Farming Systems Research and Development : Guidelines for Developing Countries

W. W. Shaner, P. F. Philipp, and W. R. Schmehl

EXECUTIVE SUMMARY

This book provides guidelines for farming systems research and development (FSR&D) as applied to conditions in developing countries. The purpose of the guidelines is to assist national governments interested in helping poor farmers–primarily small-scale farmers with limited resources. Therefore, the guidelines discuss the nature of FSR&D, processes and methodologies appropriate for various conditions, and alternative means for implementation. Because most of the applied work in FSR&D has been with cropping systems, this book of guidelines emphasizes cropping systems research. By synthesizing implemented and successful approaches, these guidelines have a strongly applied orientation.

As a synopsis of the principal features of the guidelines, this executive summary is intended for those who wish a quick review of FSR&D's principal features. This summary contains brief sections on the background of FSR&D, its nature and activities, issues of implementation, and the contents of this book.

1.1 BACKGROUND

Considerable attention is currently being given to improving the lot of small farmers in developing countries. An important way of helping them is through agricultural research, extension, and related programs specific to their needs. A better approach for such efforts became necessary because farmers' condition were not improving adequately. Research and development programs had often been undertaken without having small farmers in mind or without knowing much about them. In contrast, the FSR&D approach starts and ends with small farmers and thereby focuses specifically on their condition and aspirations.

While much of FSR&D has been directed toward farmers with limited resources, the approach has relevance for improving agricultural research and development in general. Some argue FSR&D is simply a modified version of farm management that has been widely practiced in the United States during the 20th century. While this claim has merit, the general feeling among those actively engaged in FSR&D is that FSR&D is new–at least as applied to the needs of small farmers in developing countries. The accomplishments of some national and international research organizations support the contention that improved technologies can be designed for and will be adopted by small farmers.

1.2 NATURE OF FSR&D

A common thread among alternative approaches to FSR&D is the selection of relatively uniform sets of conditions for conducting research and implementing change. FSR&D allows researchers to (1) both intensively investigate the individual conditions of small farmers and (2) make an impact on large numbers of farmers. This result is accomplished by selecting reasonably uniform physical, biological, and socioeconomic environments, where farmers' cropping and livestock patterns and management practices are similar. Improved technologies developed for farmers in these research areas are expected to be applicable to farmers operating elsewhere under similar conditions.

The FSR&D approach typically uses interdisciplinary teams, whose composition varies according to the tesk. Field teams conduct on-farm research and are aided by (1) disciplinary specialists in the physical, biological, and social sciences who may operate out of regional or national headquarters or experiment stations. (2) extension specialists, and (3) others concerned with agricultural production.

Together, they study

- ☐ physical conditions such as rainfall, temperatures, and land forms
- ☐ biological factors such as production potential and pest problems
- ☐ socioeconomic conditions such as the size and nature of landholdings, farmer and community customs, markets, and local services
- ☐ the farming system.

The farming system is the complex arrangement of soils, water sources, crops, livestock, labor, and other resources and characteristics within an environmental setting that the farm family manages in accordance with its preferences, capabilities, and available technologies. Farmers manage the household's resources involved in the production of crops, livestock, and nonagricultural commodities (e.g., handicrafts), and may also earn income off the farm.

Farms are classified according to major characteristics–e.g., grazing systems, permanent cultivation on rain-fed land, or irrigated farming-and the environment-e.g., agroclimatic zone, soils, and terrain. Researchers classify farms according to the area, the needs of the study, and the available information.

FSR&D focuses on the interdependencies among the components under the farmers' control, and between these components and the physical, biological, and socioeconomic environments. Also, FSR&D identifies and generates improved technologies and adapts, tests, and promotes them.

The various production activities are subsystems of the whole farming system. For example, crop production is a subsystem of the whole farm and is, in turn, made up of individual cropping activities. The study of a cropping system comprises everything required for the production of one or more crops, including interactions between different crops. More specifically, research on cropping systems concentrates on

- ☐ crops and cropping patterns
- ☐ alternative management practices in different environments
- ☐ interactions between crops
- ☐ interactions between crops and other enterprises
- ☐ interactions between the household and environmental factors beyond the household's control.

