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STAFF PAPER

FARMING SYSTEMS RESEARCH IN A DECLINING DONOR ENVIRONMENT

D. W. NORMAN*

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Department of Agricultural Economics
Kansas State University

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*Professor, Department of Agricultural Economics, Kansas State University, Manhattan, KS 66506.

KSU KANSAS STATE UNIVERSITY

Department of Agricultural Economics
Kansas State University, Manhattan, Kansas 66506

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BY

D. W. NORMAN[1]

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FARMING SYSTEMS RESEARCH IN A DECLINING DONOR ENVIRONMENT

BACKGROUND

The more 'traditional' research approach to developing relevant technologies has been very successful in the temperate and Green Revolution areas of the world in terms of improving and often sustaining productivity and benefiting the welfare of the majority of farmers. However, there has been less success in applying that approach to the much greater numbers of farmers in resource-poor agriculture, most of whom are located in the rainfed tropical regions of the world. Chambers, Pacey, and Thrupp [1989] suggest that the root of the problem lies in three general characteristics of resource-poor agriculture, which compare unfavorably with the types of agriculture in the areas mentioned above. These characteristics are: (a) the lack of production stability or 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.

In the late 1960s and early 1970s, recognition of the special problems of farmers in resource-poor agriculture resulted in the evolution of the farming systems research (FSR)[2] approach, in which the farmer was given a more prominent role in the research process. The process that evolved had considerable appeal in its simplicity and internal consistency, which convinced the pioneers that it would be readily accepted by other researchers and by national governments. Perhaps the FSR approach was too enthusiastically accepted by many donor agencies

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[2]. Sometimes called on-farm research with a farming systems perspective (OFR-FSP), farming systems research and extension (FSR/E), on-farm client oriented research (OFCOR), etc. A useful paper clarifying the various terms and concepts used in FSR is Merrill-Sands [1986].

before the fruits of the process had been given time to mature. For example, by the mid 1980s, about 250 medium- and long-term projects worldwide were carrying out farming systems work. As one of the major donors, USAID between 1978 and 1988 had funded 76 bilateral, regional, and centrally funded projects containing either a farming systems orientation or clearly focusing on farming systems work. Forty-five of these were in Africa [Brown et al, 1988]. This enthusiastic commitment has perhaps been unfortunate for two reasons. The first is that now many donors are going through a measured withdrawal of support of the farming FSR programs, just at the time when many national programs are justifiably accepting its value. Perhaps because of being over sold, FSR came to be viewed by many as a panacea rather than simply as an approach to developing and transferring technologies adapted to the needs of small farmers. Secondly, the initial enthusiastic acceptance blinded supporters of the FSR approach to the importance of improving the accountability and credibility of such work not only through monitoring/measuring its impact but also through maximizing its multiplier effect.

AGRICULTURAL RESEARCH AND ITS IMPACT

Indeed, the perceived lack of impact, together with the financial crises that exist in many countries in Africa, has resulted in reduced levels of support for agricultural research in general, by both donor agencies and many national governments. Although I have been asked to address issues specifically relating to FSR, the complementary relationship between on-farm FSR and on-station commodity research means that FSR cannot be treated in isolation. Impact of agricultural research is usually measured in two ways: estimating rates of return to resources devoted to agricultural research (i.e., both benefits and costs) and estimating the degree of adoption by farmers (i.e., benefits of research only). These types of studies have rarely been done in Africa. One recent paper indicates that only four rates-of-return studies have been done in Africa compared with 66 in Latin America and 25 in Asia [Daniels et al, 1990]. A general conclusion of such investigations is that success (i.e., high rates of return to agricultural research resources) depends critically on complementary infrastructure, institutions, and government policies. Unfortunately, in Africa, a lack of resources often contributes to a lack of infrastructure and ineffective institutions, which inhibit the adoption of improved technologies. However, an example of a success story that has been investigated is that of hybrid maize research in Kenya, where a rate of return of 68 percent was estimated [Karanja, 1990]. The varieties were rapidly adopted because there were parallel investments in roads, agricultural extension and credit, and seed distribution (both public and private support).

Increased efforts to monitor and improve the impact of agricultural research, in general, will be critically important in ensuring funding for the sustainability of national agricultural research institutions at the turn of the century. Numerous factors will influence the degree to which this will be successful, many of which go beyond the boundaries of this paper. Briefly, they include factors that influence both the cost and benefit sides of the equation, such as the optimal size of the research system,[3] research infrastructure, and support systems, including recurrent expenditure, incentive, and reward (i.e., monetary and professional) systems; establishment of effective systems for

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[3]. Some increasingly believe that the current sizes of many NARS are being expanded at the expense of quality and beyond the likely available domestic sources of funding to sustain them in the long-run [Eicher, 1990].

determining relevant research priorities; conducting research in a cost-efficient manner; and maximizing its impact through timely production of recommendations and timely transfer to those agencies responsible for dissemination. FSR, through being part of the research system, can influence some of these factors in a constructive manner. Therefore, although this paper is devoted to FSR, it should be recognized that FSR's effectiveness is greatly influenced by the effectiveness of the agricultural research system as a whole.

Given the reduced funds available for agricultural research as a whole, a legitimate concern is the optimal balance between applied (on-station) and adaptive (on-farm) research, i.e., FSR. There is a need for locational-specific adaptive research in all national programs. However, the same may not apply to some applied and, to a greater extent, strategic and basic research. For example, Gilbert and Sompo-Ceesay [1988] have suggested that in small national agricultural research systems (NARS), a case can be made for technologies to be selected, if feasible, from larger NARS and the international agricultural research centre (IARC) system. Although these considerations will have an influence on the size of FSR programs in NARS, I have decided, in this paper, to concentrate on what needs to be done to increase the impact of FSR, so that its future funding will be more assured.

