ODI NP 16

AGRICULTURAL ADMINISTRATION
(RESEARCH AND EXTENSION) NETWORK

NETWORK PAPER 16

ISSN 0951-1873
June 1990

ENSURING FARMER INPUT INTO THE RESEARCH PROCESS WITHIN AN INSTITUTIONAL SETTING:

THE CASE OF SEMI-ARID BOTSWANA

By

D NORMAN

Team Leader

and

E MODIAKGOTLA

Agronomist

Agricultural Technology Improvement Project
Department of Agricultural Research
Ministry of Agriculture
P/Bag 0033
Gaborone, Botswana

Acknowledgements

The editor is indebted to Prof Anil Gupta of the Indian Institute of Management, Vastrapur, Ahmedabad - 380015, India, for permission to publish this paper. The paper was presented on 9th February 1990 at the "International Workshop on Sustainability Through Farmers' Involvement in Technology Generation and Diffusion" held in New Delhi, the proceedings of which will be edited by Prof Gupta and published.

The authors are indebted to the Director of Agricultural Research in Botswana for permission to publish this paper.

This Network is sponsored by:

The Overseas Development Administration (ODA)
Eland House, Stag Place, London SW1E 5DH

CONTENTS

Abstract

This paper addresses issues of institutionalising participatory approaches to research. Experience in Botswana has led to careful consideration of the roles of different types of trial and the distinction between experimental and non-experimental variables in each. Examples from Botswana distinguish between "high leverage" interventions which address critical constraints in the farming system but whose implementation may require major changes in farmer practice, and "low" or "non-leverage" interventions which have restricted impact but are easier to implement. Requests to test the latter arise from on-station research, whereas a principal objective of on-farm research is to seek solutions to the former. The paper also describes institutional changes designed to enhance the accountability and credibility of research, and to enhance the speed and accuracy of technology recommendations which are essential to the institutionalisation of participatory approaches.

INTRODUCTION[1]

The Brundtland Commission (cited in Chambers et al. (eds), 1989) distinguished three major types of agriculture, namely industrial, Green Revolution and resource-poor agriculture. The more "traditional" research approaches to developing relevant technologies have served the temperate and Green Revolution areas of the world well, resulting in improved and sustained productivity and improved welfare for the majority of farmers in those areas. However, there has been less success in applying these methods to help the much greater number of farmers in resource-poor agriculture, most of whom are located in the rainfed tropical regions. Why has this been the case? As Chambers, Pacey and Thrupp suggest, the root of the problem lies in three general characteristics of resource-poor agriculture, which compare unfavourably with the other two types of agriculture. These are: (a) the lack of production stability and the high-risk nature of resource-poor agriculture partly because of, (b) the environmental diversity under which farmers in such areas operate, which in turn results in (c) the presence of relatively complex farming systems.

Recognition of the special problems of farmers in resource-poor agriculture led to the evolution in the late 1960's and early 1970's, of the farming systems research (FSR) approach in which the farmer was given a more prominent role in the research process. Even more recently, increasing concern that much FSR work has not incorporated the farmer to the extent that is necessary, has spawned the development of what is popularly known as farmer participatory research (FPR) (Farrington and Martin, 1988).

Our own experiences has been that:

(a) The farmer has a critical role to play in not only implementing the agricultural development process, but also in planning it. He/she must be involved, with others, in diagnosing problems, designing potential solutions, and in testing and evaluating those potential solutions.

(b) We have mainly worked within formal institutional situations, particularly within national agricultural research systems (NARS) and we believe that these have a critical role to play, by complementing and supplementing farmers' "traditional" experimentation, in designing technologies that will improve the quality of life of resource-poor farmers. We are convinced that, because of exploding populations and the relatively fragile ecologies in many resource-poor agricultural areas, the pace of technology development and adoption has to be stepped up if the quality of life of such people is to be improved and sustained.

(c) Our experience has been primarily in the semi-arid areas of Africa and our convictions have evolved within this agro-ecological niche. We do, however, believe that many of our convictions on how to help resource-poor farmers are relevant to rainfed areas outside the semi-arid zone.

The literature often indicates a potential or actual conflict between the first two points mentioned above, that is, between the formal setting and fixed operational procedures of institutions, and ensuring a constructive and productive role for the farmer which requires a more informal, fluid approach implied in FPR[2]. This paper seeks to explain how we have attempted to address this potential conflict since we believe that without the combined expertise of farmers and outside resources and the expertise of NARS and other analogous organisations, the race to help the resource-poor farmer will be doomed to failure.

Thus, much of the emphasis in this paper is to delineate ways in which we are trying, with others, to harness the power, visibility, resources and expertise of formal institutions, in such a way as to complement and support the efforts of farmers. After briefly reviewing why farmers should be involved in the research process, we discuss the issues of attaining respectability within an institutional setting, ensuring farmer input and widespread farmer adoption. We conclude the paper with a brief discussion on the impact of on-farm research and the issue of incorporating societal goals. However, before addressing these topics, we briefly review who contributes to the agricultural development process. Incidentally, in this paper we use the term on-farm research as representing FSR.

CONTRIBUTORS TO THE AGRICULTURAL DEVELOPMENT PROCESS

The development, dissemination and adoption of relevant improved technologies, and the development of relevant policy/support programmes, are two equally important, complementary approaches to improving and sustaining productivity. Four groups of actors are essential to the process of agricultural development (Table 1). Productive interactive linkages between planners, researchers (on-station and on-farm), extension and development staff, and farmers, are important. In may parts of semi-arid Africa, until recently, the one-way top-down pattern was most common, whereby the link to the farmer (top-down) was still stronger than from the farmer (bottom-up). This situation still exists in many countries. There are a number of reasons why some of these linkages are fragile[3]. We believe that farming systems research can act as a broker in helping to forge linkages amongst the groups of actors[4].

TABLE 1

ROLES AND FUNCTIONS OF THE ACTORS IN AGRICULTURAL DEVELOPMENT

ROLE	FUNCTIONS	ACTORS
Implementers		Farmers
Supporters	Transmitters Input Provision	Extension Staff/ Development Agencies
Provide Potential Means	Technology Policy/Support Systems	Research Planning

Source: Norman (1989)

WHY SHOULD THE FARMERS BE INVOLVED?