A similar description could be given for livestock systems research.

Thus, FSR&D can be summarized as being farmer-based, problem solving, comprehensive, interdisciplinary, complementary, iterative, dynamic, and responsible to society. The approach is

- ☐ farmer-based because FSR&D teams pay attention to farmers' conditions and integrate farmers into the research and development process.
- ☐ problem solving in that FSR&D teams seek researchable problems and opportunities to guide research and to identify ways for making local services and national policies more attuned to the farmers' needs
- ☐ comprehensive in that FSR&D teams consider the whole farming activity (consumption as well as production) to learn how to improve the farmers' output and welfare, to identify the flexibilities for chage in the environment, and to evaluate the results in terms of both farmers' and society's interests
- ☐ interdisciplinary in that researchers and extension staff with different disciplinary backgrounds work with farmers in identifying problems and opportunities, searching for solutions, and implementing the results
- ☐ complementary because it offers a means for using the outputs of other research and development organizations and for giving direction to others' work
- ☐ iterative in that FSR&D teams use the results from research to improve their understanding of the system and to design subsequent research and implementation approaches
- ☐ dynamic in that oftentimes FSR&D teams introduce relatively modest changes in the farmers' conditions first and the favorable results encourage more significant changes later
- ☐ responsible to society in that FSR&D teams keep the long-run interests of the general public–both present and future–in mind as well as those of the farming groups immediately affected.

While much of the above is true of other forms of agricultural research and development programs, the combination of these factors distinguishes FSR&D from other approaches. Even more, FSR&D is systems oriented in that the researchers study the farmers' conditions at the outset, keep these conditions in mind during research and implementation, and use their knowledge of these conditions in evaluating the results. In this sense, FSR&D departs from reductionism, which is an approach that breaks the whole into parts and studies them more or less independently. Furthermore, FSR&D uses acceptance by the whole family as its key measure of success, rather than some abstract or narrowly defined criteria of effectiveness.

1.3 FSR&D ACTIVITIES

The approach to FSR&D varies according to the organization's mandate, which may be for certain commodities or which may be localized, countrywide, or international. Approaches also vary by the physical, biological, and socioeconomic characteristics of the target areas and groups, as well as by the preferences of FSR&D administrators and researchers. Some approaches are comprehensive, taking many factors as variable, including public policy; but more frequently, FSR&D works within existing conditions or assumes only modest changes in the existing conditions.

The basic FSR&D activities are target and research area selection, problem identification and development of a research base, planning on-farm research, on-farm research and analysis, and extension of results. Each of these is summarized below.

1.3.1 TARGET AND RESEARCH AREA SELECTION

Using national and regional objectives, key decision makers–including those from the FSR&D team–select one or more target areas. Then, the FSR&D team divides the target area into subareas with relatively uniform characteristics and selects a research area representative of the selected subareas. The team continues by choosing the target group–farmers who have common environments and common production patterns and farming practices. This group of farmers might be those with a particular cropping, livestock, or mixed (e.g., crops and livestock) pattern; alternatively, the approach could be based more on environmental conditions. Such classifications are usually adequate for identifying problems and opportunities of sufficient magnitude to justify the research effort. Where practical, the FSR&D team tries to apply the research results to farmers operating under similar conditions beyond the target area.

1.3.2. PROBLEM IDENTIFICATION AND DEVELOPMENT OF A RESEARCH BASE

The FSR&D team identifies and ranks problems and opportunities according to such criteria as the short–run and long–run significance to the farmers and society, availability of suitable or potentially suitable technologies, and case of implementation. Besides ideas arising out of the previous activity, the team commonly identifies problems and opportunities through quick reconnaissance surveys of the area. The study of livestock systems tends to take longer and may involve aerial photography, satellite imagery of rangelands, and monitoring of development programs to learn how herding societies function over time. A subject with considerable and yet untapped potential is research on mixed farming systems in which the researchers consider the influence of crops and livestock on each other.