FORMAT OF THE PAPER

As just indicated, the underlying theme of this paper is examining ways in which the impact of FSR can be improved. Therefore, after an initial section highlighting the various contributors to agricultural development and the current and potential role of FSR in the process, there is a brief evaluation of the role of the donor agencies in contributing to the development and acceptance of the farming systems research within national programs. In essence, the future of FSR within national programs will be based on the perception of the costs of implementing it compared with the benefits resulting from its application. Therefore, a small section addresses 'costs' in terms of institutional disruption and recurrent costs. This brief discussion on institutionalization is followed by a more detailed discussion on maximizing the return from the resources allocated to implementing the FSR approach. This does not necessarily involve many extra resources and, therefore, can help impute a higher benefit cost ratio for FSR. Thus, given the right environmental situation, these can be implemented in an era when external support for FSR type work is declining. Specific areas that will be addressed are those that I believe are currently underexploited in terms of reaping the maximum benefit from FSR. Indeed, it has been suggested that specific improvements on the benefit side of the equation in some of these areas might attract focussed donor funding in the future [Baker, 1991].

A final section is devoted to a brief discussion of the potential role of FSR in addressing the new donor fad, the issue of environmental sustainability.

AGRICULTURAL DEVELOPMENT CONTRIBUTORS AND THE ROLE OF FSR

The development, dissemination, and adoption of relevant improved technologies and the development and implementation of relevant policy/support programs are two equally important, complementary approaches to improving and sustaining both productivity and welfare of farmers. Thus, four groups of actors are essential to the process of agricultural development. These are:

(a). The implementors, i.e., the farmers.

(b). The supporters who transmit messages and provide inputs, namely extension staff and development agencies.

c) and (d). Those who provide the potential means of improving or bringing about agricultural development in the form of relevant improved technologies and relevant policy support systems, namely the researchers and planners.

Traditionally, the links between these various groups of actors have had a one-way, 'top-down' character as depicted in Figure 1A. Increasingly, it is accepted that, in order for the development process to be most efficient, the linkages need to have a two-way interactive character, as depicted in Figure 1B. Farming systems research can help to create this 'bottom-up' aspect that enables such linkages to develop. Unfortunately, some of these linkages from the 'bottom-up' still tend to be fragile, and the more usual situation is the one depicted in Figure 1C.

Thus, FSR can be seen as performing an integrative role. In a sense, it facilitates the process of agricultural development but does not, by itself, guarantee a desirable end result, which usually depends on factors beyond the control of farming systems practitioners. FSR is a process or approach [Byerlee and Tripp 1988] and produces at best an intermediate rather than a finished product. Also, it provides a brokerage function in linking the various groups of actors in the development process. Thus, trying to measure the direct impact of FSR is probably futile [Gilbert et al, 1980].[4] For example, favorable adoption studies in an area where FSR has been operating not only reflect effective FSR work but are also likely to be heavily influenced by effective station-based applied research, effective policy/support systems, and effective

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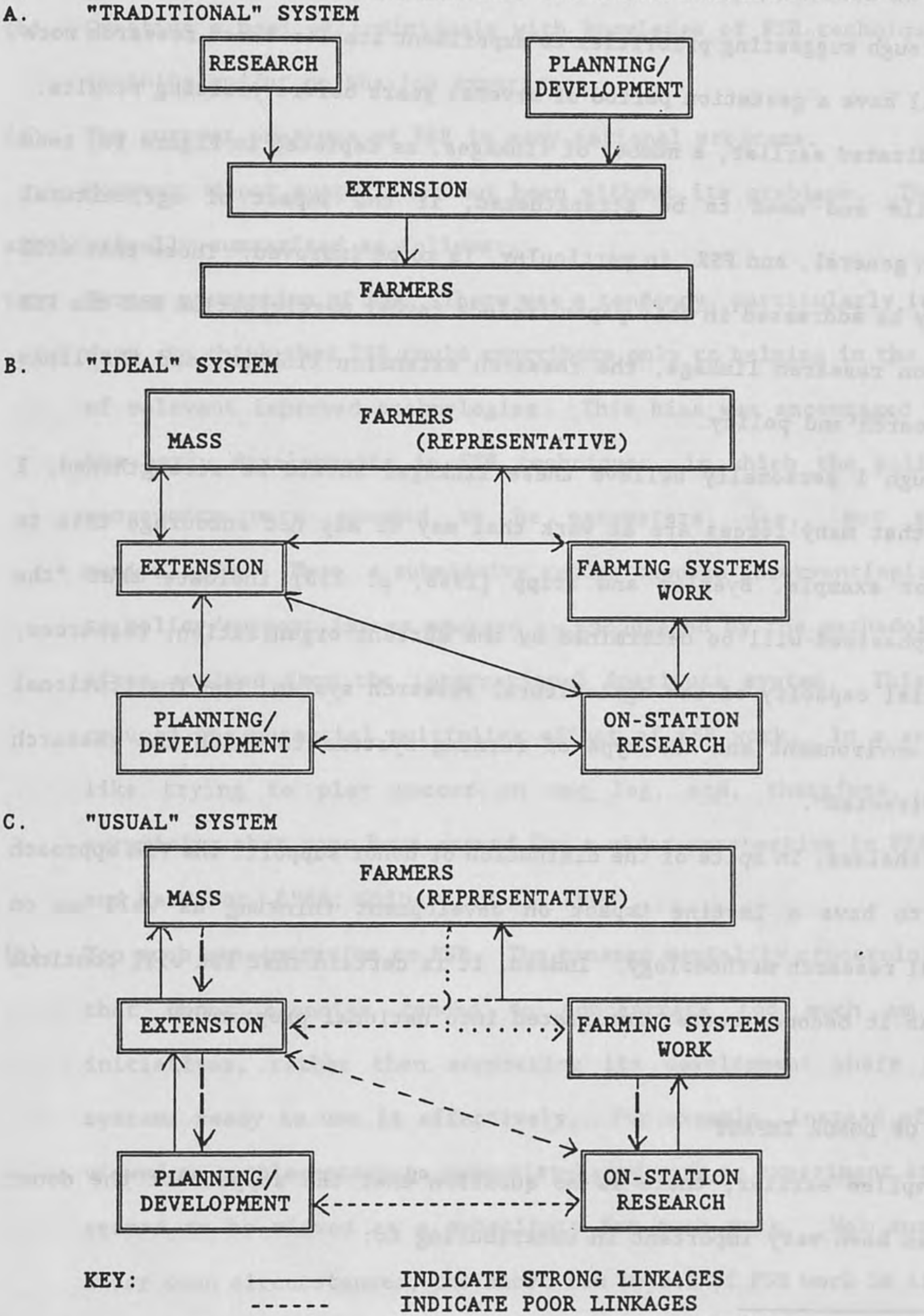
[4]. A more detailed discussion of the boundary issues that confound such assessments is given elsewhere [Baker and Norman, 1990]. Others also have alluded to the difficulty of estimating the impact of FSR, for example, Anderson [1990]. Nevertheless, some attempts have been made, for example, Grafton et al [1990], Martinez and Sain [1984].