There are, of course, two very obvious reasons why farmers, ie. farming families, should be involved in the research process.

(a) They are generally free to choose from the available technologies. Thus, if the technologies or support systems being disseminated to farmers are not accepted by them, the ultimate consumers, then all the work of other actors in the agricultural development process is wasted.

(b) They have a right to participate. Since farmers stand to lose or gain the most from adopting changes proposed by researchers, extension, development agencies and planners, they should have a voice in developing a product that they want.

However, an even more fundamental reason why farmers should be involved in the research process, is that they can improve the efficiency of the formal research process, either in terms of improving the probability of a return, or reducing the quality and quantity of the research inputs required. In other words, as implied earlier, farmers can contribute constructively[5]:

(a) during the descriptive/diagnostic stage, by articulating their needs or constraints which can help in formulating the appropriate research agendas of institutions;

(b) during the design stage, by helping to evaluate, in an *ex ante* manner, possible solutions to the constraints or needs they articulated;

(c) during the testing stage, by participating in the testing and *ex post* evaluation of the potential solutions that were identified in the design stage.

The farmers' contribution to the different stages of the FSR process is important because of their intimate knowledge about:

(a) the technical environment (physical conditions) of their farms such as soils, water movement, weed complexes, etc;

(b) the human environment (socio-economic conditions) or the quantity and quality of the resources they have at their disposal such as labour, land, capital (draught equipment, etc.) and managerial expertise;

(c) the complexity of their farming systems in devoting their limited inputs (resources) to growing a number of crops, to often keeping more than one type of livestock, and sometimes also pursuing an off-farm occupation.

The literature abounds with examples of how including farmers in the different stages of the FSR process has benefited the formal research process. Examples from Botswana are the following:

(a) Farmer soil classifications have been useful in distinguishing the different types of soil on which the main subsistence crop, sorghum, is grown (Flint, 1986). Also high potential sites have been identified by farmers on their own fields, which have been used in trials where inputs of high value or of limited availability, such as fertiliser and manure, have been located to improve the probability of a reasonable and dependable return. These high potential sites have generally proved to be located in lower parts of the fields, and to have a higher water retention capacity as a result of a higher clay fraction than other parts of the field (ATIP, 1988).

(b) On experimental stations, an evaluation of technologies-of-necessity is primarily expressed in terms of the return per unit of land. However, in most of the semi-arid areas of Africa labour is often more limiting than land because of the seasonal rainfall variability. Thus cropping activities also tend to be very seasonal in nature, resulting in critical labour bottleneck periods. Increasing the return per unit of land does not necessarily simultaneously increase the return per unit of labour. It is only by conducting on-farm research, with farmers, that more relevant socio-economic evaluation criteria can be included. Because of such inputs from farmers, some of the technologies we have worked together on have had to be evaluated somewhat differently from that originally envisioned. An example is the double ploughing technology which is briefly discussed later in the paper. The issue of return to labour during the ploughing/planting period means that labour savings in double ploughing and weeding becomes important when it would not have been considered in an evaluation based on returns per hectare.

(c) The annual rainfall, in the areas of Botswana where we work, occurs during the hot summer months and is only about 475 mm per year. This low annual total conceals considerable variation between and within years, and the fact that there is no month when rainfall exceeds potential evapotranspiration. Within this hostile environment, many farmers try to buffer their farming systems by keeping livestock and, whenever possible, engaging in off-farm enterprises. Therefore, we have concluded through our work with farmers that it is unlikely that any surplus funds they have for investment will go into arable production, since the level and certainty of the return is likely to be better from investing in livestock or off-farm enterprises. We are therefore convinced that technologies that improve the stability of production, and/or do not require substantial increases in resource outlays, are likely to be most attractive to farmers[6], yet are particularly difficult for researchers to identify. This concern for maintaining low investment has led to current system-wide research investigating better water management techniques.

(d) Wide heterogeneity exists in physical and socio-economic conditions. This gives rise to differences in the farming systems, and possibly the constraints, that farmers face. One "blanket" technology is unlikely to be relevant to all farmers. For example, water availability is undoubtedly the fundamental constraint. Improvements in the timeliness of operations, to ensure optimum use of the water when it is available, will be dependent on labour and type of draught power available to the farmers. It is important to work with a number of different "types" of farmers in order to develop a number of technological options. This heterogeneity also means looking at numerous evaluation criteria. For example, cowpea varieties are evaluated not only on the basis of palatability and yield of grain, but also according to palatability and yield of the leaves which are used for human consumption.

(c) The set of extension recommendations used when ATIP started in one area of the country were not being used by farmers. By working with farmers, it was possible to begin to find out why the recommendations were not being adopted and to propose modifications (eg. double ploughing rather than autumn ploughing) or support systems (eg. training in row planting) to make the recommendations more specific and useful.

In conclusion, the key to a collegiate relationship between FSR workers and farmer's is mutual respect. In a paternalistic relationship, only those technologies that researchers feel confident about are likely to be offered for testing by farmers. However, if a partnership develops, then an attitude of joint investigation can flourish, and no blame is likely to be apportioned to the FSR worker if the trial does not succeed. Other elements that also contribute to forming a good relationship include: sensitivity to local customs, friendliness, willingness to listen and patience to ensure that all parties understand the potential obligations and benefits of any proposed collaboration.

ATTAINING RESPECTABILITY WITHIN AN INSTITUTIONAL SETTING

Attaining respectability within an institutional setting has many analogies to the methods of achieving mutual respect between researchers and farmers, discussed above. Constructive linkages are critically important in developing attitudes of a common perspective, and a feeling of mutual dependence. Two elements that we believe are important in establishing such linkages are to:

(a) recognize the complementarity between station-based research and on-farm research;

(b) establish systems that ensure mutual accountability and credibility.

