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Farming Systems Research and Extension: An Approach to Solving Food Problems in Africa

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Yields of food crops per hectare have been stagnating in most of Africa and have been declining on a per capita basis (World Bank 1981; U.S. Department of Agriculture [USDA] 1981). Although these figures are open to questions (see Berry in this volume), there can be no doubt that yields must be raised. There are many reasons for Africa's low performance in food production, such as deficiencies in marketing, infrastructure, price incentives, and general agricultural policies. The low yields have also been attributed to the nature of African soils and climate. All of these reasons are important; yet it must also be recognized that there are considerable differences in productivity among different areas in Africa. Maize yields in Zimbabwe and intensive cropping systems in parts of Cameroon are examples of high productivity. Nonetheless, there is obviously room for improvement in most of Africa, even though ecological limits appear to have been reached in some areas such as the Sahelian belt.

It is also clear that most agricultural research conducted thus far has not produced many results that can be applied by subsistence farmers in communities in which labor is relatively scarce. The real breakthroughs in world agricultural production have been achieved in irrigated wheat and rice, and to some extent in maize, but not in any of the major African food crops such as sorghum, millet, and roots and tubers. Furthermore, most current agricultural innovations are not adapted to the rainfed shifting and fallow systems that are characteristic of most farming in Sub-Saharan Africa.

Therefore, there is an obvious need for a reorientation of agricultural research in two respects. First is the need for an inventory of small farmers' constraints that takes into account the great variability and location-specificity of African farming systems, with a view to formulating more relevant research problems. Second is the need for adaptive research procedures whereby existing innovations may be tested and adapted to the specific and localized needs of farmers. Although some general problems and solutions are known, such as the maintenance of soil fertility

through tied ridging, mulching, and manuring, these are not always translated into the terms that fit specific farming systems.

Farming Systems Research and Extension (FSR/E) provides a framework for this reorientation. Although this framework is still in many ways struggling to define its mandate and methodology, it has broad appeal among researchers, extension workers, and policymakers, as well as farmers. However, any research program or technology will have only a limited impact if other things remain equal. FSR/E is not a panacea; it is no more than a tool or an approach that may help African countries and farmers to increase food production.

The purpose of this chapter is to explore FSR/E and its use and suitability as a method for generating technology for agricultural development in Africa. A definition that includes an overview of the basic concepts, methods, and stages of activities begins the chapter, then the historical development of FSR/E in Africa is outlined. This historical perspective provides the basis for an exploration of how the approach, as it has evolved, may contribute to solving Africa's food problems. Despite a fairly widespread belief in the appropriateness of this approach in Africa, there are still a number of problems confronting its implementation in many countries. In this chapter examples from current projects and programs that illustrate these obstacles have been provided. Notwithstanding these problems, FSR/E is being institutionalized now in some national agricultural research and extension systems, and examples of such systems are included. Finally, in the last section the possible future and limitations of FSR/E in Africa are explored.

• GENERAL CONCEPTS AND FEATURES •

FSR/E has rapidly become a popular "catch word" in agricultural and rural development programming during the past decade.[1] Although by no means a new concept, since many of its principles have been used for more than a generation, it combines different earlier approaches for the dual purpose of (1) understanding limited-resource farmers and their interactions with the biological, social, and economic environment and (2) providing procedures for the adaptation of technology to the needs and constraints of these limited-resource farmers. The combination developed as a result of growing concern over the difference in yields on research stations and yields by actual farmers, the unintended negative side effects of the large scale diffusion of new agricultural technology during the Green Revolution, and the low rates of adoption of new technology by farmers, particularly those identified as small or resource limited (Simmonds 1984). FSR/E provides an orientation for commodity research and perhaps also for rural development policy. It is not, however, a development strategy by itself. It is complementary to other research and extension approaches, not a substitute for them. It is also important to recognize that there is inherent tension between systemic interdisciplinary approaches to problemsolving, such as FSR/E, and approaches that follow a more singular or disciplinary line, such as commodity and component approaches.[2]

Because FSR/E is a relatively new approach that is still taking shape, and because its name is applied as a descriptive generic label to a variety of ongoing activities known by an assortment of titles, there is still some disagreement over terminology and methodology. Most practitioners, however, seem inclined to take a pragmatic view of the field, focusing on common features and concepts, rather than arguing for a common definition and methodology. This pragmatic view allows for the development and inclusion of a wider range of research-extension projects, greater diversity of applications, and greater experimentation in methods for solving problems, all of which should promote further growth and development of the approach. Most of these practitioners agree that a farming system is a

> reasonably stable arrangement of farming enterprises that the household manages according to well-defined practices in response to the physical, biological, and socioeconomic environments and in accordance with the household's goals, preferences, and resources. These factors combine to influence output and production methods. . . . The farming system is part of larger systems—e.g., the local community—and can be divided into subsystems—e.g., cropping [or livestock] systems (Shaner et al. 1982:16).

The same authors define FSR/E as an approach aimed at "increasing the productivity of farming systems by generating technologies for particular groups of farmers and by developing greater insight into which technologies fit where and why" (Shaner et al. 1982:13).

Although other definitions exist and considerable discussion still takes place over their relative merits, there is general consensus on the basic assumptions, objectives, and methodologies of the approach. Regarding assumptions on the nature of farmers, farms, and farm households, FSR/E holds that farmers are rational and make decisions based on their understanding of their farming system and the environmental, social, and economic constraints that they face. The farm is viewed as a holistic system with all subsystems interconnected. A change in one subsystem initiates changes in the linkages within other subsystems and ultimately in the whole farming system. Research and extension improve as researchers and extension workers stop dealing with individual crop and livestock enterprises as if they were isolated and start treating farms as systems. Finally, farm households have multiple objective functions. Farmers do not necessarily seek technical optima or even optimal economic returns from a single crop or livestock enterprise, and farm level production constraints may be cultural, as well as technical and economic. Thus, FSR/E involves action-oriented research with a high degree of location specificity, usually directed toward more than one crop or farm enterprise. The primary objective is to increase the supply and stability of farmers' food as a basis for the improvement of the welfare of farmers.

The nature of FSR/E methodology is interdisciplinary, involving biological, technical, and socioeconomic scientists. It requires complementary on-farm and on-station research, and its success depends to a great extent on the linkages with component and commodity research.[3] FSR/E's starting point is the whole farm, including livestock and off-farm employment, and farmer participation in the re-

search process becomes both a means and an end in itself. Finally, FSR/E is iterative and practical, incorporating methods of knowledge generation that include two principal elements: informal diagnostic surveys and on-farm experimentation based on the results of agricultural research and farmers' experiences. As a result, FSR/E shows a new appreciation of traditional farming techniques (for example, mixed cropping or combinations of upland and valley plots) and of traditional risk averting crops and practices (for example, the use of drought-resistant but usually low-yielding cereals such as bullrush and finger millet). Further, this approach pays attention to the need to reduce variations in total farm output and to ensure household food security.

FSR/E generally proposes five steps in the development of technical improvements for limited-resource farmers: diagnosis, design, testing and evaluation, dissemination, and referral and evaluation. These steps may occur cyclically or simultaneously, depending on the nature of the research program; in most cases they are continuous activities.

Diagnosis usually consists of two steps. The first is an inventory of agricultural production systems, existing research results and recommendations, and input delivery structures in a given region, which is usually defined as the project area. The second is the determination of production constraints or problems for groups of farmers—each group consists of farmers with similar production systems. These groups are often referred to as recommendation domains for the development and testing of specific technological innovations. In both steps various methods of informal and formal, quantitative and qualitative data collection by an interdisciplinary team are used. The simple and effective diagnostic procedure, developed in Central America, known as the *sondeo* (Hildebrand 1981) and the rapid rural appraisal (Chambers 1981), similar to the sondeo, are effective diagnostic tools that may be used to distinguish groups of farmers and their production constraints. In some areas farmer groups are not easily distinguished initially, and group definitions are refined as on-farm work progresses and greater information is collected concerning the features of specific farming systems and farmer constraints. Diagnosis has often included more formalized surveys for data gathering; however, the trend is toward informal methods with complementary focused formal surveys to verify informal results or to explore in greater detail some particular aspect of the farming system. It is important to note that diagnosis does not take place only at the start of FSR/E work, but is continuously carried out to monitor on-farm experimentation, gather new information, assess impact, or generate new research directions. In the same fashion farmer groups or recommendation domains are not fixed; they are redefined as more understanding of the farming system is reached (Hildebrand et al. 1985).