FIGURE 1: NECESSARY LINKAGES FOR AGRICULTURAL DEVELOPMENT



Source: Norman [1989B].

extension. In addition, much FSR work potentially has an indirect impact, for example, through suggesting priorities to experiment station-based research work that may well have a gestation period of several years before yielding results.

As indicated earlier, a number of linkages, as depicted in Figure 1C, tend to be fragile and need to be strengthened, if the impact of agricultural research, in general, and FSR, in particular, is to be improved. Those that will specifically be addressed in this paper include farmer participation and the FSR to on-station research linkage, the research extension linkage, and the links between research and policy.

Although I personally believe these linkages should be strengthened, I appreciate that many forces are at work that may or may not encourage this to happen. For example, Byerlee and Tripp [1988, p. 138] indicate that "the linkages emphasized will be determined by the current organization, resources, and managerial capacity of the agricultural research system, the institutional and policy environment and the type of farming systems to which the research system is directed".

Nevertheless, in spite of the diminution of donor support, the FSR approach is likely to have a lasting impact on development thinking as well as on agricultural research methodology. Indeed, it is certain that FSR will continue to evolve as it becomes better integrated into national programs.[5]

EVALUATION OF DONOR IMPACT

As implied earlier, there is no question that the support of the donor agencies has been very important in contributing to:

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[5]. For a discussion of the trends that have developed during the last decade and are likely to develop in the future, see Baker and Norman [1990].

(a). The development of methodologies for undertaking FSR.

(b). Creating a pool of individuals with knowledge of FSR techniques through training and/or on-the-job experience.

(c). The current presence of FSR in many national programs.

However, donor support has not been without its problems. These can be simplistically summarized as follows:

(a). **Narrow perception of FSR.** There was a tendency, particularly in the early days, to think that FSR could contribute only to helping in the production of relevant improved technologies. This bias was encouraged by many of the early developments in FSR techniques, in which the policy/support components were assumed to be parameters, i.e., not subject to manipulation. Thus, a submissive rather than an interventionist approach to policy/support issues emerged -- encouraged by the methodologies that often evolved from the international institute system. This obviously reduced the potential multiplier effect of FSR work. In a sense, it is like trying to play soccer on one leg, and, therefore, it is not surprising that some have argued for a wider perspective in FSR [Anderson and Hardaker, 1986; Gilbert et al, 1980].

(b). **Too much concentration on FSR.** The panacea mentality concerning FSR meant that donor agencies tended to concentrate too much on FSR type initiatives, rather than supporting its development where there were systems ready to use it effectively. For example, instead of FSR being viewed as complementary to commodity-based work on experiment stations, it seemed to be viewed as a substitute for such work. Not surprisingly, under such circumstances, the short-run impact of FSR work is likely to be very low. As others have said, it is unfortunate that research thrusts have swung between commodity research and FSR, rather than viewing both as part of a holistic approach [Lele et al, 1989]. Even where both station-based commodity research and FSR were present, little or no attention was given by donors to helping national programs in deciding on an appropriate sustainable balance between the two. Instead, the strategy was one more of 'selling' the FSR approach to national programs. This 'selling' was evaluated in terms of adoption of technologies by farmers -- an ambitious task given the number of factors outside the control of the FSR teams themselves.[6] Not surprisingly, criticisms have been made that many of the FSR teams have been too large, too expensive for long-run sustainability, and too dominated by expatriates who, on arrival, had little experience with FSR [Anderson, 1990; Collinson, no date].

(c). Too short a time commitment. The lack of a long-term time commitment has been very unfortunate. For a number of reasons, the same quantity of donor resources spread over twice the time period would probably have had a much greater impact on FSR. For example, the methodologies for undertaking cost effective FSR were evolving throughout the period and had no time to mature. Thus, earlier efforts in FSR were not as effective as later efforts. Also, given the limited resources within national programs, resources more likely could be obtained for FSR through building up accountability and credibility over a longer period of time by convincing and established performance, rather than through the quick results and radical confrontationist approach implied by short-term commitments. Although donor assistance has helped in training many

[6]. Thus, it could be argued that the approach of donors has been supply driven, rather than being based on responding to demands for research [Lele et al, 1989].

individuals in the techniques of FSR, its emphasis on results (which may have advanced the case for institutionalizing the approach) has not been very helpful in making rational decisions on the appropriate form of institutionalization [Baker and Norman, 1986].

