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Project Assistance Completion Report

Project Title: Semi-Arid Food Grains Research and Development II (SAFGRAD)

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Implementing Agencies: Umbrella Coordinator SAFGRAD (Organization for African Unity), Grantees: IITA, ICRISAT and OAU

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I. Purpose of Project:

To increase the efficiency and effectiveness of agricultural research and production techniques for sorghum, millet, corn and cowpeas in semi-arid Africa by strengthening special research networks for these crops; and to improve the service capacity of regional and national research institutions to assist in these efforts.

II. Background:

In response to the agricultural crisis (drought) experienced in the 1970s, and in recognition of the urgent need for a concerted regional research effort, African heads of states created the Semi-Arid Food Grain And Development (SAFGRAD) Project in 1977. It became operational two years later as an OAU/STRC-JP-31 project mainly with USAID support to reinforce and coordinate agricultural research and develop suitable farming systems for the increased productivity of major staple food crops: sorghum, millet, corn and cowpea.

The first phase of SAFGRAD resulted in the generation of technologies targeted to improve the productivity of the above-mentioned food crops. A follow-up phase, SAFGRAD II, linked regional research efforts such as those of the IARCs (IITA, CIMMYT, ICRISAT, CIRAD) to the national agricultural research systems. The development of foodgrain research networks, therefore, became central to SAFGRAD II activities.

III. Summary of Inputs and Accomplishments:

The main objective of the SAFGRAD II project was to develop functional research crop networks in Africa. At the PACD, 26 countries were members of SAFGRAD. The networks established under SAFGRAD II were the West Africa Sorghum Network, the East African Sorghum and Millet Network, the Maize Collaborative Research Network, and the Cowpea Collaborative Research Network. Along with

the networks a coordinating office was established in Ouagadougou, Burkina Faso. Network Coordination was carried out by the Organization for African Unity (OAU). Networking in the above mentioned crops was accomplished by 1) carrying out regional research trials; 2) the identification of lead centers (countries) to carry out specific research; 3) the identification of technology testing countries to test developed technologies; 4) having effective functional Steering and Oversight Committees; 5) monitoring tours; 6) workshops and 7) short-term training. The networks were linked with International Agricultural Research Centers (IITA and ICRISAT) who provided technical assistance.

Project accomplishments were over a wide area and we believe that 1) technologies developed by SAFGRAD have had and continue to have strong economic and social impact; 2) developed technologies were designed to lessen major agricultural constraints; 3) network coordination was such that there was a strong feeling of ownership of these activities by African scientists; 4) the National Agricultural Research Systems (NARS) were strengthened considerably by these activities; and 5) the networks offered an important mechanism for influencing agricultural policy on a regional and continent wide basis. A summary of SAFGRAD II accomplishments follows.

1. Network activities have had a significant economic and social impact. For illustrative purposes the impact of several of the technologies developed by different networks will be discussed.

A. Corn Network

-Early Maturing Varieties: The development of extra early and early maturing varieties has made the expansion of corn production into drier areas such as the Sudan savanna zone possible. In Burkina Faso, alone, this represents approximately 45 percent of the country's land area. Their earliness of maturity help them escape drought and make them suitable for planting in the Sudan savanna and in wetter areas when the rainy season is delayed.

Due to climatic changes, the growing season has been shortened, in some areas by as much as 15 days, the extra early corn varieties become options that the farmer can consider in place of traditional crops (sorghum and millet) in the semi-arid zones. Also, most of the available sorghum and millet varieties are late maturing and photo-sensitive as compared to extra early corn varieties which are photo-insensitive (they flower and produce seed at without regard to day length).

Extra early and early corn varieties have become very important sources of food during the hunger period (August-September), the period when grain stocks have been depleted and new crops have not yet been harvested. These varieties fill the hunger gap by providing fresh corn during this period and by increasing farmers incomes as significant quantities of fresh corn is sold on the local markets.

