Issues in Developing and Implementing a Farming Systems Research Program

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Introduction

Farming Systems Research is a type of agricultural research which has its own unique philosophy and methodology. Its goal is to develop improved technologies that meet the needs and circumstances of small farmers.[2] FSR originally developed in response to the fact that limited resource farmers in developing countries were not adopting many improved technologies believed relevant to their needs. The blame for this situation could, in part, be attributed to the inefficiency of national extension services. Evidence also suggested, however, that many of the disseminated technologies were simply not suitable to farmer's circumstances. Resource constraints limited the applicability of some technologies. Others, upon investigation, appeared inappropriate to environmental conditions or farmers' goals. To overcome these problems, agricultural researchers sought to explicitly consider real farm circumstances and the dynamics of farmer decisionmaking in the research process. FSR methodology takes these factors into account.

Three principal elements distinguish FSR from traditional agricultural research. First, an explicit attempt is made to understand the farm, farmer, and farm environment in a holistic manner, that is, as a complex system of interdependent parts. This approach recognizes that the attempt to change any one of a system's components must be evaluated in terms of its effect on the other parts of the system. New technologies must be applied within the constraints and capacities of existing farming system operations.

Secondly, FSR begins by determining research priorities using analyses of representative, target group farming systems. Generally this involves a preliminary descriptive survey designed to define the farming system and its environment. On the basis of this information, researchers identify farming system constraints and capacities which they attempt to overcome or exploit by developing and adapting technological improvements. In other words, FSR is specifically designed to solve farming system problems with technology.

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[2] FSR need not be small farm specific. The ideas and methodologies are similarly applicable to agricultural research aimed at developing technologies for large farms. Technologies developed for small farms may be usefully employed on larger farms. The methodology, has principally developed, however, in response to the needs of small farmers in developing countries.

Thirdly, the entire process of FSR, including the analysis of the farming systems, the technology development and testing, and the verification of test results, is carried out by interdisciplinary teams of social and biological scientists.[2] Each contributes a unique and necessary perspective for understanding the constraints and capacities of farm systems. Each supplies a part of the answer to the question of why farmers do or do not adopt certain technologies.

FRS does not obviate the need for traditional commodity–based or reductionist agricultural research. The new approach simply attempts to improve the efficiency of such research programs by seeking to ensure that station based research priorities are appropriate to the circumstances of small farmers and ensuring that research results are tested on farmers' fields before being widely disseminated. The systems approach should thus be seen as complementary to traditional research.

The practical nature of FSR and its relationship to ongoing research programs can best be seen through a review of a number of successful FSR programs. In fact, the very attempts to clearly define FSR have depended, to a large degree, on identifying the valuable attributes of ongoing farmer–oriented, agricultural research programs that are systems based. While such a review lies outside the scope of this paper, certain generalizations can be made about the different FSR approaches practiced at a few of the international, regional, and national research centers.

FSR programs generally fall into one of two categories : "upstream" or "location neutral", developmental research and "downstream", or "location specific", applied research. The distinction relates to the purpose and methodology adopted by the FSR unit. Upstream FSR programs identify prototype solutions to major regional farming system problems. These programs concentrate on developmental or basic agricultural research most of which takes place at the research station. Identifying upstream research priorities and organizing the testing process, however, depends on an understanding of actual farm systems. Upstream researchers must gauge the effects of the tested technology on the system as a whole. Therefore, upstream programs depend largely upon information gained from on–farm and/or downstream research.

Downstream FSR develops or adapts agricultural technologies to improve target group production in a specific location for the short run. The entire research process is carried out on a farmer's field with the direct participation of the farmer. In most cases, potentially productive technologies developed in upstream or commodity research programs are identified for testing under farmer conditions. The ultimate success of the research is determined by the acceptance of the improved technology by the farmers.

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[2] Interdisciplinary implies the combined effort of representatives from different disciplines. FSR team members are assumed to have competency in their own disciplines. This is in contrast to multidisciplinary which implies an individual's competency in a number of different disciplines.

Having noted the theoretical difference between these two types of programs, it is important to point out that the distinction may not be so clear-cut in practice. Consequently, some practitioners suggest that upstream and downstream FSR can best be understood as two ends of a continuum for systems research. The FSR approach a research center establishes must depend, to a large degree, on the character of resources available to it and the goals sought. In this context, international research centers with regional if not global mandates for developmental research and greater research resources should probably concentrate on upstream efforts, By contrast, most national agricultural research centers should emphasize downstream programs. In the case of developing countries, location-specific, applied research techniques are probably most commensurate with the limited resources and problem-specific scope of the research centers.

Since this paper concentrates on national program design and implementation, it will focus primarily on the suitable character of downstream efforts. Unless otherwise specified, future references to FSR will refer to downstream programs.

There are four commonly recognized stages in a downstream methodology. These stages are generally known as the descriptive, design, testing, and verification/extension activities. The success of each activity depends upon the coordinated contribution of the research team, the farmer, and the extension service.

1. The **descriptive stage** involves examining the characteristics of a series of representative farming systems. The interdisciplinary team of FSR scientists can complete this stage in a number of different ways depending upon the time and resources available. Most often the analysis of farming systems targeted for assistance first requires a review of existing secondary information, such as baseline data on resources and climate, and then involves formal or informal farm surveys. Information must also be collected on the quality of available support services and produce markets.

2. The **design stage** evaluates the specific technological needs of the farming systems and identifies technologies which might be developed or adapted to increase farm system productivity. These technologies must also be judged in terms of their conformity to societal needs and goals. Field tests are then designed to evaluate whether these technologies suit farmer's need and circumstances.

3. The **testing stage** encompasses the actual trials of the chosen technologies on farmer's fields. These trials are performed under varying degrees of management by researchers and farmers. By the final phase of the testing the farmer generally supplies all the inputs and is fully responsible for managing the test.

4. The **verification/extension stage** involves a final evaluation of whether the technology is acceptable to the farmer, and the provision of information about the technology to the extension service for dissemination.

The distinctions between these stages need not and probably should not be clearcut. A further analysis of the farming system often takes place during the testing process and the kinds and character of trials may often change. FSR practitioners have commonly drawn attention to the iterativeness of the research process. This appears to be one of its most important attributes. By definition, changing one element in a farming system affects the others. This may create new constraints or capacities. Therefore, the development of a system is a continuing process.

FSR practitioners suggest the changes that can be expected from this approach to agricultural research are likely to be piece–mealand cumulative, FSR does not seek to change the entire farming system at once. Nor does FSR seek optimal solutions for any particular farm's specific problems. Some degree of optimization must be sacrificed to adapt technologies to the needs of groups of similar small farmers. Yet evidence shows that even small or nonoptimal technological changes can significantly affect farm productivity and farmer welfare.

