Farmer participation in on-farm research: The experience of the Ghana Grains Development Project

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ABSTRACT

This paper describes the Ghana Grains Development Project's research programme which used a farmer-oriented approach where farmers' constraints, conditions, and practices formed the basis for planning research and extension agenda. Multidisciplinary teams of agronomists, economists and extension specialists were involved in working with farmers in the on-farm research programme. Farmers were involved in identifying production constraints in the diagnostic as well as the planning stages of research. They also participated actively in identifying possible solutions to the identified problems. These possible solutions then constituted treatments in designed experiments and verifications. Throughout the conduct of field experiments and verifications, farmers' opinions were continually sought to help modify particular treatments which appeared unpromising. The result of this level of involvement of farmers (from the diagnostic through planning to the execution stage of field experiments) is greater farmer confidence in adopting recommendations.

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RÉSUMÉ

AFLAKPUI, G. K. S. & DAPAAH, H. K.: *Participation du cultivateur à la recherche sur le champ: La pratique du Projet de Développement des Grains du Ghana.* Cet article décrit le programme de recherche du Projet de Développement des Grains du Ghana qui employait l' approche adapté aux besoins du cultivateur où les contraintes, les conditions et les pratiques des cultivateurs constituaient la base de la planification de recherche et d'ordre du jour de la vulgarisation. Des équipes pluridisciplinaires des agronomes, économistes et vulgarisateurs agricoles étaient engagés à travailler avec les cultivateurs dans le programme de recherches sur le champ. Les cultivateurs étaient engagés non-seulement dans l'identification des contraintes de production aux états diagnostiques et d'ébauche de la recherche. Ils participaient activement à l'identification des solutions possibles aux problèmes identifiés. Ces solutions possibles constituaient ensuite des traitements dans les expériences conçues et les vérifications. Tout au long de la conduite des expériences et des vérifications du champ, les opinions des cultivateurs étaient continuellement demandées pour assister à modifier des traitements particuliers qui paraissent peu prometteurs. Le résultat de ce niveau de participation des cultivateurs (de diagnostique à travers la planification à l'étape d'exécution des expériences de champ) est la plus grande confiance du cultivateur en adoptant les recommandations.

Introduction

The objective of the Ghana Grains Development Project (GGDP), established in 1979, was to generate and transfer economically feasible and environmentally suitable technology for the production of maize- and legume-based cropping systems in Ghana. In addition, the GGDP was to develop an integrated research approach to enhance the capability of the national research and extension institutions, and strengthen research and extension linkages. The GGDP was funded by the Government of Ghana and that of Canada. The Crops Research Institute (CRI) and the International Maize and Wheat Improvement

Centre (CIMMYT) were the executing agencies for Ghana and the Canadian International Development Agency (CIDA), respectively. Other participating organizations of the project were the Grains and Legumes Development Board (GLDB), the Ministry of Food and Agriculture (MFA), and the International Institute of Tropical Agriculture (IITA). Since 1985, IITA has supported the legume component of the project.

The traditional model of research, education, and extension views agricultural knowledge and information as flowing from research organizations to farmers through extension services. Generating technology is mainly the domain of researchers, and extension has primarily a "messenger" function (Van Crowder & Anderson, 1997). When feedback to research occurs, it is provided by extension personnel, relegating farmers to a largely passive role. Knowledge is often viewed as hierarchical with "better trained" researchers at the top, extension below, and farmer knowledge at the bottom (Van Crowder & Anderson, 1997). However, there have been important shifts in approaches to agricultural research, extension, and education in the last two decades or so.

In research for instance, active farmer participation and an on-farm, farming systems perspective are believed to be indispensable to overcoming the failure of traditional experiment station research to solve the problems of many farmers, especially those outside the most favourable environments (Shand, 1985 cited by Van Crowder & Anderson, 1997; Biggs, 1989; Tripp & Woolley, 1989; Haug, 1999). In extension, thinking has moved from expert-driven transfer of technology approaches to approaches where the emphasis is on "helping farmers to help themselves"; that is, to develop their skills and information/knowledge acquisition system (Rogers, 1993 cited by Van Crowder & Anderson, 1997).

A major premise underlying these shifts is that research, extension, and education need to be farmer-participatory and interactive to contribute agricultural knowledge and technology that results in collective learning, enhances local capabilities, and generates sustainable development processes and practices (Van Crowder & Anderson, 1997). The inception of the GGDP coincided with this period of shifts in approaches and hence the incorporation of these ideas in the activities of the GGDP.

