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FOREWORD

During recent years, the Farming Systems Research (FSR) has emerged as an innovative approach to enhance agricultural productivity, as well as income of the farmer. This approach focuses on researchable issues under real life farming conditions, with emphasis on small and landless peasants, as well as relevant activities in the given ecological and socio-economic environments. FSR also provides for integrated land use. Besides, FSR has in-built functional feedback system to research scientists who can better appreciate the problems of farmers and devise appropriate measures for their resolution.

The Pakistan Agricultural Research Council under its USAID supported MART (Management of Agricultural Research and Technology) project initiated a National Coordinated Programme of FSR in 1988, which is operating in all the four provinces of Pakistan. Through this programme, the FSR approach is being gainfully utilized to promote the adoption of improved technologies to increase agricultural productivity.

In May 1989, an international workshop was organized by PARC/MART in Quetta to consider strategies to institutionalize FSR in Pakistan. The proceedings of this workshop contain the latest knowledge on FSR and consider necessary policy and resource needs to effectively internalize FSR in the national agricultural research system.

The efforts made by the MART Advisor, Dr. Abdul Majid, National Coordinator FSR, and federal/provincial scientists in organizing this workshop are commended. It is expected that all concerned will find these proceedings interesting and useful.

(Dr. C. M. Anwar Khan)
Secretary, Agricultural Research Division and
Chairman, Pakistan Agricultural Research Council,
Islamabad

June, 1990

PREFACE

Commodity research has been a significant factor in the improvement of Pakistan's agriculture. In fact an accelerated increase in small farm productivity remains an overall priority.

Unfortunately, much of the new technology generated at the experiment station is not adequately adopted by farmers. Small farmers of Pakistan characteristically manage complex crop/livestock enterprises. A Farming Systems Research (FSR) approach which encourages scientists and farmers in partnership to identify priority constraints and test improved technology based on the entire farm soil-water-crop-livestock system is needed. Technology development requires an interdisciplinary approach to understand the complexity of the farmers' environment, his farming systems, and his decision-making process.

We choose to define FSR as multidisciplinary research on diagnosed production and marketing constraints of small farm systems and will sustain an increase in productivity and net-farm income. Scientists and farmers work together to verify and adapt experiment station technology to specific agro-ecological conditions. Coordination between extension, research and agricultural education is enhanced, while feedback on research needs and adoption is swift, dynamic, and effective. Pakistan has an agricultural research system in place, but the challenge is how to build on its strengths to better serve farmers. Success depends on a commitment to a Farming Systems Research/Extension (FSR/E) approach and development of leadership to organize and manage it.

Several developing countries have successfully internalized FSR, notably Thailand, the Philippines, Malaysia and several Latin American countries. Different organizational patterns have been used but similar questions have been addressed. Examples include: What are the critical factors which will ensure its ongoing success? What general recommendations and conclusions concerning small farm development have emerged from FSR/E? What is the role of FSR/E in sustaining productivity and profitability. Will FSR be significant factor in improving the National Agricultural Research System performance?

Institutionalization of FSR nationally requires each institute/university/agency in each province to commit scientific manpower, technical assistance, support staff, and adequate budget and space to effectively conduct FSR at respective target areas. A clear policy is needed which defines expected roles and products of FSR/E. It is also necessary to develop a plan for building up the required institutional capacity in terms of staff resources and scientific and logistical support. Technical assistance provided by institute/university scientists assigned to the project by their administrators under authority delegated to a provincial FSR Director/Coordinator is also outlined. A National FSR program coordinated through PARC may be established.

Managers will need to commit the requisite staff resources to provide a scientific leader with skills in FSR methods and capacity to work with scientists in several disciplines. It is necessary for on-farm research staff to have status equal to those working primarily at the station. Other incentives are discussed.

A sustained institutionalized FSR/E program throughout Pakistan's research system network will require rather drastic changes in the agricultural university curricula and training such as internship programs for students who with more on-farm experience, could better understand the modest resources and constraints of the small farmers. Innovative changes in curriculum and training are proposed.

The FSR conference recognized three critical aspects in the institutionalization of on-farm client orientated research integrating on-farm with experiment station research, participation of resource-poor farmers in the research process and motivating interdisciplinary scientists to solve priority farm system constraints.

Succinct recommendations with concise implementation strategies developed by the three conference work groups on research, education and extension are given. Together, these constitute an action plan to institutionalize FSR in Pakistan.

Murray D. Dawson
Advisor
Farming Systems Research
MART/PARC

June, 1990

EXECUTIVE SUMMARY

Abdul Majid[1] *and M. D. Dawson*[2]

Recent experience of FSR in many countries has resulted in raising production and accelerating adoption of improved technology by small farmers. Indeed, FSR recognizes the complexity of managing a variety of crops and livestock as farm systems and within the constraints of resource poor farmers. Natural and biological scientists together are encouraged to communicate with the farmers. This approach is in contrast to the structure of national research systems, which, being organized along commodity lines, tends to focus research resources and key commodities.

In spite of the major impact FSR has made on systems research, interdisciplinary efforts and a pragmatic approach, its full potential remains to be realized. Internationalization of FSR throughout the national research system is in its infancy.

Our urgent agenda and principle challenge as Byerlee suggests is "to use the perspective and methods of FSR to improve the efficiency of our education, research and extension organizations, to communicate more effectively and address high priority farmers problems."

Strategies and mechanisms for the institutionalization of FSR in Pakistan addressed by the keynote speakers, was also the topic taken up by the conference work groups. Scientists, educators, extensionists and administrators collaborated in providing recommendations and observations relative to institutionalizing FSR in Pakistan.

The conference participants appeared unanimous in believing that a sustained and viable FSR should be encouraged. But integration of FSR into all parts of the research system, strengthened links with extension and radical changes in agricultural education will be necessary to ensure that FSR is institutionalized in Pakistan.

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INAUGURAL ADDRESS

AMIR MUHAMMED
CHAIRMAN, PAKISTAN AGRICULTURAL RESEARCH COUNCIL

Ladies and Gentlemen!

This conference represents the first serious attempt by PARC to evolve a mechanism for the institutionalization of Farming Systems Research (FSR) concept in Pakistan. It is significant that there has been an enthusiastic response from all the senior research administrators, scientists, extentionists and academic community to this idea. The participants in this meeting include senior persons from all the different agricultural organizations pertinent to FSR. I do hope the discussions during the next two days will result in an agreed mechanism to institutionalize FSR at all levels of teaching, research, extension and farming.

There is no doubt that commodity research approach has contributed greatly to improve the production of various crops and livestock. The major contribution, however, has been in the form of benefits to large farmers who have specialized in a few specific agricultural commodities. The obvious reason is that our research strategies are based on specialized farming. The Green Revolution, which covered just a few crops also provided economic and technical assistance mainly to large farmers.

Agriculture in Pakistan is primarily a small farmer activity and 70% of the farmers operate on less than 5 hectares. Their system of farming is very complex. They employ diversified farming systems to adjust the seasonal changes in temperature, rainfall, marketing conditions and the availability of labour. Tangible progress cannot be made at the national level by neglecting these farmers. We, therefore, need a complete change of emphasis to research and education. The fundamental concern of a new approach should be to help small farmers therefore increasing their income and helping simultaneously to sustain their resource base. FSR is an approach which provides an opportunity for the farmer to participate actively in technology development. Social scientists play a key role through the identification of complex production constraints in the system.

The FSR approach has been used by many developing countries. It has provided respect for small farmers and also enhanced communication across disciplines. International research centres, such as CIMMYT and IRRI, feel that an FSR approach is helpful in raising production by accelerating adoption of improved technologies because these are developed in close association with the farmer.

If we agree that FSR is more suited to the small farmer's need then we need to bring changes in our research, extension and education systems. Commodity and discipline oriented research institutes need to be oriented in such a manner that these provide an opportunity for scientists to work together.

Agricultural universities and training institutes would need major adjustments to produce scientists who can address the need of small farming communities.

Pakistan has distinct agro-ecological zones. The Farming System Research Program should take advantage of these zones. In the resource analysis of both traditional and improved technology, adopted systems should be studied. Definitions of labor, income and other socio-economic parameters

are needed. Results of such analysis should help to extrapolate the potential socio-economic impact over a realistic area that could result from similar increased productivity if the improved technology were to be widely adopted. This type of research would be more satisfying for both farmers and scientists. Administrators, and policy makers would also be more attentive to our funding needs. This would not only help our country's economy but could provide ideas and information useful to other developing countries.

CONCLUDING REMARKS

The summary of important issues presented by Dr. Amir Muhammed, Chairman (PARC) in the conference follows:

- There is need to define FSR in terms of its goals, objectives and methods. Equally important is to state clearly what FSR is not.

- A system's approach to agriculture must be taken up at the university. Course content and faculty involvement should be identified. Systems work experience should be made available to university instructors.

- Resource use, analysis and constraint prioritization of small farm problem is needed to give focus for experiment station research.

- An opportunity exists for FSR to supplement conventional disciplines and commodity research. Interdisciplinary scientists teams with systems analysis must be established.

- The FSR team should identify key system constraints and design research for agro-ecological and socio economic zones. Assessment of impact on sustained productivity follows.

- Policy makers and senior administrators should be informed of the FSR approach methods and expected accomplishments. Follow-up meetings and small workshops must be arranged which address key questions and discussions based on the work group recommendations.

IMPACTS OF FARMING SYSTEMS RESEARCH IN THE THIRD WORLD

Derek Byerlee and Robert Tripp[1]

INTRODUCTION

After almost a decade of intensive activity in farming systems research (FSR) around the world, it is appropriate to stand back and assess what has been achieved. Those of us who were involved in the early years of FSR in the last part of the 1970s, remember the excitement and evangelism that characterised the evolving methods and approaches of FSR. None of us predicted the speed and extent to which this new paradigm would capture the interest of agricultural research systems and donors during the 1980s. Now almost all countries (including many developed countries) have something called, or closely associated with, FSR. Most countries have at least five years and, in some cases, over 10 years of experience with FSR, and we can ask. have we achieved our objectives? Has FSR helped bring better and more appropriate technology to small farmers? Has FSR repaid the substantial financial investment that has been made in it?

Today we will try to answer some of these questions. Our answers will sometimes be ambiguous in some respects FSR has not lived up to its early expectations. We identify some reasons why this has not occured, and what changes are needed to ensure that FSR has greater pay-off in the 1990s. But before turning to the impacts of FSR it is necessary to go back and set the stage, by briefly outlining the origins and essential characteristics of FSR.

A BRIEF OVERVIEW OF FARMING SYSTEMS RESEARCH

ORIGINS OF FSR

By the early 1970s it had become clear that to address the technological needs of small farms required an understanding of the complexity of managing a variety of crops and livestock within the constraints of the range of economic and social parameters affecting farm-household decisions. This quickly gave credence to analysing such farms as systems and to seeing technology development as system-specific. This need was in contrast to the structure of national research systems, which had been reorganised along commodity lines in order to focus research resources on key commodities. However, in many cases there was little communication across commodity research programmes, even though each commodity was often produced as part of a complex farming system. Thus there emerged considerable justification for an approach to agricultural research that begins with an analysis of the local farming system and the biological, economic, and social factors and condition farmers' management of this system. This became the underlying rationale of FSR.

A series of specific projects in the early 1970s helped to establish FSR as a research strategy. Two efforts in Latin America, the Caqueza Project, an integrated rural development effort in Colombia (Zandstra et al., 1979), and Plan Puebla in Mexico (Jimenez, 1970), both demonstrated the importance of assessing technologies under farmers' conditions. The establishment of a national agricultural

[1] *CIMMYT Economics Programme, Mexico*

research institute in Guatemala also featured a strong farming system orientation and the incorporation of a social science component (Hildebrand, 1976), which later served as a model for other Central American programmes. In Africa, earlier work on describing and analysing local farming systems began to be used as a basis for designing technological interventions which were taken to farmers' fields for evaluation under representative conditions (Norman et al., 1979).