In the design step the results of diagnosis are used to develop strategies to overcome the identified constraints and technological innovations involving on-station and on-farm experimentation. FSR/E, in principle, introduces changes only at the farm level. Often food production is constrained by factors at other levels, for example, transportation systems or pricing structures. Following design, the testing, monitoring, and evaluation of proposed innovations are conducted in farmers' fields with varying levels of supervision from researchers, or extension agents, or both, and under varying levels of farmer management.

The fourth step, dissemination, involves the adaptation and transfer of successful innovations to other farmers in the same recommendation domain via extension systems. The development process does not end here. The fifth step, referral and evaluation, addresses unsolved problems and the evaluation of reasons for farmer adoption or rejection of the new technology, which must be communicated to relevant component and commodity researchers, as well as to policymakers.

Broadly speaking, at present most FSR/E practitioners throughout the world agree upon these five steps. Nonetheless, the historical development of the approach and the actual application of the methodological steps differ considerably from region to region, as well as from project to project. In the remainder of this chapter the history of FSR/E in Africa and its application within the sub-regions of Africa are explored.

• HISTORICAL ROOTS AND DEVELOPMENT IN AFRICA •

FSR/E is rapidly gaining a place in agricultural research and extension programs today in Africa. Though it has only recently attracted the attention and funding of foreign aid donors, it is not a new approach to agricultural research in Africa. Carl Eicher and Doyle Baker (1982:161) described an "invisible literature on FSR in Africa which can provide a perspective on current FSR programs" (1982:161). In particular, they cited the experiences of the Cotton Research Corporation in Uganda during the 1950s, the Uboma study in eastern Nigeria during the 1960s, and the Experimental Units in Senegal's groundnut basin of the early 1970s as predating contemporary FSR/E programs. In addition to these were the many multilocational testing programs instituted by various African research institutes that were valuable in identifying the potential of recommended varieties and techniques in particular agro-ecological zones. As Eicher and Baker pointed out, these early experiences demonstrated that on-farm research is not a luxury but a necessity in shaping national research programs, that multidisciplinary teams incorporating social scientists are essential to agricultural research, and that farmer testing of technological innovations is needed prior to dissemination of new technology through extension systems.

Since the early 1970s, the development of FSR/E in Africa has been largely supported by the efforts of several of the International Agricultural Research Centers (IARCs) that are sponsored by the Consultative Group on International Agricultural Research (CGIAR) (see Plucknett et al. in this volume). These efforts are detailed later in this chapter. Foreign donor agencies have also entered the picture—notable examples include the French efforts in Senegal, Burkina Faso, Algeria, Tunisia, Mali, Niger, Cameroon, and Ivory Coast; the Dutch aid to the FSR programs in Sikasso, Mali, and in Burkina Faso; and the Canadian Interna-

tional Development Research Center's (IDRC) extensive support to cropping systems research activities throughout Africa. U.S. Agency for International Development (USAID) support has come largely during the 1980s and primarily through its funding of the CIMMYT East African Programme and through bilateral contracts in Senegal, Malawi, Gambia, Zambia, Lesotho, Sudan, Botswana, Swaziland, and Tanzania.

Important also in this historical development were several conferences that served as turning points in the evolution of FSR/E in Africa (Eicher and Baker 1982:160). For example, the need to consider indigenous farm practices such as intercropping, rather than automatic promotion of Western practices, was revealed at an intercropping conference in 1976 in Tanzania. A conceptual framework for FSR was spelled out at a conference in 1977 at the Institut d'Economie Rurale in Mali. In 1977 a symposium on the Experimental Unit approach in Senegal highlighted the importance of on-farm experimentation. And in 1979, at a conference organized by the Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM) in Ouagadougou, occurred a major synthesis of social, economic, geographical, and technical perspectives on farm-level studies in Africa. Roughly half the countries in Africa had initiated FSR projects by 1981 (Eicher and Baker 1982:161).

Generally, most of the FSR/E efforts in Africa can be categorized into two groups. One group comprises studies that largely describe existing farming systems in a holistic way, with a view to understanding the relationships of the components of the system (for example see Ruthenberg 1980). This group is rarely directly related to applied developmental efforts. The second group consists of those efforts that are actively developmental, those that seek changes in the production system. Efforts in this latter category may be further divided into (1) efforts that view on-farm research as a complement to ongoing station research, usually focus on one crop or commodity system, and assume that production increases result from stepwise iterative changes in selected components of the farming system and (2) efforts that attempt to develop new farming systems under the assumption that a radical restructuring of the entire system is required, such as replacing shifting with permanent cultivation in the humid tropics or introducing farming systems based on animal traction as opposed to hoe cultivation. These categories help to structure the understanding and analysis of the development of FSR/E in Africa. To this end it is equally important to trace the roots of two sometimes conflictive, sometimes complementary FSR/E perspectives in Africa: the Francophone and Anglophone perspectives.

Francophone refers to the approaches utilized by the French during the 1960s and 1970s in the former French-speaking colonies in Africa and to the systems approaches to agricultural production that evolved in the 1950s in the former Belgian colonies. Anglophone refers loosely to the FSR/E and cropping systems research that evolved at the IARCs, in some U.S. universities, and in certain national programs around the world. Though these two terms may seem exceptionally broad and subject to overgeneralization, this simplistic dichotomy is justified because

(1) the similarities among the different Francophone approaches are far greater than their differences, as is also the case among Anglophone approaches, and (2) there seem to be some theoretical differences in perspective between the Francophone and Anglophone traditions. These differing traditions teach us something about the strengths and weaknesses of FSR/E and the ways a FSR/E approach may fit within national research programs. It should be noted that recent exchanges among national programs that are inspired by Francophone or Anglophone traditions have become more frequent, and many national programs are developing their own special blend of FSR/E. The comparison of Francophone and Anglophone approaches to FSR/E is drawn from a comparative study conducted by Louise Fresco (1984) and is summarized here to highlight some of the general issues confronting FSR/E in Africa today, with particular respect to its institutionalization and the extension of its results.

• FRANCOPHONE APPROACHES IN AFRICA •

French Initiatives

The development of French research on tropical agriculture was dominated by a commodity sector approach that was reflected in its organization. Beginning in 1924, eight research institutes were created, one for each of the following: livestock; oil crops; textiles and fibers; timber and forestry; coffee, cocoa, and other stimulants; rubber products and plastics; agricultural machinery; and food crops. Each of the institutes created its own field program both at home and abroad, resulting in the organization of agricultural research along commodity lines in many of the former French colonies in Africa. The institute for food crops, Institut de Recherches Agronomiques Tropicales et des Cultures Vivrières (IRAT), developed a concern for a systems approach to integrate the results of component research programs in field projects. A brief look at the development of the Experimental Units, or Unités Expérimentales (UE), in Senegal provides insights into the evolution of the French approach.[3]

Up until 1960, agricultural research in Senegal, mainly at the peanut (groundnut) research station at Bambey, had been nearly exclusively component or commodity oriented and focused on cash crops. Little work on food crops had been conducted. Detailed studies of specific climatological and natural constraints, as well as large-scale soil surveys, were part of a concentrated effort to overcome technical constraints to production. Development programs centered on introduction of animal traction and ploughs, breeding of heavier oxen, detailed recommendations on cultivation techniques, and the dissemination of improved varieties. During the 1960s, many development programs failed and questions regarding the role and methods of agricultural research were raised. Of the new insights gained during this period, the following laid the basis for a systems approach (Tourte 1971):

1. Agricultural production is carried out by farmers who seek production systems that best fulfill their needs given the socioeconomic and ecological environment.
2. Research priorities must be defined with an understanding of the rural environment and national objectives.
3. The transfer of research results through the extension service is inadequate, and results developed in the artificial context of research stations are inappropriate.
4. The combination and application of technologies, as well as the development of integrated production systems, must be studied; production systems must be adapted to the technical and socioeconomic environment.
5. Integrated systems must be field tested in order to identify constraints in their application.

