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AN OVERVIEW : ON-FARM RESEARCH EXPERIENCES OF SAFGRAD

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Despite the awareness of the critical requirements to build an effective agricultural technology evaluation and transfer process in the subregion, most countries have yet to give priority to an institutional reorganization that could set together the activities of research and extension systems to address farmers' needs. Furthermore, strengthening of the technology transfer system is hampered by lack of resource allocation to the development of the agricultural sector, in general, and to research and extension programmes, in particular.

The adoption of a technology can take place only when it is consistent with the agro-ecological and socio-economic circumstances of the target farmers. Institutionally, the capacity of a particular NARS to generate and verify technologies, the efficiency of the national extension systems and the conduciveness of national agricultural development policies, all play key roles in facilitating the adoption of technologies.

One of the major thrusts of SAFGRAD's activities has been to enable the national systems enhance the transfer and adoption of technology by farmers. In this regard, SAFGRAD undertook the following three approaches of moving research results to farmers:

(i) <u>The Accelerated Crop Production (ACPO) Programme</u> was SAFGRAD's approach to On-Farm Research (OFR) aimed at improving the critical weakness in crop research and at getting research results verified and disseminated to farmers. Unlike conventional integrated FSR programmes, the ACPO programme considered only a few themes in its technology packages for its multi-locational trials. Once a certain crop technology is verified, the particular national extension system utilizes the package of technology in an expanded agricultural development scheme. Screening and recommendation of varieties and agronomic practices was carried out by researchers at the national research stations and constitute the major source of themes to promote the On-Farm Research (OFR). As of 1987, this programme was operational in four countries, namely Mali, Burkina Faso, Cameroon and Togo.

The experience gained from operating the ACPO programme in the few countries involved seems to suggest that interventions in on-farm testing activities by agencies such as SAFGRAD can play a catalytic role in improving linkages between national research and extension services by providing a bridge for the activities of the two or more ministries in which national research and extension are located. Furthermore, it would appear that some of the current technologies generated through the collaborative research programmes of SAFGRAD, IARCs, and the national research stations could substantially increase crop yields provided favourable national agricultural development policies are instituted by the various countries.

Most OFR activities in many SAFGRAD member countries were aimed at developing improved cropping systems. The programmes focussed on research methodologies that can determine the best mixes and combinations to improve crop production. In order to set in motion a self-sustaining on-farm research setup throughout SAFGRAD member countries, a conceptual understanding would need to be established so that the on-farm testing programmes would be based on themes recommended by research stations or on improved traditional systems of production.

In Mali, an extensive on-farm testing was carried out in the eight major regions of rural development operations covering the main production areas for sorghum, millet, maize, rice, cotton, groundnut, cowpea, etc..

The main focus of the programme has been to strengthen the development of the national technology transfer process. This objective was partially attained through the implementation of on-farm trials involving researchers and more than 250 extension agents in each region and close to 3000 farmers. One of the technological innovations that farmers were enabled to evaluate included the identification of suitable varieties of sorghum, millet, maize, groundnut and cowpea. Based on expanded multi-locational trials involving several sorghum cultivars (CE 90, Malisor 84-1, Malisor 84-3, SB 66-42, CSM 63, CSM 219 etc..), the project provided feedback data to research from on-farm tests results that the new varieties did not out perform local cultivars. Consequently, the sorghum and millet improvement programme of Mali was reoriented to concentrate its research efforts towards incorporating beneficial traits of local sources of sorghum germplasm.

The development of packages of technology for maize production was based on local selection. As of 1987, several maize and cowpea elite germplasm were introduced from regional and international sources (IITA/SAFGRAD, ICRISAT, CIMMYT, etc).

A number of cowpea varieties were found suitable for production by farmers in various regions in Mali. More specifically in the Seno plain, early maturing varieties such as SUVITA-2, Gorom-Gorom, TN-8863, etc. were increasingly grown by farmers. Furthermore, suitable packages of technologies of intercropping systems, for example, millet/cowpea, maize/cowpea relay cropping sorghum/groundnut or sorghum/millet, etc. were developed.