Although the high level of donor support for FSR has had some positive impact, it has also created some problems. Hopefully, national programs can learn from past experiences and build constructively on them to increase the impact of FSR in the future. Certainly, the opportunity now exists for national programs to impart their own stamp on the future, both by creating institutional arrangements that can increase the impact of FSR and, further as nationals become experienced by developing methodologies for undertaking FSR in a cost-efficient manner in the local setting. The increasing maturity and acceptance of FSR within national programs will enable more selective use of limited donor funds to improve deficient areas, rather than having to accept donor funding purely on donor terms. This is consistent with the spirit of the recent Special Project for African Agricultural Research (SPAAR) initiative, which hopefully will result in joint national-donor decision making on implementing support and strategies designed to ensure the long-run productivity and sustainability of NARS. The following sections are devoted to a number of issues or areas that national programs will need to address in strengthening the impact of agricultural research, in general, and FSR, in particular.

INSTITUTIONALIZATION OF FSR

As indicated earlier, because of the quest for quick results, donors have tended to use resource-intensive models for FSR type work in field situations. However, over the years, those responsible for national programs and programs supported by donor agencies have done a great deal of thinking about feasible models for institutionalizing FSR. As a result, a number of approaches are being tried in different countries in the region [Anandajayesekeram, 1991] with various degrees of success. If institutionalization is defined in terms of "the process by which new ideas or practices are accepted as valuable and become incorporated into the normal routines and ongoing activities of the society" [Esman, 1972], then there has been some progress, especially bearing in mind the conclusion of a recent study that the total time required to institutionalize the FSR process is probably 15 to 25 years [USAID, 1989]. The various models that have been and are being used need not be discussed in detail in this paper, because abundant literature on this subject is available elsewhere [Collinson, 1986; Low, 1988; Norman and Collinson, 1985; Ewell,1988]. Very simplistically, these models range from having:

(a). 'FSR with a pre-determined focus' -- in which the FSR procedure is incorporated into commodity research teams, helped by the inclusion of a social scientist, who is usually an agricultural economist, to

(b). 'FSR in the small' -- usually conducted by full-time regionally-based FSR teams having linkages with all the commodity teams.

Both of these models and models in between these two extremes have advantages and disadvantages that have been discussed in the references cited above. Perhaps it is sufficient to recognize here that costs, in terms of required institutional/organizational changes and operating costs, are likely to be lower in model (a) than (b). Conversely, the potential benefits both to farmers and researchers, in terms of a wider systems perspective, are likely to be greater in model (b) than (a).

Whatever model is used, administrative structures need to ensure that there is regular interaction between those involved in on-station and on-farm research. The multi-disciplinary commodity[7] groups now found in most NAR, can provide a forum for peer group planning, approval, management, monitoring, and evaluation of the various studies, surveys, and trials undertaken by members of the group. Much of the FSR work undertaken, even in regionally based FSR teams, can usefully be fed directly back to commodity-oriented teams. Such organizational structures, if operated efficiently, can improve the accountability of individual research efforts, and as a result, improve the overall credibility and impact of research. It is becoming increasingly apparent that the impact of research will be improved only if ways are found to improve the quality and relevancy of research programs.

LINKAGE WITH STATION-BASED RESEARCH AND FARMERS

Nature of the Link

Table 1 illustrates some of the differences between on-station (station-based) and on-farm (FSR) research. Both have strengths and weakness. The differences help indicate why both are necessary and also indicate the potential for a complementary relationship to develop. However, the degree of complementarity will be influenced by the nature and strength of the linkage between the two. As has been emphasized, the 'top-down' link from the research station to the farmer has traditionally been much stronger than the 'bottom-up' link from the farmer to the research station. However, it is the contention of FSR practitioners that the effectiveness of the 'top-down' link will be determined by the effectiveness of the 'bottom-up' link. This feedback link is

[7]. This term is used in a broad sense to include groups that have subject area, rather than a commodity, focus.

designed to better address the needs of different types of farmers. Two kinds of feedback are possible [Baker and Norman, 1986]:

(a). Feedback to priority setting in station-based research. This involves providing information on farmers' technical and managerial problems to help in the establishment of relevant research priorities within applied station-based research programs. It also enables researchers to respond directly to the needs of the identified farmer clients.

(b). Feedback to annual programming of station-based research. This involves encouraging station-based researchers in their experimentation to systematically take into account the characteristics of farmers' environments. By designing experiments that more closely conform to the actual conditions under which farmers operate, the relevance of applied research can be increased and the process of developing appropriate technologies can be accelerated.

In general, although feedback of type (a) is more ambitious than type (b), neither type is operating very effectively within most NARS [Merrill-Sands, 1988]. Consequently, the potential complementary nature of the station-based research and FSR is reduced.

The Example of Experimental and Non-Experimental Variables

The potential complementary nature of the two is illustrated by the following discussion dealing with appropriate definitions and levels of experimental and non-experimental variables.[8] Trials conducted on experiment stations can help establish cause-effect relationships, and such information may

[8]. This discussion draws heavily on material presented elsewhere [Norman and Modiakgotla, 1990].

be useful in designing solutions to the problems and needs of farmers determined by on-farm research. With reference to experimental and non-experimental variables, the following points are potentially important in improving the practical relevance of on-station research:

TABLE 1. 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 station	Usually 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

Source: Norman and Modiakgotla [1990].

(a). Results from cause-effect type research are more relevant, if station-based researchers include in their experimental variables the levels that farmers might actually be able to implement.[9] If all levels of input required are too high for the farmers to adopt, then the research may have

[9]. 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, if the results from responses at the higher levels are likely to be used in an attempt to influence planners to change the support systems, and enable farmers to use the specific inputs at a higher level.

little relevance without the aid of special support programs for farmers. This applies not only to external inputs, like improved seed or fertilizer, but also to internal inputs, such as household labor.

(b). A closely related consideration is: what should constitute the experimental and non-experimental variables in technology development work? Generally, it is not possible to assume that the level of the non-experimental variables will be the same on-station and under farmers' conditions. For example, seedbeds are often better prepared on experiment stations. Varietal testing under such conditions can provide very different results from what would occur if the seedbed preparation more nearly approximated that generally used by farmers.