Technology hitherto generated by research for the resource-poor farmers in Ghana had little or no input from the farmer and was characterized by high-production costs and low-labour input, and was profit oriented. The attitude of researchers was to replace cropping systems which were considered archaic and ineffective. The response to such technology has been the adoption of only a few factors in some areas by a few farmers.

The non-adoption was erroneously believed to be due to inadequate physical environment to fit the new technologies, institutional, infrastructural and marketing constraints, or farmers' inability or unwillingness to change their old ways.

Recognizing that farmer input was crucial in achieving its objectives of generating and extending appropriate technology that addressed the needs and problems of farmers, the GGDP adopted an integrated research-extension-farmer linkage approach. This approach involved farmers not only in managing on-farm trials, but also in defining the research agenda, the conduct of the research, the evaluation of research results, and the dissemination of the findings.

The aim of this paper is to highlight the salient points of this approach as operated by the GGDP in Ghana.

Methodology

The participation of farmers in GGDP activities has covered a wide range of areas and it has been largely of the consultative and collaborative modes as described by Biggs (1989). The GGDP methodology has followed the broad approach to on-farm research (OFR) as advocated by CIMMYT, and has been classified along the following stages suggested by Tripp & Woolley

(1989): diagnosis and characterization, planning, experimentation, assessment, and recommendation and diffusion. During each stage, farmer participation was given prominence.

Diagnosis and characterization

Information was gathered from farmers mainly through quite extensive survey programmes: informal surveys (farmer interviews on farms and at homes, field observations or direct field measurements), and formal surveys (questionnaire) to identify characteristics of farmers' practices and problems that limited productivity. A better understanding of farmer circumstances and priorities as well as basic features of the areas in question were obtained. The use of secondary data and interviews with local officials and extensionists also provided some supporting information on farmers' practices and the constraints to production.

Individual farmers or groups of farmers were contacted by multidisciplinary teams of agronomists, economists, and extension specialists drawn from the different collaborating institutions (CRI, MOFA, GLDB) through informal/exploratory or formal surveys. These farmers were chosen at random in each locality within an agro-ecology and engaged in informal conversations or questionnaires administered through which their production constraints and other related issues were identified. In order not to scare farmers by a large army of "foreign " faces, the number of people in a team that visited a farmer was limited to three. A local resident, usually a frontline agricultural extension staff, interpreted questions from survey teams to farmers and *vice-versa* when a member of the team was unable to communicate with the farmers in their local dialect. The problems identified during the diagnostic stage served as a useful reference for research-extension teams at the planning stage of research.

Informal surveys were used by the on-farm client-oriented research (OFCOR) teams in Senegal and Zimbabwe (Ewell, 1989), and by the adaptive research planning team in Luapula Province in Zambia (Kean, 1988) to understand the major production constraints and farmer circumstances.

Through informal and formal surveys, Bruce (1980) and Bruce, Byerlee & Edmeades (1980), found that the forest-savanna transition zone had a high potential for growing maize in Ghana. The surveys showed that most maize holdings were under 4 ha, although some large holdings existed. The surveys reported, among others, that land was prepared by hand and the crop and weed residues burnt. Most farmers planted local varieties at about three to four seeds per hole in a random arrangement with a cutlass, hoe or planting stick. Planting distances were about 1 m apart. Monocrop maize was predominant, and few farmers used fertilizer although most were familiar with it. Maize was weeded once or twice by hand. Crop rotation patterns varied, but fields were sometimes cropped with maize for several years (Edmeades *et al.*, 1990).

Planning

A greater level of farmer involvement in the GGDP activities was at the planning stage. The planning stages of the GGDP's research and extension programme were conducted in all the agro-ecologies (Fig. 1) of the country from January to March each year. This ensured that research and extension agenda were formulated and trial/demonstration protocols were distributed before the onset of the rains in late March to early April in the southern sector, and late April to mid-May in the northern sector. The planning sessions brought together farmers, researchers (on-station and on-farm), socio-economists, extension specialists, and policy makers for 2 days to discuss agriculture in general and maize- and legume-based cropping systems in particular. The planning sessions had six objectives:

1. review the previous year's research and extension activities;
2. identify new agronomic and socio-economic problems;
3. integrate new problems with those already identified;