Some practitioners have noted the potential implications of FSR findings for national agricultural policy. Certain major constraints in farming systems result from inadequate or nonexistent agricultural support services or problematic agricultural pricing polices. Information gained in farming systems research could be useful to policy–makers in devising agricultural policy. Nontechnological developments in the policy area that foster agricultural productivity might then be an additional benefit from FSR.

I. Defining Farming Systems Research

1) How Holistic Should FSR Be?

In the broadest sense, FSR considers the farm system as a production and consumption unit composed of crop, livestock, and off–farm subsystems, The contribution of each subsystem and its components to the whole farm must be gauged to understand the farm system and design improved technologies for it. In practice, however, most FSR programs have concentrated on one or another farm subsystem. New technologies have been developed to overcome specific constraints or exploit specific capacities in tuese farm subsystems. As a result, questions have arisen on whether crop, cropping, or livestock systems research can be called FSR, and more significantly, how holistic FSR should be.

Several common responses are made to these questions. First, as ordinarily used, FSR encompasses crop research, cropping subsystem research, livestock subsystem research and whole farm research. The important element linking these various research orientations is the fact that while the research may be designed to develop a particular type of technology, it is based upon a holistic understanding of the farm system itself. Thus the attempt to improve a cropping pattern depends, in part, upon understanding the relationship between such a pattern and the complex system of other farm processes, e.g., the livestock system, the farmer's goals and preferences, the farm's resource limitations, etc.

FSR does not seek to change an entire farming system. It simply aims to develop and adapt improved technologies to a farming system efficiently. Such efficiency depends upon recognizing how any proposed technologies relate to the functioning of the farming system as a whole.

There are arguments both for and against the consideration of a variety of different subystems or systems components in a single research domain. FSR practitioners note that the complexity and expense of research increases as the view and goals for developing technology becomes more holistic. They suggest that a truly whole farm research orientation is simply beyond the means of the agricultural research centers. Centro Internacional de Agricultura Tropical's (CIAT) original FSR program, functioning between 1973 and 1975, is said to have failed in part because the scope of its systems research orientation was too wide. The advantage of a wider research perspective, however, lies in the greater possibility of exploiting the interdependencies between farm subsystems. Practitioners argue that without the attempt to develop technologies relevant to various subsystems, the interrelationships between these subsystems will not be fully understood.

Many research centers have limited mandates and this discourages the adoption of a whole farm approach. Some centers, however, have recently made a greater effort to gear their technology development to more than one subsystem. This seems particularly true of national research centers with wider responsibilities. Experience gained through FSR programs has stimulated this sort of expansion in the scope of research.

2) Farming Systems Research "In The Large" Versus Farming Systems Research "In the Small."

In addition to determining the extent of the farming system or subsystem to be developed, the FSR team must determine which components of the system will be defined as management variables (potentially changeable) and which will be defined as environmental parameters (not changeable). An FSR program dealing with a small number of management variables (e.g., one dealing with a specific crop) can be called FSR "in the small." A program with a large number of variables (e.g., one dealing with a multiple cropping system or cropping–livestock system) can be called FSR "in the large." There are advantages to each.

Whether a research center adopts FSR "in the large" or "in the small" largely depends on its mandate, expertise, and available resources. In practice, both types of programs can only identify and help resolve a limited number of constraints in a farming system at any one time. Both types of programs attempt to understand these constraints and how they relate to the whole farming system. The distinction between them primarily relates to the range of potential management variables they attempt to deal with in using technology to solve problems in farming systems. For example. the mandate of Centro Internacional de Mejoramiento de Maiz Y Trigo (CIMMYT), practicing FSR "in the small," demands a research emphasis on maize and wheat and associated problem areas. The mandate of Centro Internacional de Agricultura Tropical (CIAT), practicing FSR "in the large," demands research to promote food production generally.

At issue is the scope of FSR efforts. FSR "in the small" focuses from the outset on predetermined enterprises deemed of major significance to the farming system. These enterprises largely determine the types of problems identified and technologies developed. By contrast, FSR "in the large," without such a limited initial focus, is likely to recognize a wider variety of problems in a farming system and develop or adapt a greater variety of technologies. A research team practicing FSR "in the large" might then have a better chance to exploit the synergistic properties of multiple cropping or crop–livestock interrelationships.

Adopting one or the other approach should not depend solely on the extent of a research center's mandate. Most LDC research centers are responsible to a wide variety of farmers with many types of production problems. These farmers might best be served by a FSR team with no deliberate preconceptions about the problems it should address. The advantage of a smaller research domain, however, is that it does not stretch the limited resources of a national research station or FSR team too thinly. Keeping a limited research focus could also allow a research station to develop its expertise in dealing with only a small number of the most important farm enterprises.

An extension of this debate is the issue of the degree and speed of change FSR seeks to promote. FSR practitioners have often noted that the farmer is mor likely to adopt an incremental series of limited technological improvements than a larger single transformation in a farming system. Certain valuable improvements in a farming system, however, may not be achieved in an incremental way. For example, when it is not feasible to improve an existing part of a farm enterprise, small farmer welfare may best be served by introducing a wholly new crop or crop mix. If the research team aims to promote the rapid development of the small farm system and major increases in national agricultural production, larger changes in small farm production practices may prove necessary. The practice of FSR "in the large" probably best supports such major transformations.

This is not to say that major productivity advancements are not possible on the basis of small changes in production technologies. A great deal of evidence suggests that minor changes often have substantial impact. Most technological improvements fostered by FSR will likely fall in this category, but some may not.

A related issue is the need to promote outside support for the FSR program in the form of both funding and administrative assistance. FSR practitioners have feared that if expectations are too high or the changes fostered by the FSR approach are too small, such support may not be gained. They have noted the particular need for rapid, clearly identifiable and cost–justifying results in the early stages of implementing FSR.

All of these problems, of course, also characterize traditional research and development. The basic question is whether FSR should merely seek to improve existing farming practices, or should it seek major changes in the types of commodities produced? This must depend upon the character of the constraints and capacities of existing farming systems. The expectations placed on FSR, however, must be realistic. The research approach must be judged in terms of its ability to foster increased research efficiency.

3) The Distinction Between FSR and Farm Management Studies.