(a) *Understanding Complementarity*

Table 2 lists some of the differences between on-station and on-farm research and illustrates their complementary nature. For example, trials conducted on experiment stations can help to establish cause-effect relationships in designing solutions to the problems and needs of farmers. On-farm research provides a way of evaluating the technologies in a practical manner, within a systems perspective, using criteria that are relevant to the farmer. It may also feed back to researchers information on the most relevant levels of experimental and non-experimental variables, and on priorities for on-station research. With reference to the experimental and non-experimental variables, the following points are potentially important in improving the practical relevance of on-station research:

(a) Results from cause-effect type research need to include levels of experimental variables that farmers can realistically implement[7]. If all levels of input are too high, then the research may have little

TABLE 2

SOME DIFFERENCES BETWEEN ON-STATION AND ON-FARM RESEARCH

CHARACTERISTIC		ON-STATION RESEARCH	ON-FARM RESEARCH
Major emphasis of research		Applied	Adaptive
Location of trial		Usually experiment station	Unusually on-farm
Disciplines involved		Often single Mostly technical	Usually several Technical and social
Priority setting for trial:	Researcher	More involved	Less involved
	Farmer	Less involved	More involved
Experimental Design:	Complexity	Usually more	Usually less
	Management	Researcher	Researcher or farmer
	Implementation	Researcher	Researcher or farmer
Degree of experimental control		More	Usually less
Ability to establish cause/effect relationships:		Easier	Harder
Evaluation of trial results- Factors taken into account:			
	Systems perspective	Less likely	More likely
	Technical feasibility	Yes	Yes
	Economic viability/reliability	Less likely	More likely
	Social acceptability	Less likely	More likely
	Farmer opinion	Not likely	More likely
Expense of experimental programme:			
	Fixed (overhead) costs	Likely to be higher	Likely to be lower
	Variable (recurrent) costs	Likely to be lower	Likely to be higher

relevance without special support programmes for farmers. This applies not only to external inputs like improved seed or fertiliser, but also to internal inputs such as household labour.

(b) A closely related consideration is: what should constitute experimental and non-experimental variables? The level of the non-experimental variables may not be the same for on-station as under farmers' conditions. For example, well-prepared seedbeds on experiment stations can provide very different results in eg. varietal testing from what would occur under farmers' seedbed preparation.

Special justification should be made *ex ante* if the level of the non-experimental variables differs significantly from what the farmer is likely to be able to achieve[8], since differences may influence the relationships being examined between the experimental variables.

Finally, it is important to understand that not only are there some general differences between on-station and on-farm research, but there are also different ways in which trials can be undertaken on-farm. Those of us engaged in on-farm research have, as we implied earlier, multiple clients for the results of our work, namely farmers, station-based researchers, extension and development agency staff, and sometimes planners. Similar types of trials do not have equal appeal to all clients. As a result, we make substantial use of three different types of trials, differentiated on the basis of who manages and who implements the trial, ie. researcher (technician) or farmer (Table 3). Thus three types of trials are possible:

(a) Researcher managed and researcher implemented (RMRI).
(b) Researcher managed and farmer implemented (RMFI).
(c) Farmer managed and farmer implemented (FMFI).

RMRI trials use the same principles as those conducted on experiment stations[9]. Therefore, the level of testing achieved meets the standards demanded by experiment station-based researchers. However, FMFI trials are the most satisfactory for farmers and provide the most practical test of the technology. Due to management and resource constraints, yields or returns will diminish from the RMRI to the FMFI level. The information in Table 3 notes the major differences between RMRI work, mainly the preserve of experiment station research, and RMFI and FMFI trials which emphasize on-farm work. For example, the Table implies differences in the research objectives, methods, experimental designs, types of data collected, methods and analysis, and evaluation criteria. It is also important to understand that RMRI trials are more adept to identifying cause-effect relationships and yield hard data; while farmer attitudes and

TABLE 3

EXPECTATIONS OF DIFFERENT TYPES OF TRIALS[a]

Item	Researcher Managed and Researcher Implemented (RMRI)	Researcher Managed and Farmer Implemented (RMFI)	Farmer Managed and Farmer Implemented (FMFI)
Experimental			
Stage	Design[b]	1st stage testing	2nd stage testing
Design:			
Complexity	Most	Less	Least
Type	Standard	Simple standard	With and without
Replication	Within and between sites	Usually only between sites but can also be within	Between sites only
Who selects technology?	Researcher	Researcher/farmer	Farmer
Participation by:			
Farmer	Least	More	Most
Researcher	Most	Less	Least
Number of farmers	None	Some	Most
Farmer groups	Least	More	Most
Potential:			
"Yield"	Most	Less	Least
Measurement errors	Least	Greater	Most
Degree of precision	Most	Less	Least
data:			
Hard (objective)	Most	Less	Least
Soft (subjective)	Least	More	Most
Determination of cause/effect relationship	Easiest	Least easy	Least likely
Incorporation into farming system	Least	More	Most

Table 3 continued

Item	Researcher Managed and Researcher Implemented (RMRI)	Researcher Managed and Farmer Implemented (RMFI)	Farmer Managed and Farmer Implemented (FMFI)
Evaluation:			
By whom?	Mainly researcher	Researcher/farmer	Mainly farmer
Nature of test	Assesses technical feasibility	Some of each plus economic evaluation	Validity for farmers - practicality acceptability
Appeal to:			
Researchers	Most	Less	Least
Extension Staff	Usually least	More	Most
Farmers	Least	More	Most
Ease of acceptance of results of trial	Researcher	Researcher/farmer/ extension	Farmer

a. There is a degree of subjectivity in some of the entries in the Table, but in general they do reflect what is usually the case. In a sense, these expectations also reflect the reasons why the different types of trials are undertaken.

b. Standard multi-locational trials are also RMRI.

Source: Norman, 1989

inputs into the research process are more easily obtained from RMFI and FMFI work undertaken on farmers' fields. Once these differing roles are acknowledged it is easier to recognize the complementarity of the different types of trials, and the use of appropriate criteria for evaluating the value of research.

If station-based researchers, more accustomed to RMRI type trials, fail to appreciate the nuances and relevance of the different types of trial, then they may dismiss them unfairly, convinced that the experimental procedures are poor because of high coefficients of variation which result. These may arise because it is virtually impossible to ensure:

(a) standardization in the non-experimental variables (*ceteris paribus* conditions) particularly in FMFI trials;

(b) minimisation of measurement errors, particularly in RMFI and FMFI trials.

However, as long as the nature, purpose and expectations of the different types of trials are properly understood, they can help satisfy the needs of the different clients of farming systems work.

