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THE FARMING SYSTEMS RESEARCH AND EXTENSION APPROACH TO SMALL FARMER DEVELOPMENT

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I. INTRODUCTION

For about two decades, there has been an increasing focus on small farmer development strategies throughout the world. Farming systems research (FSR) has been a useful tool assisting in this process. As initially conceived, the farming systems (FS) approach was viewed as a means of improving the efficiency of agricultural research resources. However, in the early 1970s, it became evident that the integrated rural development (IRD) and basic needs' approaches lacked an engine which could sustain development in the long run.[2] In the face of lagging agricultural productivity growth, rapid population growth, and modest growth in formal sector employment opportunities, many countries initiated farming systems projects during the 1970s and early 1980s.

The distinguishing feature of the FS approach -- as a development strategy -- is an emphasis on the creation of rural income opportunities by providing limited resource farmers with relevant improved production technologies. The approach represents a "bottom-up" development strategy in the sense that a diagnosis of farmers' circumstances is used to establish research and development priorities. Non-agricultural activities and macro-economic budgetary, monetary and trade issues generally are excluded from the approach.

Interest in the FS approach peaked in the mid-1980s, at which time there were more than 250 farming systems projects worldwide and many countries had started to institutionalize farming systems programs. Much of the impetus for the approach came from donor agency funding, particularly USAID. Leadership in developing methodological guidelines was provided by the international agricultural research centers (IARCs). After a brief period, during which there were unrealistically high expectations based on successes in areas where there was an equable environment for agricultural production, a retrenchment and reassessment led to a phasing out of many FS projects beginning around 1985.

After more than ten years in the forefront of small farmer development strategies, the FS approach is likely to have a lasting impact on development thinking as well as on agricultural research methodology. This chapter gives a brief review of the approach and an assessment of its contribution. The first section discusses the rationale for the approach. This is followed by

an overview of the research and extension methodology. Some examples of FS projects and programs are then presented before turning to an assessment of contributions and factors which have prevented the approach from living up to expectations. The final section projects future directions for the approach.

II. RATIONALE FOR THE APPROACH

In most countries, the main objective in introducing the FS approach has been to improve agricultural sector performance by increasing the productivity of resources used in agricultural production. The approach has three key features which distinguish it from earlier strategies for improving agricultural sector performance. First, it is couched in systems terminology and attempts to follow the principles of systems analysis. Second, it recognizes the key role small farmers must play in rural and national development. Third, it rejects a historically dominant "top-down" approach to technology research in favor of a "bottom-up" perspective of the research and development process. This section clarifies the rationale for the FS approach with reference to these key features.

A. Systems Analysis

Systems analysis is holistic, not reductionist. While reductionism does not deny that things are part of larger wholes, its limitations,[4] Dillon[5] concluded, has often led researchers away from real world problems. Systems analysis, on the other hand, starts with a logical conceptualization of the system to be improved.[6] Once the system is identified, factors limiting the performance of the system are evaluated, a target for improving the system is established, and alternative actions for achieving the target are assessed.

The search for solutions using systems analysis cuts across the boundaries of the traditional disciplines and has a pragmatic orientation. A distinguishing feature of pragmatism is the belief that research should lead to "workable solutions" to identified problems.[7]

B. The Importance of Small Farmer Development

The meteoric spread of the FS approach was remarkable not so much because of the acceptance of systems analytical procedures, which were adopted in many areas of applied research in the 1970s, but because of an acknowledgement of the importance of small farmer development. Agriculture in the 1940s and 1950s was widely viewed as best contributing to

supporting the development of the urban/industrial sector. Therefore, the prescription for economic growth was to promote the transfer of labor from agriculture to formal employment in industry.[8-10]

However, by the late 1960s -- thanks to the work of several individuals such as Johnston, Mellor and Kilby[11-12] in pointing out the contributions of agriculture to the supply of foreign exchange and food, and the value of agricultural income in creating domestic demand for industrial goods -- the importance of agriculture in the development process was established.

Nevertheless, there continued to be an under investment in agricultural research, particularly research on small farmers. Contributing to this was the diffusion model[14,15] focussing on extension efforts designed to help farmers better allocate their resources and on the transfer of technologies from Europe and North America. This complemented the "community development" approach, which emphasized the provision of outside assistance in planning local development projects.[16]

The limitations of these approaches led to the high payoff input model,[14] in which development proceeds through research leading to the introduction of appropriate, improved production technologies. The immediate rationale for the model was derived from the dramatic successes of IRRI and CIMMYT in developing high yielding varieties -- and their associated "Green Revolution" inputs. Also, a series of comparative international studies demonstrated that the annual rates of return to resources invested in agricultural research consistently exceeded 30 to 60 percent.[17-19]

Schultz[20] played a seminal role in the shift to a small farmer orientation when he posited the "efficient but poor hypothesis." Schultz's hypothesis was confirmed in a number of empirical studies during the following decade.[21] During this same period, a wide array of micro economic studies were being carried out on all aspects of the rural economy, reflecting the "growth with equity"[16] era of development thinking. Three consistent findings which consolidated an interest in small farmer development were:

1. Small scale operations -- whether small farms or small industrial firms -- generally were often found to have as high output-capital ratios as did large firms and nearly always had greater labor-output ratios.[11,22] Therefore, it was possible to have efficient growth and increased employment generation. Also in Africa government efforts to initiate

large scale agriculture through settlement schemes, plantation and state farms have generally ended in failure[21] -- further improving the attractiveness of small scale operations.