Some farm management researchers claim FSR is no different from the farm systems development approach they have been practicing for years. They question the need for a "new" research approach. FSR practitioners have responded that FSR concentrates on technology development as opposed to reorganizing existing management practices and existing patterns of resource use. While farm management researchers tend to assume the value of the system they examine, FSR scientists aim to seek solutions to specifically identified problems. Such solutions are based on the development, adaptation and adoption of improved technologies

Some farm management scientists have suggested that they also have been involved to some degree with technology development. FSR practitioners stress, however, that the goals and structure of the FSR work process are different. Teams of interdisciplinary scientists perform holistic analyses of farm systems seeking problems for technological resolution. These efforts are explicitly linked with ongoing research in technology development. In addition, fulfilling FSR's objectives depends upon farmer acceptance of improved technologies.

4) The Role of FSR in National Development Planning and Policymaking ; The Assumption of a Fixed Versus a Variable, Policy and Infrastructural Environment.

This issue entails two related problems. First, what relationship should exist between the objectives of FSR and national agricultural development? Some practitioners envision FSR as an interface between national development priorities and development needs and opportunities at the local level. FSR has primarily evolved to orient technology development toward overcoming constraints on local farming systems. Research target areas are often identified by the central government, and technology research priorities must conform with national needs. Additionally, the successful dissemination of improved technologies often depends upon the efficiency of national agricultural support services. Therefore, the needs to coordinate national and local agricultural development efforts is extremely important.

To some degree, this coordination can be attained if the FSR team and development support organizations simply understand each other's objectives and responsibilities. In certain instances, however, establishing a coordinating entity may prove useful. It could include representatives from agricultural policymaking, research, extension, credit supply, and marketing groups. Information gained from FSR analyses of farming systems could then be shared systematically, and the efficiency of efforts to develop and disseminate technologies could be improved. The work of such a group, however, could be extremely difficult, time-consuming, and costly, thereby drawing valuable resources away from the research process itself.

Secondly, a related question is whether the FSR team should adopt an interventionist or submissive approach toward support service development. The interventionist approach calls for promoting the reform of institutional support services to speed adoption of improved technology. The submissive approach claims this is beyond FSR team capabilities and, therefore, policy and institutional factors should be regarded as fixed constraints. Innovations should not depend on reforms in support service operations which may or may not take place.

If outside factors are counted as variables, it may be possible to make a greater degree of change in a farming system. For example, an FSR team might identify the infertility of soils as a major cause of low crop productivity. This could be remedied by certain fertilizers, but the region's fertilizer distribution system is notoriously poor. The scientists must either test and introduce the fertilizer and the press for an improved distribution system or seek higher yields without the fertilizer. An interventionist approach would seek support service reform. A submissive approach would seek alternative routes to higher yields. The difficulty and complexity of changing exogenous factors like fertilizer distribution systems argues for regarding them as fixed.

Most FSR practitioners have suggested a compromise between the interventionist and submissive approaches. FSR teams hereby maintain some responsibility for identifying policy or infrastructural constraints and communicating them to the appropriate administrators. Such claims can be substantiated by program reports describing FSR field activities and summarizing survey data. Most FSR activities, however, concentrate on developing and adopting farm technologies that will probably be adoptable without substantial changes outside the farming system.

Yet another question remains. How should FSR teams regard potential or ongoing changes in agricultural support systems? For example, what if a development project is about to be implemented to reform a support service; should its success be assumed? If the hoped-for changes in the support systems do not take place, FSR innovations dependent on the change may no longer be viable. Technological changes that do not rely on reforms in the development support system would, however, likely still be beneficial. But, in this case the degree and character of development sought by policymakers may be compromised.

5) The Role of FSR in the Agricultural Research System: Upstream (Developmental) Versus Downstream (Applied) Approaches.

The distinction between "upstream" and "downstream" FSR is not absolutely clear. "Upstream" programs primarily aim to develop prototype solutions for major regional problems. "Downstream" programs seek to develop, and more importantly adapt, agricultural technologies to improve a target group's farm production and overcome specific farming system constraints. Upstream research takes place primarily on research stations. Downstream research usually takes place on farmers' fields. While both types of FSR depend upon farmer input, farmers are more extensively involved in downstream programs. Accordingly, the information and experience gained from downstream programs should play a major role in orienting upstream FSR. Similarly, downstream programs should adapt technologies developed in upstream efforts (as well as technologies developed in commodity research program) to target group circumstances. Such adaptation work involves integrating technologies into target farming systems.

In practice, most FSR programs can best be viewed as lying somewhere on a continuum between developmental and adaptive research. The distinction, however, remains important in determining the type of program a developing country should implement Developmental systems research clearly requires a greater investment of financial and manpower resources. Adaptive research may simply require a redirection of existing resource commitments. While developmental research may be more likely to foster technological breakthroughs, adaptive research seems more likely to promote immediate production gains. Resource levels, objectives, and local needs must determine the character of national program design.

Some practitioners have suggested that international research centers should concentrate on developmental research and national research centers should concentrate on applied research programs. Proponents of this view claim that the greater expertise and funding of the international centers better support basic developmental research than do the smaller resources of national centers. These national centers, by contrast, are in a better position to develop location-specific downstream programs, adapting the findings of the international centers to local circumstances. In addition, the broader mandates of the international program simply greater opportunity costs for location specific work. Investments attempting to resolve the problems or meet the needs of relatively small groups of farmers can severely limit opportunities to serve many others. By coordinating this division of labor, national centers can provide international centers with information on the major constraints and characteristics of local farm systems in exchange for information about basic technological developments.

There are also arguments, however, for not maintaining this separation of responsibilities between national and international centers. Researchers involved in developmental programs may only truly understand the complex nature of actual farming system constraints if they gain some direct experience with applied efforts, particularly with regard to understanding the tradeoffs involved in a small farmer's decisionmaking. Also, a national program might have a need for basic technology research that is unmet by either international upstream programs or commodity research efforts.

The decision on what type of FSR program to implement at a national research center must depend on national goal and resources. Factors that must be considered include the quantity and quality of available research personnel, the degree of commitment placed on the FSR effort, the technology available for applied farm based research, and the types of constraints to be overcome. Most practitioners believe that at least in the initial stages of FSR program establishment, the downstream approach is probably most valuable and viable.

6) Target Populations : How Location-Specific Should FSR Be?

This issue is part of the larger problem of cost effectiveness. Downstream research results are specifically geared to the needs of particular target groups of farmers. This ensures that the technologies developed are appropriate to actual farming system conditions and, thereby, helps ensure they will be adopted. The limited number of farmers reached, however, entails two problems. First, as research becomes more location-specific, performance costs rise. The on-farm testing component of FSR, practitioners note, is the most expensive part of the process. The greater the costs, the greater must be the improvements to small farm production and welfare. Secondly, the value of the location specific improvement must outweigh the lost opportunities in not reaching a greater number of other small farmers.