In 1968, two Unités Expérimentales (UE) were created within the National Agricultural Research Institute (Institut Sénégalais de Recherches Agricoles, or ISRA). A UE is a geographical and social unit in which the results of agricultural research are tested on a real scale to develop and refine production systems that take into account the interactions between physical and human environments. ISRA was based at Bambey and the UEs were located in the Sine Saloum region of Senegal. The two UEs covered 6,000 hectares with 2,200 inhabitants and 4,500 hectares with 2,000 inhabitants and included several villages and hamlets that were united into cooperatives. Creation of the UEs must be considered a milestone in the history of FSR/E in Africa because for the first time production systems became not only the subject of research but their study was institutionalized within the existing research structure. At the same time, the UEs were considered as a pilot project in which technically sound interventions were tested for economic and social feasibility.

With the creation and use of UEs and the attempt to involve farmers in the formulation of new technologies, a distinction became drawn between light innovations (*thèmes légers*) and more fundamental innovations (*thèmes lourds*). Light or classical innovations include improvements to the traditional production system such as new varieties, additional fertilizers or changes in their application, or light equipment that do not alter the system's basic structure. Fundamental innovations, however, are a coherent package aimed at an overall intensification and a profound transformation of the traditional production systems. These would include efforts such as land improvement and reorganization of land holdings in order to allow permanent cultivation or the introduction of animal traction and tractorization. The two sets of innovations are not diametrically opposed but complementary, and both are viewed as essential to the development of the full agricultural potential of Senegal. Therefore, restricting research to the development of improvements in the traditional production systems limits economic growth.

It is not possible to detail fully the development of the UEs in Senegal; however, it is necessary to highlight three new features introduced into agricultural research in Africa as a result of the UEs. (1) Detailed procedures for data collection outside the research station throughout the process of technology formulation were introduced—namely, case studies, focused followup thematic surveys, surveys on themes new to agricultural technology innovation such as nutrition and demography, and the use of group and individual interviews. (2) Explicit linkages were established between research and development organizations—namely, the use of experimental areas of realistic scale, continuous interaction of agricultural researchers and extension workers, direct feedback into research through field trials, and the combination of short term (*thèmes légers*) and longer term (*thèmes lourds*) development goals. (3) The production system in all its complexities was accepted as a unit of analysis, leading to a decentralization and location-specificity of research and to the recognition that evaluation criteria include farmers' motivations and national development goals, as well as agronomic criteria.

Several features of the UE experience were also prominent in other French agricultural development activities in Mali, Tunisia, Burkina Faso, Algeria, Ivory Coast, Niger, and Cameroon. All these have added to the development of what can be loosely defined as a Francophone approach to FSR/E. There is no single Francophone approach; yet some key concepts common to most French programs may be identified. Central among these key concepts is that of *recherche-développement*, which refers to the essential linkage between agricultural research and rural development. Recherche-développement is the study of the application, on the basis of tests conducted under real physical and socioeconomic conditions, of technical and social changes, in particular the intensification of production and the creation of producer organizations and delivery of extension systems. Recherche-développement concentrates mainly on innovations or packages for labor (input and skills), types and quantities of agricultural inputs (seeds, fertilizer, tools, and machinery), and the organization and management of production systems. The approach rarely tests economic innovations in marketing, price policies, agricultural wages, credit, or agrarian reform in general. Recherche-développement comprises three complementary activities: (1) studying the conditions of application of production systems that have been developed in agricultural research stations, in particular through field tests; (2) identifying the principal factors that limit agricultural production and choosing and testing solutions to overcome these constraints; and (3) developing policies and methods to improve the socioeconomic conditions of production (Billaz and Dufumier 1980:19).

That all three of the above activities are pursued in concert tends to give the Francophone approach a rather broad mandate to integrate the results of component research aimed at solving technical problems, while assessing economic feasibility and practicality at farm level. In conducting research activities, recherche-développement operates at four levels of observation to which four units of analysis correspond. From the specific to the general the levels are: the field/plot, the farm, the village, and the subregion (see Table 20.1).

TABLE 20.1. Levels and Units of Analysis in the R-D (Recherche-Developpement) Approach to Farming Systems Research

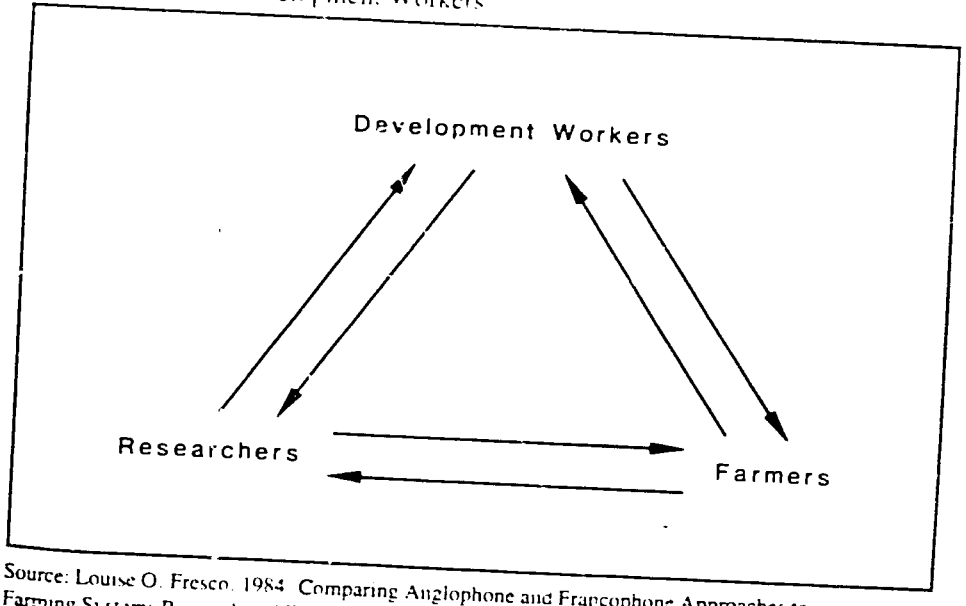
Level	Unit of analysis	Study of:
Field/plot	a. cropping system (systeme de culture)	a. soils, agro-ecological history, crop/weed/insect populations, micro-climate
	b. livestock system	b. also: herds, grazing conditions
Farm	farming system (systeme de production)	means and methods of production, including non-agricultural work; recent history, past change in capital and technology utilization; labor profiles; household budgets
Village	village production systems (systeme agraire/terroir)	management of natural resources, land evaluation, climate, vegetation, morphology, etc., (social) control of natural resources and water
Subregion	subregional production system (systeme agraire/petite region)	Same as above but on a scale of 10,000 hectares and over

Source: E. de Miranda and R. Billaz. 1980. Methodes de Recherche en milieu sahelien: Les approches ecologiques et agronomiques d'une demarche pluridisciplinaire: l'exemple de Maradi au Niger. Agronomie Tropicale XXXV:4:357-373.