2. In both Latin America and Asia, there was evidence that agricultural income inequality was associated with the size of farm operations.[22] Technological change -- even the supposedly scale-neutral Green Revolution technologies -- was shown to have a tendency to increase inequality.[23]

3. Rapid rates of population growth and urbanization, often resulting in only small increases in formal employment, reduced the capacity of governments to provide adequate services and infrastructure. The degree to which they were provided were shown to be functions of the pattern of the pace and pattern of rural income growth.[24] Since small farmers continue to dominate the rural economies of most low income countries, it was logical to give increased attention to means of increasing small farm income.

C. Shortcomings of Conventional Technology Research

The growing interest in small farmer development stimulated a reassessment of the relevance of traditional agricultural research procedures for developing technologies for small farmers. Agricultural research historically has started with predetermined commodity foci reflecting national (or colonial) policy goals.[25] Research stations were set up to generate improved production technologies, or to screen technologies transferred from elsewhere. The features of the technologies produced generally took into account national factor endowments,[26] the supply of technologies from other countries, and the mandates of institutions supporting the research, including donor agencies. Since research was carried out in isolation from farmers -- and generally from extension agents -- the resulting technological recommendations rarely addressed the diversity of circumstances affecting small farmers.[27]

During the early 1970s, it was apparent that few top-down recommendations were being accepted by small farmers and, when accepted, even fewer lived up to expectations when used on-farm. For example, research conducted by IRRI scientists made it clear that results from on-station research did not represent on-farm results due to nontransferable environmental differences (yield gap I between on-station and potential on-farm results) and due to a variety

of biological and socioeconomic constraints (yield gap II between actual and potential on-farm yields).[28] In relation to yield gap II, several diffusion studies demonstrated that yield potential often was not the main factor affecting the spread of new technologies.[29]

At the same time conventional research procedures were being challenged, there was a growing appreciation of existing small farm production systems. Many indigenous practices such as intercropping[30] were found to be more appropriate than recommendations based on experiment station findings. Also, several anthropological studies revealed that the indigenous linguistic and knowledge categories of farmers express an understanding of the constraints and potential of farming systems gained through practical experience.[31] Collinson[32] pointed out that most of the apparently sub-optimal practices of small farmers can be explained by compromises made to increase overall farm systems performance. Johnson[33] further argued that small farmers continually are experimenting and adapting their practices to changing circumstances, even if they do have a limited capacity to make large changes over a short period of time.

Based on the above observations and findings, several principles for improving the efficiency of research resources were developed. One set of principles related to the goal of increasing the supply of technologies. The main principle was that technologies needed to be adapted to on-farm technical environments through on-farm experimentation. It was also recognized that the supply of technologies could be increased by building upon the good points of existing farming systems (in order to minimize the time spent "rediscovering the wheel") and by taking into account the indigenous technical knowledge of farmers.

Several additional principles addressed the goal of reducing the gap between the demand for technologies and the supply of technologies. Among the most important were the following:[34]

1. Farmers should be viewed as the clients of agricultural research and development programs.

2. Increased priority should be given to improving communication and collaboration among the various participants in the research process.

3. When assessing the appropriateness of technologies, multiple criteria should be used, relating to technical feasibility, economic viability and reliability, and social acceptability.

4. Proposed changes generally should be evolutionary rather than revolutionary in nature.

During the 1970s, the above principles (to varying degrees) guided the development of FSR methods at several IARCs, and in a few national agricultural research programs. The methodological guidelines developed for FSR became the foundation for a fuller elaboration of the FS approach in the 1980s.[39]

During this time, however, parallel movements such as appropriate technology and women in development, were taking place. Although there were obviously many common concerns about smallholder development, between these movements and FSR, FSR has in many cases had a better record, having as it usually does better links with science, existing infrastructure, etc.

III. IMPLEMENTATION METHODOLOGY

The cornerstone of the FS approach is farming systems research (FSR) methodology. In FSR, interdisciplinary teams produce recommendations which are suited to particular local situations. This involves on-farm experimentation and working directly with farmers. Longer term technical problems identified through on-farm research are fed up to experiment station researchers. Ideally, policy and support systems problems are also fed up to relevant planning and development agencies.

Many guidelines are available on FSR methods.[44,45,47] As might be expected, there is a great deal of diversity in the terminology used and the specific methods prescribed. Nevertheless, essentially all the FSR guidelines propose a similar sequence involving four processes (or stages of research):[48]

1. Describe and diagnose existing farming systems in order to determine the constraints preventing improved farm system performance.
2. Design an experimental program for investigating technologies which might increase farm systems productivity by breaking or avoiding resource constraints.
3. Test, evaluate and adapt the most promising technologies in representative farming systems circumstances (technical environment and resource levels).
4. Disseminate information about technologies (or institutional changes) which have a high probability of improving farming systems performance.

In this section, the stages of research are characterized. Then, the various measures of success used in FSR are discussed.

A. Stages of Research

The usual starting point in systems description and diagnosis is to generate information on the technical environment, farming activities, production technologies, resource endowments, resource use patterns, farmers' goals and perceptions, and the performance of agricultural support systems. Information is generated through a number of sources, including reviews of secondary sources, rapid appraisal surveys, formal surveys, case studies, participant observation, and direct measurement of technical variables. Since diagnosis serves as the first step in an iterative problem solving sequence -- aimed at improving the welfare of farmers -- priority generally is given to low-cost and quick methods of information generation, and to developing a qualitative understanding of farming systems.