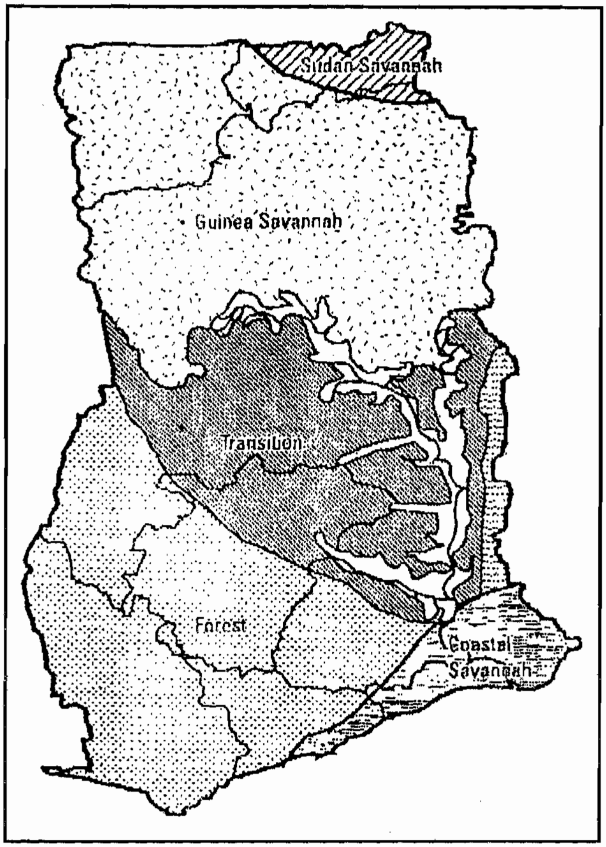

Fig. 1. Agro-ecological zones of Ghana.

4. prioritize the problems;
5. find possible solutions to problems; and
6. plan the research and extension agenda for the year.

Farmer participation at the planning stage of research is so crucial to the research programme that special efforts were made to get their active involvement. These efforts resulted in the use of the following criteria by which MOFA extension officers selected farmers to participate in the planning stage:

1. One half the number of farmers must have been exposed to GGDP on-farm trials and demonstrations or other research-extension activities conducted by the MOFA; the other half having no record of participation.
2. Both sexes must be equitably represented. (In many localities, 40-50 per cent of the participating farmers were females).

These criteria (which were used from 1991) helped to avoid the selection of a handful of so-called "progressive farmers" or "farmers engaged in special pilot projects" or male extensionists, ignoring female farmers and *vice versa*. The use of the criteria also increased the representation of farmers at planning sessions as shown in Table 1 (GGDP, 1990, 1991b, 1992, 1993, 1994, 1995).

Issues were discussed in small groups rather than at plenary sessions so that farmers could freely express their opinions. Each small group comprised two to three farmers and three to five other participants made up of agronomists, economists, entomologists, and extension specialists. Each group was assigned a specific role, a moderator to direct the discussion, and a recorder to record proceedings.

Another practice during the group dicussions was the use of the predominant local dialect spoken in each locality. This allowed farmers to freely express their opinions without any hindrance. These views were then translated to the group if anyone did not understand the local dialect. Similarly, questions and contributions by scientists who could not speak the local dialect were translated to farmers.

The small groups identified problems of maize and legume production, the possible causes and interrelations amongst the causes, and then suggested possible solutions to these problems. These possible solutions were evaluated by using the following criteria (Tripp & Woolley, 1989): probability that the technology will function, profitability, compatibility with the current farming system, contribution to reducing risk, need for institutional support, gender awareness of

TABLE 1

Participation at the Ghana Grains Development Project (GGDP) Annual Planning Sessions from 1990 to 1995 Across All Ecological Zones of Ghana

Year	Farmers (F)	Researchers (R)	Extensionists (E)	Total (T)	F/T (%)	R/T (%)	E/T (%)
1990	12	38	108	158	7.6	24.1	68.4
1991	15	46	82	143	10.5	32.2	57.3
1992	53	51	125	229	23.1	22.3	54.6
1993	40	41	106	187	21.4	21.9	56.7
1994	62	55	110	227	27.3	24.2	48.5
1995	67	51	123	241	27.8	21.2	51.0

Source: GGDP Annual Reports (1990 - 1995)

technology, ease of testing by farmers, and ease of carrying out the experimental programme. These possible solutions, after evaluation and ranking, served as treatments in field experimentation.