FSR practitioners commonly suggest two responses to these problems, First, they note that FSR does not seek optimal solutions to each famer's location-specific problems. Instead, research aims to develop improved technologies for farming systems with similar characteristics across reasonably similar regions. The basic task of FSR is to develop technologies which promote large enough improvements in productivity to be adopted by large groups of farmers. Practitioners point out, however, that technologies which may be superior over a broad area are often inferior to farmers' location-specific traditional technologies developed from generations of practice. The need to improve on these traditional technologies provides a basic justification for the location specificity of FSR.

Secondly, practitioners assert that the true value of FSR must be judged by comparing its ability to generate appropriate technologies for farmers with that of traditional research approaches alone. From this viewpoint, the costs in terms of lost opportunities (opportunity costs) of effectively assisting specific farmers are less than those of programs that develop more widely "adoptable" yet inappropriate technologies.

Little cost-benefit analysis on FSR has been done to date. While the benefits of FSR have been widely noted in terms of rapid development and diffusion of farm technology, there is little quantitative data on costs and benefits. The costs associated with FSR have not been carefully examined. Some question the feasibility of such cost analyses. They question whether FSR can be adequately judged in strict quantitative terms. Such quantitative documentation, however would at least prove useful in designing programs.

II. The Organization of Interdisciplinary Farming Systems Research.

1) Integrating the Social Scientist Into Agricultural Research.

It is difficult and complex to establish a cooperative working relationship between social and biological scientists, particularly when social scientists are first being integrated into an agricultural research institution. Several major problems can offset the attempt to achieve a synthesis of knowledge, understanding, and practice. First, a proper mix of social and biological scientists must be determined for the FSR team. If biological scientists dominate, research may be oriented toward particular biological constraints and socioeconomic and sociocultural considerations may not be given full enough attention. The opposite may occur if social scientists dominate the research team. In addition, the emphasis placed on various components of the research process could shift depending on the orientation of the team. For example, a social science orientation may emphasize description and technology design based upon existing technological knowledge. A team with this orientation might seek a rapid passage through the testing stage to the diffusion process. A biological orientation could place less emphasis on the description and design stages and greater emphasis on testing and evaluation. Distinct orientations can also appear in the evaluation stage itself...the agronomist may be more concerned with yields and the social scientist with income or welfare levels.

Secondly, cooperation among scientists can be difficult to achieve unless each works to understand the other's terminology and disciplinary perspective. This may or may not require some degree of specialized training. This need, however, underlines the value of a team leader, with some degree of multidisciplinary experience and an understanding of different disciplinary perspectives. The team leader must bring the diverse disciplinary perspectives into a common focus. Some have suggested that a farm management scientist is best suited to this role.

Thirdly, some practitioners stress that the academic training of team members must be congruent so they can better evaluate each other's opinions. FSR team members with greater understanding and experience may not seriously consider the ideas of those with less traininings. In addition, social scientists have commonly had a difficult time proving their value to technical scientists. Therefore, introducing a social scientist into the agricultural research process may, in fact, require a particularly well trained and articulate social scientist with a strong knowledge of the concerns of technical scientists. It cannot be stressed enough that a serious commitment to an FSR program depends upon recognizing the importance of sociocultural and economic considerations.

2) Downstream Staff Maintenance: Training, Length of Commitment, Rewards.

Staff development and maintenance are often problems for FSR practitioners. Research institutions in developing countries commonly have few highly trained scientists and limited monetary resources. Therefore, field teams will likely be composed of researchers with bachelor's degrees or post high school technical training. Therefore, a brief period of instruction in the concepts and methodology of FSR can be of significant value. Of greater importance, however, is basic competence in the practical application of disciplinary knowledge.

The quality of field personnel should be judged in terms of the needs of farmers. The farmer must have some respect for the researcher's technical abilities. Likewise, the team members must maintain a sincere willingness to work with and learn from the farmer.

In addition, field team scientists must be evaluated for their ability to work with research station scientists. The effectiveness of on-farm research depends in part upon strong links with research station, development programs. It will be difficult to establish the credibility of an FSR program unless station scientists understand and respect field team efforts. If the relationship between the two groups simply appears as an interaction between junior and senior scientists, an effective link may be difficult to establish.

This problem directly relates to the issue of rewards and opportunities for professional advancement for field team scientists. On-farm research must not be simply identified as a training program for junior scientists. Yet if experienced scientists are practicing developmental research and less experienced researchers are performing adaptive field trials, it maybe difficult to avoid creating this impression. In addition, if field scientists are rewarded by promotions to research station work, the cooperation between team members could be threatened. In this case each researcher might work to prove his separate competence.

The problems of professional advancement threaten both junior and senior FSR scientists. Practitioners have commonly noted that while the prestige and possibilities for advancement are clear for scientists in basic research, this is not ture for scientists doing interdisciplinary work at the farm level. Willingness to work on downstream teams could therefore be significantly compromised by the lack of adequate opportunities for professional development. The rewards for adaptive field work need to be explicitly identified, and a system of rewards established. This is, however, easier said than done. Existing opportunities for peer contact, professional reviews and publication are minimal. Current professional disciplinary distinctions, therefore, cannot help but threaten the character of interdisciplinary cooperation in field work.

3) Organizational Structure: Program Size, Funding, and the Relationship of FSR to Other Research Station Activities.

A number of developing countries have expressed interest in FSR. The question remains whether they will back up that interest with the financial and administrative support needed to implement something more than a short-term development project. Such backing must come from both the governments and the research institutions involved.

Some practitioners have noted that high expectations or the lack of adequate understanding of FSR can significantly compromise the value of the program. Therefore, initial attempts to implement FSR should probably be small in scale. The minimal viable size of an FSR program is open to question, as are the most effective staff size and level of staff expertise. One practitioner has suggested that field teams may be as small as two individuals. The ideal staff size must largely depend on the goals of the program and the area to be covered.

The links between an FSR program and other research station programs are extremely important to the success of an FSR effort. Research' stations hold baseline data and information about improved technologies crucial to systems analysis and testing in FSR. On the other hand, data gathered by the FSR team can be usefully employed to help determine station research priorities. Some practitioners argue that establishing a distinct organizational unit for FSR is necessary to maintain the interdisciplinary integrity of the program. They also feel that a separate budget should be established to reinforce this commitment. Yet such a mode or organization could threaten the cooperative links with the other research programs. This threat might be avoided if the FSR unit evolved from an ad hoc group of representatives from other ongoing programs.