I would argue that it is important, ex ante, to evaluate whether the levels of the non-experimental variables are likely to influence the relationships being examined between the experimental variables.[10] Special justification should be made if the levels of the non-experimental variables differ significantly from what the farmer is likely to be able to achieve.[11]

In essence, the above discussion illustrates that improvement of the

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[10]. A well-known example of this is the cross-over effect, where improved varieties of crops perform poorer than more traditional varieties under minimal or zero rates of fertilizer. If it is likely that farmers will not apply fertilizer, then the robustness of the variety under such conditions should be determined and, if necessary, the released variety should be targeted only to those farmers who use fertilizer.

[11]. For example, an on-going multi-locational National Tillage Trial in Botswana, being undertaken on a number of different soil types, 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 weeds 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.

feedback loop from on-farm research to station-based research can improve the accountability, credibility and, hence, potential impact of the latter. However, the effectiveness of that link is often inhibited by the perception on the part of station-based researchers that on-farm research lacks credibility. This stems not only from the differences between station-based research and FSR highlighted in Table 1, but also perhaps from a lack of appreciation of the different ways in which trials can be undertaken on-farm. The reason for this is that there are multiple clients for the results of FSR work with whom there is day-to-day interaction -- namely farmers, station-based researchers, extension and development agency staff, and sometimes planners. Similar types of trials do not have equal appeal to all the clients. As a result, substantial use is often made of three different types of trials. These trials can be differentiated on the basis of who manages and who implements them, i.e., researcher (technician) or farmer (Table 2). 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 are the same as those conducted on experiment stations[12].

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[12]. An issue relating to RMRI trials is whether this type of trial should be undertaken on-station or on-farm. In general, trials designed to answer cause-effect relationships should, whenever possible, be carried out on experiment stations. The reasons for this include; lower implementation costs (e.g., in terms of logistics, time, etc.) and potentially better control (e.g., 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. This 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 very different from that on the experiment station. Another example is the Botswana National Tillage Trial mentioned earlier, which is being undertaken mainly on farmers' fields, so as to test the trial treatments

TABLE 2: 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
Numbers of farmers	None	Some	Most
Farmer groups	Least	More	Most
Potential:			
"Yield"	Most	Less	Least
Measurement errors	Least	Greater	Most
Degree of precision	Highest	Less	Least
Data:			
Hard (objective)	Most	Less	Least
Soft (subjective)	Least	More	Most
Determination of cause/effect relationships	Easiest	Less easy	Least likely
Incorporation into farming system	Least	More	Most
Evaluation:			
Who by?	Mainly researcher	Researcher/farmer	Mainly farmer
Nature of test	Assesses technical feasibility	Some of each plus economic evaluation	Validity for farmers - practicality, acceptable
Appeal to:			
Researchers	Most	Less	Least
Extension Staff	Usually least	More	Most
Farmers	Least	More	Most
Ease of acceptance of results of trial	Researcher extension	Researcher/farmer/	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 [1989B].

Therefore, the level of testing achieved meets the standards demanded by experiment station-based researchers. However, FMFI trials are the most satisfactory for the farmer and provide the most practical test of a technology. Because of management and resource constraints, yields or returns will diminish from the RMRI to the FMFI level. The information in Table 2 notes the major differences between RMRI work, mainly the preserve of experiment station research, and RMFI and FMFI trials that 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 at identifying cause-effect relationships and yield hard data, whereas farmer attitudes and 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 to use appropriate criteria for evaluating research. Surprisingly enough, a survey of 41 FSR projects undertaken a few years ago indicated that only 32% undertook all three types of trials, 12% undertook only RMRI trials,[13] and only 46% undertook FMFI trials [Barker and Lightfoot, 1986]. This implies to me that FSR work has not been addressing the needs of the different clients interested in the results of FSR.

Returning to the question of convincing station-based researchers of the credibility of FSR work, they are more accustomed to RMRI type trials, and, if the differences are not well articulated, they may fail to appreciate the nuances

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on a number of soil types.

[13]. Which are really simply multi-locational trials.

and relevance of the different types of trials. They then may dismiss the unfamiliar trial types, convinced that the experimental procedures are poor because of the high coefficients of variation that tend to result. These high coefficients may arise because it is virtually impossible to ensure:

(a). Standardization in non-experimental variables (ceteris paribus conditions), particularly in FMFI trials.

(b). Minimization 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 (e.g., on-station researchers, extension workers, and farmers). In order for this to occur, it is critically important to specify the type of trial when presenting results. Too often, FSR practitioners fail to do this, creating confusion and, through a lack of specification of the intended clients, devaluing the results, because they are not explicitly directed towards any particular client.

Farmer Participation

Another whole area that needs rethinking in many current FSR programs, is the extent to which farmers contribute to the identification, development, and evaluation of relevant improved technologies. I suspect that this is not as great as would be desirable. For example, in the Barker and Lightfoot [1986] survey cited above, 54% of the FSR teams undertook no FMFI trials. In recent years, the tendency not to include the farmer in the research process has come under greater scrutiny and criticism [Chambers and Jiggins, 1987]. As a result, a burgeoning literature has developed on this subject.[14] Biggs [1989] has differentiated four modes of farmer participation, namely contract, consultative, collaborative, and collegial. In a survey of a number of FSR programs, he concluded that most operated in a consultative or collaborative mode. However, the collegial mode, in which researchers respect and help to strengthen farmers' independent informal capacity to define research problems and organize strategies for solving them, was generally absent. This mode, popularly known as farmer participatory research (FPR), is extremely difficult to incorporate into the formal institutional arrangements within which most FSR teams operate.[15]

Nevertheless, if the impact of farmers' involvement is to be maximized, the search for cost effective ways of incorporating farmers into the research process must continue. Sondeos (informal surveys), farmer implemented and farmer designed trials, farmer field days, and workshops have become part of FSR programs. In Botswana, extensive use is being made of farmer groups designed to increase the role of farmers in technology design and assessment.[16]

Although the move to greater participation of farmers in the research

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[14]. Useful references on this are Chambers, Pacy and Thrupp [1989], Farrington and Martin [1987], Ashby [1986], Matlon et al [1984], Tripp [1989] and Lightfoot [1986].