A notable feature of FSR diagnosis is the identification of particular areas and/or groups of farms to serve as the targets of technology development research. The target areas or groups of farms typically are called recommendation domains[46] or research domains[73] (RDs). Farms within RDs ideally have similar circumstances and, therefore, similar paths to improved productivity. RDs usually are defined on the basis of the research mandate and a rapid appraisal survey, but revisions often are made following additional diagnosis and testing.

The design process which is of critical importance links diagnosis and the testing process. After determining what causes the problems identified in systems diagnosis, the researchers rank the problems with reference to their impact on system performance, and several alternative technologies for addressing each problem are identified. The alternatives generally are based on experiment station research results, farmers indigenous technical knowledge, and the heterogeneity in existing practices. Ex ante assessments then are made on: (a) the contribution of each technology to the solution of each problem, (b) the number of farmers who are likely to adopt each technology, and (c) the research and extension resource requirements necessary to test and disseminate each technology. The ex ante assessments are used, in conjunction with the original research mandate and knowledge about available resources, to develop a series of testable hypotheses about the specific technical and economic benefits from new biological inputs, component husbandry practices, systems of practices, and/or practices by environment

effects. Appropriate on-farm experiments for testing the hypotheses are then designed.

There are many approaches to on-farm experiments. The FSR literature focusses primarily on a conceptual continuum based on trials management to characterize experimental formats.[38] The continuum is from researcher managed and implemented trials (RMRI), to researcher managed but farmer implemented (RMFI), to farmer managed and implemented (FMFI). Which format is used is a function of the trial objectives, resources and skills required, and the risk involved. Except when the emphasis is on technical assessments, there is a presumption in favor of maximizing farmer involvement in managing and implementing trials. In practice, some aspects of most trials are managed and implemented by both researchers and farmers. Therefore, as an alternative, trials also have been classified on the basis of their function, ranging from exploratory, to refinement, to verification testing.[44]

FSR guidelines generally include dissemination as part of the sequence, but specific procedures for disseminating findings remain underdeveloped. For years, it implicitly was assumed that the involvement of farmers and extension agents in the technology development process would ensure that relevant technologies were produced and, in turn, that appropriate technologies would be self-spreading. By the mid-1980s, evidence had accumulated that high profitability and acceptability of an innovation -- when evaluated by farmer cooperators -- did not necessarily translate into high adoption rates. As a result, in recent years greatly increased attention has been given to institutional innovations in extension, communication procedures, and modes of farmer participation.

6. Measures of Success

There are three "boundary issues" which preclude reliable quantification of the contributions of FSR to small farmer development. First, the relative contributions of conventional research and FSR are not separable since they are complementary activities. Second, the adoption of technologies depends on a wide range of circumstances, including the performance of support systems, which are not under the control of FS teams. Third, because the FS approach encompasses technology development and institutional change, significant results often are realized only after 10-25 years.[19] Over such a time horizon, any assumptions about what would have taken place in the absence of FSR would be quite arbitrary.

Due to the problems encountered in measuring the impact of FSR on small farmer

development, FSR generally has been assessed on the basis of success in identifying and screening improved production technologies. The various measures used to gauge success can be divided into four categories: technical performance, profitability, risk, and farmer adoption rates. The first three measures relate only to the features of the technologies developed, and are often measured on a small sample (or case study) basis. The last measure encompasses success in dissemination as well as technology development research and, correspondingly, has been less frequently used.

Historically, yield increase has been the main technical performance measure used in agricultural research. Some farming systems practitioners feel that often too much emphasis has been, and continues to be placed on, maximum yields as a measure of success, which detracts seriously from issues such as yield stability and tasks such as technology delivery.[45] Yield increase has continued to be a crucial criterion in FSR but has been supplemented with additional measures reflecting: (a) sources of utility besides quantity and, (b) success in utilizing scarce resources. As examples, one can cite reductions in the time required for tillage or planting operations, increases in percent seed field emergence, or land use ratios. A cropping intensity index has been commonly used in cropping systems research.[46] While these measures are not unique to FSR, their use has become common due to the availability of information from systems description and diagnosis.

The popularization of FSR has stimulated greater use of economic measures of success, which in the past have often received scant attention on the part of agricultural researchers. Based on farm management budgeting techniques, a key measure of success is the change in return per unit of scarce resource (generally land or labor, but also cash). Enterprise budgeting usually has been used when comparing systems involving multiple changes, while partial budgeting (which focuses only on the changes in costs and returns) has been used when assessing changes in specific component practices.

Most FSR reference manuals also propose various measures of the riskiness of a technology. One simple approach has been to use a minimum return ("risk premium") to the additional cash investment.[47] At a more sophisticated level, analyses which take into account the distributions of outcomes, such as stochastic dominance analysis, have been used. Another commonly used measure is the stability of yields or net returns across environments which can

help in deciding whether different recommendations should be made according to different environments (including management) with different yield potentials.[39]

The most important measures of success in FSR are documented changes in farming practices and farm income. For example, many of the Asian cropping systems projects have reported the percent of farmers adopting recommended cropping patterns. Elsewhere, FSR projects have cited adoption rates for animal traction or new tillage practices, and changes in fertilizer rates, seeding rates, insecticide application rates, etc. When citing adoption rates, there is an implicit presumption that farmers have actually benefited from the changes.