Extra early varieties can be harvested in about 65 days for green (fresh) corn and in 82 days for dry grain. Early varieties can be harvested in about 75 days for green corn and 90 days for dry grain. This compares with intermediate and late varieties that require 110 and 120 days, respectively for dry grain harvest.

-Streak Resistance: The development of the streak resistant variety SR 22 has meant that yield losses formally attributed to this virus disease (30-40%) have been abated. The disease is especially prevalent in years when rain is followed by 10-14 days of dry weather, alternative periods of moisture and stress is conducive to the development of the disease. In 1984 the corn crop in the southern part of Burkina Faso was lost to streak virus disease. The 1992 growing season was a good year for the development of streak. The fact that streak disease was not an important factor in reducing corn yields was due to the wide distribution of streak virus resistant varieties in the Guinea savanna zone. SR 22 is now planted in about 80 percent of the Guinea savanna zone of Burkina Faso and it has now become the local variety in many of the villages in this area.

Screening techniques for streak virus have been developed and transferred to the 2 countries in the network, Togo and Ghana, that are responsible for breeding for streak resistance.

-Row Planting: The introduction of row rather than random planting has allowed for several important changes among them: 1) an increase in plant populations per hectare; 2) the use of animal traction; and 3) efficient double cropping.

Planting of early varieties in monocropping with a population density of 66,000 plants per hectare allows for the compensation of the lower yields obtained from the early varieties to equal that of intermediate maturing varieties. The use of animal traction has allowed farmers to increase their area under cultivation and income. A farmer, that I had a chance to talk to, indicated that animal traction had allowed him to go from 7 to 11.5 hectares under cultivation, increasing his production and income. Double cropping with lower plant densities, made feasible by early maturing corn varieties, allows for the production of a second crop during the same season in the same field.

B. Cowpea Network

-Low Input Requiring Varieties: Cowpea varieties developed during SAFGRAD Phase I required large inputs of insecticides (7 to 8 spraying per year) to yield well. A new breeding approach was initiated during SAFGRAD Phase II. Cowpea lines were selected for high insect tolerance and low input requirements. This breeding approach has resulted in the development of cowpea varieties that require only 2 applications of insecticides per growing season. At the same time yields of these varieties have been maintained as per the high input requiring varieties (.7 to 1.5 metric tons per hectare).

The impact of this technology is that: 1) the farmer save a significant amount on the cost of production; 2) there is less pesticide residues in the soil; and 3) as cowpea leaves are an important component of the human and livestock diet, the reduction in pesticide application means that the danger of pesticide ingestion through the consumption of cowpea foliage is reduced.

-The Development of Widely Adapted Cultivers: Previously cowpea varieties were very limited in their are of adaptation. Photoperiod and climatic constraints were major barriers in limiting adaptability of varieties. Borrowing a page out of history which was the development of dent corn where Northern Flint types crossed with Mesoamerica soft flour types to produce dent the most productive type of corn in the world SAFGRAD breeders crossed widely diverse Northern and Southern type cowpeas. Selections from these crosses have resulted in cowpea varieties that are widely adapted, productive and highly acceptable through a wide range of ecological zones. Other desirable characteristics are being incorporated into these widely adapted crosses such as drought tolerances and insect and Striga resistances.

-Tied-Ridging: For various reasons, including soil factors such as compaction, low organic matter content and poor structure a large percentage of the rainfall in West Africa is lost as runoff(60 percent of rain falling in the Alfisols in the Sudan savanna). To retain a larger share of the rainfall tied-ridging was introduced by SAFGRAD Both donkey and oxen ridge-tying mechanical devices have been developed and made available. Tied-ridging is basically the creation of small potholes that are tied together by ridges. Water accumulates in these ridges allowing for greater infiltration of water into the soil, it also reduces soil erosion and drought stress.