Some FPR practitioners would criticise our approach as still being too dominated by scientists and formal institutions, arguing that, although allowing for increasing involvement of farmers, it does not give sufficient latitude to farmers to incorporate their own informal R and D and to decide for themselves what research questions they wish to address[10]. This issue has not been an easy one for us to resolve. In the farmer group approach, which we discuss later in the paper, we have allowed farmers to decide their own research agenda by selecting those technologies they wish to test. However, we have also suggested but not insisted, that they use some form of side-by-side or with/without comparison to provide some comparative information that the other clients can relate to. Given the institutional setting, our concern is not only with those we are working with directly, but also with the need to use our very limited research resources in collecting and information from them to convince station-based researchers, extension/development agency staff and planners that certain technologies should be offered to the mass of farmers[11]. The more diverse the ways in which comparisons of a technology are made by different farmers at the FMFI level, the less likely it is that a valid and general statement can be formulated and offered to the other clients[12]. In any case, as we discuss in the next section, data from FMFI work sometimes has limited credibility as far as other clients are concerned.

(b) *Accountability and Credibility*

Often there tends to be a wide gulf between on-station and on-farm research, creating problems of accountability and credibility within and between institutions that contribute to the agricultural development process. Consequently in Botswana, there is currently a move to improve the planning, management and evaluation of research as a whole. The approach that is developing involves the following:

(a) A number of multi-disciplinary research groups based on specific commodities or subject areas are being formed and will include representatives of both on-station and on-farm research, and hopefully extension. These groups will plan, manage and monitor the studies, surveys and trials that are approved for their group.

(b) It is likely that the proposals on recommended new technologies will be presented with supporting evidence from the research groups to the recently revitalised Recommendations Committee. This committee is to comprise research and extension personnel and is likely to be chaired by the Director of Agricultural Research. If approval is granted, the technology becomes officially accepted for extension and an *Agrifact*, a recommendation leaflet, is created or modified. This is then published by the Department of Agricultural Field Services (DAFS), and distributed to extension staff (ie. Agricultural Demonstrators) for dissemination to farmers.

The intention is that this newly adopted strategy should help to improve both accountability and credibility by encouraging more communication, better understanding, more collaborative work, and by ensuring that all research activities are directed towards the resource-poor farmers who predominate in Botswana.

There are, of course, several issues that will need to be resolved. Two obvious ones are: what should be included in a recommendation and, what types of information are acceptable as supportive evidence for a recommendation? These issues have become much more apparent with the development of on-farm research involving the incorporation of farmers in the research process and, as a result, the growing recognition of the heterogeneity in the physical and socio-economic environment. As a result, the procedure for approving recommendations would be more relevant if:

(a) conditional clauses and targeted information were incorporated;

(b) the information base were to include farmers' opinions;

(a) *Incorporation of Conditional Clauses and Targeting*

The technological package concept assumes that farmers have homogeneous agroecological and socio-economic conditions. It is therefore not surprising that many farmers have adopted components rather than the complete package and in doing so, receive little advice from researchers. For example, should they apply a top-dressing of fertiliser when they don't weed? The return from limited research resources[13] can be improved by:

(i) incorporating conditional clauses, which would advise on what to do under circumstances different from those originally envisaged in the recommendation. These deviations could be attributable to the farmer, weather conditions, lack of availability of some of the technological components, etc. Included in the conditional clauses are possible variations such as: a recommended step-wise approach to the adoption of the different components of the package, and a suggested range of options for the farmer to pursue;

(ii) including targeted information to show under what technical and socio-economic conditions the technology being recommended would be most applicable. For example, a particular technology may be most suitable for one soil type, and for farmers with a specific resource base.

Thus in recognizing the diversity of farmers, on-farm research can help in developing targeted and conditional clauses for proposed improved technologies. In doing so, it can potentially improve the multiplier effect of the limited research resources by providing a technology which is appropriate to more farmers through widening intervention possibilities. It is particularly important to develop a range of options in the more marginal farming areas.

(b) *Widening the Information Base for Approving Recommendations*

The hard objective data conventionally required for approving recommendations has to be collected in an RMRI experimental environment. However, it is increasingly accepted that there is a need also to conduct a socio-economic evaluation. We have found that in order to approach farmers' operational environments more closely, much of the data required are best collected in an RMFI experimental environment. However, as was shown in Table 3 there is likely to be a corresponding increase in the "softness" of the data, therefore potentially reducing its acceptability in the technology evaluation process. Increasing amounts of qualitative attitudinal data collected at the FMFI level, are likely to be regarded with even more suspicion by an approval committee. There is obviously no easy solution to this problem, but we believe a judicious mix of hard/quantitative and soft/qualitative data is appropriate in the evaluation process.

Scientific objectivity, requiring many years of painstaking experimental work, often in a somewhat artificial environment, should not be completely substituted for common sense. For example, some of the information needed for drawing up the conditional clauses and targeting information, does not require exhaustive experimentation, but can be derived from the knowledge and experiences of scientists working at the farm level. Resources for research are limited, and ways need to be sought to maximise the return from them so as to facilitate the agricultural development process.

On-station researchers are understandably conservative in making recommendations[14], while extension staff are, also justifiably, anxious that recommendations are forthcoming on a regular basis. Since farming systems researchers work with relatively few farmers, it is important that the recommendations are formulated and passed to extension staff at the earliest possible opportunity, in order to maximize their impact on the farming population. Recommendations will therefore need to be based largely on *ex ante* evaluation. Because of limited research resources and the needs of various interest groups, devising interim best-bet recommendations based on knowledge currently available to the research scientists can be justified. These should have the proviso that they can be modified in the light of knowledge obtained later. There is, of course, an inherent danger in doing this especially if an interim recommendation has any possibility of adversely affecting the environment or farmers' welfare. However, if the relevant interested parties are brought together, it should be possible to avoid drawing up inappropriate recommendations. This is one reason why we see a role for a Recommendations Committee at the headquarters level.

ENSURING FARMER INPUT INTO THE RESEARCH PROCESS

We have already argued that a pre-condition for ensuring active constructive input by farmers into the research process is to develop a good collegiate relationship between researchers and farmers. We have also indicated that we believe farmers can play important roles in the descriptive/diagnostic, design and testing stages of FSR.