There is also some question about whether funds for an FSR budget can be diverted from existing research center programs or whether new sources of funding must be found. While practitioners have noted that the lack of additional monetary support could hinder the development of an FSR program, there is no precise information on the size of the commitment needed for a successful program. In general, the costs of off-station research, particularly when it involves a great deal of travel between different sites, have been said to be higher than those for traditional on-station research. FSR programs are likely to require new investments in vehicles for transportation to widely dispersed farms, and a larger variety of research personnel. Yet, presumably, as a greater degree of a research center's effort is directed off the experiment station, money used for on-station programs and station maintenance can be diverted to service off-station activities. There is a need for more specific quantitative data on these questions.

4) Links Between FSR Program and Other National Institutions that Support Agricultural Development.

Establishing adequate relationships between various agricultural development support agencies can be crucial to the success of an FSR program. How effective these agencies operate can determine the options available for technological improvement and the value of the developed technologies by FSR. Some FSR practitioners have suggested, therefore, that these relationships be explicitly structured with channels of information exchange and administrative overview. It remains questionable, however, whether responsibility for promoting the coordination of the agricultural development effort should be taken up by the research institute. The problems with such attempts have been identified earlier.

One link, however, which merits closer examination is that with the extension service. A close working relationship between an FSR team and extension service representatives is generally said to be of major value to on-farm research. Extension agents should participate in all stages of FSR work. Agents possess useful information that can be used in analyzing farming systems and testing program designs. Their participation in the testing and verification stages can significantly improve the ultimate dissemination of technological improvements.

Some people question how much responsibility FSR scientists should have over the extension and diffusion of their research findings. Insofar as one element in FSR is analyzing the acceptability of the team's technological innovations, there seems a tendency for downstream scientists to involve themselves in disseminating these innovations.

This may in part be attributable to the fact that the adoption of new technologies determines the success of FSR. The costs of a researcher's extensive involvement in the dissemination of research results are likely to be high.

Practitioners point out, however, that verification trials by farmers are not a usurpation of extension responsibilities. While these tests may be seen by nonparticipating farmers as demonstration trials, they are in fact important means to assess innovations. Once such evaluations are completed, the extension service holds full responsibility for disseminating research findings.

5) Coordination Between International, Regional, and National Research Programs.

Three basic issues are involved in coordinating the work done at different research institutions. The first is the question of an appropriate division of labor. The values and problems associated with dividing labor in the research area have been discussed earlier. Some degree of division of responsibility already exists and is valuable. The actual character of this division must depend upon the degree to which international centers serve national needs. It seems clear that national centers must maintain some responsibility for developing basic technologies that meet the demands of local circumstances.

Secondly, FSR practitioners have noted that research institutions depend on each other for information. The success of both international and national FSR programs can be enhanced by establishing channels for sharing FSR-related information. These channels can carry information on developed technologies from the international research centers to national centers and information about farm system constraints from the national research centers to international centers. It has also been suggested that these links be made on a multilateral rather than a bilateral basis. This implies that formal channels of communication should be established between international and national research centers. Information flow should not depend on informal contacts between scientists.

Thirdly, some international centers are already training national FSR scientists. The length and character of these training programs should perhaps be evaluated to maximize their effectiveness. There has been some suggestion that FSR methodologies taught at the international level are not relevant to local level needs. The methodologies promoted by international centers may be more complex, or rely upon a greater degree of field staff expertise than national centers can provide.

III. The Methodology of Farming Systems Research

1) Identifying Target Areas and Farmers.

Identifying a target area for agricultural development is principally a political decision. The target area limits where an FSR team conducts its search for technological improvements. This may commonly be an area in which little research has been previously done. Identifying the characteristics of target areas by examining baseline data, secondary sources, and on-farm surveys gives the FSR team a basis for determining likely "recommendation domains." These recommendation domains are made up of groups of farmers with roughly similar circumstances and problems. There may be one or more recommendation domains in a target area. Generally, however, a single FSR team will work to improve production in a single recommendation domain at any one time. Presumably, an innovation approved by representative farmers within the domain will also be appropriate for most other farmers in that domain.

Determining the actual character and extent of recommendation domains can be difficult. For FSR to be cost effective, the number of farmers who can adopt an improved technology must be reasonably large. As noted earlier, however, the domains cannot be so large that the technological improvements offered will not be rapidly accepted or less than significant for each individual farmer.

Recommendation domains can be determined using a wide variety of criteria. Such decisions partly depend on the amount of baseline data gathered and the types of farming system variables deemed most important. The extent of domains can also depend on the general types of innovations sought. Baseline data on resources and climate previously collected by a research center can provide a starting point for identifying boundaries. Information gathered from on-farm surveys and secondary sources can then be evaluated in terms of the priorities and development objectives of the government, scientist, and farmer. Research priorities established with this information finally determine the range of farmers for whom innovations might be appropriate. The point is that decisions on the amount of information gathered and the needs to be addressed can significantly affect the type and number of farmers who will benefit from the research process.

One additional point should be stressed. While recommendation domains generally include similar farming systems, different systems may be suited to the same technological innovation. In addition, the farmers to whom an improved technology is recommended may differ for each technology. Therefore, the identification of a "similar" group of farming systems on which an FSR team might concentrate should always be open to revision. The FSR team must not simply confine its efforts to those farmers it initially identified as similar.

2) The Objectives and Character of Data Collection; Appropriate Types of Field Surveys.

Before going into the field, FSR teams should acquaint themselves with all relevant information about the target area. Research stations often have some survey data on climate and resources that relates to the team's region of interest. The use of such information can significantly improve field research and provide important links between the FSR scientists and the researchers who collect this data. A coordinated review of such data can also introduce a field team to the difficulties of cooperative work.

FSR practitioners often point out that small farmers have developed farming systems through generations of experience in order to make optimal use of their limited resources. The base data farm survey can acquaint the field researcher with the environment in which farmers operate and the farmers' understanding of that environment. The survey can be used to determine how and why farmers operate as they do. To determine if and how farmers can be assisted to improve their productivity, a researcher must understand the complex interrelationships and decisionmaking on small farms. The effects of many outside influences including market character and quality, price levels, availability of farm inputs and the quality of extension must also be considered. The evaluation of survey information then helps the research team choose and evaluate technological innovations.

The greater the understanding researchers have of the circumstances affecting a farming system the better they are able to develop or adapt agricultural technologies to farmers' needs. FSR practitioners commonly note, however, that data collectors working to identify constraints on a farming system and design on-farm research must guard against gathering too much information. There is a strong tendency to collect more information than is necessary for research design and more information than can be effectively digested in a reasonable time. This needless information includes both measurements of useless variables and unnecessarily precise measurements of useful variables. Clearly, a proper tradeoff must be established between the speed of data collection and the amount of data gathered. A method must be identified for gathering sufficient information at the least possible cost.