By 1975 many of the International Agricultural Research Centres (IARC) had also begun work in FSR. The International Rice Research Institute (IRRI) saw significant potential in adapting new early-maturing rice varieties to intensify cropping patterns in south and southeast Asia, and developed a set of methods and an extensive network of collaborators in cropping systems research (Zandstra et al., 1981). About the same time CIMMYT, based on early experience in eastern Africa and Latin America, developed a set of methods for commodity based on-farm research with a farming systems perspective (Collinson, 1982; Moscardi et al., 1983; Byerlee et al., 1982).

By the mid-1980s most countries had established FSR or on-farm adaptive research programmes, often with donor funding which increased rapidly in the 1980s for FSR-type activities. The organisation of these programmes varied tremendously. In Asia much FSR work developed around cropping pattern testing, which has now been formalised into the Asian Farming System Network. Several African countries, including Zambia, Ethiopia, and Malawi, have established teams of agronomists and economists in all major regions of the country to conduct FSR. Pakistan has at least three levels of FSR activity: (1) adaptive research, which is now institutionalised in the extension service of all Provinces. (2) on-farm commodity-oriented research using a farming approach (e.g. on-farm maize research in NWFP), and (3) the FSR programme organised through PARC/Winrock, which takes a broader crop-livestock mandate.

WHAT IS A FARMING SYSTEM?

A great deal of effort has been spent on trying to decide exactly what constitutes research on a farming system. One place to start is the definition of a farming system given by the review of FSR in the IARC.

A farming system is a complicated interwoven mesh of soils, plants, animals, implements, workers, other inputs and environmental influences, who, given his [sic] preferences and aspirations attempts to produce output from the inputs and technology available to him [sic] (CGIAR/TAC, 1978).

The definition makes clear that both the complexities of the system and the decision making criteria of farmers should play important roles in shaping the perspectives and methods that researchers employ. System complexities are the product of several characteristics of small farm agriculture, such as (1) long growing seasons, which allow for multiple cropping and intercropping, (2) uncertain markets and climates which, combined with low farm incomes, make risk an important factor in farmer decisions, (3) farm households that consume a significant proportion of their production, thus making household food supply an additional criteria in farm management, and (4) labour and other household resources that exhibit considerable heterogeneity and increase management complexity. The combination of these factors often leads to complex and varied farming systems.

Virtually all FSR is oriented by some reference to a farming system, but defining the boundaries of the system has been problematic (Merrill-Sands, 1986).

Some FSR projects have been too ambitious in the conception of their responsibilities and have felt obligated to investigate all farm enterprises in the system simultaneously. The impression that FSR necessarily involves studies of intercropping, multiple cropping, and crop-livestock systems has at times contributed to a breach between FSR activities and commoditiy or disciplinary research. This division has made commodity programmes suspicious of data developed through FSR ,and has meant that FSR often fails to pursue research themes of value to commodity research. With increasing experience and tighter budgets in recent years, work has generally become more focused, concentrating on key enterprises, cropping patterns, or crop-livestock interactions in the farming system where success in introducing technological innovations will have a major impact on system productivity. Research on these key enterprises takes account of interactions with other elements of the system (Table 1).

WHAT DO WE MEAN BY FSR?

Although all agree on the complexity of small-farming systems, the term Farming Systems Research is in retrospect a confusing choice of terms. It has been applied to describe: (1) an approach or perspective in research and extension which is particularly appropriate to small farmers, and (2) defined research activities focusing on system interactions.

Farming Systems Approach or Perspective (FSA): The essential characteristics of a farming systems approach to research are: (1) its explicit concern with farmers, especially small farmers, as the focus of the research, and (2) its commitment to solve problems i.e., to find technological interventions that are adopted by farmers to increase farm productivity and incomes.

The farming systems approach to research is a systematic way of identifying and solving farmers' problems. It is based on an explicit diagnosis of farmers' existing systems, problems, and opportunities as a basis for carefully planning on-farm experiments for selected technologies which are deemed to be compatible with farmers' circumstances (Figure 1). The farming systems approach also explicitly recognises that: (1) problems and opportunities must be identified in the context of farmers' systems, recognising system interactions, and (2) target farmers for any research programme usually exhibit substantial heterogeneity and should be stratified into more homogeneous groups for the purposes of organising research and making technological recommendations. While a farming systems approach has usually been associated with on-farm adaptive research (see below), the approach can and should be used to organise and set priorities in applied research programmes (such as plant breeding) and in extension. For example, the maize breeding programme of NWFP should aggregate the experience of on-farm research teams in the province and could even organise special diagnostic tours to further refine the major environments for maize varietal development, and farmers' needs for grain type, maturity, and fodder characteristics. Similarly, in southern Africa, some extension services now formally require a diagnostic exercise as a way of identifying extension priorities.

It should be noted that some research that is classified as FSR does not use a farming systems approach. A common example is intercropping trials that test various combinations and densities of crops without reference to farmers' existing intercrop system and their rationale for using the system.

FSR as an Activity: The most common activity associated with FSR is on-farm adaptive research (OFR), whose main characteristics are summarised in the left column of Table 2. OFR has a well-defined sequence of steps, from diagnosis to plan technology assessment and recommendation that characterise the farming systems approach to research (Figure 1). It is site specific and usually focuses

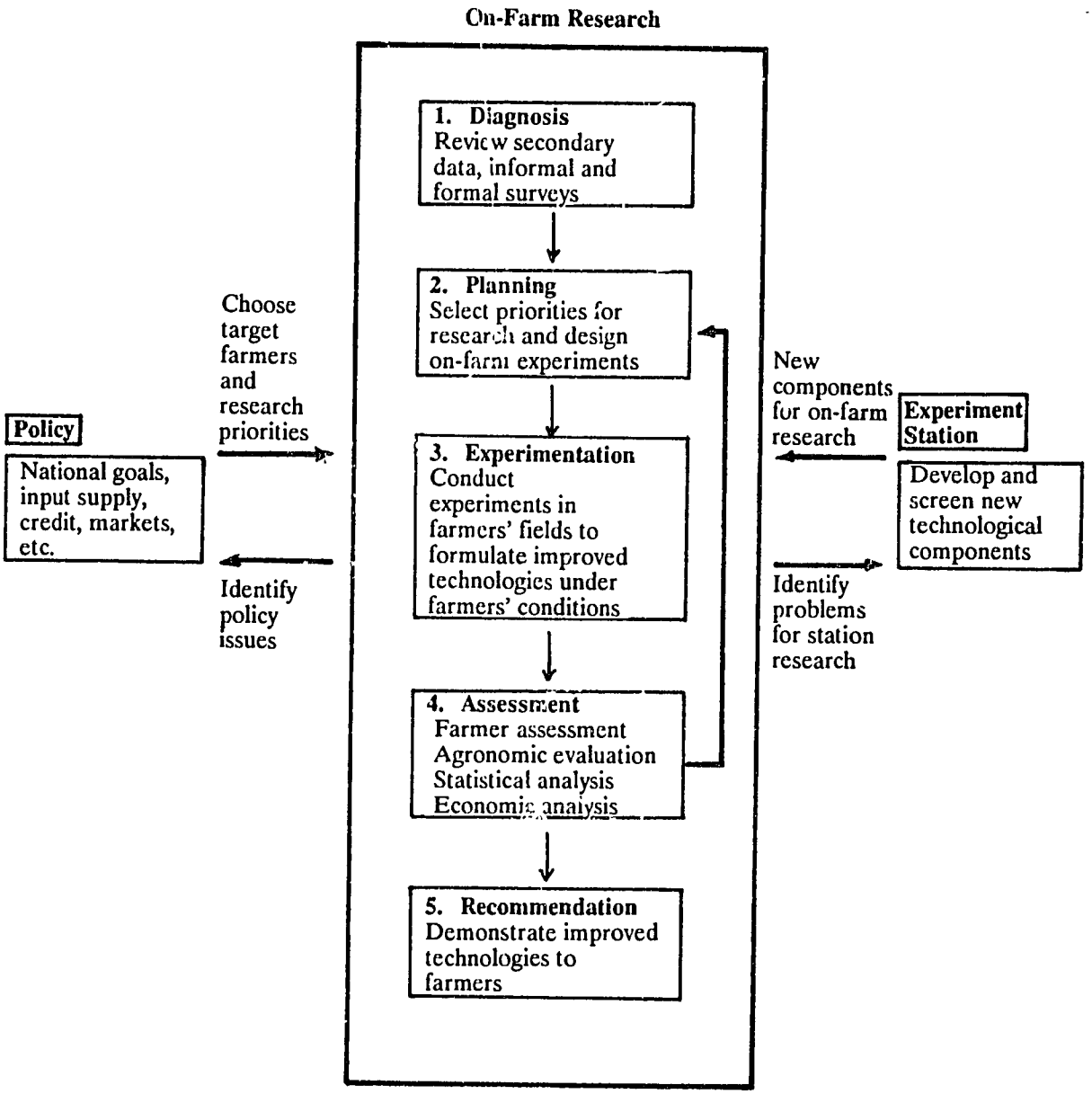

Figure 1. Stages of a farming systems approach to research

on stepwise introduction of improved technological components for a major crop or livestock enterprise in the system, with the goal of increasing system productivity in the short term.

Table 1. Classification of farming system interactions

Interaction	Examples
• Direct between crops	
a) Interactions in space	i) Interactions due to intercropping
b) Interactions over time	i) Conflicts in planting crop in relation to harvest of previous crop
	ii) Carry-over of soil structure and crop residues from preceding crop
	iii) Carry-over fertility from previous crops
	iv) Carry-over and build-up of weed seeds and other pest populations from previous crops
• Between crops and livestock	i) Use of crops and crop residues for fodder
	ii) Use of farm yard manure as crop nutrient source
	iii) Use of animals for draft power
• Resource competition and complementarity	i) Conflicts in labour use and cash needs between and complementarity enterprises including non-farm enterprises
	ii) Competition for irrigation water between enterprises
• Meeting multiple objectives of farm households	i) Choice of multiple crops, livestock and production objectives of farm practices to manage risk
	ii) Planting and storage of food crops to balance seasonal food needs and off-farm work to provide seasonal cash needs

Source: Byerlee and Tripp (1988).

Another major type of FSR activity has been applied or strategic research on major system-wide constraints for an important farming system, which in Asia may cover millions of hectares. This research is less site specific and longer term (Table 2). It looks for interventions usually a radical change such as a new crop, a new tillage technique, or a new early season variety to increase cropping intensity which will significantly increase productivity over a wide area. Examples in Pakistan include the rice-wheat system, where conflict between rice and wheat might be resolved by zero tillage or by introducing an early-maturing rice variety, and the rainfed (*barani*) areas of northern Punjab, where the major constraints is low cropping intensity and moisture availability. Evaluation of interventions will have to be done at the system level and will often require considerable research (for example, to evaluate the impact of zero tillage in wheat on the stemborer population in subsequent rice crops in a rice-wheat system, or in rainfed areas, to assess the implications of introducing sunflowers on fallow land on moisture availability in the following wheat crop). Hence this research is usually conducted by research institutions at representative sites from which results can be extrapolated to the target system. A significant proportion of this research may be done on the experiment station but should be guided by careful diagnostic at the farm level.

The two activities delineated in(Table 2)represent extremes of FSR activities. To justify this delineation a number of qualifying statements are needed. First, adaptive OFR is often considered by research administrators as "simple" research and hence is placed in the extension service. In fact, the diagnosis, planning, and interpretation of results in adaptive OFR often require considerable research skills and scientific knowledge, so the involvement of experienced researchers is important to the success of adaptive OFR. Second, it will not always be easy to make the delineation between adaptive OFR and research on major system constraints. Adaptive OFR teams may discover that little technology is available to be adapted and hence must turn to technology generation. Likewise, research findings from applied and strategic research on system-wide constraints need to be adapted and tested before recommendations can be made for a wider area. Finally, in the Pakistani context, adaptive research is already institutionalised (in the extension service) although stronger links to

Table 2. Characteristics of on-farm adaptive research and research on major system wide constraints

Characteristic	Adaptive OFR	Research on system-wide constraints
• Target	Site-specific	Broadly defined system (e.g. rice/wheat)
• Type of intervention	Component technology (e.g. variety, fertilizer)	New crop, zero tillage, early variety for multiple cropping, etc.
• Time horizon	Short term	Medium to long term
• Evaluation of technology	Partial (at sub-system level)	System level
• Involvement of research and extension	Both research and extension have key roles	Mostly research

research are often needed. However, very little applied/strategic research is conducted on the major systems in the country, despite concern about the long-term sustainability of the productivity of several of these systems. In both cases much of the research is conducted at specific sites. However it is important to consider efficiency and representativeness in the choice of the size and number of study areas or research sites. It is not uncommon to see exhaustive work carried out in relatively small areas at a very high cost per farmer and per hectare, where the possibilities for extrapolation to a wider area are unclear.