In the process of identifying problems and opportunities, the team gains considerable knowledge about the area. This knowledge and the collected data form the initial research base for developing improved technologies for the area's small farmers.

1.3.3. PLANNING ON–FARM RESEARCH

Once the FSR&D team has identified and ranked problems and opportunities, gathered preliminary data, and set out hypotheses, it plans the on–farm research activities. Early in the process, the team needs to decide the extent to which the farmers' environment can be changed. For the most part, the team takes resource availability, support services, and government policy about as they are. But, an important part of FSR&D is to identify where and how much change of this type is possible. Given an understanding of this, the team then considers opportunities for improving farmers' conditions.

On–farm research emphasizes alternative cropping and livestock patterns, management practices, and other activities of the farm household. The team incorporates the farmers' conditions into the design procedures by working closely with farmers. The team meets with farmers in their fields and learns farmers' terms such as those for farmers' activities and units of measure. Researchers also learn how the farm household divides its activities, which members perform which activities, who has responsibility for the different family decisions, who controls which resources, how members tend the family's crops and livestock, and how they market their surplus production. Farmers, in turn, take part in the research experiments and evaluate the results. This collaborative style calls for integration of experiment station and other research and development personnel who are specialists in (1) disciplines such as entomology, economics, and soil conservation; (2) commodity topics, such as plant breeding and cattle production; and (3) extension.

Furthermore, the team designs record keeping systems, special studies, climatic monitoring, and surveys to provide additional information about the farmers and their environment. Often the team initiates recording of farmers' activities early in the FSR&D process to develop a continuing base of information on farmers' productive activities throughout the cropping and livestock seasons. The team uses special studies of selected topics, such as cultivation practices, to help fill in gaps in its knowledge about the area. The team needs information on the environment, including climatic data, to help design research and interpret the results from crop and animal experiments. Also, the team uses long-run studies of farm households, local conditions, and related topics to provide a sound basis for understanding the situation and implementing change.

Before finalizing the research plan, the team evaluates the proposed techno-logical changes. It does this to learn if the results are biologically feasible and in the interests of the farmers and society. Finally, the team assesses the extent to which local support systems and national policies will accommodate the new technologies.

1.3.4. ON-FARM RESEARCH AND ANALYSIS

Most national FSR&D programs emphasize applied research by conducting much of the research on farmers' fields. Three types of biological production experiments are common: researcher-managed trials to experiment under farmers' conditions where control of the experiment is important; farmer-managed tests to learn how farmers respond to the suggested improvements; and super-imposed trials to apply relatively simple researcher-managed experiments across a range of farmer-managed conditions.

The researchers initiate experiments, studies and other activities, and gather data. Then, they analyze the results in terms of the statistical meaning of biological performance, actual resource requirements, economic and financial feasibility, and sociocultural acceptability. They estimate the overall impacts on both farmers and society. Researchers study the acceptability of the experiments to farmers through observations of farmers' actions, talking with farmers, and in other ways. Finally, the researchers examine the opportunities for improving support services and government policies.

1.3.5 EXTENSION OF RESULTS

Throughout the research process, the FSR&D team maintains contact with support organizations in the area. Extension plays an especially important role in the process. Inputs from extension should occur at all levels of FSR&D-from initially identifying areas to the broad implementation of results. FSR&D practitioners generally recommend that the extension staff be trained in FSR&D and become regular members of the field and regional teams.

Extending the results involves multi–locational testing–an activity that spreads the improved technologies more broadly than the previous on–farm trials and tests. Multi–locational testing helps define the specific conditions by applying the results on a broad scale. In this process, extension agents learn the details of the technologies and how to apply them.

Another means of extending research results is through pilot production programs–an activity that applies the improved technologies on a scale large enough to effectively test the area's support systems. This activity provides further insight into the needs for modifying the technology, altering the support system, or both. However, the concept of FSR&D is that the derived technologies should fit the farmers' and environ–mental conditions sufficiently well so that few adjustments are needed at this stage.