[15]. For a discussion on the problems of doing this see Norman and Modiakgotla [1990].

[16]. The farmer group approach used in Botswana allows farmers to decide their own research agenda, by selecting those technologies they wish to test. These groups have also proved to be efficient in reducing time and logistical costs, in providing a good forum for station-based researchers and extension personnel to interact with farmers, in ascertaining farmers' interest in interventions that do not necessarily address the most critical constraint or enterprise but can improve overall farming system productivity (non-leverage interventions), in decreasing the necessity to tightly specify recommendation domains because farmers' choose the technologies they wish to test, in improving farmer to farmer dialogue on the merits of the technologies they are testing in a forum where researchers are present, etc. [Norman et al, 1988]. They have even been used in getting farmers opinions on possible treatments to use in design type RMRI trials [Worman et al, 1990A].

process is fully justified, it is important to recognize four issues that can arise from increased emphasis in this area [Norman,1989B]:

(a). Increased farmer participation implies the need for greater skills in verbal communication. This is an area in which technical and social scientists -- apart from sociologists and anthropologists -- have received little or no training.

(b). There is likely to be increasing emphasis on 'soft' (qualitative and maybe subjective) rather than 'hard' (quantitative and usually objective) data. This makes results less acceptable to experiment station-based scientists.

(c). Complete submission in responding to the felt needs of farmers could be deleterious to society, for example, by increasing inequalities in the society, accelerating ecological degradation, etc. It could also unnecessarily limit the opportunities available to farmers, because they may only articulate those needs they think researchers can help them with, that they are conscious of, etc.

(d). Increased farmer participation implies a constructive interactive relationship between farmers and researchers. This raises the possibility of possible biases in the selection of farmers involved in the research process.[17] Are technologies evaluated by participating farmers equally valid for those farmers with similar characteristics but who did not participate in the research process?

I do not mean to imply a lack of support for increasing farmer

[17]. Ewell [1988] in a survey of different NARS in fact found bias towards larger farmers who are influential in their community.

participation in the research process.[18] Rather, the point is to note that problems arising from such issues need to be monitored, and, if necessary, corrective action should be taken.

LINKAGE WITH EXTENSION

Implementing the Linkage

It is apparent that there is urgent need in many NARS for development of stronger research-extension linkages [Tripp et al, 1990] that will improve the payoff from research work and perhaps permit more direct participation of extension staff in the generation of technology. A recently conducted survey of NARS indicated that only a few had even attempted to organize joint activities between research and extension directed towards common goals [Ewell, 1989]. This is not altogether surprising given the fact that research and extension are usually located in different departments and sometimes different ministries. Because control is organized 'vertically' through these units, creation of effective 'horizontal' linkages becomes difficult. Nevertheless, there have been, and continue to be, strenuous efforts to improve the linkage between research and extension with some degree of success, for example, in the cases of Zambia [Kean and Singogo, 1990], Zimbabwe [McLaren, nd], and in a more informal manner, Botswana [Worman et al, 1990A]. Linkages can involve activities requiring various levels of commitment such as discussions on work programs, joint field days; and collaborative work including trials, joint training programs, and joint programs at agricultural shows. Through avoiding duplication

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18. As Tripp et al [1990, p. 393] indicate, "incentive systems must be devised to direct researchers towards farmers' problems, and these must be balanced by opportunities to apply political pressure on research and extension to address their concerns."

of efforts, the productivity of limited research and extension resources can be improved. To my mind, an important joint activity that needs to be undertaken regularly is a meeting of some type of Recommendations Committee consisting of representatives of both research and extension,[19] with the mandate of approving recommendations for general dissemination through the extension service. In many countries, the impact of research has been reduced because too little attention has been given to the process of assessing and approving recommendations that will facilitate the work of extension staff, while at the same time taking into account the heterogeneity that exists in the real farming environment.

Developing And Approving Recommendations

In developing and approving recommendations, two obvious issues that need to be considered[20] are:

(a). What should be included in a recommendation and

(b). What types of information are acceptable as supporting 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, with reference to approving recommendations, it would be good to see an increasing acceptance of the following:

(a). Incorporation of conditional clauses and targeting information to help

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[19]. For reasons discussed later, it would also be highly desirable to have representation from agricultural planning.

[20]. This discussion also draws heavily on material presented elsewhere [Norman and Modiakgotla, 1990].

ensure that the recommendations are relevant to more farmers.

(b). Widening of the information base for approving recommendations so that greater weight is given to the opinions of farmers.

With reference to (a), there is often a tendency to assume that the farmers are homogeneous in the natural (technical) environment that they face and the socio-economic characteristics or resources they posses. As a result, the monolithic technological package concept has been widely advocated, but rarely works well [Sutherland, 1986]. It is not altogether surprising that where technological packages have been disseminated, many farmers have adopted components rather than the complete package. In such cases, there is often little advice available on what farmers should do. For example, should they apply a top dressing of fertilizer when they don't weed? The return from the limited research resources[21] can be improved by:

(i). Incorporating conditional clauses that state what to do under circumstances different from those originally envisioned 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 should be possible variations such as: a recommended step-wise approach to the adoption of the different components of the package and suggestions for a number of options for the farmer to pursue.

(ii). Including targeting information showing 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

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[21]. See also discussion by Byerlee [1986; 1987] on prescriptive and auxiliary information.