IMPACTS OF FSR

The impacts of FSR can be assessed at two levels: (1) at the level of the research system through changes in, (a) research attitudes, (b) research methods, and (c) research organisation, and (2) at the level of farmer through generation of improved technology as a result of the FSR activities (Merrill-Sands, et al., 1989). In this section, we briefly address each of these types of impacts.

ATTITUDES AND KNOWLEDGE OF RESEARCH

FSR has been responsible for permanent and significant changes in the way that research is conceived and carried out. The force of the FSR movement has led both its supporters and detractors to pay more attention to the conditions and problems of their clients, especially resource-poor farmers. FSR can take some credit for the fact that an increasing number of researchers can provide good descriptions of local farming practices, explain their rationale, and offer examples of how technology must be tailored to farmers' needs.

An examination of research attitudes and activities in relation to the system interactions listed in Table 1 illustrates the changes that have taken place in the past decade as a result of the FSR movement. Some examples include:

Intercropping: A decade ago very little research was conducted on intercropping or on evaluating improved technologies (such as varietal performance in intercrops), even though intercropping was and is, a dominant practice among small farmers in the Third World. Indeed intercropping was often regarded as a "bad" or "primitive" practice. In the 1980s the rationale and advantages of inter-cropping in terms of resource efficiency, risk management, and the pest disease control are widely appreciated, and a great deal of research is now being done on intercropping.

Crop Rotation: In the intensive cropping systems of Asia there is now much more emphasis on early-maturing and on evaluating varieties in terms of yield per day rather than yield per crop season. For example, until recently, in Pakistan, researchers conducted numerous trials to find the optimum date of planting for a given variety. Now researchers are more likely to recognise that planting date (often later than optimum) is fixed by cropping patterns and to seek the optimum variety for a given planting date.

Crop-Livestock Interactions: Livestock are now acknowledged as an integral part of small farmer systems with important implications for crop production (Amir et al., 1987). Whereas previously researchers emphasised only grain yields in evaluating improved technologies, much more attention is now given to the value of crop by-products such as a fodder (e.g., Byerlee, Iqbal, and Fischer, 1989). Likewise, researchers in Southern Africa now recognise that land preparation and planting are often

sub-optimal because of the poor nutrition of draught animals at the end of the dry season; hence improvements in crop productivity depend critically on better animal nutrition (Collinson, 1982).

Resource Competition: A decade ago few researchers undertook economic analysis of experimental results as a basis for making recommendations to farmers. Today economic analysis is required in many research institutes. Researchers studying labour scarce, land extensive systems (e.g., parts of Africa) increasingly evaluate technologies in terms of family labour availability and the opportunity cost of labour in competing crop, livestock, and off-farm activities.

Multiple Objectives of Farm Households: Besides evaluating technologies in terms of profitability, researchers are increasingly aware of other objective of farm-households, such as risk management. In subsistence farming, food supply management over the year is often a critical objective, and there is now more attention to use of early varieties to augment food supplies during the "hungry season".

These broader systems oriented concerns of agricultural research represent a major contribution of FSR in the past decade. More needs to be done, but research is gradually being weaned away from a "transfer of technology from the experiment station" view, to an orientation which is much more sensitive to the circumstances and needs of small farmers.

RESEARCH METHODS

FSR has motivated an immense amount of work on research methods and some important contributions have been made. We will mention three of these.

First, a critical stage in FSR is the diagnostic survey, especially the informal survey, is a powerful tool for bringing researchers of different disciplinary and commodity teams together with farmers in order to gain a common understanding of farmers' circumstances and problems. Generally this process involves assembling a multidisciplinary team of researchers and extensionists representing key commodities in the target farming system, who then spend several days visiting farmers in the target areas, conducting informal interview and observing their fields. At the end of each day, researchers meet to pool information and discuss key features of the system. They also identify practices which are not well understood and list possible research opportunities; these then become the subject of subsequent interviews. Hence the informal diagnostic survey is a dynamic process in which researchers gradually learn from farmers and from each other and arrive at a consensus on research priorities. It has been successfully used in Pakistan (Byerlee et al., 1989), and while the diagnostic survey has usually been associated with on-farm adaptive research, it can play a valuable role at all levels in the research and extension system, including the setting of plant breeding priorities. Indeed the rural appraisal technique which has its origins in the diagnostic survey of FSR , is now commonly used at all levels of agricultural and rural development planning.

A second methodological innovation of FSR has been the concept of stratifying target farmers into more homogeneous groups, often called recommendation domains, for the purpose of efficiently organising research and making recommendations. This stratification departs from the standard approach of agro-climatic zoning by recognising that socio-economic factors are often important in stratifying farmers for setting research priorities.

Finally, FSR has added vitality to farm-level research by economists, who until 1980 used standard farm management techniques borrowed from developed countries, such as farm enterprise

budgets or production functions based on aggregated categories of inputs land, labour, purchased inputs, and capital. The clients for this work were never clear in part because it lacked a problem solving orientation (Collinson, 1981), FSR has simulated economists to consider more pragmatic approaches to understanding the complexity of farming systems that consider physical and biological parameters, risk management, farm-household interactions.

RESEARCH ORGANISATION

Perhaps one of the major contributions of FSR in research organisation has been the recognition of the role of social scientists. Until recently few research institutes had economists and other social scientists on their staff, and if they did the social scientists were relegated to an ex-post role of checking the profitability of technology (after its release). In recent years the number of social scientists has increased dramatically in research institutes around the world, although their numbers are still few in relation to technical scientists, and in most cases they lack experience. Nevertheless, the ex-ante role of social scientists in agricultural research planning and priority setting is being increasingly recognised.

FARMERS

The ultimate aim of improvements in research systems brought about by FSR is to increase the productivity of farmers. To date there is relatively little documented information on farmers'adoptionof technology developed as a result of FSR programmes and even less evaluation of the impact on farmers' income. Nevertheless location specific on-farm research has brought new technology to farmers for improved tillage in Panama (Martinez and Sain, 1983), pest control and plant stand management in Indonesia (Dahlan et al., 1987), improved maize varieties and planting practices in Ghana (Tripp et al., 1987), and new bean varieties and disease control in Colombia (Woolley et al., 1988). The work of the Asian Rice Cropping Systems Research Network, has been instrumental in fostering the intensification of rice-based cropping patterns through use of early maturing varieties, new tillage, planting techniques and new crops in several Asian countries, most notably the Philippines (Morris, 1984), Indonesia (Siwi et al., 1986) and Nepal (Mathema, 1986).

The following examples from Asia, Africa, and Latin America illustrate different types of impacts of FSR on farmer adoption.

Cropping Patterns, Indonesia: Siwi et al. (1986) summarise various success stories of cropping systems research in Indonesia. The partially irrigated rice-based system, covering about 100,000 ha in Indramayu in West Java, illustrates the potential effectiveness of cropping systems research. Prior to the beginning of the research programme in 1975, only 36% of land was double cropped and none was triple cropped, due to water shortages in second and third seasons. Cropping systems research sought interventions to increase the security and profitability of double and triple cropping. These interventions included:

1) Direct seeding of the first rice crop in unpuddled soils before the rains began to accelerate planting by about one month.

2) Zero tillage and direct planting to reduce turnaround from the first to the second crop by 7-15 days.

3) Introduction of high-yielding rice varieties maturing 20 days earlier than farmer's varieties.

4) Introduction of short-season, drought-resistant crops such as mung beans to plant after the second rice crop.

The introduced cropping patterns and planting methods increased rice yields and profit by at least 50%. Farmers quickly responded to the new opportunities and by 1984, 46% of the area was double cropped and 18% triple cropped. Single cropped area had fallen from 64% to 27%. Profitability of the new system was over 50% higher than the traditional cropping pattern,leading to significant increase in farmers' incomes. While steady improvements in the irrigation system played a role, the major factor was the development of new cropping patterns through FSR and their widespread extension to farmers (Siwi et al., 1986).

Maize Varieties, Tanzania: In the Kilosia area of Tanzania, there are two growing seasons, the lower and less reliable "short rains", and the main rainy season, the "long rains". Researchers had focused maize breeding and seed production on a full-season variety for the long rains (Lev, L. nd.). A short season variety, Kito, was available for late planting in the long rains. Diagnostic surveys indicated that farmers preferred to concentrate maize production in the short rains, both to provide food for the "hungry season", and to leave land and labor for other crops in the long rains, especially the main cash crop, cotton. The FSR team in the diagnostic survey identified the potential of the early maturing variety, Kito, in the short rain, both to fit the agro-climatic circumstances and also to allow double or delay-cropping of cotton after maize. On-farm testing indicated that Kito gave 23% higher yields per day than full season varieties in the short rains and also increased cotton yields. Farmers enthusiastically accepted Kito maize. An adoption study is in progress, but it is known that hundreds of farmers are already growing the variety.

The "Kito Story" indicates that, even where technology is available, it may not be utilized without a better understanding of the farming system and farmers' preferences.

Maize Agronomic Practices, Panama: In the Caisan area of Panama, an on-farm research program was initiated in 1979 focusing on the main crop, maize. On the basis of diagnostic surveys, researchers identified the following opportunities to increase system productivity: (1) chemical weed control using Atrazine, since labour scarcity did not allow adequate hand weeding, (2) line planting to facilitate chemical weed control, and (3) minimum and zero tillage to replace costly tractorized land preparation. After two cycles of experiments all the three practices were recommended and promoted to farmers. A survey in 1982 indicated that 61% of farmers had adopted Atrazine herbicide, 71% line planting, and 44% zero or minimum tillage. A unique result of this project was an evaluation of the benefits and costs of the program which indicated an overall return of at least 60% per year on the research investment.

Maize for Grain and Fodder, Pakistan: Our final example comes from Pakistan and illustrate the potential impact of FSR on research priorities rather than on farmers' technology adoption. Farmers in Swat valley and many other areas of NWFP use somewhat unconventional maize production practices. They broadcast maize seed at three or four times the recommended rate, and then proceed to thin surplus plants, sometimes upto harvest point. After extensive programmes were carried out in the 1970s. Farmers adopted new varieties and moderate doses of fertilizer; however, the rate of adoption of the recommended line planting, seed rate, early thinning, and insecticide practices was practically zero.

In the 1980s, the Cereal Crops Research Institute began extensive on-farm research with a farming systems perspective, concentrated in the Swat valley. It was hypothesised that a major rationale for farmers' unconventional practices was the dual production of grain and fodder (provided

by green maize thinnings and dry stover). The programme therefore focused on quantifying the relative importance of fodder production in the system and evaluating alternatives. By counting plants at regular intervals and interviewing farmers on fodder fed to animals, it was estimated that 45% of the total value of production was provided by fodder (Byerlee et al., 1989). In addition when the value of fodder was included, the farmers' system was found to be more profitable than the recommended system, even though the latter provided 1.5 t/ha higher yields (Table 3). After considerable experimentation it was found that the variety "Azam" performed well under farmers' management and provided good grain and fodder yields. This variety was adopted by about 70% of farmers in villages where the research was conducted. Although for farmers the impact of this research was modest ("Azam" gave 10-20% higher yields than the farmers' varieties), the research helped set priorities for maize breeding (i.e., varieties with good grain and fodder yields and able to tolerate high densities) and avoided further waste of resources on demonstrating inappropriate technology to farmers.