Once these steps have been taken, the country can broadly apply the new technologies among the groups for which they have been designed.

1.4 ISSUES OF FSR&D IMPLEMENTATION

Some of the issues concerning FSR&D implementation relate to the time required to obtain results, organizational flexibility, staffing requirements, training, FSR&D costs, and governmental support.

1.4.1 TIMING

The general approach to FSR&D is rapid initiation of on–farm experiments combined with adjustments in the program's direction as results provide feedback. With adequate planning, researchers often start experiments without missing a cropping season. Sometimes they try exploratory experiments to learn how farmers respond to new oppor–tunities; at other times, researchers conduct trials to screen locally available technologies for their applicability to specific farmers' conditions. Under favorable conditions, some research results may be ready for widespread diffusion to farmers within a few seasons. However, more fundamental changes in farmers' cropping patterns and management practices normally take longer.

The approach being developed for livestock systems is an exception. For larger animals such as cattle, the environment, livestock systems, and growth stages often re–quire more careful study than most crops or small animals.

1.4.2. ORGANIZATIONAL FLEXIBILITY

FSR&D is primarily a modification of existing research and extension methods; therefore, the approach is adaptable to a variety of situations, as illustrated by the following possibilities. A country can implement FSR&D through a semiautonomous government corporation that has more flexibility in operations, budgeting, and person–nel management than ministerial research and development organizations. A country can implement FSR&D through a ministry of agriculture if the ministry is responsible for research and extension. A country can apply FSR&D to the activities of an experiment station in which one or more teams trained in FSR&D methods work closely with experiment station staff. Or, a country can build FSR&D into a project to increase production; in such a case, FSR&D methods can improve the efficiency of the overall project.

Each approach has its advantages and disadvantages, so the approach selected depends on the situation. Here, we emphasize that FSR&D, whether in whole or in part, can be and has been implemented in a variety of ways.

1.4.3. STAFFING REQUIREMENTS

FSR&D strongly emphasizes working with farmers in their fields. To the extent that this emphasis is new, those currently at research stations or at regional or national headquarters will require some reorientation. This reorientation includes research methodology as applied to field conditions and methods for working with the whole farm family–male and female, young and old. Where appropriate, females may need to be added to the research and extension staff.

However, FSR&D does not replace existing research or extension; rather, it builds on the existing base. Consequently, experienced researchers and extension specialists usually remain in their existing organizations and much of the field staff consists of young professionals trained specifically for FSR&D's purposes. Enough senior staff members will be needed–whether nationals or expatriates–to guide the younger members of the staff until they gain adequate experience.

One approach is to begin FSR&D activities in one or two regions and, after several years of experience, to choose leaders from these teams when moving to new areas. Heads of FSR&D programs must also train staff to replace those who periodically leave the program.

1.4.4. TRAINING

An early activity when implementing an FSR&D approach is to train the staff about the objectives, processes, and methodologies of FSR&D. Training materials will need to be collected from ongoing programs elsewhere and augmented by new materials appropriate for the country. During this early stage, the International Agricultural Research Centers (IARCs) and organizations with similar activities can be especially helpful.

The principal objectives of the training are to

- acquaint team members with on-farm techniques
- give them guidance and experience working as an interdisciplinary team
- instill in the team members an enlightened appreciation of small farmers as a useful source of information and as valuable partners in the research and implementation process.

Where members of the FSR&D team are recent graduates, in-service field training under the guidance of experienced staff is needed.

Initially, program leaders may want to take advantage of production and farming systems training at one or more of the IARCs and any regional center specializing in applied agricultural research. With such training as a base, in-country training programs for both research and extension personnel can then be developed and implemented. Some staff members may be selected and sent abroad for further academic training.

In training, as well as in other aspects of FSR&D programs, national governments may want to consider using expatriate staff experienced in FSR&D. As the program matures, the expatriates can be phased out gradually; In one case, this occurred about six years after the program began.