All the groups then assembled for plenary sessions where each group presented its work. The outcome of the planning breaks down identified problems into the following categories:

1. Problems for on-station research.
2. Problems for on-farm research.
3. Problems that require additional diagnosis.
4. Problems that can be addressed through extension messages.
5. Problems that need policy attention.

Experimentation

All field experiments were based on information derived from the diagnostic activities and priorities that were set at the annual planning sessions. Every activity carried out by the farmer was influenced by the scientist/extension specialist and *vice versa* after all these procedures. It is, therefore, not easy to fully classify experiments into categories such as researcher- or farmer-managed groups. Albeit, the GGDP, classified experiments into three main categories: researcher-managed, verification, and result demonstration. A fourth category, known as the farmer-managed trials, was used on some occasions.

Researcher-managed trials (RMTs). In RMTs, researchers or trial supervisors (mostly officers with a certificate in agriculture) were responsible for planting, data collection, and harvesting of the trials. The researchers supplied all the inputs. The farmer provided land and labour, especially for weeding trials, and received the produce after harvest. Farmers were free to select options that addressed their particular problems to fit their specific resource constraints.

The RMTs, which were characterized by four to 10 treatments replicated two or three times at each location with plot sizes of 5 m × 3 m, were usually concentrated in about 10 farms to ensure effective monitoring by the researcher.

A strong farmer-researcher interaction to facilitate honest exchange of views was highly encouraged, because farmers' opinions concerning the various treatments were solicited during the trial. The farmers were encouraged not to view the trials as the work of a government agency or just planting to obtain some of the new improved seeds. The results of most RMTs did not provide immediate solutions; rather, they increased the design capacity of the teams and served as a means of screening which technology finally goes to the farmer.

One advantage of conducting RMTs in farmers' fields is that it affords the researcher the opportunity of testing technologies under a wider range of soil types, climatic conditions, weed situation, tillage methods, cropping histories, and insect and disease infestation levels. In addition, using the extension frontline staff as trial supervisors is a practical attempt at involving extension in technology generation, and hence ensuring more effective transfer of technologies to the farmer. Finally, soliciting farmers' reaction to the trials assists researchers to modify or eliminate technologies which appear unpromising.

An example of a researcher-managed trial is a simple 3 × 2 factorial combination of three maize varieties grown at two fertilizer levels replicated three times in about six to 10 farms.

Verifications. Verification is the process by which technological alternatives are tested and evaluated in the environmental realities of potential users. It includes the practices that make up the alternatives, as part of the farmers' activities in the farm.

The major objectives of verifications are as follows:

1. To evaluate the level of compatibility of the alternatives with other farm activities and with technical, economic, and social aspects (keeping in mind limiting factors, productivity, and variability of the results).
2. To evaluate the acceptability of the alternatives by the farmers.
3. To generate information on the requirements for the transfer of the alternatives (considering credit, network of technical assistance, and availability of inputs).
4. To obtain feedback information (from previous phases of the process-diagnosis, planning, experimentation) on the performance of the alternatives (in the agro-economic context) and identify positive or negative factors that affect adoption.

Verifications were usually laid out in larger plots (example 10 m × 9 m) per location with each location serving as a replicate. The verifications were spread over more locations than the RMTs. A two-treatment verification test such as improved maize variety + fertilizer and local maize variety+ fertilizer or no fertilizer was conducted from the simple researcher-managed trial. This test was conducted on about 40 to 60 farms.

At the verification stage, researchers/ extensionists remained as open as possible in collecting information, and avoided giving the farmer the impression that they already knew the answers. An attitude of honest curiosity was adopted by the officers to give the farmers the confidence to fully express their opinions and experiences. Farmers were encouraged to express their opinions rather than affirming what the officers said. For example, it was at the verification stage when farmers voiced out concerns on the management of ropes for line planting which led to the use of sighting poles instead.

Result demonstration. Proposed alternatives which were verified and found to be socio-economically feasible went into result demonstrations (usually sized one-half of an acre to one acre). The demonstrations were treated as part of the management practices of the farmers' cropping system; that is, the demonstrations were completely managed by the farmers. Other farmers from nearby fields or in the locality were invited to participate in field days at any stage of the process from the time of planting to harvesting. This gave the farmers the chance to compare the performance of the various technological options. At this stage, assessments were made as to whether the technological alternatives yield (both biophysical and economical) as much or more than the farmer's practice. In the evaluation, the causes and extent of any changes the farmers introduced into the alternatives were analyzed. So also were the practices which were rejected by farmers. Finally, information on each farmer's (especially those who had the demonstrations on their farms) self-evaluation of the various components of the alternatives were gathered.