Table 3. Comparison of profitability of farmers' technology and the recommended package of technology in maize production, Swat, Pakistan

Characteristic	Farmer technology (Rs/ha)	Recommended package of technology (Rs/ha)
• Total variable costs	995	2,387
• Gross revenue		
Grain	5,320	7,315
Fodder	5.000	3,000
• Gross margin excluding Fodder value	4,325	4,928
• Gross margin including Fodder value	9,325	7,928

Source: Byerlee et al. (1987)..

The above example iilustrate the wide range of situations and forms in which FSR has ultimately benefitted farmers. But even taking account of the time required for technology development in the efforts necessary to establish a new orientation to research, the current assessment must be that FSR has not yet repaid its intellectual and financial investment with increases in productivity for resource-poor farmers. The limited number of success stories to date gives cause of serious concern about the efficiency with which past FSR activities have been conducted, and even about the future of the FSR itself. Our final comments relates to changes that must be made in order to increase pay-offs to FSR in the 1990s.

FSR LOOKING TO THE 1990s

Our review to date has shown that, although to date FSR has had disappointing impacts in terms of actual technology adoption, it has greatly influenced the attitude and knowledge of researchers with

respect to small farmer constraints and on appropriate research methods to address small farmer problems. The foundation has therefore been laid for FSR to realise its potential in the next decade. But to realise that potential will require a certain reorientation of FSR and greater integration of FSR into all parts of the research system.

ORGANIZATION AND INTEGRATION OF FSR

The greatest challenge for FSR in the 1990s and the only way to take full advantage of its potential is to find a place in the context of the entire research system. Upto now much FSR has been "project implemented" and in many cases remains isolated from the mainstream of the research system.

The FSR approach is applicable through out the research and extension system, from plant breeding to extension, and not just for on-farm adaptive research. Research systems need to develop incentives for researchers at all levels to focus their efforts on farmers problems and provide opportunities to interact with farmers and observe their fields. Similarly, the emphasis of FSR on stratifying farmers for designing and disseminating technology should be applied throughout the research system. Resources in the form of operating budgets must be provided for on-form work and ways must be found to direct the extensive information collected in on-farm research back to the experiment station to help set priorities.

The idea that FSR should become an integral part of all agricultural research argues against the establishment of separate FSR departments. Rather, ways must be found to stimulate more communication across disciplinary and commodity research programmes to address farmers' problems. In some cases a FSR coordination unit may be appropriate, not to conduct the research, but to act as a forum for bringing together researchers from different disciplines and commodity groups. For example, in the context of Pakistan's Punjab, we can envisage a small coordination unit for each of the major irrigated farming systems. The unit for the rice-wheat system would aim to increase communication and coordination among rice and wheat breeders, soil and water specialists, social scientists and specialists in pest management, in order to address major research issues in the system.

EXTENSION AND POLICY LINKAGES

Although FSR preaches the improvement of research extension linkages, in fact this has been a weak linkage in most FSR programmes. At the same time, farm management is increasing in complexity, and greater skill and knowledge are required of farmers, especially in a country such as Pakistan where farmers have already adopted the seed fertilizer technology, and further productivity gains depend on many smaller incremental changes. Hence in the 1990s an effective extension system with strong links to research will be critical to increase agricultural productivity (Byerlee, 1987).

Training and Visit (T&V), a major effort at organising extension promoted by the World Bank in many countries (Benor and Harrison, 1977), has been developed parallel to FSR, with few obvious connections. The T&V extension method assumes that technology is available for farmers and that the critical factor is the organisation of clear extension messages and methods for delivering them. But FSR has not yet accepted that effective transfer of technology often begins with a better understanding of clients's needs. Hence in the 1990s, much more emphasis must be placed on the development of stronger research extension linkages and more direct participation of extension staff in the technology generation process.

Many FSR projects have taken a conservative stance by assuming that the policy environment is fixed, and hence a lot of effort has been devoted to "tinkering" with the existing system (e.g., comparing

intercropping combinations or dates of weeding) when the real payoffs may only come by introducing new technology based on increased use of purchased inputs. Data from on-farm research can be highly relevant to policy issues, especially input supply, as demonstrated by (Yates et al., 1988). FSR can provide information to help resolve policy related issues impeding technological change, although it should not be presented as a substitute for conventional policy research on issues such as channels of communication need to be developed so that policy formation can better utilise the unique information on the technical and socio-economic circumstances of farmers now being generated by FSR programmes.

SUSTAINABILITY

FSR has placed particular emphasis on developing technologies acceptable to farmers in the short-term. In the 1990s it must give greater attention to analysing the longer run issues of sustaining productivity and maintaining the natural resource base. In the intensive cropping systems of Asia and fragile environments every where, these sustainability issues arising from problems of soil fertility and structure, salinity, pests etc., are often critical to long-run food security. But it is not likely that the concerns raised by sustainable agriculture can be addressed by ignoring the experience of FSR. A considerable amount of applied research will have to be combined with widespread, location-specific, adaptive research before much progress is made towards developing sustainable agricultural systems.

CONCLUDING COMMENTS

FSR has made a major impact on research systems during the past decade, but is far from achieving its full potential. The FSR movement has been responsible for focusing attention on resource-poor farmers as clients for agricultural research. It has placed agricultural research scientists in much closer contact with farmers and has provided a wide variety of innovative research methods to help understand farmers' priorities and test and assess technologies under farmers' conditions and criteria. But FSR has often been implemented in national agricultural research systems with little thought to the clear definition of staff responsibilities, interdisciplinary communication, or the setting of research priorities within the larger institution. The consequence has been a much slower rate of technology generation than expected, and often a perceived split between farming systems researchers on the one hand, and the commodity and disciplinary researchers on the other. The principal challenge for the 1990s is to use the perspective and methods of FSR to improve the efficiency of entire research and extension organisations, to help them communicate more effectively to identify and address high priority farmer problems.

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REVIEW OF PAPER ON IMPACT OF FARMING SYSTEMS RESEARCH

Pervaiz Amir[1]

The authors Derek Byerlee and Robert Tripp first trace the origins of FSR, highlighting its institutional development. Perhaps the 1970s may have fostered this concept, but it existed much earlier. The term farming systems research was used interchangeably with balanced farming. Many farm management researchers have claimed that the FSR proponents have simply changed names for what they have been saying for decades. The later criticism is not justified because farm management seldom had the objective of providing feedback to the research station. It dealt more with the management aspects of the farm as opposed to on farm technology testing that formulates the crux of FSR.

Byerlee and Tripp identify three levels at which FSR is organized in Pakistan. I would add that some provincial institutes have been involved with variants of on-farm research utilizing several concepts now promoted by FSR proponents. The definition of FSR used by the authors is simple and authoritative, but still lacks clarity for the layman. The most confusing word is system which any fails to understand. A system can be considered a group of interacting components, operating together for a common purpose. The authors go on to define their own concepts of FSR which has a problem focus and aims to improve the lot of small farmers. However, little is served by restricting the focus to small farmers. FSR is appropriate under all farming systems that are not mono commodity. They may be crop or livestock or mixed farms.

Byerlee and Tripp provide convincing evidence that FSR can have a high pay off. Unfortunately with the possible exception of India, most countries allocate their junior and in-experienced staff to conduct FSR, where component staff has been made available high quality publishable research has been the outcome. Pakistan, Thailand and the Philippines provide good examples in crop-livestock research and systems component (Soleh, Amir and Mulyadi, 1989) studies. It is now recognized that livestock innovations found acceptable in one area can easily be generalized for a much wider area as compared to crops (Amir and Knipscheer, 1989). The scope of FSR needs to be widened to include all important components of the farm.

The authors identify FSR as having a significant impact on researchers attitudes. A client oriented agenda is prominently featured in FSR. The realization of targeting research agenda to meet needs of the farming community are now increasingly realized in Pakistan. Whether there is a clear analytical framework to allocate research resources within the research system is still questionable. Some guidance on this topic is provided by Arnon (1989) and also alluded to by Knipscheer and Harwood (1989). FSR can play an important role to help guide farm level research and provide the necessary feedback to research and extension agencies. Simply relying on extension to provide such a feedback which the authors claim demands considerable research skills, has seldom proved successful.

FSR impact on research methods has been highlighted by the authors. The contribution of the diagnostic survey has shown its worth in many environments of Pakistan and abroad. The same tool is

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now being applied to address agricultural research problems beyond the limits of the farm. For instance the successful application of the rapid appraisal or diagnostic technique to identify communication constraints in an FSR project has been well documented. There is little reason why this approach should not be widely used to diagnose problems in agricultural research and extension.

FARMING SYSTEMS RESEARCH IN MANSEHRA, N.W.F.P

Abdul Rauf Khattak[1] *and Gulfam Khan Jehangiri*[2]

INTRODUCTION

New technology relevant to small farm conditions requires a systematic and regular analysis of problems, family goals, existing crop-livestock enterprises and market potential. The policy of the Government for improvement also should be articulated.

Several approaches so far have been carried out for the analysis of the situation. These approaches include the traditional farm management practices and agricultural extension methods. The recent FSR multidisciplinary approach to link research, extension and farmers has gained impetus for the dissemination of new technologies.

The FSR approach aims to describe the target area, diagnose production constraints and design and test new technologies at the farm level. Through improvements in the farming system and sound resource allocation productivity, net farm income can be increased. A FSR project was initiated which utilized the previous described approach. The target area selected (Figure 1) included three villages viz Dhodial, Tanda and Trangri adjacent to the Agricultural Research Station, Dhodial, District, Mansehra.

Supported by the PARC/MART project, interdisciplinary scientists worked with farmers diagnosed problems and patterns of existing crop/fodder/horticulture and described livestock production systems.

WORK/DIAGNOSTIC SURVEY/BUDGET/INTERVENTIONS

Before starting FSR two or three meetings were held and a workshop was arranged to train officers in approach and methods of FSR extension, livestock and dairy development department. Research scientists delivered lectures as subject-matter-specialists. Trainees were provided "hands on" experience in conducting a survey into the target areas and in carrying out interviews with farmers. An additional two days were spent with the farmers. The survey helped in knowing the problems of the farmers and interventions needed for higher crop and livestock production.

For *Kharif* 1987 priority constraints suggested that farmers would benefit from testing improved agronomic practices (including "Azam" maize variety) and better animal husbandry. Livestock and agriculture extension were active collaborators. "Pirsabak 85" variety of wheat was planted. Weedicides for weed control and NPK fertilizer were used. The planting of improved varieties with recommended fertilizer and use of weedicides in the maize system provided the farmer an attractive return on investment over traditional cultural practices. A cost benefit ratio ranging from 1:2 in wheat to almost 1:4 for maize (Table 1 and 2) respectively was obtained.