Because of the increasing cost of chemical fertilizers to apply on staple food crops such as millet and cowpeas, low-cost alternatives of natural sources of fertilizer were investigated. Indigenous rock phosphate is an alternative to the more costly imported chemical fertilizer. On-farm tests of rock phosphate from the Malian Tilemsi deposit (TRP) have shown significant yield effects in the Seno plain (18). A single dose of 300 kg/ha TRP was applied at the outset of two types of three-year rotations: groundnut-millet-groundnut and millet-millet-millet. "On two series of tests, production for the three years increased on average by 230 kg for groundnuts and 372 kg for millet for the groundnut-millet-groundnut rotation and by 816 kg for millet for the millet-millet-millet rotation ("Henry de Frahan et al. (19) However, because of the TRP's low solubility, the yield effect shows up only after the second year of application in areas receiving at least 400 mm of rainfall, enough to allow solubility to proceed".

The project provided short-term training to more than 30 technicians and researchers. The training varied from regular crop production courses, seminars, workshops and in-service on-farm trial activities. Furthermore, three Malians were trained at M.Sc degree level in agronomic research and production.

Research-extension-farmers linkages were further strengthened through on-the-service training of more than 1040 extension agents thoughout the eight rural development operations (ODIPAC, CMDT, OMW, ODIK, OHU, OVSM, DRAS and ORM).

In Burkina Faso, the Accelerated Crop Production project covered five major rural development regions (CRPA du Centre Est, Nord, Ouest, Est et du Mouhoun). The technological innovations evaluated on farmers' fields included (i) tied ridges to conserve soil moisture and soil to improve water and nutrient infiltration, to minimize drought risks, etc (twenty farmers evaluated this technology for three consecutive years). In general, tied-ridging had positive effect on yield and was also found feasible economically. (ii) Close to 500 on-farm trials on maize, millet, sorghum, cowpea and groundnut were carried out between 1984-1987.

The promising varieties that were identified included four maize varieties: SAFITA-2, SAFITA-104 Maka, and CSP; two cowpea varieties: SUVITA-2 and TVx 3236; three sorghum varieties were: Framida, ISCV1002 and ICSV-16-5; and four millet varieties: IK MV8201, IK MP2, IK MP1 and IK MP5.

While the cowpea varieties mentioned above gave higher yields than the local cultivars, the improved varieties of maize outyielded local ones with the application of fertilizer. As of 1988, the project, in cooperation with extension agents, involved the direct participation of 487 farmers in implementing the trials. Indirect contacts with the farming community in the five major districts is estimated to involve about 5000 farmers since each peasant within the project was encouraged to spread improved seed and technology to other farmers. The project served as a useful link between research and extension although the limited resources at the disposal of the latter did not permit greater enhancement of the transfer of technology.

In Cameroon, the ACPO programme was reoriented towards the conduct of pre-extension trials on farmers' fields. The liaison between research and extension was established through involvement of agents and farmers in the active participation of both groups on the implementation of on-farm trials.

On-farm testing as practised in Cameroon is the link between research and extension for increasing food production. Between

1984 and 1987, close to 800 on-farm trials were carried out. Each year, more than 300 agents were involved in supervising the on-farm tests. The ACPO was able to sucessively serve as an effective linkage between research and extension by training over 300 extension agents by successfully testing new technologies on farmers' fields, and providing some feedback on farmers' reactions to the research centres.

A number of maize, sorghum and cowpea cultivars were identified as promising for Northern Cameroon. The maize variety TZP was released and was cultivated by SODECOTON farmers on 4678 ha (20). The cowpea variety TVx-3236 was introduced as an extension package and was cultivated by more than 1000 farmers as of 1986. Among the sorghum introductions, S-35 was found significantly superior to the local variety and was initially introduced by the extension system to over 2500 farmers (20).