C. Sorghum/Millet Networks

-Variety Development: When major sorghum production constraints were being identified several African countries listed bird damage along with the parasitic weed, Striga. Due to their tolerances to bird attacks the Ugandan varieties Seredo and Serena have become major sorghum varieties in the lowlands of Kenya and Ethiopia. ARN-39, a Sudan released Striga resistant sorghum variety is being mechanically cultivated on about 50,000 hectares. The sorghum variety S35 has been a success story in Northern Cameroon. This high yielding, non-photosensitive, short cycle duration (90 days) variety is the most widely extended variety in Northern Cameroon. It is the only main modern variety being incorporated into traditional cropping systems. Its adoption has been extended to Chad during the last four years. S35 was released through the support of the SAFGRAD project.

Since the beginning of the SAFGRAD Phase II project, the National Agricultural Research Systems (NARS) have become major sources for material for variety adaption trials. NARS contributed 73 and 53%, respectively of the early and medium sorghum advance lines and 11%

of the sorghum hybrids used in these trials.

-Industrial Utilization: Sorghum varieties were evaluated for their nutritional quality and for their suitability for industrial uses. Out of these evaluations, varieties were identified that had a higher food quality rating. In Nigeria the local variety farafara and a new variety Kat 369 in Kenya were found to be suitable for wheat-sorghum composition bread and for confectionery (cakes and pastries). In Nigeria, wheat-sorghum flour is being used in a 50 to 50 ration for bread making and 40 wheat to 60 sorghum in confectionery baking. The wheat-sorghum bread has become more popular among the low income group of people.

Sorghum varieties were identified for industrial uses such as malting quality for brewing. Varieties identified include SK5912, Gambella 1107, 5D x 160 in Nigeria, Burundi and Rwanda, respectively. The importation of barley for use in making brewer's malt has ceased in Nigeria. The brewing industry now meets its malting needs through the use of locally produced sorghum.

2. Technologies Designed to Lessen Major Agricultural Constraints:

Illustrative examples presented below show how SAFGRAD II worked to develop technologies that would lessen major agricultural constraints.

-Striga a serious parasitic weed of sorghum and millet can reduce yields by as much as 40 to 80% in farmers fields. An integrated Striga control package using tolerant varieties, agronomic practices, fertilizers and herbicides has been developed. This package is being extended to farmers in Kenya, Ethiopia and Tanzania. The Cowpea Network developed and released widely adapted, drought and Striga resistant varieties, namely, KVX402-19-1, KVX402-19-15, and KVX-398-7-1. The Corn Network developed advance Striga tolerant lines such as SYN E1 and SYN E2 which were at the advanced testing stage.

-The crop networks supported by SAFGRAD II also developed varieties which were selected for greater insect tolerance, drought resistances and drought tolerance. At PACD the Cowpea Network was working to increase insect resistance in cowpea varieties with a goal of achieving high yields without the application of pesticides. Their goal is to go from two to zero insecticide applications per year. The Corn Network continued to test varieties from national programs for streak resistance and to improve drought tolerances in early varieties. The Sorghum and Millet Networks were working on the development of varieties that are resistance to Striga, leaf anthracnose disease and head blast disease.

3. Network Coordination:

SAFGRAD II activities were coordinated to minimize the duplication of effort among member countries. The coordination of network

activities was in the shape of a triangle involving the Organization of African Unity (OAU), represented by an Oversight Committee (OC), composed of 6 National Directors of Agricultural Research or University Scientists elected by their peers during a biennial meeting of the Council of Directors of Agricultural Research. The second leg of this triangle were the National Agricultural Research Systems (NARS), represented by a Steering Committee (SC), composed of 6 active National Scientists working in the crops of the particular network (maize, cowpea, sorghum or millet), these scientists were elected by their peers during a biennial workshop. The third leg of the triangle were the International Agricultural Research Centers (IITA and ICRISAT), represented by the Network Coordinators (NC). In the case of IITA the NCs were seconded to serve the networks on a full time basis.

The Oversight Committee established the guidelines to be followed by the networks in their collaborative research efforts. The Steering Committee presided over any decision affecting network activities and the Network Coordinators implemented the decisions taken by the Steering Committee. The Network Coordinators worked closely with National Scientists from the NARS in the implementation of the decisions taken by the Steering Committee.