Despite the prodding of sponsoring institutions (particularly donor agencies), there are few examples which document changes in farmer income or consumption levels (over a large area) due to FSR -- in part because of the boundary problems cited above. As an alternative, mathematical programming has on occasion been used to project the whole farm income effects of proposed changes in practices.[40]

In conclusion, although some perhaps would agree that the case for FSR is still to be proven, the fact is in many countries support for conventional research is weakening, as shown by cut backs in research budgets. Given support and time, FSR should be able to reverse this trend. Also FSR, in recognizing the diversity of farmers, has been instrumental in developing non-blanketed, targeted and conditional recommendations. Unfortunately, however, conventional extension programs -- and even the Training and Visit approach[41] -- are not yet usually geared to accepting and delivering such recommendations.

IV. OVERVIEW OF FS PROGRAMS

The FS approach did not emerge fully developed at a single time and location. During the 1970s, there were a few landmark programs which demonstrated the effectiveness of FSR methods. In the late 1970s and early 1980s, the initial experiences with FSR were documented through a few key conferences[42] and "state-of-the-art" reports.[43,44,45] This led to an expansion phase, between 1980 and 1985, during which a majority of the low-income countries launched FSR projects. Although the record of FSR projects was mixed, many countries, IARCs and universities had made commitments to institutionalize FS programs by the mid-1980s.

A. Early Landmarks

In Latin America, FSR techniques were first introduced through cropping systems research projects set up in 1973 and 1974 in Colombia,[46] El Salvador[47] and Costa Rica.[48]

The first, and best known, national Latin American program was established in the Guatemalan Institute of Agricultural Science and Technology (ICTA). With leadership provided by Hildebrand, ICTA social scientists used rapid appraisal survey techniques, referred to as "sondeos," to identify bean seeds and planting labor as the key constraints. A new cropping pattern was developed which led to an increase in the area cultivated by 40 percent and resulted in 75 percent more maize, 40 percent more sorghum, no reduction in the amount of beans, and a 33 percent increase in income. Reviewing the impact of ICTA after ten years, Fumagalli, Ortiz and Castillo[49] reported that, because of the success of ICTA, Guatemala had registered significant increases in basic grains production that enabled it to shift from being an importer to an exporter of grain.

In Africa, an example of the anglophone tradition of FSR[50] is the multidisciplinary on-farm research carried out at Ahmadu Bello University, Nigeria, which started in the mid-1960s. Through on-farm trials, improved packages for cotton, maize and cowpeas were screened for their technical feasibility and economic profitability. The research showed which aspects of cotton, cowpea and maize recommendations best fit into farmers' circumstances.[51] Later, together with inputs from other countries, the procedures developed and used at Ahmadu Bello University served as the basis for formulating the "stages typology" of FSR methods introduced at the Rural Economy Institute in Mali in 1976.[52]

The best known precursor of a francophone approach to FSR in Africa was the Experimental Units program in Senegal, which lasted between 1968 and 1980. By the mid-1970s, improved farming systems had been developed involving the introduction of animal traction, improved seeds, fertilization and pesticides.[53] Eventually, improved production systems were established on nearly half of the farms located in the Experimental Units. Reviewing the contributions of the Experimental Units, Bingen and Faye[54] concluded that the program made a significant contribution to agricultural development in Senegal. Bingen and Faye also noted that the Experimental Units program contributed to the development of an effective extension model involving farmer groups and that both researchers and farmers developed a better understanding of the organization of farming families.

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Among the IARCs, the best known and most influential FSR during the 1970s was the rice based cropping systems research led by the International Rice Research Institute (IRRI). Using IRRI cropping systems methodology, intensified cropping systems were developed and extended to farmers in several Asian countries.[41] In India, the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), generally eschewing minor system changes, developed a new farming system for the regions dominated by vertisol soils. Ryan and Sarin[42] present data showing that in preliminary testing, the return to the increased cost was 258 percent. Later, in farmer managed trials, the return to the farmers' added expenditure was 244 percent.[43,44]

B. Expansion Phase

During the FSR expansion phase in the early 1980s, the IARCs played a leading role in promoting FSR, with much of the funding for FSR projects coming from the international donor agencies. In addition to IRRI and ICRISAT, The International Maize and Wheat Improvement Center (CIMMYT) developed and actively promoted its own approach to on-farm research with a farming systems perspective. CIMMYT's approach and training materials[45,46] were used in several Latin American countries and were influential in Africa, in large part because of an active demonstration program led by Collinson.[46] The International Potato Center (CIP) in Peru developed a farmer-first approach to FSR and used the approach to introduce a diffused light potato storage technology in more than 25 countries.[47]

As more FSR programs developed in national settings, the rate of expansion exceeded the development of methodology and, before long, stories of failure outweighed success stories. Nevertheless, there were projects in many countries which identified modified production practices that outperformed existing practices. Some examples which have been cited in the FSR literature include the following:

1. Sudan. In research in the Nuba Mountains, there was found to be a high benefit-cost ratio for the introduction of improved legumes. It was also shown that animals would benefit from dry season feed supplementation with legume forages.[66,67]

2. Nigeria. In various trials in Bida, the addition of a short season cowpea variety had benefit-cost ratios ranging from seven to twelve. Benefits were also achieved through the introduction of a serrated sickle and increased rice hill density. On properly selected sites, a change from ridge to flat planting of rice increased yields by 23 percent and returns per day of

labor by 30 percent. Also on appropriate sites, a change in planting densities increased yields by 14 percent.[68]

3. Burkina Faso. A Purdue University farming systems team showed that tied ridges and phosphate fertilizer were of significant agronomic and economic benefits.[69] With donkey traction, tied ridges and fertilizer increased returns per hour by 3[illegible] percent and returns per hectare by 113 percent.[70] Nagy et al.,[42] later reported that in a farmer implemented trial, less than eight percent of the farmers would have lost cash by shifting to the recommended system.