It is often difficult to determine the nature and extent of the information needed. FSR practitioners have found that each member of a team tends to collect excessive amounts of information pertinent to his own discipline. Therefore, researchers should establish strict guidelines on information before the team begins field work. Such guidelines, however, must not be so strict that they prevent recognition of important unexpected variables.

In addition to determining the proper amount of information needed, practitoners must identify an appropriate method for its collection. Researchers commonly argue about the value of different survey methods. Rapid, informal surveys are said to allow researchers to gather a great amount of relevant information cost effectively. Scientists question a large number of small farmers and continually redirect their questions in response to what they observe and to farmers' concerns. Scientists using informal surveys may also be less inclined to orient their questioning in terms of preconceived notions about farming systems.

Questionnaires, by contrast, have the advantage of producing at least minimal amounts of quantitative data useful for justifying research priorities and test designs. They can also be used to substantiate claims for policy or infrastructural reform. In addition, greater amounts of more random, representative data can be collected using questionnaires. Questionnaires, however, can reinforce preconceived notions about farming systems.

Some researchers stress the value of simple participant observation over the length of a cropping season. A great amount of information can be then obtained about farmers' needs and practices which would probably be missed by short and/or formal surveys. In using this technique the researcher might be more likely to recognize the value of the farmer's traditional technologies. A valuable give and take report can be established between the researcher and a group of farmers in a region. Participant observation, however, might be needlessly costly, particularly if such information and report can be gained during the technology testing phase.

Indepth case studies help show the wide variety of relationships between the variables that affect farming systems and how these relationships develop over time. Random sample surveys can show which characteristics are most representative of the farming systems in a particular area.

Every type of data collection has its advantages and disadvantages. Resolving the detailed problems of data collection must finally be left up to each FSR team. Several key factors can be identified, however, as important determinants in choosing a survey method. These include: (a) The amount of information initially available to team members about the target area; (b) the team's degree of experience with the farmers in the region; (c) the amount of a team's experience with FSR; (d) the amount of resources available to a team to collect and analyze its information; (e) the circumstances under which the team operates—cultural factors, language barriers, etc.; and (f) the time the team allots for data collection.

Evaluating the tradeoffs in initial attempts to understand a farming system becomes slightly easier with the recognition that farming system analysis continues throughout the research process. The research team may find it useful to employ several survey methods at different stages of the process. Additionally, the results of initial surveys need not all be evaluated before the testing stage begins. FSR involves an iterative sequence of events in terms of both attempts to learn about farming systems and attempts to promote their development.

One final point should also be made about issue of data collection. Some practitioners strongly caution against an excessive concern for quantified data. They claim FSR should not serve as a foundation for benchmark studies. Instead, FSR scientists should concentrate on understanding the farmer and his circum-stances. Gathering quantifiable data can distract the researcher from this purpose. Other practitioners note, however, that quantified data could supply valuable credibility to the research and be necessary for the professional development of the scientists involved.

3) Character, Value, and Degree of the Ex Ante Screening of New Technologies.

Ex ante screening attempts to determine what technologies should be tested on the basis of initial survey information. Two distinct issues are involved here. First, the value of relying too much on ex ante screening has been questioned. The initial screen-ing process itself is necessary as a starting point for designing tests of technology. The screening evaluates farmers' needs and circumstances in relation to society's objectives. Adaptable technologies can then be chosen from known production tools. At issue, however, is the degree of time and effort spent on the screening process. Some practi-tioners feel that much more can be learned about a farm system in technology testing than in extended initial attempts to analyze that system. The iterativeness of FSR ensures continued reevaluation of test designs as knowledge about farming circumstances increases. Therefore, the initial data collection and analysis need not be too complex.

Secondly, there are questions about the relative value of adaptive as opposed to developmental technology testing on farms. The adaption of known agricultural technologies has been said to produce more rapid and significant improvements in farm systems. Some suggest that an FSR program can gain rapid initial credibility by assessing improvements already developed or adopted by the most innovative farmers for their wider acceptability. There will always be certain constraints on farm systems, however, which can only be resolved by newly developed technology. It may be profitable to perform this developmental work in the field. Yet researchers must be careful not to threaten a small farmer's production or welfare. The final answer to these questions largely depends on the availability of adaptable technologies.

4) The Character of On-Farm Testing

Several types of testing are used in most FSR programs. These can include a researcher's on-farm tests, a farmer's on-farm tests, and verification trials. A variety of factors must be taken into account in designing these trials. These factors range from determining the variables to be accounted for, including nonexperimental variables that measure effects on the farming system as a whole, to identifying appropriate test sites and plot size.

Evaluating the advantages of various testing techniques lies outside the scope of this paper. Such an evaluation must consider country-specific goals and circumstances. Two major issues, however, can be highlighted.

The first concerns the degree of farmer participation in the research process. Such participation is crucial. The farmer must be the ultimate judge of the results of research trials and, thereby, the value of the improved technology. The greater his involvement in testing, the more likely test results will meet his needs. Researchers must recognize, however, that farmer involvement entails a degree of risk to the integrity of the trials. There is always the chance that the farmer may mistakenly compromise the test process, for example, by harvesting a crop before it can be measured. In addition, researchers must recognize that farmer involvement entails a degree of risk to the farmer himself. A failed farm trial can reduce a farmer's basic food supplies. The technologies to be tested on farms must be carefully screened, and compensation must be assured for any losses.

Another issue which merits careful consideration is whether participating farmers should be representative or innovative. In most cases, farmers who volunteer to participate in testing programs will most likely be those who have been innovative in the past. Such farmers are often innovative, however, because they are subject to different constraints than more representative farmers who are not innovative. Even when these farmers operate under objective circumstances similar to those of noninnovators, subjective differences may be significant. As a result, improved technologies accepted by these farmers may be seen as inappropriate by others. The value of using innovative farmers, however, lies in the greater likelihood that they would understand the nature of farm trials, and contribute useful information during the testing and during the evaluation of the results.

The use of representative farmers would probably more effectively simulate circumstances common to larger numbers of farmers. Technologies so developed might then be seen as appropriate and valuable by more farmers. In certain cases, explicit attempts to work with noninnovators could make them more receptive to innovations in the future.

5) Evaluation of Research and Testing Results.

The principal issues relating to evaluation are how and by what criteria evaluations should be made. FSR practitioners note that the best measure of the value and appropriateness of improved technologies is the farmer's adoption rate. This measure can be compromised, however, by the lack of effective dissemination. The influence of an inefficient extension service on the rate of technology diffusion can be difficult to distinguish from the influence of the quality of the technology itself.