This triangular concept of network coordination closely involved the NARS and the OAU and as a result there was a strong feeling of African ownership of these networks.

4. Strengthening of National Agricultural Research Systems (NARS):

SAFGRAD II played a major role in strengthening NARS by: 1) identifying major production constraints for the different crops of the networks; 2) assigning research responsibilities to different NARS to overcome these constraints; 3) provided funds to carry out the research; 4) through the training of NARS scientists; and 5) by providing a means of networking and improving communications among the scientists working on the same crop.

IV. Development Impact

The report entitled the "Impact Assessment of the SAFGRAD Commodity Networks" dated January 1994 by John H. Sanders, Taye Bezuneh and Alan C. Schroeder classified project impact into four categories: 1) economic impact, 2) development and flow technology, 3) change in the human and institutional base of NARS, and 4) future prospects. A summary of these findings follows.

1. Economic Impact:

Research in Maize and cowpeas provided a substantial impact in West Africa. For example, in Ghana the area in improved maize cultivars increased from 20% in 1982 to 55% in 1991. From 1985-92, the annual social benefits from maize research ranged from $4.8 million to $84 million. The estimated internal rate of return to this investment in public research was 73%.

Maintaining yield gains or avoiding yield declines is a critical factor to consider in funding decisions in agricultural research. High social benefits were also estimated for maintenance research on cowpeas in Mali and Burkina Faso. These social benefits ranged from $800,000 to 12.3 million annually over the period 1984-91.

Farm-level diffusion of new varieties of sorghum was substantially less than for maize and cowpeas. Nevertheless, S-35 has been introduced into northern Cameroon and more recently into Chad. During seven years of diffusion in Cameroon, the estimated social benefits were as high as $288,000 for the conservative estimate and $831,000 for the optimistic scenario.

The report estimates the social benefits to research for only the three illustrative cases cited above. However, the report presents substantial documentation of diffusion of new cultivars and, to a lesser extent, of improved agronomic techniques associated with new cultivars. The most successful and best documented examples of diffusion were for maize and cowpeas. In the future it will be critical to obtain these same success levels with sorghum and millet in the semi-arid regions. The overemphasis on breeding is hypothesized to be one of the main factors explaining the lack of success of new technology introduction for sorghum and millet. Achieving gains with sorghum and millet to those of maize and cowpeas is expected to require much more applied research on integrated agronomic improvements.

The report states that most of the social benefits that consumers received resulted from lower food prices. Farmers benefitted from lower production costs. Although it is difficult to separate the contributors to these successes, the research of national and international centers clearly has had high returns in Sub-Saharan Africa. The networks have performed an important role in accelerating the diffusion of technologies as they become available. For most food crops, these impacts appear to be in the initial stages. Therefore, it is important to maintain and to accelerate the diffusion process.

V. Lessons Learned

1. The SAFGRAD Phase II Project succeeded in strengthening national agricultural research programs. It encouraged national scientists to work in multidisciplinary research teams to solve agricultural production problems.

2. SAFGRAD II promoted scientific information, scientific personnel and new technology exchanges among member countries.

3. SAFGRAD II pulled down linguistic barriers that existed between anglophone, francophone and luzophone speaking countries. National scientists in the sub-region got to know one another.

4. The training, scientific backstopping and resources that SAFGRAD provided to the NARS, enabled them to increase their

research outputs significantly, both qualitatively and quantitatively. As a result, a strong linkage was established between NARS scientists and farmers through extension workers, nog-government organizations and farmer organizations.

5. There is a need for closer collaboration between donors and project implementing organizations not only to ensure the continuity of a successful project but also to phase our a program smoothly.

6. After SAFGRAD project close out the OAU/STRC has maintained linkages with Network activities currently being managed by IARCS, indicating that the OAU Coordination link developed by SAFGRAD continues to be important.

7. There has been a substantial institutional capacity building on the improvement and production of food grains in semi-arid Africa through the USAID funded SAFGRAD Project.

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