One may interpret Table 20.1 as representing a certain hierarchy of systems, much as Robert Hart and Antonio Pinchinat (1980) have discussed elsewhere. The major contribution of this distinction of levels of activity and corresponding units of analysis is that it explicitly carries the results of field-level testing to the regional policy levels, and vice-versa, and it effectively demonstrates the necessary linkage of on-farm research to extension, natural resource management, and policy formulation. Although it is possible to distinguish six phases in recherche-développement, in practice these phases are not necessarily conducted chronologically—that is, the phases may occur simultaneously or as problems emerge in the research process (Ramond 1970; Billaz and Dufumier 1980; Tourte and Billaz 1982). The six phases are as follows:

1. Observation and analysis of constraints to rural and agricultural development that require a multidisciplinary effort and rely on various types of surveys that lead to a zonage (homogeneous units based largely on agro-biological and technical criteria) and to a typology of farm enterprises
2. Formulation of farm models or new farming systems formulated in a quantitative way and comprising the hypotheses to be tested
3. Definition of multilocational trials on substations, on farms, and in test villages

FIGURE 20.1. Communication Among Researchers, Farmers, and Development Workers



Source: Louise O. Fresco. 1984. Comparing Anglophone and Francophone Approaches to Farming Systems Research and Extension. Farming Systems Support Project Networking Paper No. 1.

4. Evaluation and interpretation of trial results
5. Proposals for and discussions with development programs
6. Definitions of new hypotheses for further research

Concerning these phases, great attention is placed on the classification of farms according to their size, number of people employed, and annual per capita income. Several different socioeconomic types of farms may be found within a single agro-ecological zone. Additionally, farm models are proposed combinations of improved or new technologies.

To summarize, recherche-développement is an integrated attempt to define the sequence of technical and socioeconomic changes and pathways required for a farming system to reach optimal production levels. To achieve this result, there must be an ongoing, functional partnership among research, farmers, and development (see Figure 20.1). This triangular relationship allows researchers to learn from farmers how they manage their existing farming systems and allows farmers to try innovations proposed by researchers. The role of development is one of a long-term iterative process between researcher and farmer that leads to the diffusion of innovations.

Belgian Contributions

Though there are many examples worthy of note, this section focuses on only two Belgian contributions to FSR/E in Africa: the first is the work of Pierre de Schlippe and the second is the INEAC experience with *paysannats*, or resettlement schemes. Pierre de Schlippe, a Belgian agronomist, must be regarded as one of the founding fathers of farming systems; yet his work in Central Africa has been neglected for a long time. During the 1950s, his study of the traditional agriculture of the Zande in Zaire led him to conclude that agricultural technologies developed in research stations must be preceded by a detailed analysis of local agricultural traditions and the rationale behind them (de Schlippe 1956). He proposed that this analysis must involve agronomy as well as anthropology because "traditional agriculture is at once both a human activity and a natural process" (de Schlippe 1956). De Schlippe warned against promoting interventions that were not based on thorough knowledge of farmer practices and constraints. He proposed that traditional agriculture be studied by agricultural anthropology because all students of traditional agriculture need to be both agronomists and social scientists. Agricultural anthropology, according to de Schlippe, is based on two concepts: the system of agriculture and the field type.

The system of agriculture consists of agricultural as well as cultural elements, and is influenced by the whole culture of the group. Agricultural behaviour is governed by social norms and values and by knowledge of the environment. This knowledge is extremely detailed, covering the criteria for relative fertility of each soil-vegetation pattern, the exact timing of every operation in the process of raising each variety of every crop, and the utilization of all sorts of fruits, seeds, leaves, wood, and barks for every kind of food and utensil. This knowledge is shared by the community, and its practice is codified by rules that govern behavioral patterns.

The field type is both an agronomic term and a sociological one. In the sociological sense, a field type is a cluster of behavioral constraints that rigidly define the way fields are to be cultivated and the obligations of the cultivator of a field toward others. In the agronomic sense, a field type consists of an association or sequence of crops, or both, with the following characteristics: (1) prescribed combination of crops and varieties, (2) a determined ecological environment, and (3) a fixed succession of cultivation practices throughout the season to take place at predetermined moments in time (de Schlippe 1957, 12-13).

De Schlippe used illustrations from the Zande to show that a combination of field types allows a population to make the best use of its natural environment and labor resources. He demonstrated that field types change over generations. Farmers do conduct experiments, and the results of successful experiments can lead to new field types. Changes also occur as a result of the process of incorporation and the introduction of innovations such as cash crops. New varieties of existing crops such as short cycle groundnuts may induce new field types and a better use of fields. De Schlippe stated that observation and interviewing are key tools in agricultural anthropology, but cautioned that interviews often give idealized pictures of reality. He makes no mention of on-farm experimentation in his work, but he contributed much to the understanding of agriculture as a cultural-agronomic phenomenon, rather than as solely an agronomic or solely an economic activity, especially regarding subsistance production.

A second important contribution comes from the experience of the Institut National pour l'Etude Agronomique du Congo Belge (INEAC) in Zaire. Created in 1933, INEAC succeeded in creating one of the best basic research organizations in tropical Africa. Among its other duties, INEAC assisted the government in implementing its 1917 legislation to enforce compulsory cultivation of predetermined acreages in order to encourage food production. Paysannats (resettlement schemes) were a feature of this project, and INEAC assisted in developing the technical features of the resettlement policy. Paysannats were primarily formed to develop and disseminate improved farming methods. The main feature was the spatial reorganization of agriculture to make optimal use of and improve the physical resources. In each ecological region, the exact location and the necessary improvements were determined for the spatial units—namely, the village, the fields under cultivation, the fallows, the rotations, the pastures, the perennial plantations, firewood lots, fish ponds, and roads. Fields and fallows were laid out in *couloirs*, or corridors, one hundred meters wide and laid east to west to gain maximum daylight. The length of the couloirs depended on the number of farmers; the number of the couloirs equalled the total number of years in the cultivation and fallow cycle so that alternating couloirs could be opened annually. This system was modified to suit each ecological and social setting. The objective was not only to encourage

modern farming techniques, including the use of machinery, fertilizer, and pesticides, but to facilitate supervision by the administration. At the same time, the couloir system mimicked the Bantu traditional system of farming.

The couloir system was far from successful everywhere; expected breakthroughs in productivity did not materialize, and a large gap remained between research station results and average farmer yields. The paysannats remained a colonial invention and have been severely criticized for their paternalistic and authoritarian features (Dumont 1962). However, many concepts underlying the paysannat strategy—the holistic approach,the detailed study of agro-biological and socioeconomic aspects of the environment, and the gradual introduction of appropriate technical innovations—cannot be ignored in an analysis of the roots of FSR/E.

• ANGLOPHONE APPROACHES IN AFRICA •

In contrast to the Francophone approaches in Africa, which largely may be traced to efforts initiated by France and Belgium in areas of former colonial influence, the various Anglophone approaches found in Africa have their roots in a wide variety of development efforts. Though diversity is great, two general sources of influences can be identified. One source is the several International Agricultural Research Centers (IARCs) active on the continent. The other source is characterized by bilateral donor intervention and national initiatives. These two Anglophone influences often overlap a great deal, and within each influence distinct and often differing philosophical and methodological underpinnings exist.

David Norman and Michael Collinson offer another useful perspective on the characterization of the different FSR/E approaches by distinguishing among "in the large," "in the small," and "with a pre-determined focus." FSR/E in the large "treats all system parameters as potentially variable in a wide ranging search for improvement" (Norman and Collinson 1985). In this instance the emphasis is placed on the development of optimal new farming systems that take advantage of state-of-the-art technology applied to existing ecological conditions. This concept parallels that of thèmes lourds, introduced earlier. FSR/E in the small and FSR/E with a predetermined focus recognize that

> small farmers evolve from their existing situation in steps. The content and scale of these steps must necessarily be compatible with farmer resource endowments, their risk ceilings and their management capabilities. Both seek a focus within the system which identifies potential development steps. Because both recognise the step by step development process in small farming and both seek to identify steps in technology there has been confusion between the two. The difference is that FSR "in the small" arrives at a focus within the system in the course of diagnosis, while FSR "with a predetermined focus" moves into the system to research an enterprise, or one facet of an enterprise, looking for improvements within that focus, which are compatible with the whole farming system. The two approaches have different implications for the level of leverage obtained in the system and for institutionalization (1985:6).