We have used a number of different methods for obtaining information from farmers and for exchanging information with them. Fundamental to our approach has been the conviction that farmers can provide valuable information that can greatly reduce the time and resource commitments of researchers[15], and thus improve the productivity of our limited research resources. The most innovative and important method we have used in facilitating research/farmer interaction (Table 4) has been the extensive use of researcher-led farmer groups.

Details of these groups have been reported elsewhere (Norman et al., 1988; Masikara et al., 1988). Very briefly, in addition to furthering communication between researchers and farmers, and among farmers, the groups also provide an efficient and productive forum for designing, implementing and evaluating joint research activities. Over the years, we have found them to be very useful in facilitating farmer field days, in encouraging farmer-to-farmer interaction and in providing an opportunity for other actors in the agricultural development process (eg. on-station researchers, extension/development staff, etc.) to interact with farmers. We have sought to make the groups more effective by: reducing the opportunity cost of meeting times, ascertaining the optimal group size,

TABLE 4

TYPES OF CO-OPERATION BETWEEN FARMERS AND ON-FARM RESEARCH

NATURE OF COLLABORATION	DEGREE OF COMMITMENT FARMER	DEGREE OF COMMITMENT RESEARCHER	WHAT FARMER HAS TO COMMIT
A. Mainly dialogue			
Survey (formal and informal)	Low	Some	A little time
Opinions on RMRI trials[a]	Low	Low	A little time
Farmer field days	Low	Low	A little time, maybe some money
B. Trial participants			
RMFI	Some	Some	Land, labour
FMFI	Much	Low	Land, labour, management
C. Farmer group			
Researcher-led:			
Mahalapye[b]	Much	Some	Time, land, labour, maybe management
Francistown	Much	Much	Time, land, labour, management
Extension-led	Much	Low	Time, land, labour, management

a. Informal groups of farmers have been brought together in the Mahalapye area to respond to specific questions about the different treatments being tested in the trial. This is done in the field when differences in various treatments are visible.

b Consists of both RMFI and FMFI trials, with an attempt to reduce the intensity of researcher input by having fewer meetings than in the case of Francistown area. However, undoubtedly, this reduces the farmer-to-farmer interaction and farmer-researcher interaction in a group situation.

c. Consists of FMFI trials and monthly farmer group meetings to promote farmer-to-farmer interaction and farmer-researcher interaction.

determining the amount of researcher initiative that should be used in running the groups[16], and considering the desirability of group continuity vis-à-vis farmer replacement.

Resolution of these issues will be culture and/or location specific. For example, given the nature of the society in Botswana, we have found no need to differentiate groups according to socio-economic class or gender. Membership of the groups is voluntary, the majority of participants are women and members of the different socio-economic classes appear to participate freely in the discussion. These features, of course, make our task somewhat easier. A major advantage of the farmer group approach is that detailed prior knowledge of the circumstances of individual families is not necessary: families form sub-groups spontaneously to test technologies according to their own assessment of how appropriate they are.

The best indicator of a productive researcher-farmer relationship is the spontaneous adoption of technologies tested by farmers in on-farm trials. Various types of indices have been developed to measure this. One index used in recent ATIP work is calculated as the percentage of representative farmers using a technology multiplied by the percentage of the land for which the technology is used, divided by 100 (Hildebrand in Shaner et al., 1982). A recent study (Worman et al., 1989), indicated that in 1988-89, 26 percent of the interviewed farmers had spontaneously adopted some of the technologies that ATIP had tested with them over the years. On average, 14 percent of their crop land was devoted to the new technology. Overall, the adoption index amounted to 3.6. Possible reasons why spontaneous adoption has not been higher are discussed in the next section.

ENSURING WIDESPREAD FARMER ADOPTION

The extension/development agency staff play a major role in disseminating technologies to the mass of resource-poor farmers. At best, all on-farm researchers can do is to help the extension/development agency staff and farmers **create processes** that will improve the efficiency of dissemination and adoption. In this sense we see our role as being **supportive and catalytic**, rather than being one of leadership.

Three issues that need to be addressed in creating favourable conditions for adoption are:

(a) The technologies must be readily available

(b) It is important to establish an efficient means of relating to the farmers.

(c) Under certain circumstances, farmer training courses are desirable.

(a) *Range of Technologies*

Earlier, we discussed the need for targeting and conditional information to enable a greater number of farmers to approach their optimum situation. These types of information imply a need for a range of options, not only based on the different physical and socio-economic circumstances under which farming families operate, but also to provide an element of choice according to eg. rainfall patterns. The more closely these options reflect the farmers way of thinking and the decision-making strategy they use, the more likely they are to be interested and the more effective will be the role of extension/developmental agency staff.

(b) *Extension-Led Farmer Groups*

Botswana is a very thinly populated area, with very limited numbers of extension staff and farmers scattered over large areas so that working with individual farmers is not efficient. Extension-led farmer groups have recently been pilot-tested as a way to address this problem and to try and transfer to the extension-farmer contacts some of the desirable characteristics and attributes that have been discussed earlier with research-led farmer groups. These two types of groups differ with respect to leadership and types of technologies offered to farmers. In extension-led farmer groups only recommended technology is usually offered to farmers, while in research-led groups, technologies which are still to be approved are also offered. The pilot-testing of these extension-led farmer groups, which changes the relationship of the farmer from essentially a "receiver" of technology to an active collaborator with the extension staff, has had sufficient success to be recommended for expansion in the second phase of a major development programme in Botswana. However, the quality of the extension staff, and the timeliness of material input supply are critical in determining the success of this approach.

(c) *Farmer Training Programme*

More complex technologies, and those that require substantial changes in farmer practice, are less likely to be adopted. For example, in the adoption study referred to earlier, the index for relatively simple double ploughing was 8.6 compared with 2.9 for more complex planting, usually done with animal drawn equipment. Consequently, in another area of Botswana we have concentrated on helping the extension/development agency staff to train farmers in row planting (Siebert et al., forthcoming).