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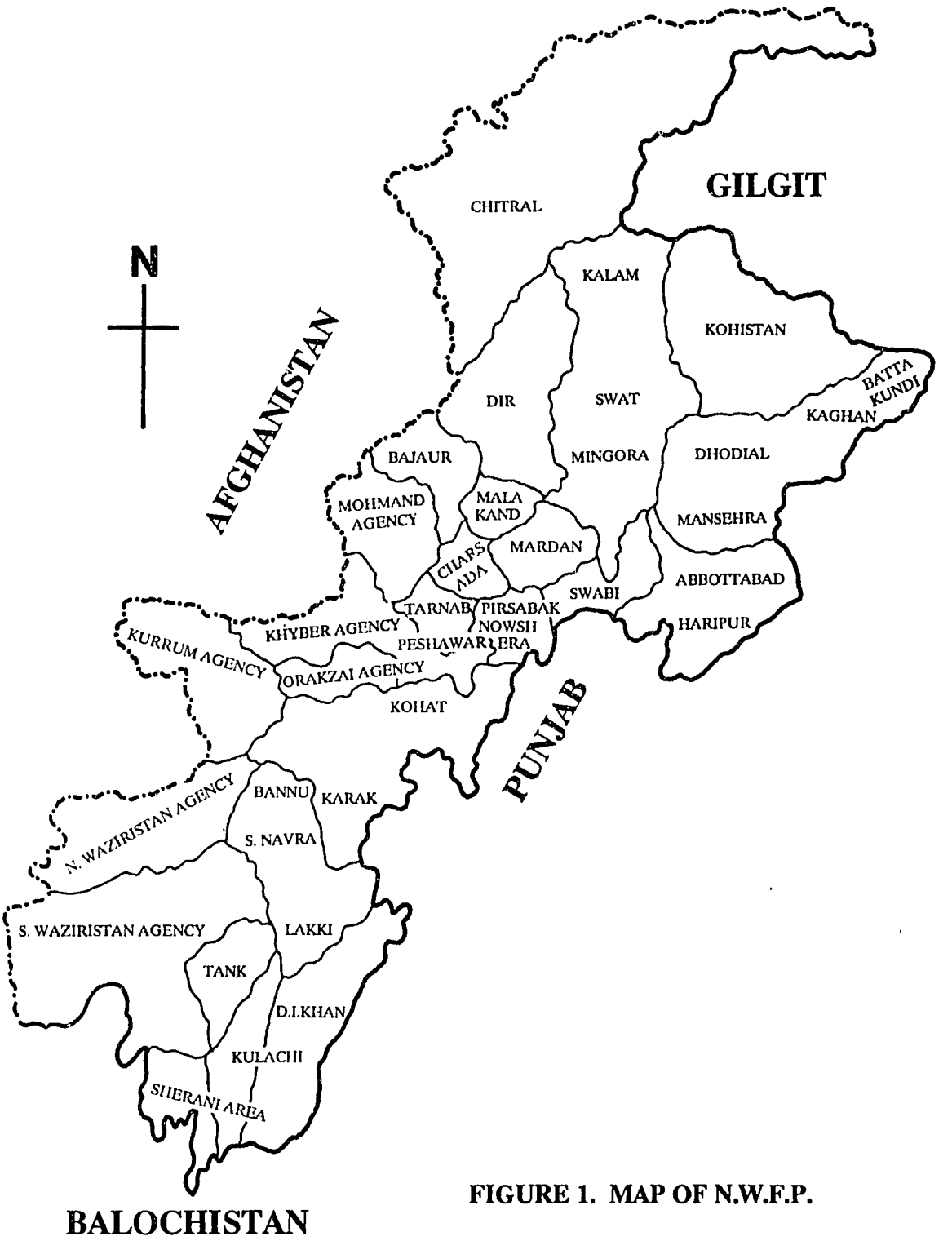


FIGURE 1. MAP OF N.W.F.P.

Table 1. Maize-wheat system response to improved interventions compared with traditional farmer management for *Rabi* wheat 1987-88 (Mansehra)

(Interventions-Variety + Fertilizer + Herbicide)

Treatment	Cost of Inputs	Addl. Cost on Inputs (Rs)	Av. Yield (t/ha)	Net Income (Rs)	Cost Benefit Ratio
Farmers; Technology	700.00	-	1.32	-	-
Improved Technology	1752.50	1052.50	2.95	2207.50	1:2.10

Farmers' Technology (Inputs/ha)		Cost (Rs)	Improved Technology (Inputs/ha)	Cost (Rs)
Variety	Maxi-Pak		Pirsabak 85	
Seed rate	110 kg Rs 2/kg	220.00	110 kg Rs. 3.50/kg	385.00
Fertilizer	2.5 bags urea	330.00	5 bags urea + 2.5 bags DAP	1067.50
Weeding	By hand	125.00	Herbicide (Buctril-M) 1.25 L	225.00
Fertilizer application		25.00		75.00
Total Cost		700.00		1752.50

Table 2. Maize-wheat system response to improved interventions compared with farmer practice 1987-88 *Kharif* maize

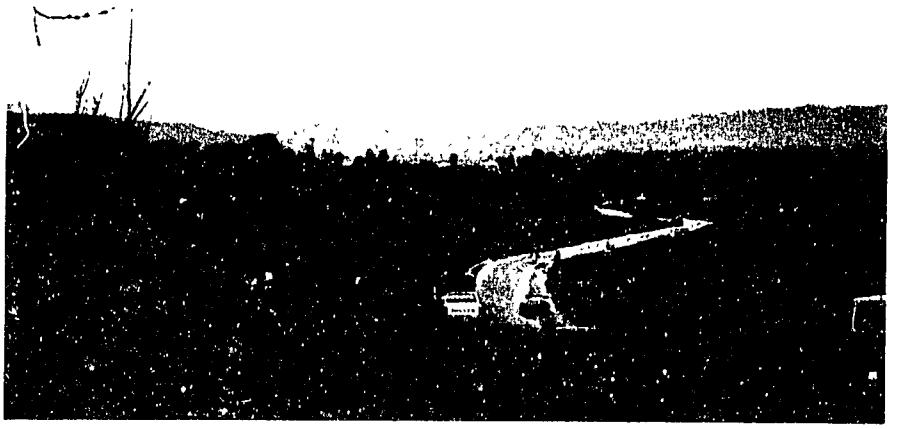
(Interventions-Variety + Fertilizer + Herbicide)

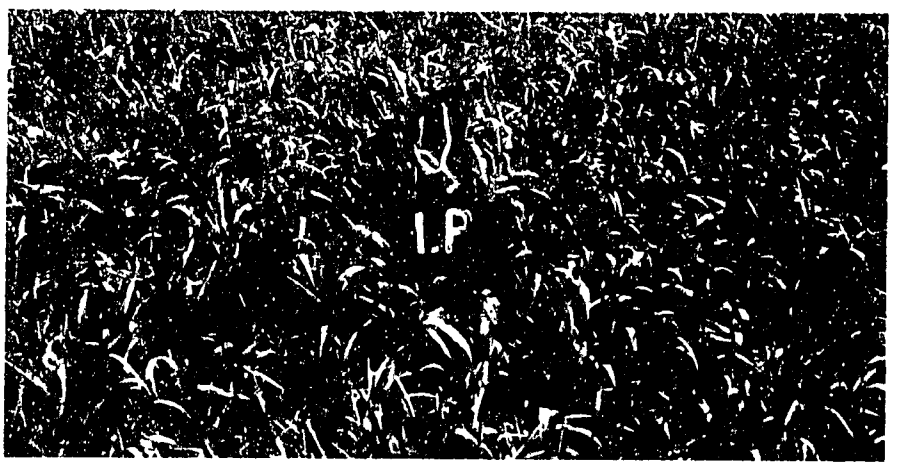
Treatment	Av. Cost of Inputs (Rs)	Av. Addl. Cost on Inputs (Rs)	Av. Yield (t/ha)	Net Benefit (Rs)	Cost Benefit Ratio
Farmers, Technology	642.50	-	1.89	-	-
Improved Technology	1717.50	1075.00	4.44	4135.00	1:3.84

Farmers' Technology (Inputs/ha)		Cost (Rs)	Improved Technology (Inputs/ha)	Cost (Rs)
Variety	Double Hazara		Azam	
Seed rate	75 kg Rs. 2.50/kg	187.50	50 kg Rs 3.50/kg	175.00
Fertilizer	2.5 bags urea 57.5 kg N/ha	330.00	5 bags urea and 2.5 bags DAP (137.5 kg N+57.5 kg P_2O_5)	1067.50
Weeding	By seel	100.00	Herbicide (Primextra) 2.5l.	400.00
Fertilizer application		25.00		100.00

Superimposed single factor interventions into the maize-wheat system were carried out among participant farmers in the FSR project target area. Since weeds were recognised as a serious production constraints, a herbicide intervention was applied to a given crop in the system by the farmers, where a herbicide was used on the maize "Azam" crop resulted in a very favourable 1:9 cost benefit ratio.

During 1987 FSR participant farmers of Mansehra compared the performance of maize grown under traditional management with improved "Azam" seed and recommended fertilizer practice. The





In the wheat/maize livestock system of NWFP, low density stands of cereal crops are due to inferior seeds and agronomic practices. Improved intervention of high quality tested variety of wheat is the improved practice in contrast to the common low density stand found in farmer's fields.

improved technology provided the farmers a higher net-farm income of Rs.5292.50/ha over traditional farmer practice (Table 3). This amounted to an attractive cost benefit ratio of almost 1:6.

Table 3. Maize yields and net farm income obtained from farmer seed and fertilizer compared with improved Azam variety and recommended fertilizer 1987

(Average five farmers)

Treatment	Farmer Practice	Recommended Practice
Nitrogen	57.5 kg/ha	137.5 kg/ha
P_2O_5	-	57.5 kg/ha
K_2O	-	62.5 kg/ha
Cost of inputs	Rs 355.0	Rs 1,242.50
Extra cost on inputs	-	Rs 887.50
Average yield	2.8 t/ha	4.24 t/ha
Additional yield		2006 t/ha
Additional income		Rs 6180.00
Net income		Rs 5292.00
Cost benefit ratio	1:5.96	
Percent increase in yield	95	
Over control		

The low wheat yield after rice noticed in other parts of Pakistan due to late planting had been particularly solved by growing "Basmati 385". In case of FSR Mansehra, "Basmati 385" a fine variety was planted against locally grown coarse variety "JP5". This provided the farmers a higher income of Rs.4740/ha over "JP5" rice commonly grown by local farmers (Table 4).

Encouraged with the results of Kharif 1987, the NWFP Agricultural University Peshawar scientists decided to launch a pilot to production project based on the improved maize system. Extension took the lead. Agriculture extension has been helpful in passing the improved seed production in the target areas and has been emphasizing the adoption of improved technology by the farmers. Accordingly six union councils were covered in Mansehra district and 12 hectares maize sown

Table 4. Comparative yield and net farm income obtained from two different rice varieties listed in a rice-wheat system (Mansehra 1985)

Treatment	Cost of Seed (Rs)	Average Yield (t/ha)	Decrease in Yield t/ha)	Gross Income from Yield	Additional Income	Net Income
Farmers variety	150.00	4.12	-	12,360.00	-	-
Improved variety (Basmati 385)	250.00	3.44	0.68	17,200.00	4,840.00	4,740.00
Farmers' variety J.P.5 coarse type Seed rate 50 kg/ha Cost of seed: Rs. 150/- @ Rs 3/kg.				Improved variety Basmati-385 fine type 50 kg/ha Rs 250/- @ Rs 5/kg		

Target area: Dhodial

during *Kharif* 1988 besides 15 hectares in the three target areas. The yields harvested by the farmers ranged from 2.9 to 3.2 tons/ha as against their traditional yield of 1.5 tons/ha.

Almost all maize, seed produced in the six union councils and in the 3 target areas has been passed on the farmers in the area for planting in coming Kharif 1989. The goal is to saturate the entire Mansehra district and the entire Hazara division under improved "Azam" variety of maize within 3 and 5 years respectively.

Animal scientists through livestock extension have embarked on the control of internal and external parasites with collaborating farmers. In addition, ammonification of wheat straw and feed supplements are presently under test by FSR project farmers. Impact on milk production and improvement in animal health is being recorded. An average increase of 37.22% in buffalo milk production was recorded during July 1987 to December 1988 in the treated animals (6 litres/day) compared with the control animals (4.3 litres/day).

FSR - MALAKAND DIVISION SWAT

Encouraged with the FSR-PARC/MART Project results, the NWFP Agricultural University Peshawar, during *Rabi* 1988-89 started work in Swat district of Malakand division. Improved wheat variety and fertilizer doses have been used in case of wheat. Improved rape variety has been introduced. Weedicides for comparing the efficacy have been included in the study.

FSR - EFFORTS EXPAND

In addition to the pilot to production extension of improved "Azam" maize system technology, the NWFP Agricultural University FSR scientists are initiating new projects.An integrated pest control programme to control sugarcane borers and stone fruit borers in Peshawar has commenced. Diagnostic Surveys of each area have been conducted. Plans to expand the FSR to D.I. Khan district are also being formulated.

FARMING SYSTEMS RESEARCH IN FATEHJANG

Abdul Majid[1], *M. Yousaf*[2], *Abdur Razzaq*[3],
Imdad Mirza[4] *and Ikram Saeed*[5]

INTRODUCTION

Rainfed agriculture contributes significantly to crop and livestock production in Pakistan. Inspite of research, farm productivity and income remains low. Age old traditional practices are in common use by farmers. Much new technology is not being adopted by the farmers.

Strategies are urgently needed to assist the farmers of barani lands to adopt modern methods. A farming systems research approach which encourages scientists and farmers in partnership to identify constraints and test improve technology is needed. Technology development requires an interdisciplinary approach to understand the complexity of the farmers environment, his farming systems and his decision making process.