4. Nepal. At several cropping systems sites, recommended cropping patterns gave returns over variable costs which were generally above 30 percent.[71] At some locations there was dramatic evidence of adoption. For example, between 1981 and 1984 in Sukchina, the proportion of farmers using improved varieties increased 20 to 98 percent; there was a 45 percent increase in fertilizer application rates; and a short season cowpea variety had benefit-cost ratios ranging from seven to twelve. Benefits were also achieved through the introduction of a serrated sickle and increased rice hill density. On properly selected sites, a change from ridge to flat planting of rice increased yields by 23 percent and returns per day of labor by 30 percent. Also on appropriate sites, a change in planting densities increased yields by 14 percent.[72]

5. Panama. INIAP research showed that an increase in plant density had a marginal rate of return of 687 percent. If a new herbicide was used at the recommended higher population density, there was an additional return of 716 percent. As a result, by 1982 there had been a high degree of acceptance of the recommendations relating to weed control (61% of farmers), density and row planting (71%), and zero or minimum tillage methods (44%).[73] Also in Panama, FSR methods were used to develop a dual purpose cattle production system -- involving mineral salts, a health package and paddocks for calves -- which was readily accepted by farmers.[74]

6. Botswana. The Agricultural Technology Improvement Project (ATIP) showed that yields could be increased by 77 percent, on average over five drought seasons, through the addition of an early season plowing operation. The net gain per additional hour invested was 50 percent higher than the urban minimum wage. In addition, the return to a fungicide treatment for peanut seed was above 400 percent. The return to hand planting labor for gap filling was two to three times the minimum wage. Several additional promising interventions were screened

and promoted including an improved donkey harness (from Kenya) and a hand operated rotary injection planter (from IITA).

C. Institutionalization

Although the contributions of FSR to small farmer development could not live up to the early claims of its proponents, the logic of the systems perspective and on-farm research stimulated many countries, universities and IARCs to begin institutionalizing FSR programs. By the mid-1980s, for example, the research services in nine African countries had been reorganized to accommodate FSR. Ten universities in the United States had established FSR programs focused on American agriculture. In Asia, six major universities formed the Southeast Asian Universities Agroecosystems Network (SUAN), which is an organizational framework for promoting and supporting FSR-type activities.

Although support for FSR was seemingly increasing among national planners in some low-income countries in the mid-1980s, USAID decided to shift the emphasis of its funding to traditional commodity research and biotechnological research.[9] As part of its shift in emphasis, USAID ended funding for the Farming Systems Support Project (based at the University of Florida) which had played a major FSR networking and training role. The declining support from USAID, and the International Development Research Center (IDRC) in Canada, dramatically reduced the pace of FSR institutionalization after 1985.

After 1985, the institutionalization of the FS approach proceeded primarily in three contexts: at the IARCs, through regional networks, and in countries which had already institutionalized national programs before the ending of donor subsidies. Most of the IARCs continued to have active FSR programs, even if not independently labelled as such. The International Institute for Tropical Agriculture (IITA), for example, devotes 40 percent of its budget to FSR.

Regional networks were particularly important in supporting FSR in the mid-1980s. In Asia, the cropping systems network (ACSN) began a shift to a FS approach with the crop-livestock workshop at Los Banos in April, 1983. Three years later the shift was formalized at a follow-up workshop held in Khon Kaen, Thailand (July, 1986) when the ACSN was renamed as the Asian Farming Systems Network. In Africa, the West African Farming Systems Network (WAFSN) held its inaugural meeting in 1986. Also, many of the projects

supported by the Southern African Development Coordinating Council (SADCC) had explicitly adopted elements of the FS approach. In the Caribbean, CARDI was sponsoring FSR in eight countries. Also, many of the Collaborative Research Support Programs (CRSPs) were supporting FSR activities.

V. ASSESSMENT

There is no simple way to assess the FS approach. As a small farmer development strategy, the approach involves modified research and development processes, evolutionary changes in farmer (and researcher) practices and behavior, and a restructuring of agricultural institutions. Moreover, the approach has been applied in different ways at different times in different settings.

A. Contributions

When initially conceived, the primary contribution of the FS approach was to identify interventions to improve the farming systems productivity. As the FS approach has become more fully elaborated, there have been four additional contributions: (a) development of better agricultural research methods, (b) improvements in institutional performance, (c) documentation of factors affecting existing farming systems, and (d) promotion of farmers' perspectives.