In Togo, ACPO activities are located in the Kara region and Savanna zones of Northern Togo. The on-farm testing activities of the project were concerned with trying promising varieties. Promising maize varieties that were identified included IKENNE 8149 SR, EV 8430 SR, TZP3, TZESR-W, Across 86 Pool 16 DR, DR Comp Early, DMR-ESRY and SAFITA-2. The recommended cowpea barieties included: 13:301, TN-121-20, TVx 3236, IT81D-985 and KVx 39-4-4. With regard to sorghum trials, the Striga resistant variety Framida has been shown to have good potential.

Each year, close to 120 farmers participated in on-farm trials of which 30% and 70% of trials were in the Savanna and Kara regions respectively (21). In Northern Togo, the project contributed effectively in filling the research gap as well as the technology generation and diffusion of improved food grains in Northern Togo. It also contributed towards the establishment of good working relations between the national agricultural research system and the extension system. The working methodology being used was well integrated within the new rural development strategy which was being implemented in Togo.

One of the specialized programmes of SAFGRAD for strengthening the NARS technology transfer process has been through the development of farming systems research. Whereas the ACPO programme has been the delivery of research results to farmers through on-farm agronomic research, the emphasis of FSR was to develop integrated technological innovations comprising sub-systems of production (such as crops, livestock, agroforestry etc.) and management of the available resources such a labour, land, soil-water resources, capital and off-farm activities.

(iii) Farming Systems Research

The Farming Systems Unit (FSU), a collaborative programme between Purdue University and SAFGRAD, through USAID funding, not only developed FSR methodologies for addressing agricultural production constraints but also sorted out technological options for the West African Semi-Arid Tropics (WASAT). With regard to soil fertility and water retention technologies, a number of on-farm studies confirmed that tied ridges have shown significant yield increases and economic returns on maize, sorghum and millet (22) on farmer-managed trials (carried out by FSU/SAFGRAD) in various locations of the Mossi Plateau of Burkina Faso. Both yield and profitability were shown to have substantially increased on sorghum, maize etc., when tied ridges and fertilizer were used in combination. The use of commercial fertilizer, especially with sources of nitrogen and phosphorus was explored through SAFGRAD FSR support programmes in various countries. For example, in the Mossi Plateau, it was observed that provided adequate soil moisture was available, minimum dose of fertilizer, 100 kg/ha NPK (14:23:15) plus 50 kg/ha urea significantly increased yield of maize and sorghum and, to a lesser extent, millet yields. Similarly, cowpeas and groundnuts responded to the application of rock phosphate (400 kg/ha) during the first season, while growing cereals on the same location the second season, did improve yields.

In the FSR studies of the 1980s, among the on-farm labour saving technologies evaluated by FSU of SAFGRAD, included animal traction and Mechanical Ridge Tier (MRT). Animal traction, which is utilized by 15% of the farmers in the WASAT, can minimize farm-labour drudgery, for example, in the preparation of soil and weeding 6 to 7 times faster than manual (Jaeger and Sanders, 1985). Manual construction of tied ridges, being cumberome, impeded its adoption by farmers. On-farm evaluation of MRT showed substantial reduction in labour requirements from an average of 75 hours/ha for manual tying of animal traction ridges to 20 man hours/ha.

Based on the first generation FSR experience of SAFGRAD (1979-1985), three pilot FSR projects within the national systems of Benin, Burkina Faso and Cameroon were established through the financial assistance of the International Fund for Agricultural Development (IFAD). In the three countries, initially the biotic, socio-economic and physical environmental constraints to food production were identified through base line surveys.

Concurrently, available technologies were inventoried. In Burkina Faso, an integrated FSR programme including crop and animal production, forage legumes and tree/crop associations was initiated primarily to intensify agricultural production in areas where prolonged fallow practice could no longer be practised (23). Dual-purpose forage legumes such as cowpea cultivar KN-1, Lablab purpureus and Phaseolus aureus (planted on fallow land) improved forage and grain production when followed with sorghum, maize and millet.

Livestock accounts close to 50% of its foreign exchange earnings. Small ruminants, particularly sheep, predominate in the Mossi Plateau and constitute a major source of meat and cash.