The harsh climatic environment of Botswana leaves little flexibility in the farming system, and a key management factor is the ability of farmers to plough and plant when it is likely to improve water availability for plant growth. Researchers are therefore faced with the challenge of developing relevant technologies to break a major constraint, rather than having the easier task of developing technologies that will avoid the constraint by exploiting flexibility (Norman and Collinson, 1986).[18] Under these conditions, adoption by farmers of technologies, such as the ATIP ploughing-planting operation (see below), involves major changes in their farming system. In the absence of comprehensive farmer-training, it is not surprising that spontaneous adoption indices in the ATIP study referred to above are generally low[19]. Interestingly enough, in the same study, it was found that the wealthier farmers had a much higher level of adoption (ie. adoption index of 12.0 for those owning any cattle). Obviously, the relative risk for wealthier farmers in making major changes in their farming system was much lower than for poorer farmers.

(i) It is apparent that farmers who already own row planting equipment are more likely to practise it after the training course.

(ii) It is beneficial to have husbands and wives present at courses which emphasize row planting combined with mechanical inter-row cultivation. Since men are often primarily responsible for the plough/planting operation and women usually do the weeding, row planting is more likely to be performed if the women perceive the potential savings in weeding time and as a result exert pressure on the men to adopt row planting.

IMPACT OF ON-FARM RESEARCH

Although in this paper we have stressed that the **primary** role of on-farm research is to serve the farmer, it also has an important **secondary** role in assisting on-station researchers to develop technologies that reflect the needs of farmers[20].

This may be illustrated by looking at on-farm research in another way, in terms of **leverage** or **non-leverage** interventions. High leverage interventions involve introducing changes in an operation or enterprise in a part of the farming system which is a major absorber of farm resources, and/or where timing of those resources is restricted. All other things being equal, the adoption of technologies that improve the productivity of such resources is likely to maximize improvement in the productivity of the farming system as a whole. Low or non-leverage interventions, on the other hand, may not have a major impact on the productivity of the farming system as a whole, but may help in improving the productivity of a particular enterprise. Such interventions involve less change and are likely to be more acceptable to farmers.

In Botswana, on-farm research has had an impact in both ways. For example:.

(a) On-farm research has responded to requests from on-station researchers to evaluate specific technologies. This supportive role has generally involved potential low-leverage type interventions arising out of commodity research programmes such as crop variety evaluation (eg. cowpea, sorghum, groundnuts, etc.), evaluating seed dressing on groundnuts, evaluating whether labour-intensive hilling of groundnuts can be avoided, etc. These types of technologies are sometimes evaluated at the RMFI level (ie. if "hard" data are required), but more commonly evaluated in the FMFI mode by offering them as options in the researcher-led farmer groups. The major motivation behind on-station researchers requesting on-farm research evaluation of their proposed technologies is to elicit the opinions of farmers and to determine the robustness of the technology when implemented and managed by farmers themselves.

(b) The primary aim of on-farm research has been to respond to the needs and problems articulated by farmers. The focus has been on high-leverage interventions that will ensure maximum use of water during the ploughing/planting bottleneck period. Timeliness of operations is largely a function of the availability of draught power and labour. The traditional system in Botswana is therefore to broadcast seed and plough it in two or three days after each planting rain[21]. This land extensive system, which is a natural rational response to the limited draught and labour available during the ploughing-planting bottleneck period, improves the probability that post-planting rains will be sufficient to result in a harvestable yield, on at least some plots. However, it does not, on any given planting, improve the probability of establishing a good plant stand, which is an important pre-condition for obtaining a good yield. Much of our work has focused on this issue. Unfortunately, strategies designed to improve the amount of water available at planting require more draught and labour because of the desirability of a early ploughing - at least one rain before planting - to open up the soil profile to trap more water. At planting we have, at a minimum, advocated broadcasting the seed and ploughing, or alternatively, have suggested using the more complex row planting technology which sometimes may need to be immediately preceded by another cultivation to provide a suitable seedbed and/or to get rid of weeds.

In our earlier work we considered these strategies as substitutes for the traditional system. Not surprisingly, farmers were sceptical about proposals, since they implied sacrificing production from early rains by doing just ploughing when planting could have been undertaken. Fortunately, in an attitudinal survey some farmers straightened our thinking out! They advocated that the preliminary ploughing should be done when soil moisture was too little for planting, therefore reducing the opportunity cost of the first ploughing, through not sacrificing days when soil moisture was sufficient for planting. Therefore, we now view our proposed strategies as **options** for farmers to pursue alongside their traditional system, by increasing the length of time planting should be possible during subsequent planting periods.

Time does not permit us to go into more detail at this point, but further research and analysis has resulted in a proposal recently submitted to the Director of Agricultural Research suggesting that the Recommendations Committee approve the preparation of a recommendation leaflet on double ploughing. This leaflet advises that the first ploughing should be carried out when planting cannot be done, when farmers are faced with a land constraint or lack of labour for weeding and in situations where soils are relatively deep and have a good water holding capacity[22].

Although in this discussion we have concentrated on double ploughing, row planting has also received a great deal of emphasis in work undertaken by ATIP. One aspect of this has dealt with testing the potential of a hand pulled rotary injection planter intended to give some control over the timing of planting to those farmers who do not have control over drought. A related area has been to improve the productivity of donkeys by introducing a harness from Kenya; this has been enthusiastically tested by farmers.

INCORPORATING SOCIETAL GOALS

In this paper, we have stressed the importance of on-farm research responding to the "felt" needs articulated by farmers. However, the closer farmers are to the survival level, the more likely that such needs will be those that need fulfilling in the short-term (eg. producing enough food to survive until next year) and the less concerned they will be about environmental degradation in the longer term. As a result, there is often a short-term focus in much on-farm research to the neglect of longer-term orientation in which societal impacts become more crucial. This, combined with the methodological complexity of incorporating societal evaluation criteria and the time required in deriving such societal impact evaluations, has limited the role of farming systems work in this area. Emphasis has largely been confined to subjective *ex ante* evaluations of the likely long-term impacts of technology.