1. Interventions Identified for Increasing Productivity

In several locations, FSR teams have shown that farm profitability can be increased through modified tillage practices, new varieties, adjustments in plant populations, fertilizer or herbicide applications, increased cropping intensity, etc. In addition, substantial progress has been made in determining the technical factors affecting the success of competing agronomic practices such as ridge versus flat planting, animal traction versus hand hoeing, and intercropping versus sole cropping. Even where specific improved practices have not been identified, the technical and social science diagnosis associated with on-farm trials has helped establish a foundation for technology development research programs for the next 10 to 20 years.

In general, FSR has been more successful in identifying interventions for equable environments. Perhaps the most dramatic examples obtain from Asian cropping systems research, where large increases in farm profitability have been demonstrated through the

addition of short cycle crops.[75] In harsh production environments, fewer interventions have been identified since it often is necessary to develop substantially modified farming systems, rather than introduce minor changes based on exploiting flexibility in existing systems.

2. Improved Agricultural Research Methods

The development of agricultural research methods through FSR has been nothing short of revolutionary in nature. Through FSR, technical research has in most countries shifted from a single-location to a multi-location orientation.[76] In addition, the range of technical factors considered when evaluating technologies has increased. For example, it is now usual practice to consider the threshing characteristics of new varieties, complementary products such as cowpea leaves, and the value of intermediate products -- such as that of manure in producing crops.

One of the most commonly acknowledged contributions of the FS approach has been a move away from a technical perspective of agricultural research. With the inclusion of agricultural economists, greater attention has been given to the returns to labor or capital, and to risk factors. Later, as anthropologists started to play a greater role, the social acceptability and impact of innovations were acknowledged to be important criteria in agricultural research. On the other side, FSR has provided an opportunity for social scientists to begin making more tangible contributions to the development process.

FSR has stimulated a number of innovations in research procedures for rapid appraisal surveys and on-farm trials. Progress has also been made on formal and informal techniques for eliciting farmers' assessments of problems and practices, including the use of farmer groups.[77]

Closely related to the spread of FSR has been the introduction and use of micro-computers. The increased capacity to do on-site data analysis has been coupled with a commitment to collecting less data. Taken together, a bias has been established in favor of pragmatic research, minimizing the time required to complete analyses, and making sure analyses are understandable. This bias is now impacting on on-station research programs and on macro policy analysts -- reflecting a spread of the FS perspective beyond the bounds of formal FSR.

3. Improved Institutional Performance

The FS approach has contributed to improved institutional performance through its bottom-up development perspective. In many countries, results from FSR have been used to

target commodity research programs, and to make sure on-station research is relevant to farmers' needs. The emphasis on adjusting to farmer circumstances has led to more relevant policies as well as technologies. For example, in Botswana, research findings from one FSR team were used to help design a major farmer assistance program targeted to resource poor farmers. In Mexico and Panama, insights from FSR led to revisions in national credit programs.[30]

The FS approach has further contributed to improved institutional performance through the development of linkages between on-station research, farmers, and extension agents. As a result of improved linkages, commodity researchers now more commonly visit farmers' fields compared to ten years ago and, at least in some countries, extension agents are actively involved in technology assessment.

4. Data on Farming Systems

A major contribution of the FS approach is the information which has been generated about existing farming systems. Until the 1970s, most research had a single-discipline perspective and covered a narrow range of factors affecting farm systems performance. Particularly in Africa, there was an inadequate base for development planning.[21] Through FSR, much information has been generated on farm-household relationships, the roles of women, inter-household linkages, livestock and crop-livestock linkages, agro-ecological issues, and farm-level resource constraints. The insights about traditional farming systems gained through FSR may enable the elaboration of a comparative theory of agricultural development.

5. Appreciation of Farmers' Perspectives and Farmer Participation

The contributions of farmers to the development process has been documented at several conferences -- see, for example, Matlon et al.[78] and papers given at a workshop held at the University of Sussex in July 1987. Ashby,[79] Lightfoot[80,81] and many others have demonstrated the value of farmers actively participating in on-farm trial work. As a result, most donor agency project documents and national agricultural plans now explicitly recognize farmers' goals and give emphasis to who gains -- rather than just growth perspectives. There is also greater awareness of the heterogeneity among farmers, farmers' indigenous knowledge, and the range of factors affecting farmer behavior.

B. Factors Limiting Success

Before considering these in detail, the issue of funding should be mentioned. As earlier emphasized, donor agencies have played a major role in providing funds for FSR. FSR is expensive in terms of recurrent costs vis-a-vis station based research, where fixed and sunk costs dominate. The practical problems of keeping FSR activities going after the withdrawal of donor funding limits the potential for success and highlights the need for an approach to FSR that minimizes the demand for resources. This of course is a major determinant for the institutionalization of the FS approach.

Despite the substantial long-run contributions of the FS approach, there is a consensus among donor agencies and development specialists that the FS approach has not lived up to short-run expectations. Several assessments point up different reasons why, but disagreements continue over the validity and relative importance of the different reasons.

1. Unit of Analysis

One key issue is whether the normal unit of analysis used in FSR -- individuals, farms or groups of farms with similar practices and circumstances -- is appropriate. Both more aggregated and disaggregated units have been proposed as being more viable. A growing literature on intra-household dynamics suggests that specific individuals, or classes of individuals, should serve as the units of analysis.[82,83] On the other hand, FSR has also been criticized for giving too little attention to policy issues and the macro economic implications of agricultural development programs.[84] As a result, there have been calls to reject farming systems as the unit of analysis in favor of agro-ecological systems,[85] agro-forestry systems,[86] food systems[87] etc.