Using the above criteria for categorization, in the following sections the major Anglophone FSR/E efforts are outlined, providing some insight as to their different methodological frameworks and the directions in which they are evolving. FSR/E efforts that were influenced by the International Agricultural Research Centers are discussed first, followed by discussion of the efforts that developed through bilateral or national initiatives.

CIMMYT Initiatives

The International Center for Maize and Wheat Improvement (CIMMYT), headquartered in Mexico, has probably inspired greater FSR/E activity in Africa than any other single entity. Their Eastern and Southern African Economics Program (CIMMYT/ESA) established a base in Nairobi and posted Michael Collinson, a farm economist, there in 1976 to begin on-farm research work with a focus on maize. In 1983 he was joined by two other farm economists, one as a training officer based in Nairobi and the other based in Mbane, Swaziland, to work with the Southern African countries. In 1985 four agronomists were appointed to the CIMMYT African maize and wheat program, two to focus on on-farm research development in national programs. As CIMMYT gained experience in on-farm research, primarily in maize, a more holistic perspective was incorporated and the label on-farm research in a farming systems perspective (OFR/FSP) was adopted to identify the FSR/E orientation.

CIMMYT's overall objectives in OFR/FSP are: (1) to improve the capacity of national agricultural research services to develop appropriate technologies by establishing the routine use of OFR/FSP as an agricultural research tool, (2) to improve the procedures of OFR/FSP through the experiences of the national programs, and (3) to help national programs be even more precise in reflecting germplasm needs of farmers so that CIMMYT can be even more responsive to those needs. There are four methods to pursue these overall objectives: (1) demonstration of OFR/FSP procedures and direct participation in national agricultural program field research work, (2) training of national research staff in OFR/FSP procedures, (3) networking through a newsletter and a series of workshops on technical and management issues, and (4) institutionalization of OFR/FSP through counseling on ways to create linkages among research, extension, planning, and OFR/FSP.

CIMMYT/ESA proposes that OFR/FSP may play several important roles in national agricultural research programs (Collinson n.d.). First, OFR/FSP allows for testing technical research findings in appropriate farming systems. It also enables national programs to better identify farmers' priority problems and the unsolved technical questions in these problems and then channel this information to

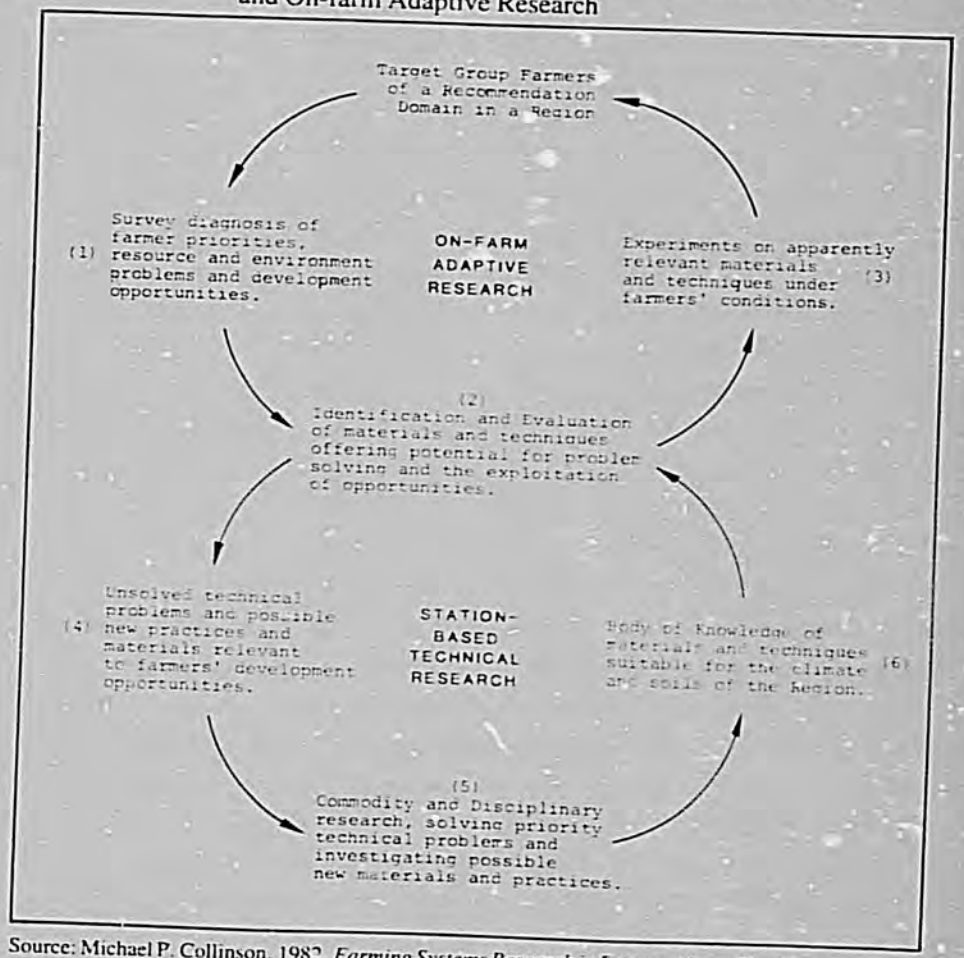
propriate specialist researchers. Finally, the approach encourages researchers, extension workers, and farmers to cooperate in the selection and adaptation of agricultural technology to farmer situations.

Collinson argued that adaptive research and on-farm experimentation are not novel techniques, but that OFR/FSP provides these procedures with new perspectives. Among these perspectives is the view that social and economic circumstances, not just agro-ecological ones, dictate farmer decisionmaking on potential new technology. Therefore, innovations should be exposed to farmers and extension staff as part of the technology development process to weed out nonviable options before making recommendations. Of equal importance is the realization that farmers operate multiactivity systems that demand compromises on technical perfection in any one activity in the interests of the whole system. New technology packages that are not accepted by farmers may not be inherently bad but may prove unacceptable if they were developed without consideration of these OFR/FSP perspectives. The procedures followed in OFR/FSP are the same as those listed previously (diagnosis, design, testing and evaluation, dissemination, and referral) with only slight modifications in application. The essential linkage between on-farm and on-station work in conducting effective research is explicit in OFR/FSP procedures (see Figure 20.2).

With the CIMMYT mandate focused on maize and wheat, their FSR/E activities could easily have the predetermined focus described earlier in this section. However, it is clear that the CIMMYT/ESA program promotes FSR/E in the small as the more appropriate alternative in the long-term effort to institutionalize the process (Norman and Collinson 1985). FSR/E in the small may be seen in the countries with which they are currently working, primarily because these countries want to use OFR/FSP as a basis for the total agricultural research and extension effort, not just for the improvement of maize and wheat. These national programs may be grouped as follows: (1) There are three countries (Zambia, Malawi, and Zimbabwe) in which the national agricultural research and extension system has been reorganized to accommodate OFR/FSP and its linkages among farmers, researchers, and extension personnel through regionally deployed teams of on-farm researchers, each team a mix of technical and social scientists. (2) Ten countries have OFR/FSP-type programs and are actively debating how these may be best integrated with technical component research and extension (Botswana, Ethiopia, Kenya, Lesotho, Sudan, Swaziland, Tanzania, Zimbabwe, Rwanda, and Burundi). (3) Three countries (Mozambique, Uganda, and Somalia) have initiated or will shortly initiate pilot programs in OFR/FSP.