Fateh Jang has been selected as a FSR target area since it represents an important rainfed region of the Punjab. A group of scientists including biological and social scientists are conducting system research and testing improved technology in collaboration with the farmers.

GENERAL DESCRIPTION OF THE AREA

The FSR target area of Fatehjang is located 40 km away from Islamabad. Annual rainfall is 754 mm. Year to year variability is high. Irrigation is not available to farmers in this area. Average house hold size is 8.4 persons. Full time and part-time workers are approximately two persons respectively. Eighty two percent of the farmers own less than 5 acres of land. Cropping intensity is 54% in kharif and 60% in rabi. Farmers classify their land in two categories i.e. Lepara and Maira. Lepara lands are close to the houses and receive regular farm yard manure application. Maira lands,located at a distance from the village are less fertile due to infrequent manure application. Farmers keep all kinds of animals. The average herd size of 16 consists of mainly small ruminants.

FARMING SYSTEMS

The farmers operate complex farming systems. This complexity arises out of the small size of most farmers combined with management strategies that reflect multiple objectives of the farm families. Cropping intensity is low. Farmers either keep the land fallow during kharif and plant wheat in rabi or take both rabi and kharif crops followed by a year of fallow. Wheat is the main rabi crop. It is usually mixed with *brassica* crops (rape/mustard to meet livestock fodder needs. Sorghum, a major crop of kharif season, is mainly grown for fodder. Maize, pulse and millets are also produced.

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Livestock are very important in barani farming systems. They provide security against crop failure and climatic risks. Farmers keep all types of animals. They include buffalo, cattle, cows, goats and sheep. Sheep and goats are most numerous.

MAJOR CONSTRAINTS

Diagnostic surveys identified the following major constraints to the production of crops and livestock in the target area of FatehJang:

1. Low cropping intensity and low farm income.
2. Low yields of commonly produced mixed mustard wheat crops.
3. Poor performance of small ruminants.
4. Low productivity of lentil.

CROP AND LIVESTOCK INTERVENTIONS

To address these constraints, improved technology was introduced into the traditional farming systems. In the Fatehjang FSR target area under dryland conditions, sunflower was introduced in the wheat-fallow-wheat system to increase farm income. The intervention of sunflower into a wheat system was tested among 5 farmers. An average sunflower yield of 1680 kg/ha was obtained. It was observed that during years of low rainfall the succeeding wheat yield was drastically reduced when planted after sunflower (Table 1). Nevertheless the wheat-sunflower-wheat improved system provided an additional Rs.3492/ha net farm income compared to the traditional system.

Table 1. Introduction of sunflower in wheat-fallow-wheat system

Parameter	Wheat after fallow	Wheat after sunflower
Grain Yield (kg/ha)	1792	717
Straw Yield (kg/ha)	2725	1808
Gross Return (Rs)	5170	2428
Input Cost (Rs)	1737	910
Net Return (Rs)	3433	1518
		Sunflower
Yield (kg/ha)		1680
Gross Return (Rs)		7140
Input Cost (Rs)		1747
Net Return (Rs)		5393
Overall Net Benefit in Wheat-Sunflower-Wheat System (Rs/ha)		3492

A MUNGBEAN SYSTEM INTERVENTION

The introduction of Mungbean in the wheat-fallow-wheat system appears feasible. Mungbeans maintain soil fertility and sustain system productivity, while FSR participant farmers (six) who replaced fallow with Mungbeans were able to raise their net system income to Rs.3327/ha (Table 2). Somewhat lower wheat grain and straw yields were obtained after introducing mungbeans in the cropping system to replace the preceding fallow. Moisture stress in wheat after mung probably accounted for the decreased wheat yield. But the added income from Mungbeans more than affect the loss from wheat. Furthermore, mungbean residue proved to be a most effective small ruminant nutritious feed.

AN IMPROVED MUSTARD WHEAT INTERCROP

Intercropping of mustard in wheat is a common practice of barani farming. Farmers pull mustard and feed it to livestock according to their need. Local mustard varieties produce less fodder and usually compete with the wheat crop. A recently developed mustard variety was compared with local mustard. Fodder yield and competitive effect on companion wheat were investigated. An equal area from traditional farmer practice and improved mustard/wheat was sampled at three different periods. Fodder yields were recorded as presented in Table 3. Improved mustard/wheat produced almost 1500 kg/ha more fodder than farmer practice without significantly affecting wheat yields. The extra fodder produced from the improved mustard/wheat provided the farmers an additional Rs.470/ha net farm income.

Table 2. Introduction of mungbeans in wheat-fallow-wheat system

Parameter	Wheat after fallow	Wheat after mungbean
Grain Yield (kg/ha)	1417	1061
Straw Yield (kg/ha)	1532	1131
Total Return (Rs)	3683	2748
Cost of Production (Rs)	2226	1831
Net Return (Rs)	1457	917
		Mungbeans
Grain Yield (kg/ha)		677.5
Straw Yield (kg/ha)		1769
Gross Return (Rs)		5627
Cost of Production (Rs)		1760
Net Return (Rs)		3867
Overall Net Benefit in Wheat-Mungbeans-Wheat System (Rs/ha)		3327

Table 3. Comparison of improved mustard with local variety mixed in wheat crop

Parameter	Improved practice	Farmer practice
Fodder Yield (kg/ha)	9153	7665
Return (Rs)	2288	1805
Wheat Yield (kg/ha)	1147	1190
Straw Yield (kg/ha)	1483	1529
Return from Grain and Straw (Rs)	3263	3276
Total Return (Rs)	5551	5081
Net Benefit (Rs)	470	-

A NEW LENTIL VARIETY INTERVENTION

A new disease resistant lentil variety was compared with the local variety. Recommended fertilizer and weed control was included as an improved technology package. Improved lentil technology as adopted by six participant FSR averaged 1262 kg/ha as compared to 495 kg/ha obtained

by farmers who produced local lentil. Improved lentil technology resulted in a net return of Rs. 4748/ha (Table 4).

DEWORMING SHEEP AND GOATS

High incidence of endo and ecto parasite in sheep and goats were diagnosed as major livestock production constraints in the Fatehjang target area. Animal scientists initiated work to compare the

Table 4. Comparison of improved and farmer technology of lentils (average of 6 farms)

Parameter	Farmer Practice	Improved Practice
Grain Yield (kg/ha)	495	1262
Gross Return (Rs)	3712	9457
Production Cost (Rs)	1350	2327
Net Return (Rs)	2362	7130
Net Benefit of Improved Practice over Farmer's Practice	-	4768

effect of deworming with traditional sheep and goat management practices prevailing in the area. Twelve farmers were included in this study. Approximately 550 sheep and 650 goats were involved. Deworming sheep and goats at Fatehjang FSR target area was a popular system intervention introduced by animal scientists. Within a 16 months trial period there was 12% decrease in flocks mortality due to deworming (Table 5). The untreated sheep compared with dewormed animals recorded 16.8 and 4.6% mortality respectively. Moreover, animals on average clipped 50 percent more wool (612 and 424 g/h) and produced almost 30 percent higher lambing due to deworming. An overall net profit of Rs.18,345 was realized annually as a result of deworming the 432 sheep.

Table 5. Effect of deworming on goats from October 1987 to April 1989

Parameter	Treatment group	Control group
No of Farmers	7	7
No. of Goat	567	98
Mortality %	7.04	14.07
Average Weight Gain (g/h/d)	24	15
Average Hair Production (g/h)	554	480NS
Percent Kids Obtained	128	88
Sale Price/Animal	469	403
Overall cost and benefits (Rs./100 animals) over 16 months		
Mortality	-3471	-5670
Hair Production	776	672
Weight Gain	28800	18000
Kids	25600	17600
Gross Return	51705	30602
Total Input Cost	2560	-
New Benefit	18543	-

Livestock is an important source of income in each of the barani lands similar to the Fatehjang FSR/Target Area. Interventions by animal scientists include deworming and vaccination of sheep and goats. This farmer is pleased with the response his goats have shown of this interventions with less mortality, more twinning and and better growth.

Improved fodder and treated introduced by animal scientists and agronomists have increased the growth rate and decreased the mortality in larger cattle of the Fatehjang area.

With goats deworming resulted in a similar benefit (Table 6). Percent mortality, in the controll group (14.07) decreased due to drenching (7.04) while percent kids was increased from 88 to 128 in the control and dewormed goat groups respectively. The net benefit of Rs.18,543 obtained from

Table 6. Effect of deworming on sheep from October 1987 to April,1989

Parameter	Treated	Control
No. of Farmers	5	5
No. of Sheep	432	125
Mortality %	4.63	16.8
Wool Production (g/h)	612	424
Average Weight Gain (g/h/d)	73	65
Lambing %	161	139
Sale Price/Animal (Rs)	567	526
Overall cost and benefit (Rs./100 animal) over 16 months		
Mortality	-2625	-8853
Wool Production	2203	1526
Weight Gain	87600	78000
More Lambs	32200	27800
Gross Return	119378	98473
Input Cost	2560	-
Net Profit (Rs)	18345	

deworming 567 goats was due to decreased mortality, higher percentage of kids and an additional 9 gms/head weight gain/day.

INSTITUTIONALIZATION OF FARMING SYSTEMS RESEARCH IN SINDH

G.. H. Memon[1], *S. A. Siddiqui*[2] *and N. M. Miano*[3]

INTRODUCTION

Farming systems research approach embodies researches at farm level wherein farmers and multi-disciplinary research team work together to diagnose and identify priority research areas, design technology, test it at farm level and eventually modify and improve the existing farming system. It is the result of complex interaction of a number of independent components of which the farmer is a central figure.

Since researches under the farming system perspective are carried out with the active participation of the farmer himself, after analyzing his entire environment, the approach is considered a "bottom up" activity. The conventional approach to develop farm technology without assessing its need is a "top down" approach in which human elements are ignored.

The researches in Pakistan, organized along with disciplinary or commodity lines, have been conducted at research institutes under conditions that are not representative of farmer's fields. It is often argued that technologies recommended by research institutes are not widely adopted because they are not consistent with farmers' circumstances. To overcome this problem, on-farm research programs under a farming system research perspective were developed and made operative in Pakistan. Objectives were:

1. To verify and generate technology to increase resource productivity for an identified group of farmers.

2. To work for an entire farming system based conceptually on the farming system perspective.

3. To use on-farm research methods.

Thus, a farming system research approach develops technology according to the available environmental and consequently farmer's participation makes it feasible to adopt. It studies the physical, biological and socio-economic factors available in an agro-ecological region and the farming system as a whole.

FSR IN SINDH

Realizing the role that the farming systems research program has already played in the development of the agriculture sector in many developing countries of the world such as Senegal, Guatemala and South Africa, MART with the collaboration of PARC has formulated a plan to carry out on-farm researches in various agro-ecological zones of the country under a farming systems research perspective.

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A research program under FSR approach was initiated at Sindh Agriculture University, Tandojam in kharif 1987 as a follow-up to the FSR workshop held at the University during March 1987, during which an action plan, formulated by a multi-disciplinary team after undertaking informal surveys, was discussed thoroughly. Two sites in Hyderabad district were selected for carrying out FSR activities. These sites included Tando Mohammad Khan Taluka, a rice-sugarcane based area and Hala Taluka, a cotton-wheat based zone.

The research activities in these target areas initiated from *Kharif* 1989 have now attained full swing with the joint efforts of all three on campus institutions viz., Sindh Agriculture University, Agricultural Research Institute and Atomic Energy Agricultural Research Centre, Tandojam. The program now uses the expertise of 22 subject specialists/collaborators which included 13 from Sindh Agriculture University, five from the Agricultural Research Institute and three from the Atomic Energy Agricultural Research Centre. The extension wing of the Animal Husbandry (Livestock) Department of the Government of Sindh, has cooperated with the program by providing services to the stock of the target area.

The program entails a survey of the target area for characterization of existing conditions, identification of the key constraints and experimental trials with the active participation of farmers on more than one dozen interventions in management, crop protection, socio-economics, agricultural extension and livestock disciplines. The research work has been progressing satisfactorily in all fields.