Because of low production and a high demand for agricultural products, tremendous pressure is now placed on the agricultural sectors of many African countries. However, current adoption of technologies and the implementation of support programmes can have either negative or positive influences on environmental stability. There is explicit concern for conserving the productivity of the soil. However, both technologies and policy support systems need designing now so that they will have a positive impact on environmental stability in the future. We believe these policy support systems should foster the idea that if something is taken out of the land in encouraging production, something else needs to be put in to sustain land productivity in the future. For example, in Botswana two development programmes provide incentives for destumping to improve the efficiency of the ploughing operation. This could have a negative impact by encouraging erosion, thus lowering the potential of the land in the future. A constructive policy is to encourage destumping along with a programme to encourage planting of windbreaks, live hedges, etc.

However, conservation measures by themselves are unlikely to be very attractive to most resource-poor farmers. Rather, implementation will need a high degree of subsidization, or the use of a "carrot and stick" approach which might require, for instance, that farmers participate in a specific conservation practice if they are to benefit from programmes designed to stimulate production.

CONCLUDING COMMENTS

In this paper we have tried to demonstrate the critical role that can and should be played by resource-poor farmers in planning as well as implementing the process of agricultural development. At the same time, however, it is important to appreciate that although farmers constitute the major group of actors in the agricultural development process, other "actors" have important supportive roles to play. Substantial power, resources and expertise are in the hands of these other "actors" and have the potential to expand the horizons of farmers to speed up the process of agricultural development and to control the balance between the attainment of private and societal goals. This is why we believe it is critically important to determine how the formal institutional settings, in which most of the other "actors" are located, can interact with farmers in the ways advocated by FPR. We believe that FPR without the support of these formal institutions will have little sustained success.

ENDNOTES

1 Originally presented at the Indian Society of Agronomy-sponsored International Workshop on "Farmers Experimentation, On-Farm Research, Risk Adjustment and Traditional Wisdom" held at an "International Symposium on Natural Resource management for a Sustainable Agriculture" in New Delhi, India on February 6-10, 1990. The opinions expressed in this paper do not necessarily reflect those of the Department of Agricultural Research. The authors wish to acknowledge the comments offered by Dr F Worman and the editorial assistance of Mrs J Snyder.

2 Related to this, Chambers et al., (1989, p 186), have observed that bureaucracies (formal institutions) tend to centralize, standardize and simplify. This is largely incompatible with the conditions of resource-poor farm families who practise complex farming systems, exhibit considerable heterogeneity and are geographically scattered.

3 Some of these factors, which are discussed elsewhere, include educational elitism, the desire to maintain the *status quo* on the part of existing personnel, institutional rigidity, evolving methodology of farming systems work and a lack of expertise in farming systems work (Poey, 1986; Fresco and Poats, 1986).

4 In other words, farming systems research facilitates a process and does not produce a product by itself. Therein lies the problem and the difficulty of accountability and credibility for farming systems research. Discussion on this issue has been presented elsewhere (Norman, 1989).

5 The descriptive/diagnostic, design and testing stages, together with the dissemination stage, constitute the different steps in FSR. Obviously farmers are involved in the dissemination stage, since they are the adopters of the technologies.

6 Having said this, it should be noted that if the opportunity cost of such resources could be lowered, then farmers might be more interested in increasing resource outlays. Obvious examples would include: input subsidisation to decrease the financial outlays required, use of labour and draught in non-peak periods, etc.

7 There is, of course, justification for having a range of levels of experimental variables that go beyond what farmers are likely to adopt. This is particularly relevant if it is a design-type experiment used to estimate response curves. Also, this approach can be justified by eg. using the results from responses at the higher levels to influence planners to change support systems to stimulate higher use by farmers of the specific inputs.

8 For example, in an on-going multi-locational National Tillage Trial, being undertaken on a number of different soil types, which has the objective of systematically comparing different tillage treatments designed to improve water available to the plants, it has been decided to keep the treatments as weed-free as possible so that they do not complicate an analysis of the differences between the tillage treatments in what is a design-type trial. It is recognized, however, that farmers may

not be able to create a weed-free environment. Therefore, measurements are being made of the time required in each treatment to keep the plot weed-free.

9 An issue relating to RMRI trials, but not central to the theme of this paper, is whether these types of trials should be undertaken on-station or on-farm. In general, we believe that trials designed to answer cause-effect relationships should, whenever possible, be carried out on experiment stations. The reasons for this include; lower implementation cost (eg. in terms of logistics, time etc.), and potentially better control (eg. in terms of easier supervision, easier maintenance of *ceteris paribus* conditions etc.). However, there are occasions when conducting such trials on farmers' fields is highly desirable and sometimes even essential. Such a situation arises if it is felt that the special environmental situation of the experiment station does not provide a realistic environment for testing a technology. Would the technology fail completely if it were then transferred to farmers' fields? For example, a great deal of herbicide work probably needs to be done on farmers' fields where the weed complex is likely to be different from that on the experiment station. The National Tillage Trial mentioned earlier is being undertaken mainly on farmers' fields, so as to test the trial treatments on a number of soil types.

10 Further clarification on these points can be obtained from the following references: Biggs and Clay (in Chambers et al. (eds) 1989); Waters-Bayer, 1989 and Chambers et al. (eds), 1989) particularly pages 165-169.

11 Basically, we would argue that the FPR approach is fairly resource intensive, in terms of materials, and researcher and extension time and skills. We see great value in using the approach with a limited number of farmers who are hopefully representative of other, but we believe that, because of resource limitations, there will still have to be a technology transfer element in helping the mass of resource-poor farmers.

12 However, on occasion this free expression can have useful consequences for furthering station-based research. For example, Sumberg and Okali (1989) cite experiences with the rather complex alley cropping technology in Nigeria. It was introduced to farmers in the FMFI mode and was subject to varied application by farmers. As a result, there was considerable potential for influencing the station-based alley cropping research agenda.

13 See also discussion by Byerlee (1986) on prescriptive and auxiliary information.

14 Optimum recommendations, drawn up after many years of work on the experiment station will, in fact, for most farmers, given the heterogeneity within their environment, not be optimal.

15 One of us learnt this the hard way. After painstakingly collecting detailed data on intercropping in northern Nigeria, empirical analysis indicated valid reasons for growing crops in mixtures (Norman, 1974). Upon completion of the work, the farmers were asked why they grew crops in mixtures. The reasons compared very closely with those tested via hypotheses. Treating the farmer as a person, rather than as an object,

could have saved a large research resource commitment, although the 'hard' objective data were probably more influential in convincing station-researchers of the validity of intercropping.