Assessment

Data obtained on farmers' experiences with the technological alternatives were used to make judgements on promoting recommendations. As such, results from all the stages discussed were analyzed carefully. These included agronomic evaluations, economical and stability analyses, and farmers' reactions and opinions. Farmers' views were given prominence, since they formed an important component to adoption. Results of the assessment were then used to plan for future research and also to make recommendations.

Recommendation and diffusion

When all the pieces of information were

critically assessed and researchers were confident that enough information had been gathered, recommendations were formulated. These recommendations were totally based on farmers' experiences and opinions, as well as on those of extension officers who also participated in the process of technology generation. An example of a simple recommendation package for monocrop maize by the GGDP included plant density (planting in rows for optimum density), use of fertilizer (time, rate, and method of application), and use of improved varieties. Adoption studies to assess adoption/diffusion rates were carried out 6 to 10 years later as the last stage of the generation and transfer of technology. Reasons for non-adoption were used to make changes in the recommendation package or used to set new research priorities.

Results and discussion

Some of the major findings of the importance of the farmer-oriented approach to increasing the adoption of improved technologies and consequent increase in agricultural productivity come from surveys carried out in six maize-producing areas in Ghana in 1990 (GGDP, 1991a) and a national survey conducted in 1998 (Morris, Tripp & Dankyi, 1999).

1990 adoption survey

The "local" maize in Ghana is a mixture of materials brought by the Portuguese during the 16th century, and others that were introduced subsequently in colonial times. Several aid projects in the 1960s attempted to introduce new varieties with little success (Tripp, 1993). Through the on-farm research activities of the GGDP, CRI materials were tested on farmers' fields and acceptable varieties were identified. The new varieties were not only more responsive to improved management, but also outperformed local varieties under traditional management (Table 2).

TABLE 2

Results of Farmer-managed Variety Trials, Transition Zone, 12 Sites, 1985

Variety	*Maize yield (kg ha⁻¹)*
Farmers'	2180
Aburotia (CRI)	2460
Dobidi (CRI)	2780

Source: Tripp *et al.* (1987)

Seed was produced and distributed by the GLDB, the parastatal Ghana Seed Company (now defunct), and lately by private seed growers. The 1990 survey estimated that 58 per cent of the maize farmers were planting at least one improved maize variety, and that about 48 per cent of the maize area was into improved varieties. Table 3 shows that the principal reason for not planting improved maize varieties was lack of seed, but marketing and storage problems were also important. The storage problems that were identified were fed back into the planning process for studies to be conducted on storage and drying cribs as well as on the appropriate use of storage chemicals and other local materials such as neem extracts. The on-farm research effort also focused on improving fertility management.

Initially, on-farm experiments concentrated on deriving yield response data, but once these were available, more attention was devoted to developing methods and timing for fertilizer

TABLE 3

Reasons for Not Using Improved Maize Varieties

Reason	*Percentage of farmers who are adopters**	*Percentage of farmers who are disadopters**
Seed not available	62	64
Lack of knowledge	29	0
Storage problems	27	39
Marketing problems	20	49
Cooking quality	8	6
Yield	2	6
(Number of farmers)	(98)	(33)

* Percentage total is more than 100 because of multiple answers.

Source: GGDP (1991b)

application acceptable to farmers. The result was a set of guidelines that based fertilizer recommendations on ecological zone and cropping history, and translated fertilizer rates into measures with which farmers were more familiar. The 1990 survey showed that 30 per cent of monocropped maize fields (but a much lower proportion of intercropped fields) received fertilizer, and that those farmers who used fertilizer were following recommended practices fairly closely. Fertilizer use is correlated highly with the adoption of improved varieties and planting practices (Table 4), although there is evidence that the adoption of these components usually followed a logical stepwise pattern (Tripp *et al.*, 1987).

TABLE 4

Fertilizer Use by Planting Practice (Monocropped Maize)

Planting practice	*Percentage of fields using fertilizer*
Random plant, local variety (N = 43)	2
Random plant, improved variety (N = 35)	23
Row plant, local variety (N = 15)	67
Row plant, improved variety (N = 72)	68

Source: GGDP (1991b)

The advantages of the new varieties and inorganic fertilizer are less pronounced if farmers use their traditional methods of plant spacing. Farmers were encouraged to plant maize in lines, with less distance between hills and fewer seeds per hill. The line planting is not merely agronomic aesthetics, but rather an aid in encouraging better plant spacing, as well as facilitating fertilizer application and weeding. Those farmers who adopted line planting had much more efficient plant populations (Table 5).