In each country within each group, some initial leverage may have been gained through a commodity program entry (predetermined focus), since it is usually easier to begin on-farm research when a priority commodity or problem has already been determined before the diagnostic process begins. For CIMMYT, maize as a priority commodity provides an advantage because they are able to draw upon their store of maize technology in proposing potential solutions for maize problems. However, the perspectives and methods of the institutions in most of

FIGURE 20.2. Interactions Between Station-Based Technical Research and On-farm Adaptive Research



Source: Michael P. Collinson. 1982. *Farming Systems Research in Eastern Africa: The Experience of CIMMYT and Some National Agricultural Research Services, 1976–81*. MSU International Development Paper No. 3. Department of Agricultural Economics. East Lansing: Michigan State University.

these countries are emphasizing FSR/E in the small in order to address the total agricultural system.

Other IARC Initiatives

Though not active in as many locations as CIMMYT, the International Potato Center (CIP) has been engaged in FSR/E for several years in those regions of Africa most appropriate for white potato (*Solanum tuberosum*) production. Their

work has a pre-determined focus on potatoes, but the underlying principles and philosophy are quite similar to CIMMYT. The "farmer back to farmer model" (Rhoades and Booth 1982) describes the FSR/E approach used by CIP. Three points distinguish this approach from that used by CIMMYT/ESA: (1) CIP often begins exploring a technical problem with an on-farm trial, which engages the farmer in active interaction with researchers to determine the nature of the problem before them. (2) The whole food system is considered to be the target area, and researchable problems include technical and management issues in postharvest storage, processing, consumption, and marketing. (3) CIP often works with existing farmer groups or social organizations as the locus for on-farm trials.

CIP views national programs as the home for FSR/E and pursues the institutionalization of FSR/E into national potato programs. Activities are most visible in Rwanda and, to a lesser extent, in Burundi, and a "Francophone Office" is maintained in Tunis to service French-speaking African countries. In Rwanda, CIP's work with the National Potato Improvement Program (PNAP) has been quite successful. FSR/E is an integral part of the PNAP program, and there is evidence that the methods employed by PNAP have had a "spread effect" to other commodity and agricultural development projects in the country (Bicamupaka 1985: personal communication). One of the interesting sides to CIP's work in on-farm research in Africa is that CIP has been implementing programs, largely based on previous Anglophone experiences or concepts generated in Latin America, in French-speaking African countries. It will be interesting to observe, as these programs mature, to what extent Anglophone and Francophone concepts and methods merge together.

The International Institute for Tropical Agriculture (IITA), located in Ibadan, Nigeria, has had a farming systems program for the past fifteen years. This program, at least for the initial twelve years, could best be described as FSR/E in the large or as having a thème lourd focus. The objectives of the program were (1) the environmental characterization and analysis of humid and subhumid farming systems in the West and Central African region and (2) the development of crop and soil management technologies suited to these areas. This work, though officially titled Farming Systems Research, was done largely on-station and resulted in a considerable body of information and technology that should now be tested under farmer conditions. IITA's program today is expansive, with on-station efforts at the main campus and FSR/E extending through the outreach program across a variety of ecological conditions through cooperative efforts with national programs.

IITA's FSR/E activities follow stages that are similar to the programs described earlier (diagnosis, design, experimentation and recommendation, and extension). The program emphasizes that far greater efforts have been placed on diagnosis than on experimentation, especially in West and Central Africa (where the bulk of IITA work is conducted). For this reason IITA now pushes hard for more rapid initiation of on-farm trials in their FSR/E-supported programs. The Institute has also recently placed more attention on gender issues in FSR/E and is increasing the consideration of gender variance to ensure equitable access, appropriateness, and benefits for new technology. Like the other IARCs, IITA is engaged in the institutionalization of FSR/E into national programs. IITA has been very effective in assisting the organization of a Nigerian network of FSR/E and has been supporting a similar effort in Ivory Coast. Malik Ashraf et al. (1985) discussed IITA's FSR/E activities in cooperation with Nigerian institutions in their report on the Bida project. These national networks have come about largely as a result of training efforts and collaborative on-farm diagnosis and experimentation. IITA is also expanding its cooperation with national programs in Cameroon, Zaire, Benin, Sierra Leone, Tanzania, and Rwanda. In several of these situations, IITA appears to be merging concepts and methods from both the Francophone and Anglophone experience. A more explicit effort to promote exchange between these two bodies of experience is IITA's part in the efforts to develop the West African Farming Systems Research Network (WAFSRN). This network is coordinated from Amadu Bello University in Nigeria and includes sixteen West and Central African countries. Though slow to get started due to financial and organizational problems, WAFSRN has the potential to become a vehicle for expanded communication within the region and should promote greater interaction between researchers following a largely Francophone tradition and researchers connected to the Anglophone experiences.

The West African Rice Development Association (WARDA), headquartered in Monrovia, Liberia, does not use the FSR/E or OFR/FSP terminology; nonetheless, it conducts on-farm interdisciplinary research and extension within its Technology Assessment and Transfer (TAT) program (Levasseur et al. 1981). WARDA operates with a predetermined focus on rice and uses an ecological perspective in defining four systems of rice production within the West African region: the mangrove swamp system, the floating rice system, the upland rice system, and the irrigated rice system. WARDA has based interdisciplinary TAT teams at four research stations designated to focus on each of the rice production systems. One of the important results from the on-farm work is the discovery that many of the improved rice varieties developed in other regions of the world do not perform better than existing West African varieties in the upland system. These results indicate the need for locally developed varieties rather than the simple transfer of existing varieties and help to reorient WARDA's program.

Three other IARCs active in African FSR/E are: the International Center for Tropical Agriculture (CIAT), the International Center for Research for the Semi-Arid Tropics (ICRISAT), and the International Livestock Center for Africa (ILCA). CIAT's FSR/E activities in Africa have only begun recently and are focused on the Great Lakes Region of East Africa, including Rwanda, Burundi, and eastern Zaire. CIAT works with a pre-determined focus in FSR/E in Africa—beans, in this case. CIAT's methodological stages are similar to those of CIMMYT and other Anglophone FSR/E projects. The CIAT bean program in the Great Lakes Region has focused initially on the question of bean varieties, and much of their initial diagnostic efforts have been toward understanding traditional bean variety systems, varietal characteristics desired by farmers for beans, and bean pro-

duction systems. On-farm research is still in the exploratory trial stage (Voss 1985: personal communication).

ICRISAT's FSR/E activities in Africa have been concentrated primarily in the Sahelian regions of West Africa, principally in Burkina Faso and Niger, and are grounded firmly in a village studies framework that relies heavily on baseline surveys and other formal survey tools. Farmer tests are an integral part of the approach, and ICRISAT enumerators live in the villages to monitor the tests and continue the companion baseline studies. ICRISAT's FSR/E may be described as having a predetermined focus on sorghum and millet production. The primary audience for the results of the on-farm tests is the ICRISAT scientists. "The tests are designed not only to examine technologies that are in a final stage of development but also to examine the concepts and objectives on which the technologies are based. Results are intended to help scientists appreciate the conditions that technologies must satisfy if they are to be widely adopted" (Matlon 1983).

Major differences exist between FSR/E as practiced by ICRISAT and the other IARCs previously described. That the major client for the results is ICRISAT scientists has meant that less attention is paid to developing the concepts and practices of FSR/E within national programs. Less attention is paid to the merits and effectiveness of informal surveys for diagnosis, and the extensive formal surveys used by ICRISAT are less readily transferable to national program management. The existing extension system is virtually excluded from the FSR/E activity, a situation more common in Francophone countries than in Anglophone ones. Finally, ICRISAT uses FSR/E to see if developed technology fits within existing farming systems, rather than turning the process around to develop technology that satisfies farmer priorities and existing farmer conditions.