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 targeting information 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 that is appropriate to more farmers by widening intervention possibilities. It is particularly important to develop a range of options in the more marginal farming areas. In a sense, these guidelines indicate how greater numbers of farmers can more closely approach the optimal situation and, thus, improve the potential productivity of research efforts.

Turning to (b) above, concerning widening the information base for approving recommendations, information traditionally required for approving recommendations has consisted of hard objective data collected in an RMRI experimental environment. However, there is an increasing acceptance of a need to conduct a socio-economic evaluation, as well as the more common technical analysis. In order to more closely approach the farmers' operational environment, much of the data required are best collected in an RMFI experimental environment. However, as was shown earlier in the paper (Table 2), there is likely to be a corresponding increase in the 'softness' of the data, thereby potentially reducing its acceptability in the technology evaluation process. Increasing amounts of qualitative attitudinal data, collected at the FMFI level, are likely to be even more suspect in such an evaluation exercise. Although the reasons can be appreciated, it is unfortunate that attempts towards greater incorporation of the farmer -- the ultimate customer of trial work -- in the evaluation process have this effect. There is obviously no easy solution to this problem, but I believe a judicious mix of hard/quantitative and soft/qualitative data may be useful 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 of trained scientists and experiences of scientists working at the farm level. Resourcesfor research are limited, and ways must be sought to maximize the return from them so as to facilitate the agricultural development process.

On-station researchers are understandably conservative in making recommendations,[22] whereas extension staff, also justifiably, are anxious that recommendations are forthcoming on a regular basis. Because farming systems researchers work with relatively few farmers, it is important that recommendations are formulated and passed to extension at the earliest possible opportunity, in order to maximize FSR's impact on the farming population. Although, ideally, it would be desirable to defer making recommendations until some adoption has occurred, this would often result in unacceptable time delays. Rather, recommendations will need to be based largely on ex ante evaluation. Because of limited research resources and the various interest groups, devising interim best-bet recommendations,[23] based on the best knowledge currently available to the research scientists, can be justified. These recommendations

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[22]. Optimum recommendations that are drawn up after many years of work on the experiment station, given the heterogeneity within the farmers' environment, in fact, will not be optimal for most farmers.

[23]. Years ago, the current Director General of CIMMYT argued for what he called, a "non-perfectibilitarian" or "better-not-best" approach to the development of improved technologies, an approach that has more recently been endorsed by Low [1988].

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, bringing together the relevant interested parties should avoid drawing up inappropriate recommendations. This is one of the reasons why there is a role for a Recommendations Committee, usually at the headquarter level.

LINKAGE WITH PLANNING/SUPPORT

Earlier in the paper, it was mentioned that some of the developers of FSR techniques advocated a submissive rather than an interventionist approach to policy/support issues. As a result, it is not surprising that the research to policy linkage is usually the weakest. Given the complementary nature of the relationship between technology and policy/support, this is unfortunate. It is also unfortunate that the impact of FSR has often been evaluated in terms of adoption of technologies by farmers. Yet, examples abound of deficiencies in policy/support systems being blamed for the slow adoption of improved technologies. For example, Kaluwa et al [1990] discuss this with respect to Malawi. In Botswana, low spontaneous adoption rates were found for some of the technologies developed [Worman et al, 1990B]. I would hypothesize that, in harsher climatic areas where the main route to improving the productivity of the farming system is through breaking constraints (implying major changes on the part of farmers), the support system is critically important in providing the necessary inputs and managerial skills (Table 3). On the other hand, in more equable areas, potential exists for exploiting flexibility (implying less dramatic changes on the part of farmers) and the use of divisible inputs. In such situations, the policy/support systems, although still important, may not have to be so efficient in order to encourage spontaneous adoption.

TABLE 3: HYPOTHESIZED SIGNIFICANCE OF POLICY/SUPPORT SYSTEMS

Climate	Route to Improvement	Nature of Change	Significance of Support System
Drier	Break constraints only	Lumpy inputs/ major changes	Very critical
Wetter	Break constraints or exploit flexibility[a]	Divisible inputs/ can be minor changes	Important but less critical

a. Most success in FSR to date has been achieved in wetter areas through exploiting in the farming system.

I believe that, given the increasing need for accountability, some form of monitoring of uptake of technologies needs to be incorporated under the rubric of FSR. This provides an opportunity for the possible feedback of fresh research priorities to station-based research and providing pertinent information to help those responsible for the policy/support systems. With reference to the latter, Byerlee and Tripp [1988] have suggested that the types of information that would be useful to policy makers are:

(a). Technical information relating to physical and biological responses under farmer conditions.

(b). Information on institutional constraints to effective use of appropriate technology at the farm level.

The former type of information is useful for policy makers in making decisions concerning production inputs. Information on the latter, which can involve marketing (both inputs and output), credit, extension, etc., can indicate the way to implement changes that will improve farmer adoption. It should be emphasized, however, that such information would be used to help sort out policy-related issues that impede technological change. As Herdt [1987] has emphasized, FSR should not be used as a substitute for conventional policy research on pricing, marketing, credit, input distribution, etc.

Therefore, in order to improve the impact of FSR in the 1990s, I believe much more emphasis needs to be given to nurturing the research-policy link. In fact, it would be highly desirable to have representation from planning on the Recommendations Committee mentioned earlier, to improve the potential for increasing the congruence between technology and policy/support systems.

ENVIRONMENTAL SUSTAINABILITY

It appears that sustainability will be the theme for much of the donor community during the 1990s. Do FSR techniques have a role to play in this area? I believe the answer is yes, but there are a number of challenges.