Natural pasture was improved through the establishment of forage legumes such as stylosanthes hamata. In cooperation with ILCA, which provided forage nutritional analysis, it was shown that early September was the best time to harvest natural grassland hay where an average yield of 4.5 t/ha could be obtained. Pigeon pea and other fast growing browses were established as alley crops and grew successfuly on residual moisture. To sustain livestock production during the dry season, silage of forage herbs and grasses as means of conserving feed was demonstrated to farmers. Cotton seed cake commonly available was included in ration of feeding trials on small ruminants that were contributed by farmers. These and related studies were demonstrated to farmers as sustaining livestock production during dry seasons. In Northern Benin, FSR activities through SAFGRAD assistance were concerned on improving cropping systems (24). The improved maize variety (TZB) was observed to fit well in the sorghum/maize intercrop due to different growth patterns which minimized competition. Regarding cereal/legume associations, Crotolaria spp. as green manure increased the yield of maize by 45% when incorporated into the soil. This practice has been recommended for pre-extension tests as it involved minimal additional labour. Further trials with cereal/legumes showed grain yield increases, of more than 40% for sorghum and cowpea in association with Acacia albida. Evaluation of adaptable forage species for introduction in the traditional farming systems showed Stylosanthes hamata, Centrosema pubescens, Leucaena, Pennisetum purpereum and Panicum maximum as promising.

In Northern Cameroon, where the IFAD-supported FSR activities were based, the existing farming system in area consisted of a cotton-based as well as sorghum/groundnut/maize cropping systems. To address the constraints of soil fertility stress, application of 5 t/ha organic manure in combination with 25-50 kg/ha urea was found to be the most economical option (25). As a result, income returns of those farmers that owned animals was generally higher than those without access to animal manure. Furthermore, among the soil-moisture retention techniques that were evaluated, tied-ridging and mulching increased sorghum yields by over 77%, more than the traditional practice. The maize variety, CMS8501, that was evaluated in the North East Benue area of Cameroon, gave the best economic returns. With regard to sorghum, two improved varieties, S-34 and CS-63 out-yielded the local cultivars. Some improved varieties of cowpea with yield potential (up to 2 tons/ha) were identified. Those recommended to farmers were TVx 3236 and VYA with mean yields over eight locations of 813 and 947 kg/ha, respectively.

(iii) A Research-Extension Interphase: Technology Verification Activities.

Lessons learned from the previous technology transfer and adoption processes indicated that a research and extension interphase technology verification system was one of the missing links to narrow the "yield gap" between on-station and on-farm.

In 1990, this project was realized in eight countries (Burkina Faso, Cameroon, Ghana, Mali, Nigeria, Niger, Senegal and Togo) through the financial assistance of the African Development Bank (ADB). The strategy of this project was based on the fact that the agronomist plays a key role in the verification of crop production technologies by working very closely with breeders, soil fertility, management and protection specialists, etc., while liaising on-farm tests with extension agronomists for FSR field level activities. Nine sub-projects that received ADB financial assistance were implemented in eight countries. In Burkina Faso, six improved cowpea varieties and agronomic practices were evaluated in crop associations and in mono-culture, using plant protection measures in 13 districts in cooperation with rural development centres and 120 farmers.

In Cameroon and Mali, the project emphasis was to develop packages of improved agronomic practices for the adoption of early (80-90 days) and extra-early (75-80 days) maturing maize cultivars in the Sudan and Sudano-Sahelian zones. These short cycle maize varieties with characteristics for drought resistance, could result in an expansion of maize production in the semi-arid zones where gaps of food shortage could be filled with green maize available within 65 days, two to three months before the harvest of sorghum and millet.

In Senegal, the production of an improved cowpea variety, IS-86-275 was promoted in five villages where it had been ac-

Niger in Sokondii Birini village in the Sudanian zone . Some of the agronomic practices evaluated were to develop appropriate intercropping (sorghum/millet/cowpea; millet/groundnut) and relay cropping systems with the application of minimum doses of inorganic fertilizers.

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