ILCA is the only IARC in Africa to focus FSR/E on livestock systems. FSR/E as a whole has devoted very little time to the problems of diagnosis and on-farm experimentation with animals. ILCA focuses on ruminant livestock due to their prevalence in African farming systems and has placed priority on the development and testing of FSR/E methodologies appropriate for the African setting. ILCA FSR/E activities follow stages similar to those followed by the other IARCs (diagnosis, design, testing, and extension). Somewhat different than the other international centers, ILCA has research farms at the station in which trials are conducted that are researcher managed and farmer executed. This research seems to be a cross between on-station and on-farm research. At the same time, ILCA runs on-farm trials within the traditional farming systems surrounding the station. Within this setting, ILCA is conducting on-farm research on animal traction with Ethiopian farmers and reports some success in adapting single ox plowing within the traditional plowing system (Gryseels 1984).

Unfortunately, there are relatively few examples in which an IARC has combined technological solutions from different centers for testing on-farm; however, in Nigeria ILCA is using IITA's alley-cropping technology as a basis for the integration of crops and small ruminants. ILCA is also using FSR/E methods with other types of livestock producers such as agropastoralists, highland pastoralists, and pastoralists in arid and semiarid zones. In these research endeavors, they are working with national livestock programs in Kenya, Botswana, Ethiopia, Niger, and Mali.

Though it is difficult to summarize the efforts of the various IARCs involved in FSR/E in Africa, it is possible to see common methodological threads. All of the centers identify the same or almost the same procedural stages in OFR or FSR/E. Differences appear in the interpretation of the actual implementation of these stages. There is still little consensus on the appropriate methods for diagnosis, and each center promotes differently the usage of informal and formal diagnostic tools. Most of the IARC-influenced FSR/E falls within the category of having a predetermined focus. Though this is not recognized as a major initial problem, it poses a challenge to national agricultural research and extension systems if each commodity has a different IARC backstop or collaborator with a different set of jargon and specific methods to be followed. Institutionalization of FSR/E within any national system requires an agreement on FSR/E among the different commodity programs and a national approach shaped to fit national needs. Better inter-center cooperation and collaboration among the IARCs will help this process.

National Initiatives in FSR/E

Strong, well-developed, national agricultural research and development programs are essential. Although the appropriate role of the IARCs is to support national programs, less has been written about national initiatives in Anglophone African countries to develop FSR/E than about those initiatives supported by the IARCs. In East and Southern Africa, it is safe to say that most FSR/E efforts have the support of an IARC either through training, networking, and technical assistance or through direct financial or personnel support. Even where there are bilateral contracts for FSR/E projects or projects with FSR/E components there has been considerable IARC collaboration. This is especially true of the relationship between the United States Agency for International Development (USAID) and CIMMYT/ESA, since the latter receives funding from USAID to provide substantial support to USAID-funded FSR/E projects in East and Southern Africa.

Since 1979, USAID has taken a strong interest in supporting the development of FSR/E in African agricultural programs, and large projects have been funded in Zambia, Malawi, Lesotho, Botswana, and Sudan, as well as in several Francophone countries including Senegal and Burkina Faso. These project contracts have been directed largely by U.S. agricultural land grant universities. One important result of having universities involved in the development of FSR/E bilateral projects has been the growing institutionalization of the approach within the home campuses. Though resistance was initially strong, continued contact with FSR/E practitioners has gradually pushed the acceptance and legitimization of the approach within academic departments and, more recently, the agricultural professional societies. USAID further encouraged the growth of FSR/E with the creation

in 1982 of the Farming Systems Support Project (FSSP), managed by the University of Florida, which provides technical assistance, training, and networking support to many FSR/E projects in Africa. New USAID-funded projects with strong FSR/E components are being implemented in Rwanda, Burundi, Mali, Mauritania, Zaire, and Gambia. British assistance to FSR/E has not been as large as that of USAID; it has concentrated on placing skilled individuals within national agricultural programs in which they have been able to assist in the development of FSR/E skills and projects. Examples of their efforts include the assignments of two agricultural economists, one to Gambia and one to Zambia—both have played catalytic roles in encouraging FSR/E.

Outside donor funding has played a major role in the development of FSR/E activities in national programs, and there are relatively few examples of FSR/E activities initiated without donor funding. Those that do exist are unique and should be highlighted. A number of African universities have initiated FSR/E projects, often with limited funding, as a way of conducting on-farm research to complement academic research and introducing students to the concepts of FSR/E. Njala University in Sierra Leone is one such program. With a small grant from the Canadian International Development Research Centre (IDRC), Njala has been conducting a FSR/E project in several chieftancies near the university. On-farm experimentation has included work on root and tuber crops and has incorporated a nutrition and consumption component. Another example comes from Nigeria: several universities there are engaged in on-farm research, and professors from the universities, as well as researchers from government agricultural agencies, participate in the Nigerian FSR Network. Though supported in part by CIMMYT, the University of Zimbabwe has taken a lead in incorporating FSR/E through on-farm projects conducted by university faculty and students.

It is important to note the role IDRC has played in national initiatives in FSR/E. In contrast to IARCs and most bilateral donor projects, IDRC has placed its emphasis on funding national researchers to conduct projects. The funding level is considerably lower than with most donor projects in agriculture, primarily because there is no reliance on expatriate teams. IDRC-funded FSR/E projects have been linked with IARC initiatives, but most of the planning and implementation of the projects is done with national researchers and a regional project officer (Kirkby 1984). Occasionally, IDRC has funded an expatriate adviser; yet national leadership is being developed and the projects retain a strong national identity, rather than a donor identity. Examples of IDRC national projects include the highland maize project in Burundi, the Tanzanian projects based out of Morogoro University, the efforts in southern Mali, and the work at Njala University previously mentioned.

Other national initiatives exist and are not fully elaborated here. It is obvious, however, that the major thrust behind FSR/E in the Anglophone efforts comes from external donors and IARCs. It is difficult to say whether national programs have no interest in or knowledge of FSR/E until the IARCs or bilateral donors get involved, or whether the cost of getting started and maintaining FSR/E is too high for national research and extension systems to undertake on their own. However, despite strong external support, FSR/E will not become institutionalized within national research and extension programs without strong national commitment and management of the FSR/E activities.

• MAJOR OBSTACLES TO IMPLEMENTATION IN AFRICA •

Five major obstacles to FSR/E implementation in Africa can be identified: (1) a technical shortfall, (2) the institutional separation of research and extension, (3) the lack of human resource capability, (4) the lack of necessary infrastructural support, and (5) actual versus perceived holism. Each of these contribute to difficulties in getting started with FSR/E or even in making an initial commitment to the concept.

Technical Shortfall

Technical shortfall refers to the general lack of what is called "shelf technology" for many agricultural problems in Africa. Unlike other regions of the world, less investment has been made in basic agricultural research in Africa. Therefore, when researchers attempt on-farm activities, little technology is available to test immediately. In other areas of the world, FSR/E made initial headway with technology that was available already in the area and required only minor adaptation. In contrast, there have been no clear technological breakthroughs with sorghum and millet, the design of improvements for low external input, rainfed systems is still in its infancy (Fresco 1985), and African root crops are only beginning to draw attention from geneticists and agronomists. West and Central Africa suffer more from the technological shortfall than do East and Southern Africa where prior maize research provides a substantial database. If FSR/E is to overcome the technical shortfall, there will have to be far greater cooperation between systems research and commodity research, as well as between on-farm and on-station activities, in order to set priorities for research based on farmer priority needs.

Institutional Separation of Research and Extension

To function, FSR/E requires involvement of both research and extension from the beginning. Extension personnel cannot be tacked on to the last stage of the process and be expected to achieve successful mass dissemination. Planning for eventual dissemination and diffusion of technology through the extension service should begin before on-farm trials are designed. Extension personnel should be members of FSR/E from diagnosis forwards. The unités expérimentales in Senegal are an example of an attempt to link research and extension within a project framework.