Practitioners note that there are a number of other criteria which are useful in evaluating research. They also suggest that different bases of judgment can be usefully employed at different stages in the testing process. Judgment criteria, however, must be carefully chosen to serve the particular objectives of the testing process. Practitioners must guard against the traditional tendencies of agronomists to solely evaluate the success of their experiments in terms of yields and input–output ratios. In many cases, these may be less important measures than socioeconomic factors such as income, employment generation, or risk reduction.

Some FSR practitioners have also specifically noted the importance of accounting for the long–term consequences of adopted technologies. Such considerations may conflict with the need to generate rapid, significant farm system development. Yet the lack of this type of evaluation can ultimately cause great harm to the farmer. An assessment of long–term consequences should consider how technology adoption affects the environment, markets, and prices, sociocultural traditions, and national development goals.

6) The Diffusion of Research Findings.

As noted earlier, extension agents should participate in all phases of the research process. They can help analyze farming systems and promote ties between research teams and farmers. Involvement in the testing process can also teach extension agents about the technologies they will later be responsible for disseminating.

There remains some question, however, about how much reliance should be placed on extension services which may be plainly recognized as inefficient for disseminating research findings. To what degree should the FSR team concern itself with the character and quality of technology diffusion?

Farm trials, particularly in the later stages of the testing, could be viewed as demonstration plots. This, however, is not their major purpose. If extension inefficiency does appear to be a common problem, FSR researchers can take a more explicit and active role in extension agent training. While this may appear to be an expensive use of a scientist's time, the lack of effective technology dissemination must be recognized as a greater loss. Minimal amounts of extension training are probably more productive and less costly than if the researcher attempts to take responsibility for the extension process himself. The involvement of extension representatives in the research process can provide an important basis and incentive for extension system improvement.

7) Dynamic and Iterative Research.

The dynamic and iterative nature of FSR is extremely important. In essence, FSR is developmental. Researchers are called upon to constantly reevaluate their basic knowledge about the farmer and farm system. Failed research tests provide useful information for redesigning new tests. The adoption of improved technologies creates farming systems with new characteristics and often new constraints. An ongoing FSR program in a single recommendation domain involves a continual progression from testing and evaluating test results to the redesign of farm trials and back to testing again.

Effective feedback and a continuous process of learning are thus of great importance to FSR's productivity. This suggests that FSR teams should maintain a significant degree of integrity over an extended period of time. Each change in team membership can involve a loss of valuable knowledge and experience. In addition, feedback channels between the field and the research station supply an added dynamic dimension. Such links should probably be explicitly organized.

The Applicability of Farming Systems Research to U.S. Small Farms Research.

1) Domestic Small Farm Development and Technology Needs.

Over the past few years there has been renewed concern for the needs of American small farmers. This has arisen in part as a result of the reaffirmation of the value of the small farm as a way of life, and a new concern for the effective use of small farm resources. In addition, the concern arose out of the perception that national and local research and extension program were primarily oriented to serve larger commercial farmers and, therefore, were not adequately meeting small farmers' needs.

This interest in domestic development to small farms has largely been directed in two areas. First, there has been a desire to determine how the national extension service can more effectively assist small farmers. New channels of communication are being opened and more deliberate assistance offered. Secondly, there has been a desire to ensure that agricultural research considers small farmers needs. This has involved evaluating whether existing agricultural technologies are suited to small farmers' circumstances, and reorienting some research to better serve the distinct needs of small farmers.

Within this context, two major issues underlie the evaluation of how much FSR can assist domestic small farmers. First, the renewed concern for small farmer welfare has uncovered a lack of knowledge about the actual nature of small farm conditions. More information needs to be gathered about small farmers before funding priorities for development can be established.

Secondly, examining FSR's applicability demands a preliminary assessment of how well existing agricultural technologies meet small farmers needs. This must include an evaluation of why small farmers do or do not adopt known technologies, and an evaluation of unmet technology needs on small farms. Such an analysis lies outside the scope of this paper. What follows simply represents a series of considerations which provide a useful starting point for such an evaluation.

Most agricultural technologies presently developed for U.S. small farmers are classified as scale neutral. Clear evidence suggests, however, that many limited resource small farmers have not adopted many apparently useful technologies. Low rates of adoption are commonly seen as resulting from a lack of knowledge about these technologies and a simple lack of initiative or desire to apply them.

The first of these causes implies inefficiency in the dissemination of farm technology. This could in part result from the fact that extension service are generally inadequately funded and staffed to meet the needs of every farmer, and smaller farmers are often the first to be neglected. The problem could also result from the inadequate training of extension personnel.

The second cause for low rates of adoption could be the multiple goals of many small farmers. These farmers commonly operate on the basis of objectives other than profit maximization. Quality of life concerns are often equally if not more important incentives. Yet evidence suggests that in many cases scale neutral technologies are simply inappropriate to small farmers with limited resources. Land, labor, and capital constraints do in fact limit the adaptability of certain technologies commonly thought of as scale neutral. To many small farm researchers or extension agents, examples of this are somewhat common. Fertilizer applications, particularly in the strengths recommended for large and medium scale commercial farmers, are simply too expensive for small farmers. A seed variety which requires intensive application of water, fertilizer, and insecticides or maintains a short optimal harvest season can also be inappropriate. A highly toxic insecticide often cannot be used by a small farmer without a license or an appropriate applicator.

In addition, there is evidence that small farmers have many unmet technology needs related to the size of their enterprises. The most commonly cited are needs for small scale machinery. Increasing numbers of size-specific needs are beginning to be recognized by people interested in small farm development. These include needs for new plant varieties, cropping techniques, weed control measures, etc.

How can such small farm needs be met? If agricultural research institutions have not adequately served small farmers, how can research be reoriented? FSR represents one approach. While the specific methodology which has been developed for dealing with needs and circumstances in developing countries may not be strictly applicable (and the point in itself is debatable), some on-farm research methods could be. Apparently small farmer needs and circumstances need to be better identified and understood. The value of involving technology research scientists in this task needs to be examined. Some people interested in domestic small farm development have suggested interdisciplinary investigations can be of great use.

A related question concerns location specificity. Some small farm development specialists note that small farmers who live in different regions with different goals and circumstances have different needs. Whether FSR is a cost-effective way to meet these different needs should, perhaps, be evaluated. The least that can be said is that FSR represents a potentially valuable option for improving research and extension for domestic small farms.

2. Historical Use of On-farm Systems Research.

Many U.S. agricultural researchers and extension representatives have remarked that FSR is similar to the on-farm, systems research which aimed at assisting domestic small farmers in the early part of this century. Some note that these sorts of endeavors only disappeared from use a few years ago. There are, however, two opposing reactions to these observations.