Among FSR practitioners, an unresolved "unit of analysis" issue is proper use of the recommendation domain (RD) concept. Implicit in the RD concept is an assumption that research can focus on groups of farms and still sufficiently take into account the circumstances determining adoption behavior. However, since there remains little evidence on adoption response, the level of appropriate aggregation is by default based on researchers' intuition. Perhaps individual farm planning is necessary or, in contrast, perhaps it is sufficient to develop general sets of alternatives and let farmers decide whether proposals make sense.

Even if one accepts the RD concept, there remains the problem of when RDs should be defined. Important dynamics might be missed if RDs are defined before researchers understand

the social organization of production.[88,89] Waiting too long to focus research on particular problems of specific RDs, however, can greatly increase research resource requirements.

2. Scope of Research

In spite of the broad conceptual framework of the FS approach, FSR projects and programs have tended to be narrowly focused. Most FSR teams have focused on improved crop production technologies. In some cases the emphasis on crop production resulted from a diagnosis that one or a few main crops could served as a "leverage" point through which the most substantial gain could be achieved.[90] In other cases, FSR teams have been assigned a "predetermined focus" to do research on one enterprise or one facet of an enterprise.

An active debate among FSR practitioners is whether the scope of research has been too much predetermined by institutional mandates. Norman and Collinson[90] have argued that most FSR success stories have derived from programs with specific, and relatively narrow, mandates to focus on particular commodities. However, teams operating with predetermined mandates often have not addressed the most important issues from farmers' perspectives. Fresco and Poats[90] label this the problem of "real versus perceived holism."

On balance, it does appear that too many important phenomena were left out of early FSR analyses. As Johnson[91] argued, the scientists involved in FSR at the IARCs during the 1970s did not really take a holistic approach, encompassing human and institutional change as well as technological change. Moreover, due to institutional mandates, livestock often were (and in fact often still are) ignored. Also, in general, a submissive approach[92] was taken to support systems improvement.

The potential shortcomings of predetermined FSR became more evident as FS work developed in national programs.[93] Consequently, during mid-1980s, there was a trend toward abandoning the emphasis on particular enterprises and quick turnaround time in favor of a broader systems perspective, encompassing livestock,[94] food consumption,[95] nutrition,[96,97] gender issues,[83] and the requirements for national development planning.[98] Despite adjustments, Eicher,[84] among others, has recently argued that the scope of FSR continues to be too narrow to have a significant impact.

3. Project Format

Most FSR has been carried out on a project basis, independent of on-station research

programs and isolated from agricultural policy debates.[84] This has in many cases led to a fragmented set of initiatives, an inability to undertake long-term research -- due to the vagaries of donor agency funding -- and failure to develop credibility among planners, on-station researchers and extension agents.

Institutionalized FSR programs clearly are preferable to donor funded projects, but there has been little agreement on how best to institutionalize the FS approach. In some countries, a separate institutional structure has been created for FSR, but this now appears to be only a marginal improvement over the FSR project format. Consequently, Stoop,[79] and others have argued that on-farm research and the FS perspective should be gradually introduced into existing institutions. Nevertheless, the institutional requirements for FSR cannot be underestimated. As Poats et al.[78] point out, success in FSR requires a reorganization to support and coordinate field teams and to integrate national and location-specific development priorities, even if no separate institutional structure is created for FS work.

4. Lack of Technologies

One of the main limitations on FSR has been the lack of technologies which are ready for farmers after modest adaptive research. FSR was never intended to substitute for applied commodity and component design research. But many FSR teams have been assigned a poor farmer-harsh climate focus, where there are few if any on-the-shelf technologies ready for location-specific, adaptive research. Consequently, FSR has involved a mixture of technical diagnostic, design and adaptive research to a much greater extent than was initially envisioned. Particularly in harsh environments, there is a long time required for on-farm technical diagnostic and design research -- and the results often are not spectacular in a short-run context. The tendency to ask FSR teams to do more than they should, rather than only investing in FSR when the conditions were appropriate, has substantially contributed to the impression that the FS approach has not lived up to expectations.

5. Lack of Trained Personnel

There continues to be an insufficient supply of the skills required for multidisciplinary systems analyses. The lack of systems training has resulted in poor problem definition, use of inappropriate methodology, and a tendency for FSR researchers to concentrate on topics relating to their disciplinary expertise -- rather than on farmers' problems. While disciplinary

orientations can be overcome through the use of multidisciplinary teams, experience has shown that in-depth collaboration among team members has been relatively rare.

The lack of trained personnel applies to the FSR technical assistants brought in by donor agencies,[100] as well as to national scientists. Few universities have paid attention to the type of training or retraining which is required for FSR.[121] As a result, many donor sponsored FSR projects have been staffed with individuals having little or no training or experience in on-farm research methods or team research approaches. When weaknesses have been identified in the procedures of one or more team members, the tradition of academic freedom and individualism has hindered efforts to make those individuals adjust their methods.[122]

Relevant training and experience are critical ingredients in lending credibility to FSR and creating conditions conducive to the institutionalization of the approach.

6. Role of Farmers

Through the early 1980s, most FSR focused on evaluating the technical feasiblity and economic viability of modified practices and varieties. Farmers generally had a passive role. Farmers were the clients of research[42] and generally implemented the trials, but the goals of research often were the agronomic and economic analyses of input-output relations and profitability.[31] In many cases, the farmer perspective got lost.