The desire to have extension and research engaged in on-farm research is hindered when the two are located institutionally within different ministries. It is logistically difficult to manage FSR/E teams if staff members are not responsible to the same institution. The duties of extension personnel often include jobs related more to the monitoring of government credit or cooperative programs, land tenure decisions, or distribution of inputs. None of these duties provide a base for building farmer collaboration in most developing countries. Extension is further hampered by its lower status, compared to research. The existence of these agricultural hierarchies increases the difficulty in fostering interdisciplinary relationships between research and extension.

Lack of Trained Human Resource Capability

The lack of trained and available personnel in agricultural research is a serious problem for FSR/E implementation. Too often researchers who wish to engage in FSR/E are also responsible for major commodity programs, manage research stations, handle large-scale multilocational trials, and are already involved in other donor-assisted agricultural development projects. It is possible that lower-level field technicians and extension workers could be the better target as team members than highly qualified researchers, especially for field-level FSR/E work. In-country, in-service FSR/E training, which could proceed in step with the unfolding stages of field-level activity, has the potential for relieving the lack of human resources. For this to take place, training would have to begin in the very early stages of the project, and the time frame for on-farm experimental results and dissemination would have to be lengthened. However, such an approach could engage the national senior researchers as part-time members of FSR/E teams, interacting with several locally deployed teams on a regular but discontinuous basis. It is obvious that FSR/E in Africa will not be able to contribute to solving Africa's food problems without specific steps to train a larger number of people, both men and women.

Lack of Necessary Infrastructural Support

Two key problems are embodied within this topic. The first relates to the fact that FSR/E means getting out to see and talk with farmers, which cannot take place if team members have no mobility beyond the research station fence. Transportation of some practical nature is an absolute requirement, and this requires its own support system, particularly maintenance and gasoline. Many of the frustrations in trying to deal with on-farm research come from trying to gain access to transportation. Some of the problem is alleviated with locally deployed teams within walking or bicycle distance; however, team leaders need to meet with field teams, and interaction between FSR/E and commodity research can only occur with adequate transportation. For successful implementation of FSR/E, the transportation issue

must be worked out in advance of any plans to begin diagnostic or other field-level activity. A second infrastructural issue regards financial flexibility. FSR/E usually requires readily accessible funds to purchase necessary inputs for trials and other needs on a timely basis to coincide with normal farmer production activities, which is difficult to achieve if the research-funding system is highly centralized.

Real Versus Perceived Holism

Viewing the farming system with a holistic perspective is a basic concept in all of the FSR/E approaches described in this chapter. One would assume from this perspective that both males and females would be considered equally. Unfortunately, very few FSR/E initiatives anywhere in Africa actively seek to uncover any gender considerations in the on-farm generation of new agricultural technology. In a world region where women are documented as performing up to 80 percent of agricultural production in many countries, it is a serious oversight to neglect women farmers. If FSR/E is to serve the needs of Africa's small farmer majority, it will have to adopt a perspective that encompasses both male and female farmers and their respective constraints and potentials.

• THE FUTURE OF FSR/E IN AFRICA: IS IT AN APPROPRIATE SOLUTION? •

It is the obvious bias of the authors that FSR/E can be appropriate and important in future agricultural development in Africa. The challenge before us now as we close this chapter is to explore what shape and responsibilities this future will have. If one looks generally at FSR/E projects to date, particularly in Africa, by far the greater proportion of time has been spent in diagnosis. Testing and evaluation, in many projects, has only gotten underway during the past four years. In the future, far greater attention must be placed on the testing and analysis of proposed solutions on-farm. For most projects, linkages with extension systems to initiate dissemination of successful innovations have been very weak and ineffective. Little if any development of referral systems has taken place, and adoption studies are few. Consequently, it is too early to judge the impact of FSR/E on food production in Africa. Much greater attention will have to be placed on evaluations of the FSR/E approach—both procedures and results. FSR/E may be able to provide a sound framework for better analysis of farmer constraints, but there is still the risk that too much emphasis will be placed on diagnosis.

FSR/E will not solve all nor even a large part of Africa's agricultural problems, and it should not be burdened with the responsibility to achieve results beyond its capabilities. The approach on its own will not radically alter the level of infrastructural development, the degree of institutional proximity of research and extension, the rate of improving the human-resource capacity, nor the wider political and eco-

nomic issues. FSR/E is not a development strategy by itself but must be part of a broad development plan. For FSR/E methods and concepts to be of practical value, they must become part of the whole research and extension system and not remain only in pilot projects. Once fully integrated, FSR/E is likely to vanish in name, but the principles will remain, just as some of its principles were already in use before the name was applied. Future research procedures will likely be a composite of the various approaches detailed in this chapter.

In summary, FSR/E offers three concrete measures for the future of agricultural development in Africa. First, if FSR/E is functionally linked to basic research, it helps set priorities for basic research. With scarce national funds available for basic research, national systems need to set priorities based on the most pressing needs of the majority of the farmers. FSR/E will be a key tool in determining these priorities. Second, FSR/E offers the potential for success in extending new technology because FSR/E provides far greater assurance that the new technology is appropriate to the needs of the client farmer group. Finally, if FSR/E can achieve true holism in its diagnosis, design, experimentation, and dissemination stages, it will be able to overcome many of the gender biases inherent in most other agricultural development projects. This potential alone gives FSR/E sound footing in the future of agricultural development in Africa.

• NOTES •

1. Readers of the growing literature find a profusion of acronyms. Farming Systems Research (FSR) has probably been the most widely used label in the past. Concern over the apparent exclusion of the extension function encouraged the addition of "E" in order to highlight the fact that effective FSR only occurs when research and extension are engaged simultaneously in the process. As part of the dynamic development of the approach, FSR/E has been further refined as micro-level activity involving diagnosis and experimentation both on-farm and on-station. A new label, Farming Systems Infrastructure and Policy (FSIP), is used to describe the macro-level activity that provides an orientation for agricultural research and agricultural sector policy. FSR/E and FSIP are often collectively covered by Farming Systems Research and Development (FSR&D), although many simply use the FSR acronym as a collective label. Complementary to these terms is OFR/FSP, or On Farm Research with a Farming Systems Perspective, which is widely used in East and Southern Africa, particularly in those programs influenced by the technical assistance and training conducted by CIMMYT. OFR/FSP and FSR/E are being used more and more interchangeably, particularly in those regions. Because of the perceived need to actively integrate research and extension in the technology generation process, especially in areas where these two functions have been historically separated, this chapter will use the FSR/E label.

2. Commodity research refers to work focused on one specific crop or animal within the farming system. Component research refers to work on a specific input to the farming system, such as fertilizers.

3. In the French agricultural research institutes, as well as in the Francophone West and Central African institutions, a distinction is made between basic research (*recherche fondamentale*) and adaptive research (*recherche d'accompagnement*) that is undertaken in the context of a development program. In 1974 the eight French sector institutes were centralized into the Groupe d'Etudes et de Recherches pour le Développement de l'Agronomie Tropicale (GERDAT) to promote better coordination. The integration of the institutes was completed in 1984 with the creation of the Centre International de Recherche pour l'Agriculture et le Développement (CIRAD). In addition to the eight institutes mentioned above, which have become departments of CIRAD, two more departments were created, one of which, the Département Systèmes Agraires (DSA), is concerned with farming systems research. The farming systems approach embodied in DSA is drawn largely from agricultural research and development experiences in Francophone Africa.

4. One of the few unifying characteristics of the Anglophone approaches is that information concerning their results is published in English. Additionally, some contributions to the collective Anglophone approach in Africa come from reports in English on activities conducted in French-speaking countries.

5. Though initially there were differences between FSR/E and OFR/FSP, they are currently converging upon a common definition. The term OFR/FSP will be used in conjunction with CIMMYT activities, and FSR/E will be used in all other instances.

• SUGGESTED FURTHER READINGS •

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