First, there are those who believe that there was good reason for terminating such efforts. These people claim that the American farmer has become more knowledgeable and commercialized, and thereby more independent. Most small farmers, it is argued, at least have access to the information they need to operate their farms efficiently. Compared to developing countries' circumstances, input and output markets are generally well developed, as are research and extension services. In this view, an FSR type of approach is too costly to support in relation to existing needs. Such needs, according to this view, can be adequately served by existing agricultural support services.

By contrast, some agricultural researchers and extension agents have reaffirmed the need for this type of approach. These people note that the termination of on-farm, systems research coincided with a growing preoccupation with medium and large-scale commercial farmers and a corresponding loss of concern for limited resource small farmers. This loss of concern has been reflected in a number of ways. Proponents of this view claim U.S. agricultural support systems, although well developed, no longer adequately serve many small farmers. National and state economic policies have begun to push them off the farm. In addition, the changed goals of many small farmers (e.g., the lack of a simple concern for maximizing profits) need to be responded to in ways that differ from those used to meet the needs of larger farmers. The problems faced by many limited resource farmers are so different, it has been argued, that they must be dealt with uniquely. Application of an FSR approach might, therefore, be justified.

3) Existing Research and Extension: Expansion Versus Reorientation.

Some small farms development specialists have suggested that the small farmer's needs can be met simply by expanding the existing research and extension services. This would involve three initiatives. First, increased funding for extension personnel and training could foster better assistance for small farmers. Paraprofessional programs operating recently in Missouri and Texas are examples of this type of initiative. Extra money could also be used to simply hire more county extension agents, and provide better training and education programs.

Secondly, more funds could be allocated for research aiming to solve specific small farm problems. Initiatives have also been made in this area, although questions have been raised about the appropriateness of particular funding priorities.

There is a third significant initiative that could expand efforts supporting small farmers. This is promoting better information flow between extension agents knowledgeable about small farmers' needs and researchers working to develop technologies to meet those needs. Information gathered from extension agents can be used to help determine research priorities.

The question remains, however, whether there is greater value in getting the scientist out on the farm and involved in an interdisciplinary research effort. This would mean a clear reorientation of small farm development. The scientist might thereby learn much more about small farmers' needs and circumstances. Research priorities and the design of trials would likely be more relevant to small farmers' needs. The resulting technologies might be very different from those developed on experiment stations. They would undoubtedly be more rapidly adopted. The costs of this type of effort, however, need to be carefully evaluated.

4) Integrating FSR Into the Domestic Research System.

The value of both a multidisciplinary perspective and 'onfarm research has been recognized by many domestic agricultural researchers and extension agents. Most agricultural research, however, has remained on the experiment station and within a disciplinary context. Interdisciplinary interaction has largely come in the form of informal links and communications. On-farm work has generally been left as the distinct responsibility of the extension agent. These facts highlight two major problems which could inhibit the implementation of a domestic FSR program.

First, some degree of disjunction commonly exists between many agricultural research and extension programs. Channels of communication between researchers and extension agents could be improved. While in some cases the two types of programs are closely tied, in others relations are fraught with mutual distrust and jurisdictional jealousy. Mutual respect and cooperation, however, are important for successful FSR.

Secondly, developing an efficient formal process of interdisciplinary interaction could be problematic for two reasons. Academic and professional success depends on disciplinary excellence. Since FSR requires that a group of scientists share responsibility for farming system analysis and technology development, opportunities for individual disciplinary distinction are limited. In addition, professional and disciplinary pressures cause research to become increasingly specialized. Communication across disciplinary lines can therefore often be difficult. These problems may be particularly severe when the research base is an academic institution.

Conclusion

The successfull application of farming systems research by several research institutions in the developing countries has stimulated widespread interest. Representatives from increasing numbers of countries have sought to learn about FSR, and many have initiated their own programs. Such evidence suggests that the concerns which prompted the development of FSR are widely held. The more effective and efficient provision of technical development assistance to small farmers with limited resources has been recognized as an integral part of national development. Agricultural planners and development practitioners have acknowledged that past research has failed to adequately generate technologies appropriate to these farmers' needs. Farming systems research holds significant potential for both helping small farmer better meet their subsistence needs and integrating them into national market economies.

This paper has described some of the problems those considering the implementation of FSR programs must take into account. Clearly, organizing and implementing these programs is not easy. Practitioners have repeatedly emphasized the complexity and difficulty of FSR. In view of this, it is perhaps useful to briefly reexamine several facts.

First, the methodology of farming systems research continues to evolve from experience gained in field operations. The similarity of most existing FSR programs can, in large degree, be attributed to the similar problems researchers have faced in their attempts to better serve the limited resource, small-farm constituency in developing countries. The existence of a common general methodological model presently provides a basis for the replication of the approach. Expanded interest in and support for FSR is clearly justified since this model appears useful in a variety of environments. Yet implementors of FSR must keep in mind that many of the more specific issues and problems of FSR implementation remain in the process of being resolved. Such problems can only be resolved through experience, not theoretical analysis.

Secondly, the construction of new programs should not be viewed as a simple process of applying a known methodology. Each FSR program must be closely adapted to the particular circumstances in which it is to be implemented. The existing general methodological model along with specific program experiences should be used to guide future FSR. The essential quality and form of each program, however, can only be created by the implementing agency. The level of financial and ideological commitment, and the physical and social character of the environment should determine the structure and mode of operation of each FSR program.

Thirdly, farming systems research must not exclude consideration of the contribution of extension. The dissemination of appropriate technologies is essential for the success of the research process. In addition, extension representatives can make an important input to the research both as a valuable link between researcher and farmer, and as experienced interpreters of the farmers' needs and circumstances. Implementors of FSR programs should carefully review the role of the extension service in small farm development.

Fourthly, the value of the contribution of social scientists to FSR programs should be clearly recognized. These scientists play a crucial role in identifying and analyzing sociocultural and socioeconomic factors influencing the production, consumption, and marketing processes. Identifying the significance of these factors, which have not traditionally been considered in research and extension, is an essential characteristic of FSR. The input of social scientists, particularly sociologists and/or anthropologists, provides an important element of this sort of analysis.

Lastly, implementors of FSR should be clearly aware of the reorientation of roles and responsibilities the systems approach demands. FSR practitioners must learn to work as a team, with farmers and other people who play roles in the agricultural support system. Specialized training helps to orient the researchers. Such training, however, must be coordinated with efforts to ensure a national commitment to the value of FSR.

FSR has been widely applauded as a means to fulfill many goals of agricultural and rural development programs. Supporters have claimed that not only can agricultural productivity be increased, but the welfare of the urban and rural poor can also be improved. Evidence clearly suggests, however, that FSR cannot be viewed as the sole answer to rural development problems. Farming systems research must be recognized as but one important element in a coordinated strategy for rural development.

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