Although the seed-fertilizer-plant population technology is by no means novel, it illustrates what a well-organized effort by public sector institutions to involve farmers in on-farm research can accomplish. The development and diffusion of technology is an important factor contributing to the fact that maize production in Ghana increased at an annual rate of 8.9 per cent between 1977 - 1979 and 1987 - 1989 (MOFA, 1991).

TABLE 5

Planting Practices of Farmers with Monocrop Maize, Brong Ahafo

Practice	*Recommendation*	*Mean for farmers who row plant (N = 40)*	*Mean for farmers who random plant (N = 14)*	*Significance by T-test*
Hills/ha	27 777	24 717	17 545	<0.05
Seeds/hill	2	2.62	3.50	<0.001

Source: Tripp *et al.* (1987)

1998 adoption survey

Table 6 shows the percentage of farmers that used one or more of the GGDP's maize technologies on at least part of their farm during the growing season in 1997. Over 54 per cent of farmers sampled planted improved varieties and 53 per cent planted at least part of their maize crop in lines (rows) whilst 21 per cent applied fertilizer to their maize fields. Adoption rates varied across agro-ecological zones, with the forest zone recording the lowest rates of all three

TABLE 6

Adoption of Maize Technologies Generated by GGDP, 1997

	Percentage of farmers that had at least part of their farms used:		
Agro-ecology	*Improved variety*	*Fertilizer*	*Planting in rows*#
Guinea savanna	66	36	73
Transition	68	29	59
Forest	38	9	39
Coastal savanna	69	29	65
All zones	54	21	53

n = 392 (excludes planting on ridges)

Source: Morris *et al.* (1999)

technologies. The lowest adoption rates in the forest zone for all three technologies may be attributed to a combination of reasons, namely: maize is not a major staple in the forest since there are other staples such as cassava, cocoyam, and plantain; relatively more fertile lands compared to the other zones; and difficulty in planting in rows due to the numerous stumps that characterize the forest terrain.

Table 7 shows the interaction among the three GGDP maize technologies, expressed as a percentage of farmers that adopted them. The interactions show that 37.5 per cent of the farmers did not use any of the recommended technologies; these farmers neither planted improved varieties, applied fertilizer, nor planted in rows. The rest of the farmers adopted one, two, or all three of the technologies recommended. The most common combination of these involved adoption of improved varieties and planting in rows without applying fertilizer which was adopted by 22.7 per cent of the sample farmers. However, all three technologies were adopted by 12.3 per cent of the farmers sampled.

TABLE 7

Interactions among Maize Technologies Generated by GGDP, 1997

	Percentage of farmers that planted on their primary maize field jointly:			
Planting method	*Planted improved variety*		*Planted local variety*	
	Applied fertilizer	*Applied no fertilizer*	*Applied fertilizer*	*Applied no fertilizer*
Row planted	12.3	22.7	4.5	11.1
Random planted	1.0	10.3	0.5	37.5

Note: n = 392 (excludes planting on ridges)
Source: Morris *et al.* (1999)

These results show that the technologies generated by the GGDP have diffused widely. Two-thirds of the maize farmers in Ghana used at least one of the three improved technologies. This indicates that the GGDP made good progress in developing and disseminating improved technologies for maize in Ghana.

Conclusion

It is quite easy to conduct trials on farmers' fields, make observations, harvest and take yield data, all without involving the farmers. However, this could result in a great loss of vital information, as the observations and opinions of farmers are valuable data to be collected on-farm. The GGDP's experience at promoting the participation of farmers has provided evidence that involving farmers in the generation and transfer of technology from the on-set enhances the effectiveness of adoption of the alternatives. It has also shown that the research potential of the farm populations can be used effectively, and that they should not be reduced to mere labourers by transferring on-station research methodology/ results to the farmers' fields.

The farmers provided important information and insights into the identification of the most limiting production constraints, and were instrumental in the choice of the alternatives that were tested/evaluated. Farmers' participation was also instrumental in evaluating the success of the alternatives, particularly in determining the reasons for success or failure. Finally, farmers' participation strongly influenced the making of recommendations.

In view of the foregoing, the GGDP has been successful in recommending and diffusing improved maize and legume varieties, and has provided useful information on planting and fertilization methods in maize and pest control in legumes (especially in cowpea).

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