ACCOMPLISHMENTS

It was decided, through diagnostic survey that, the main constraints to high yields of the various crops, grown in both Hala and Tando Mohammad Khan target areas, were the use of impure seed of inferior varieties, inadequate tillage, improper pest management, application of fertilizer inconsistent with recommended doses and other agronomic interventions.

Accordingly, the recommended and improved technologies regarding all these constraints were tested at farmer's fields in both the target areas during 1987-88 and 1988-89. The outstanding results which were appreciated by both subject specialists and the farming community are indicated hereunder

Wheat

Hala FSR Site trials with four cooperating farmers on pure seed of high yielding varieties cultivar "Sarsabz" with other improved agronomic interventions such as the application of the recommended dose of fertilizer (120-75-0) were conducted during 1987-88. They performed very well and the results were appreciated even by the neighboring farmers. Data in (Table 1) revealed an increase of 57.2 percent in grain yield and 76.3 percent in straw yield over farmer's practice. This increase yielded an additional net income of Rs.4,534.38 per hectare and cost benefit ratio at the rate of 1:4.

Similar trials were carried out at the Tando Mohammad Khan site with three cooperative farmers. The results indicate that the farmers with improved practices, on an average, harvested incremental yields of 29.4 percent in grain and 22.5 percent in straw over farmer's practice (Table 2). This amounted to an additional net income of Rs.1,140.72 per hectare which provided a cost benefit ratio at 1:3. Since Tando Mohammad Khan is a rice tract, the increase in yield was less compared to the Hala area, due to a heavy soil texture and salinity.

Zero tillage drill was introduced at the Hala site in an onion-fallow-cotton system. Trials on wheat with zero tillage drill were carried out at three sites. They resulted not only in the minimization

Table 1. Grain and straw yield of wheat obtained through agronomic improved interventions at Hala Site during *Rabi* 1987-88

t/ha

Site	Grain Yield Farmers practice	Grain Yield improved practice	Straw Yield Farmers practice	Straw Yield Improved practice
I	3.47	5.07	2.80	6.13
II	3.00	5.00	3.60	6.90
III	3.00	4.70	3.60	5.60
IV	3.60	5.80	3.40	6.40
Mean	3.27	5.14	3.55	6.26
Mean added productivity		1.87	-	2.71
% increase over farmer practice		57.20	-	76.30

a) Incremental output value

	Unit	Quantity	Price(Rs)	Value(Rs)
Grain	Ton	1.87	2,062.50	3,856.88
Straw	Ton	2.71	250.00	677.50
				Rs 4,534.38

b) Incremental input value

DAP	kg	61.75	3.22	198.83
Urea	kg	123.50	2.64	326.04
Proportional cost (threshing and marketing) @ 20% of grain incremental output (Rs.3856.88)				771.38
				1,296.00

c) Incremental Net Returns (a-b) = Rs. 3,238.13/ha

d) Cost benefit ratio (a/b) = 1:3.49

of production costs by minimizing labor inputs and tillage operations but also yielded higher returns. It was proposed that more comprehensive studies should be conducted in the forth-coming season under the systems in both the target areas. Feedback from the farmers is expected from this system research study.

Mungbean

Mungbean is an important pulse crop under the cropping systems existing in the Hala area. Farmers either cultivate it during the spring season on fallow lands or the land vacated by onion after

its harvesting. Having observed the interest of farmers, a high yielding mungbean cultivar 20-21 was introduced in the area which performed excellently in association with other improved agronomic interventions like inoculation and the application of N.P fertilizer. The data in Table 3 revealed an overall increase in net returns of Rs.3,454.03 per hectare and a cost benefit ratio of 1:3.52.

Table 2. Grain and straw yield of wheat obtained through agronomic interventions at Tando Mohammad Khan site during *Rabi* 1987-88

(t/ha)

Site	Grain Yield		Straw Yield	
	Farmers practice	Improved practice	Farmers practice	Improved practice
I	3600	5600	4248	6000
II	2933	3333	3446	3866
III	2533	2800	2989	3227
Mean	3022	3911	3561	4364
Mean added productivity		899	-	803
% increase over farmer practice	29.4	-	22.5	

a) Incremental output value

	Unit	Quantity	Price(Rs)	Value(Rs)
Grain	Ton	889	2.06	1831.34
Straw	Ton	803	0.25	200.75
				2032.09

b) Incremental Input Value

DAP	kg	61.75	3.22	198.93
UREA	kg	123.50	2.64	326.17
Proportional cost @ 20% of grain value				366.27
				891.37

c) Incremental net return (a-b) = Rs. 1,140.72

d) Cost benefit ratio (a/b) = 1:3

Since cultivar "20-21" is a short maturating and high yielding mungbean variety, farmers of the area were impressed with its performance. They showed an inclination for the inclusion of this crop in their cropping systems. They have started storing seed for planting next season. During the 1989 season, it was observed that the area devoted to mungbean 20-21 cultivation has increased three fold. The neighboring farmers have also shown an interest in adopting this pulse crop in their cropping system.

Table 3. Total biomass, grain and straw yield of mungbean at Hala during *Rabi* 1988

(kg/ha)

Trial	Treatment	Average yield of 5 sites		
		Total Biomass	Grain	Straw
T1	Farmers Practice	4283	799	3484
T2	Improved Practice	4481	1319	3162
T3	Improved Practice (less fertilizer)	3526	1000	2526
Added output (T2-T1)		198	520	328

a) Incremental output value

Parameter	Unit	Quantity	Price (Rs)	Value (Rs)
Grain	Ton	520	9.37	4875.00
Straw	Ton	322	0.15	48.30
				4826.70

b) Incremental input value

DAP	kg	123.5	3.22	397.67
Proportional cost @ 20% of grain value			975.00	
				1372.67

c) Incremental returns (a-b) = Rs. 3454.03/ha

d) Cost benefit ratio (a/b) = 1:3.5

Cotton

Cotton is the main kharif crop in the farming systems at the Hala site. A few years back, the farmers used to get a good return from this crop, but with the passage of time the seed cotton yields have dropped miserably in this area. On a survey by the FSR team, it was observed that the use of seed of inferior varieties, improper pest management and inadequate tillage operations can well be attributed as the main factors for harvesting low yields. Therefore, the pure seed of high yielding cotton cultivar "NIAB-78", under improved pest management practices and with levelled land proper tillage operations performed excellently at Hala. The increase in yield (Table 4) amounted to 112.6 percent over farmers practice and so there was a cost benefit ratio of 1:4.32 during kharif 1988. The performance of "NIAB-78" was also appreciated by the farming community of the area.

The farmers ginned some of the produce with home made ginners and stored the seed to plant next season. The farmers wished they could get a small ginner for obtaining pure cotton seed of their own for the next season's crop.

Table 4. Yield of cotton performance of cotton "NIAB-78" under improved agronomic and water management interventions at Hala site during *Kharif* 1988

kg/ha

Farmers	Improved Practice (Pure seed+F+DP+PP+L)	Farmer Practice
1	3859	1963
2	3947	1830
3	4320	1983
4	4371	1898
5	4022	1976
Mean	4104	1930

F = Fertilizer, DP = Deep Ploughing, PP = Plant Protection M = Measures, L = Levelling

Total grain yield:

Improved practice	=	4104
Farmer practice	=	1930

2174 kg /ha say 112.6% over farmer practice

Income analysis

a) Incremental cost (Seed+DP+PP+L) 2767.50

b) Incremental output

	Unit	Quantity	Price(Rs)	Value(Rs)
Seed	kg	2174	5.50	11,957.00

c) Incremental net income
(b-a) i.e. 11,957-2768 = Rs. 9,189.00/ha 9,189.00/ha

d) Cost benefit ratio (b/a) = 1:4.32

Sugarcane

At Tando Mohammad Khan site, the main cropping system is sugarcane-rice. The area is a bit humid and has medium to heavy textured soils excellent for the growth of sugarcane. More than 50% of the total production of sugarcane in Sindh is around Tando Mohammad Khan during a diagnostic survey, it was observed that low yields are due to low plant population, inadequate use of fertilizers and improper pest and rodent control. On this basis an increased seed rate with an overlapping system of placement of cane-sets in furrows has been introduced along with other improved practices of pest management and recommended fertilizer management.

To increase farm income, inter-cropping of sugarcane with radish and onion was also carried out. These interventions have proved excellent and have convinced farmers to adopt improved cane

technology the seasons. Table 5 clearly indicates the increase in yield with improved practices over farmers practices. The increase in yield (5000 kg/ha) of sole crop sugarcane under improved practice amounted to 41.6% over farmers practice. The cost-benefit ratio obtained with the sole crop averaged 1:1.80 during 1987-88. Intercropping of sugarcane with either onions or radish is occassionally practiced by farmers in the area. Under improved technology net-farm income from intercropped onions and radish was raised to Rs. 14,108.00 and Rs. 6, 703.00, respectively. The cost benefit ratios were calculated to be 1:5.3 in the case of sugarcane with onion and 1:6 with radish over a sole sugarcane crop.

Table 5. Yield income from sugarcane as sole crop versus intercropped with radish and onion under improved agronomic practices during 1987-88

(kg/ha)

Activity	Average yield	
	Improved Practice	Farmer Practice
Sole crop	17000	12000
Sugarcane+Onion	15000(SC)	-
Onion	15000	-
Sugarcane+Radish	14000(SC)	-
Radish	9000	-

Economics of sole improved practice versus farmer practice

a)	Incremental output /ha		
	Cane stick 5000 kg @ Rs 0.28		Rs 1,400.00
	Cane fodder 1250 kg @ Rs 0.10		Rs 125.00
		Total	Rs 1,525.00
b)	Incremental input/ha		
	Seed 800 kg @ Rs 0.30		Rs 240.00
	Fertilizer 123.5 kg @ Rs 2.64		Rs 326.00
	Harvesting and marketing charges @ 20% of cane stick value		Rs 280.00
c)	Incremental net returns (a-b)		Rs 679.00/ha
d)	Cost benefit ratio (a/b)		1:1.80

Economics of sugarcane + onion

a)	Incremental output/ha		
	Onion 12000 kg x Rs 1.50		Rs 18,800.00
	Sugarcane stick (-)		
	200 kg x 0.28	560	
	Cane fodder 500 kg x 0.10	50.00	
		610.00	Rs 610.00(-)
		Total	Rs 17,390.00

(Cont'd)

(Cont'd)

b)	Incremental input/ha		
	Seedlings		Rs 1,000.00
	Transplantation charges for onion		Rs 500.00
	Additional fertilizer one bag/ha		Rs 132.00
	Weeding charges		Rs 150.00
	Harvesting and filling charges		Rs 1,500.00
		Total	Rs 3,282.00
c)	Incremental net returns/ha (a-b)		Rs 14,108.00
d)	Cost benefit ratio (a/b)		1:5.30

Economics of sugarcane + radish

a)	Incremental output/ha		
	Radish 9000 kg x Rs 1.00/kg		Rs 9,000.00
	Cane stick (-) 3000xRs.0.28 =	840.00	
	Cane fodder(-) 750xRs.0.10 =	75.00	
	Total	915.00	
		Total	Rs 8,085.00
b)	Incremental input/ha		
	Seed		Rs 350.00
	Plantation charges		Rs 200.00
	Additional fertilizer		Rs 132.00
	Weeding		Rs 150.00
	Spray charges including poison		Rs 250.00
	Harvesting charges		Rs 300.00
		Total	Rs 1,382.00
c)	Incremental net return/ha (a-b)		Rs 6,703.00
d)	Cost benefit ratio (a/b)		1:5.85

Rice

In the case of rice, pure seed of "IRRI-6",a known high yielding variety, and "DR-83", a short duration variety were introduced. Normally the farmers grow "IRRI-6" in the target area but "DR-83" was introduced to fit the rice-sugarcane system and to save time for early planting of sugarcane.