16 The ideal, of course, is to play a catalytic rather than leadership role.

17 In other words, in FSR terminology, we do not need to know *ex ante* what recommendation domain they fit into since they are doing the selecting.

18 In fact, if one looks at the performance of FSR to date, it has generally been more successful in more equable climates than exist in Botswana. In examining the relative success of FSR in such environments, it is apparent that much of it can be attributed to exploitation of flexibility in the farming system, often requiring only minor changes on the part of the farmer, rather than breaking constraints. Technologies aiming to exploit flexibility in the farming system are thus more likely to be spontaneously adopted and are less likely to require farmer training programmes to encourage their adoption.

19 In a sense, implementation of such programmes would mean that any adoption occurring would cease to be spontaneous. One interesting alternative that ATIP has tried, instead of a large-scale aggressive farmer training programme, is to concentrate on teaching row planting to a few farmers who have then done row planting on a custom-hire basis for other farmers. Because of the amount of row planting these farmers did in one year, they quickly built up their managerial skills with respect to this practice (Modiakgotla, 1989).

20 An alternative way of viewing these roles is as direct (primary) or indirect (secondary) impacts.

21 Usually there are not more than 15 days suitable for planting in any given year.

22 Much of the data on which these conclusions are based are as yet unpublished, but some empirical data is available in Worman (1987), Heinrich and Worman (1988) and Heinrich et al. (1989).

REFERENCES

ATIP. 1989. *Annual Report* Number 6. ATIP RD 88-2.

Biggs S D and E Clay. 1989. "Institutions and Decision-making in Agricultural Research". In Chambers R, A Pacey and L A Thrupp (Eds) 1989. *Farmer First: Farmer Innovation and Agricultural Research.* London: Intermediate Technology Publications Ltd.

Byerlee D. 1986. "Some Common Sense about Farmer Recommendations and Extension Advice". *FSSP Newsletter.* 4(4):4-6.

Chambers R; Pacey, A and Thrupp, L A (Eds). 1989. *Farmer First: Innovation and Agricultural Research.* London: Intermediate Technology Publications Ltd.

Farrington J and Martin, A. 1988. "Farmer Participation in Agricultural Research: A Review of Concepts and Practices". *Occasional Paper* No. 9. London: ODI.

Flint M. 1986. "IEPP Farm Management Survey". Mimeo. Botswana.

Fresco L and Poats, S. 1986. "Farming Systems Research and Extension: An Approach to Solving Food Problems in Africa". In Hansen, A and McMillen, D (Eds). *Food in Sub-Saharan Africa.* Boulder: Lynne Rienner.

Heinrich G and Worman, F. 1988. "Double Ploughing: A Low-External-Input Technology for Increasing Grain Production on Hardveld Soils in Eastern Botswana". ATIP MP 88-17.

Heinrich G; Worman, F and Masikara, S. 1989. "1987-88 Double Ploughing Systems Trials (Researcher Managed/Farmer Implemented)". ATIP PR F89-1.

Hildebrand P E. 1982. Incorporating the Social Sciences into Agricultural Research: The Formation of a National Farm Systems Research Institute". Cited in Shaner, W; Phillip, P and Schmehl, S (Eds), *Farming Systems Research and Development.* Boulder: Westview Press.

Masikara S; Worman, F and Heinrich, G. 1988. "The Role of Farming Testing Groups in Research and Extension: Some Experiences in Botswana". Paper given at the 8th Annual Farming Systems Symposium at the University of Arkansas. Fayetteville, Arkansas. October 9th-12th. ATIP MP 88-11.

Modiakgotla E. 1989. "Custom-hire Row Planting Scheme, 1987/88". ATIP PR M89-1.

Norman D. 1974. "Rationalising Mixed Cropping under Indigenous Conditions: The Example of Northern Nigeria". *Journal of Development Studies* 11, 3-21.

Norman D. 1989. "Accountability: A Dilemma in Farming Systems Research". *Culture and Agriculture,* 38 (Spring/Summer): 2-8.

Norman D, and Collinson, M. 1986. "Farming Systems Research in Theory and Practice". In Remenyi, J (Ed), *Agricultural Systems Research for Developing Countries.* ACIAR Proceedings No. 11. Canberra, Australia: Australian Council for International Agricultural Research.

Norman D; Baker, D; Heinrich, G and Worman, F. 1988. "Technology Development and Farmer Groups: Experiences from Botswana". *Experimental Agriculture,* 24(3), pp 321-331.

Poey F. 1986. "The Bi-level FSR/E Team: Function, Composition and Implementation". In Butler, F C and Tomecek, M (Eds), *Selected Proceedings of KSU's 1985 Farming Systems Research Symposium. Farming Systems Research and Extension: Management and Methodology.* Farming Systems Research Paper No.11. Manhattan: Kansas State University.

Siebert J; Molatsi, L and Caplan, A. Forthcoming. "A Report on Field Courses to Train Farmers in Row Planting and Inter-row Cultivation". ATIP WP 24.

Sumberg J and Okali, C. 1989. "Farmers, On-farm Research and New Technology". In Chambers, R; Pacey, A and Thrupp, L A (Eds). *Farmer First: Farmer Innovation and Agricultural Research.* London: Intermediate Technology Publications.

Waters-Bayer A. 1989. "Trials by Scientists and Farmers: Opportunities for Co-operation in Ecofarming Research". In Kotschi, J (Ed), *Ecofarming Practices for Tropical Smallholdings - Research and Development in Technical Co-operation.* Eschborn: GTZ.

Worman F. 1987. "Economic Analysis of the ATIP Double Ploughing Trials, 1983-87". Presented at Department of Agricultural Research Seminar on Double Ploughing. Sebele: Botswana, September 7th. ATIP MP 87-6.

Worman F; Tibone, C and Heinrich, G. Forthcoming. *1989 Adoption Study: Sponteneous Adoption in Farmer Groups.* ATIP.

Agricultural Administration Unit
Overseas Development Institute
Regent's College
Inner Circle
Regent's Park
London NW1 4NS
England
Telephone: 071-487 7413
Fax: 071-487 7590
Telex: 94082191 ODIUK