A number of social scientists have recently been promoting a farmer first approach to FSR.[27,78] Implicit in a farmer first approach is a belief that research methods and priorities will be more relevant and, therefore, adoption rates will be increased -- even if the returns per farmer adopting a technology are lower. The main argument against a farmer first perspective is that farmers' do not have sufficient knowledge of technological options or national planning goals to be given a controlling role in FSR. The issue remains unresolved and, in practice, most FSR teams try to achieve a balance between researchers' and farmers' perspectives when determining the research agenda.

VI. EXPECTED TRENDS

There was a substantial evolution in the FS approach between the late-1970s and the mid-1980s, and there is every reason to believe that the approach will continue to evolve. A summary of recent adjustments and expected further adjustments is presented in Table 1.

In general, the narrowly focused FSR developed at the IARCs has given way to a more comprehensive, longer-horizon systems approach. Farmers are playing an increasing role. At the same time, the domination of FSR by donor agencies and expatriate technical assistants has started to give away to localized programs. While there continues to be a substantial investment in the diagnosis of problems, there is declining interest in describing farming systems and increasing interest in pushing technologies through the testing stage into actual extension.

Two major forces have impacted on the evolution of the FS approach. One has been the expanding number of academic professionals, representing several disciplines, involved in FSR. During most of the 1980s, academic supporters of the FS approach have shown a bias in favor of a systems approach and farmer first perspectives. The second major force has been the bureaucratic interests of donor agencies and national agricultural ministries. Bureaucrats have increasingly expressed reservations about the likelihood that FSR can produce short-term, tangible payoffs.

Both the academics and bureaucrats agree that certain developments in the FS approach have been appropriate and should continue. For example, there appears to be a consensus that more attention needs to be paid to livestock, support systems performance, extension linkages, and working through existing channels. Similarly, there is widespread agreement that the trend toward less reliance on donor funding should continue, that factors beside private profitability need to be considered, and that FSR should not be dominated by expatriates.

Most areas of contention about the future of the FS approach stem from disagreements about the viability and affordability of a decentralized, bottom-up approach to development. The dominant academic perspective seems to be that a broad systems focus is needed and that farmers' views should determine the agenda. The bureaucratic perspective emphasizes instead the importance of commodity program priorities as determined by national planning goals, and the value of concentrating efforts in areas with equable environments – so the payoffs will be higher.

The battle is joined over the future of the FS approach, but the outcome is uncertain. Based on past experiences, however, bureaucratic imperatives will probably dominate academic "optimality" perspectives. In such a case, it can be expected that commodity programs and

macro policy issues will receive greater attention during the late 1980s than during the prior ten years, and that farmers' perspectives may play a declining role in determining national priorities. In any event, multidisciplinary on-farm research is likely to continue in some format, and systems analysis is likely to have a growing impact on national research and development planning processes.

VII. CONCLUSIONS

The FS approach has been an important tool in developing strategies for small farmers for more than a decade, starting in the mid-1970s. By 1986, donor agencies, national agricultural research directors and agricultural researchers had started to revise their high expectations for FSR. Funding for FSR projects and programs has been greatly reduced. In part, the retrenchment can be seen as a "technical" adjustment in the resource allocation process, reflecting the cyclical thinking of donor agencies and development specialists. The reduced support for the FS approach, however, does not reflect what appears to be a continuing -- if not increasing -- interest in the FS approach and FSR methods in many low income countries.

Regardless of the future of FSR as a distinct entity, the FS approach has made several lasting contributions. The approach has provided a problem solving methodology for developing and evaluating relevant, improved production technologies. The development of production technologies has generally been the short-run objective of FS projects and programs. The approach has also contributed indirectly to improved productivity by inducing the improved performance of agricultural institutions.

To the extent the approach has failed to live up to expectations, it is partially because the expectations were unrealistic. The systems perspective represents an advancement over reductionism. On-farm research is a needed complement to on-station research. Social science perspectives are a needed complement to technical agriculture research. But the FS approach cannot be expected to solve all small farmer development problems. When FSR is properly implemented, it should be possible to identify alternatives for improving small farmer productivity, but there is more to small farmer welfare and to national development than small farmer productivity.

TABLE 1: EVOLUTION OF THE FARMING SYSTEMS APPROACH

Characteristic	1970s To Early 1980s	Adjustment By Mid 1980s	Further Adjustment
INCREASING TRENDS TO CONTINUE			
Support system perspective Extension linkage Area development mandate Work through channels	LESS	MORE	MORE
INCREASE TRENDS SUBJECT TO REVERSAL			
Feed-up research priorities Emphasis on farmer first Sub-RDs within ecological zones Baseline diagnosis	LESS	MORE	LESS
DECREASING TRENDS TO CONTINUE			
Implemented by isolated teams Rely on donor funding Emphasis on quick turnaround time Dominated by expatriates Focus on private profitability	MORE	LESS	LESS
DECREASING TRENDS SUBJECT TO REVERSAL			
Focus on equable areas Pre-determined commodity focus Feed down from technical research Researcher managed trials	MORE	LESS	MORE
TRENDS YET TO BEGIN			
Focus on adoption rates Focus on social profitability (sustainability) Inclusion of macro-analysis	LITTLE	LITTLE	MORE

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