1.4.5. FSR&D COSTS

A discussion on the relative costs of FSR&D centers on expenditures, rates of adoption, breadth of coverage. This discussion must be general since carefully quantified appraisal of FSR&D's costs, relative to other research and development approaches, has not, to our knowledge, been made. While firm estimates are not available, those closely associated with FSR&D generally feel that the approach is cost effective. The reasoning follows.

The first of the three issues concerns expenditures for facilities and operating costs. To the extent that FSR&D reduces experiment station activity, costs of expanded installations, operations, and the accompanying staff will be lowered. In its place will be more work on farmers' fields by generally less expensive staff. However, the field work requires increased expenditures for vehicle purchase and maintenance, field equipment, perdiem, and incentives. Overall, the combined initial and recurring costs of FSR&D appear to be less than the costs of comparable levels of activities on experiment stations, when administrators consider the costs of building, staffing, and equipping the stations. However, such comparisons are of limited value since FSR&D replaces only a portion of experiment station activities.

The second issue concerns the generation of new technologies acceptable to farmers. This too is not a straightforward issue, because the target group for FSR&D is sometimes different from that of general agricultural research. Proponents of FSR&D, however, point to the high levels of adoption of improved technologies by small farmers targeted by the FSR&D process.

The third issue centers on the range of applicability of research results. Opinion differs about how widely FSR&D can be applied. Traditional research, by its nature, often has general and wide applicability. FSR&D is designed to be more specific, but it may also be applied broadly if the team can identify environmental conditions sufficiently wide ranging and target groups in sufficiently large numbers. FSR&D practitioners expect work in categorizing research areas to eventually make it easier to locate situations in which the new technologies generated by FSR&D will have broad applicability. Eventually, the study of environmental gradients will permit a better understanding of the relationship between research results and the conditions leading to these results, but this latter possibility, especially when speaking of national programs, lies in the future.

1.4.6 GOVERNMENTAL SUPPORT

Because FSR&D concentrates on field activities, the government will need to take steps to allow team members to effectively carry out this work. Materials for conducting experiments need to be available at appropriate times, otherwise the experiments may not be completed. Reliable transportation is essential, especially where the terrain and weather conditions make travel difficult. The FSR&D team needs adequate servicing and spare parts for its vehicles. Finally, incentives are often required to attract and hold qualified staff. Incentives such as the recognition of team accomplishments will be needed to overcome the uncertainties of working in a new and different program and the hardships of living and working in remote areas.

FSR&D does not place great demands on the government, but these demands must be met to create and maintain the momentum necessary to sustain an effective FSR&D effort. Where the central or regional organization cannot meet some of the above requirements, the organization should give the field teams adequate local autonomy.

1.5 WHAT THIS BOOK OFFERS

To repeat, this book of guidelines describes an approach to agricultural research and development for governments of developing countries interested in improving the output and welfare of small farmers. We present the FSR&D activities, methods, and illustrations of various approaches in the main body of this book and elaborate on these points in the appendixes. We emphasize cropping systems research because most experience lies her; however, we include materials on livestock systems. Systems concepts are included, but few analytical tools for systems analysis such as simulation or linear programming are included because we found few examples of their use in national FSR&D programs.

This book of guidelines is for those in the developing countries who must decide whether to accept FSR&D and bear the responsibility for its implementation. This book is also for the expatriate who aids in this process.

In designing FSR&D activities, administrators must decide on the approach, methods, organization, staffing, training, and ways to secure technical assistance and funds. The book should aid such individuals in making reasoned decisions on these topics. Because of the diversity of conditions and the wisdom of allowing those in a country to make their own decisions, the book does not prescribe how a country should implement FSR&D activities. Instead, the book presents general concepts, offers alternatives that have worked in different countries, and provides the reader with sources of additional information.

In conclusion, undertaking an FSR&D approach that modifies a more traditional approach to agricultural research presents a considerable challenge to any country. Existing institutions and individuals may feel threatened by the change. False starts are possible. Still, if the enthusiasm of those who have been most active in the FSP&D movement is any indication of its validity, the effort is justified.