which have a yield potential close to that of improved varieties and that they have certain interesting and perhaps useful characteristics. Furthermore, it has been found, that local cultivars often respond differently than improved cultivars to certain management factors. Ways of exploiting these unique characteristics and the response to various management factors are being studied.
10. It has been demonstrated that cowpea striga can result in substantial yield losses. A method for artificial infestation has been tested and results indicate that it is adequate for screening of germplasm for resistance.
11. Flower thrips, Maruca pod borer and aphids were found to be the most important insect pests in the semi-arid region. Control of flower thrips alone increased yield by 50 to 70 %.
12. Insecticide treatments at flowering stage had the maximum effect on reducing yield losses due to insects followed by treatments at the post flowering stage.
13. In a thrips screening trial, KN-1 was found to be susceptible and TVx 3236 appeared to be the most promising in terms of tolerance to thrips.

14. Synthetic pyrethroids applied at low dosages appear to be effective in controlling flower thrips and have significantly increased yields.
15. Results have indicated the presence of a new biotype of aphids at Kamboinse (designated as K biotype) as some of the cultivars resistant to biotypes A and B elsewhere were found to be susceptible at Kamboinse. TVu 36, TVu 2896 and TVu 3000 have been identified as being resistant to aphid biotype K.
16. Minimum insecticide trials indicated that, under minimum protection, TVx 3236-1-2 was a promising variety and gave higher yields than VITA-4 and VITA-5.
17. A local variety, Kamboinse local, has been shown to possess some level of tolerance to the pod borer, Maruca.

I.I.T.A. Principal Staff in Upper Volta

1. *ASNANI V. L.* *Project leader & Maize Breeder*

2. *AGGARWAL V. D.* *Cowpea Breeder*

3. *BROCKMAN F. E.* *Soil fertility Specialist
(Cowpea Agronomist)*

4. *RATHORE Y. S.* *Entomologist*

5. *RODRIGUEZ M. S.* *Maize Agronomist*