The basic philosophy underlying FSR has been one of responding to the 'felt' needs articulated by farmers. The closer farmers are to the survival level, the more likely that they will have needs that require fulfilling in the short-term (e.g., producing enough food to survive until next year). As a result, they will be less concerned about environmental degradation in the long-term, etc., which is more of a societal concern. It is becoming increasingly apparent that a move is necessary towards a convergence between private short-term interests of farmers concerned about attaining an adequate standard of living and the long-term societal interest in maintaining the environment for future generations. As Tripp et al [1990] have emphasized, it is likely that, if progress is to be made towards developing sustainable agricultural systems, a considerable amount of applied research will need to be combined with widespread location-specific adaptive research. It is very likely that over the next few years, an explosion will occur in the development of methodologies for addressing sustainability. In the meantime, I see FSR and related activities making contributions in the following areas:

(a). **Prevention rather than cure or cure based on proper diagnosis.** FAO has recently been taking the lead in advocating the development of methodologies that can be applied in designing strategies to prevent soil erosion developing, or if it is has developed, designing strategies that will cure the problem. This is in contrast to the more traditional approach, usually unsuccessful, of trying to implement strategies that simply treat the symptoms without proper diagnosis of the problem. FAO believes farmers have to be intimately involved in designing such strategies and that FSR techniques can help in this exercise.

(b). **Piggyback conservation on the back of production.** Given the low levels of welfare of most farming families, it is unreasonable to expect conservation measures by themselves, with their tendency to have a long-term pay-off, to be attractive to farmers. Instead, strategies need to be designed that also ensure a short-run pay-off in terms of production. Three obvious strategies are:

i. Ex ante screening of all technologies to ensure, to the extent possible, that their adoption will result in no negative environmental impact. This can be assisted with simple measurements on soil structure and nutrient content (i.e., including organic matter) both in on-station and farm-level trials.

ii. Developing technologies that have both a production and conservation impact. An obvious area that has been badly neglected in FSR is agro-forestry.[24] Agro-forestry can potentially be made attractive to farmers, if there is a short-run pay-off in terms of fuel, animal fodder, soil nutrient enhancement, etc. Obviously, there is a role for FSR in testing and monitoring the impact of such technologies at the farm level.

iii. Encouraging a convergence between policies designed to promote production and those designed to facilitate conservation. For example, a 'carrot and stick approach' could be tried, which would require that farmers participate in a specific conservation practice if they are to benefit from programs designed to stimulate production. For example, in Botswana there is a development program designed to encourage destumping. A constructive approach would be combine destumping along with a program designed to stimulate the planting of windbreaks, living hedges, etc. FSR techniques could be used in monitoring the impact of such policies.

In the long-run, I suspect that the linkage between research (technology) and planning (policy/support system) will be critically important in encouraging environmental sustainability. Given the realities in most low income countries, it is unreasonable to expect technological developments to be sufficiently spectacular to solve the sustainability problem by itself.[25] It is to be hoped that donor agencies, in recognizing the long-term pay-off of sustainability work, will be prepared to make an input for a minimum of 15 to 20 years.

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[24]. An obvious exception to this has been the pioneering work done on alley cropping by IITA, ILCA and other institutions.

[25]. Indeed, this has not even been the case in the USA. Conservation strategies have been successfully implemented only with high levels of subsidization.

CONCLUDING REMARKS

With financial support of donor agencies for FSR on the decline, an opportunity now exists for NARS to step back and evaluate, in an environment less influenced by external forces, what should be done in the future. Fortunately, the decline in external funding is taking place at a time when the philosophy of FSR has already been accepted in most NARS in Eastern and Southern Africa. The needs now are a nurturing strategy and a continuing search for cost efficient ways of undertaking FSR and of improving the impact of FSR. I believe that NARS now have an opportunity to put their own national stamps on those activities and, as a result, are in a position to move away from a situation in which the experience and collective memory is appropriated by foreigners who later leave the country, taking their knowledge with them [Helleiner, 1979]. I believe there is still a potential need and role for donor funds, which hopefully can be given to a greater extent based on needs perceived by the NARS themselves. The spirit of greater self-determination on the part of recipient countries, in fact, is embodied in the spirit of the SPAAR initiative, mentioned earlier in the paper. With reference to future donor support, possibilities are as follows:

(a). **Networking and training**. New donors supporting general FSR in the Eastern and Southern Africa areas (e.g., SIDA) appear to be willing to support network activities and development of training capacity at institutions of higher learning in the area. Networks are important in further developing FSR expertise in the region, while expertise in teaching FSR techniques is developing at three institutions in the region, i.e., Kenya, Tanzania and Zimbabwe. Such activities deserve continued support.

(b). **Support in specific areas**. In general, there is a trend among more traditional donors (e.g., USAID) not to continue vigorous support of research. However, some of the activities discussed in this paper, which are designed to increase the impact of FSR, might receive some support as long as they are consistent with new donor initiatives. These include funding to help develop the research-extension and research-policy/support linkages and work in the area of environmental sustainability, including agro-forestry.

(c). Contingency support. Baker [1991] has suggested the possibility of attracting donor support in a manner analogous to structural adjustment programs, which consist of a set of contingencies forcing certain actions towards desirable reforms, in exchange for support funds. Possible contingency examples he gives include: percentage of tests subject to economic as well as technical analysis, numbers of technologies on which closure is obtained, and numbers of farmers involved in FSR activities.

Although direct donor support for FSR activities is desirable and probably essential for some time to come, I have tried to indicate in this paper that a considerable amount can be done currently to improve the impact of FSR activities and, therefore, pave the way for more sustainable domestic support in the long-run.

Finally, mention should be made of the resource crisis facing NARS in many countries at the present time. The problems of FSR are just part of those facing research systems as a whole. The SPAAR initiative is potentially very important in moving countries away from the revolving door of technical assistance, overseas training, and brain drains [Eicher, 1990]. The long-term sustainability of FSR in many countries will be determined, in part, by the extent to which the SPAAR initiative is successful in transforming African research and academic institutions.

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