Unfortunately the short duration rice "DR-83" yield of 5677 kg/ha compared unfavourably (Table 6) with "IRRI-6" yield 7833 kg/ha and, therefore, was not adopted by farmers. So far as pure seed of "IRRI-6" is concerned (Table 7), it performed well. The improved practices yielded 17.0% increased in grain yield and 2.1% increase in straw yield over farmers practices and the farmers earned Rs.1,302.85 per hectare as an incremental net return and cost benefit ratio of 1:3.6 over farmers

Table 6. Performance of DR-83 versus IRRI-6 at Tando Mohammad Khan area during kharif 1988

(kg/ha)

Site	"DR-83"		"IRRI-6"	
	Grain Yield	Straw Yield	Grain Yield	Straw Yield
1.	5250	17666	8000	15333
2.	6000	25000	6933	21066
3.	5500	28000	8133	24533
4.	5900	27375	8266	25600
Mean	5677	24510	7833	21633
Increase/Decrease			+2156	-2877
Percent			+37.98	-11.74

practices and the farmers earned Rs.1,302.85 per hectare as an incremental net return and cost benefit ratio of 1:3.6 over farmers practices.

IMPACT ASSESSMENT

The impact of various interventions was assessed on each crop and from each collaborating farmer. Interviews with neighbouring farmers to assess impact were also conducted with FSR. Project participated farmers and neighbouring farmers in the target area.

It was noticed that extension workers had never visited the target area farmers. Extension staff were quite unaware of the interventions introduced by the FSR team on their fields. From subsequent involvement with the FSR team, they learned a lot about the technologies which increased farm production.

Farmer's days were organized during the season of 1987-88 and 1988-89. The purpose of organizing these farmer's days was to acquaint the farmers with modern technologies, to popularize the use of varied techniques and to provide them with an opportunity to observe the results of scientific farming. On March 21, 1989 a field day/farmers' day was organized in which the farmers were invited to see the performance of tested interventions over their own practices. Farming Systems Research scientists explained different aspects of the experiments to more than five hundred farmers attending the function.Dr.Illahi Bux Bhatti, Vice Chancellor, Sindh Agriculture University, Tandojam, Dr. A. R. Azmi, Director, Atomic Energy Agricultural Research Center, Tandojam and Mr. Altaf Hussain Chaudhry, Director Agriultural Research Institute, Tandojam, Dr. M. Saeed of USAID, Dr. Abdul Majid, FSR Coordinator and various Deans of Faculties, Sindh Agriculture University, Tandojam were also present to observe the interest and inclination of farmers towards FSR work.

Delivering the presidential address, Dr. I. M. Bhatti, Vice Chancellor, said that we have been striving to disseminate scientific know-how among the farming community so that they may be able to increase yields and their own disposable income. Now it is the study of the farmers to make use of the information. He further added that technical know-how on the health and care of cattle is also being imparted to farmers. Dr. A. R. Azmi, Chaudhry Altaf Hussain and other experts also appreciated the

Sugarcane inter-cropped with radish at Tando Mohammad Khan site

FSR Scientists and Farmer with cane sticks at Tando Mohammad Khan FSR sugarcane field. The difference is clear.

Dr. Illahi. Bux. Bhatti, Vice Chancellor, Sindh Agriculture University, Chaudhry Altaf Hussain, Director, Agricultural Research Institute, Dr. A. R. Azmi, Director Atomic Energy Agricultural Research Centre, and other prominent scientists, looking at performance of intervention of pure seed of high yielding wheat cultivar "Sarsabz" over farmers' seed at Hala site.

Table 7. Performance of pure seed of IRRI-6 under improved agronomic practices at Tando Mohammad Khan Area during 1987-88

(kg/ha)

Site	Grain Yield		Straw Yield	
	Improved Practice	Farmers' Practices	Improved Practices	Farmers' Practices
1.	8000	7933	15333	14666
2.	6933	6666	21066	20000
3.	8133	6533	24533	22133
4.	8266	5866	25600	27462
Mean	7833	6700	21633	21066
Increase	+1133	-	+ 433	-
% Increase+	17.0	-	+ 2.1	-

Economic analysis

a)	Incremental output value/ha	
	Grain 1133 kg x Rs 1.50	Rs 1,699.50
	Straw 433 kg x Rs 0.25	Rs 108.00
	Total	Rs 1,807.00
b)	Incremental input value/ha	
	Urea 62.5 kg x Rs 2.64	Rs 165.00
	Proportional cost	Rs 339.00
	@ 20% of grain value	Rs 504.90
c)	Incremental net returns (a-b)	Rs 1,302.85
d)	Cost benefit ratio (a/b)	Rs 1:3.58

work of FSR team. Many farmers thanked the Vice Chancellor and the other experts, saying that they appreciated FSR activities and they are benefiting from them.

ADAPTATION

At the time of the start of the FSR programme, farmers in the target area were hesitant to collaborate. They considered it a waste of their land to work with scientists. This was probably due to lack of rapport between extension workers and farmers. However, after their involvement in the 2 years programme the vision and thinking of not only the collaborating but also the neighbouring farmers has changed. They have started taking an interest in improving their cropping systems and in adopting interventions for increasing farm produce. The collaborating farmers have started storing seed of high yielding wheat cultivar "Sarsabz", cotton cultivar "NIAB-78", rice "IRRI-6" and mungbean cultivar 20-21 for planting next season and distributing among neighbouring farmers.

Some of the collaborating farmers have adopted the same method of sowing sugarcane (overlapping system for increased plant population) as suggested by FSR team. It is also noticed that the sugarcane crop of the farmers to be harvested in September, 1989 will yield almost the same as that sown under improved practices. Due to the increase in farm income by inter-cropping onions with sugarcane, it is expected that this system will surely be adopted by the farmers.

INTERNALIZING FSR ORGANIZATION

The virtues encompassed by the FSR programme include:

a) It is system orientation
b) It is interdisciplinary
c) It ciaims to be location specific
d) It focusses on resource poor farmers but farming under varied circumstances
e) Its activities are carried out on farmers fields with the active participation of farmers
f) It is a way of adopting technologies to specific farming conditions

However the effectiveness of FSR is highly dependent on the way in which it is incorporated within the framework of national research. Its activities demand the identification of responsibilities and the establishment of channels for communication. A strong organization can achieve desired goals by creating work incentives among workers. Therefore, FSR now requires a separate entity through a strong organization. Since FSR places researchers and teachers in much closer contact with the farmers, it can achieve much better results if it is provided with an efficient infra-structure of an institution within the national research organization.

DISSEMINATION

Dissemination of the performance of improved agronomic practices on farmers field is done through:

1. Organization of field/farmers days.
2. Invitation to neighbouring farmers to visit FSR sites.

CONCLUSIONS AND RECOMMENDATIONS

From the results of the past 2 years, the FSR programme has really proven to be a problem solving research on farmers fields. It is more practical than any other program in agricultural research. Thus in the future too it is expected that this programme will play a vital role in increasing farm production and in making the farmer more prosperous.

Also this programme has provided every chance for scientists to interact with farmers directly, in identifying the problems of low production and in suggesting solutions. In the greater interest of the farming community, it is recommended that the FSR programme in Pakistan must find a place for its permanent establishment as is being in other developing countries in the far-East.

FARMING SYSTEMS RESEARCH INSTITUTIONALIZATION (PROKA)

M. Akram Raja[1] *and S. H. Hanjra*[2]

INTRODUCTION

In the past two decades the crop sector has experienced rapid growth by virtue of modern technological package comprising bio-chemical, engineering, and high potential crop technology. Livestock forms an integral part of Pakistan farming systems and it contributes about 30 percent to the agriculture sector. In comparison to crops, the livestock component have remained neglected. The problems of small livestock component have remained unsolved. Livestock production generally revolves around small farms and landless livestock owners. In recent years, there has been ample awareness regarding the ability of livestock in stabilizing income of small farmers.

New technology relevant to small farm conditions requires a systematic analysis of problems, family goals and aspirations, existing crop-livestock enterprises, market potential and government policy. Traditionally farm management specialists and agricultural extension have been largely responsible for such analysis. Recently a Farming Systems Research (FSR) approach to research and extension has gained acceptance. Essential features of FSR require scientists in collaboration with the farmer to describe, diagnose, design and test new technologies. A measure of farming system success is the degree to which farmers can maximize returns per hectare or per animal sustain maximum returns per hectare or per animal from limited resources.

A project was thus planned to study the farming systems in the village around Livestock Experiment Station, Proka, district Faisalabad. Initially the target area was described, problems diagnosed and patterns of existing livestock/fodder crop production defined. A total of 153 respondents were selected through stratified random sampling. Based on identified priority production constraints the testing of improved feeding and animal health management was carried out by scientists working with farmers in the target area. Keeping in view the results of survey other constraints were identified. Multidisciplinary teams of scientists assembled appropriate crop-livestock production technologies and with collaborating farmers concerned extensive field testing. In contrast to on station research, the FSR involves scientists and farmers who work closely in the farmer's field.

STRAW TREATMENT

Akram et al. (1987), studied the effect of urea treated wheat straw on milk yield and composition. The data indicated that the cows fed urea treated wheat straw yielded more milk as compared to those fed untreated straw (Table 1). The differences however, were statistically non-significant. The animals fed treated straw exhibited significantly ($p>0.01$) higher intake as compared to those fed untreated straw. The cows fed on treated wheat straw consumed significantly less green fodder than the untreated group. Since urea treated straw enabled the farmer to partially substitute straw for expensive "off-season" fodder, the farmer profited. The urea treated straw overcome the

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shortage of green fodder and helped in sustained milk production in the fodder scarcity period. Farm net income was increased (Table 2).

Table 1. Selected constituent composition of wheat straw treatment and untreated (%)

Particulars	Wheat Straw	Wheat Straw Urea Treated (4%)
Dry Matter	92.09	83.84
Crude Protein	3.06	7.23
Ether Extract	0.65	0.65
Ash	12.10	11.39
Crude	38.73	38.48
NFE	45.46	42.55
Digestibility	42.00	54.00

N.F.E. = Nitrogen Free Extract

Table 2. Effect of feeding urea treated wheat straw on the milk production, composition with costs and returns

Particulars	Untreated Wheat Straw	Urea Treated Wheat Straw
Number of Experimental Animal	8	8
Days on Experiment	75	75
Feed Consumption/day (kg)		
a) Green fodder	24.10	18.05
b) Wheat straw	3.37	6.64
c) Concentrate	2.28	2.38
Average Milk Production/day (l)	5.51	6.50
Total Variable Production Costs (Rs)	10.57	11.83
Cost of Production/l (Rs)	16.53	19.50
Gross Margin/litre (Rs)	1.08	1.18

FODDER PRESERVATION

The fodder preservation on several farms has been undertaken through silage making of surplus fodder using the available farmer's facilities. The preserved fodder can be used during the scarcity periods (May-June and December-January). Hanjra, et al. (1988) conducted a field trial to study the effect of silage feeding on the production performance of buffaloes. The results revealed that differences in milk production resulting from feeding of silage and green fodder were non-significant. Similarly, the difference in the production of fat-corrected milk (FCM) by the animals in the two groups were non-significant. Highly significant difference between the consumption of the two roughage (silage and green feed) by the experimental animals was observed. Based on these findings silage feeding can be practiced without affecting the milk production and general health of the animals (Table 3).

Table 3. Average milk production, composition and feed consumption from animals fed silage or routine fodders

Particulars	Silage	Conventional Fodder
Number of Experimental Animal	8	8
Days on Experiment	84	84
Daily Milk Yield (kgs)	9.39	9.28NS
Daily FCM Yield (kgs)	13.87	13.62NS
Milk Composition (%)		
Milk Fat	6.96	6.78*
Milk Protein	4.70	4.72NS
Total Solids (T.S)	15.47	15.45NS
Solids-not-Fat (SNF)	8.51	8.5NS
Ash	0.75	0.74 NS
Feed Consumption (kg) DM basis		
Silage	8.47	-
Fodder	-	8.86**
Concentrate	2.99	2.98NS
Cost of Production of Milk/litre (Rs)	1.25	1.30NS

*NS = Non Significant, * = (P < 0.05), ** = (P < 0.01)*

FODDER PRODUCTION

Field trials were conducted at several farms to increase the fodder yields. During Rabi season improved seeds of Berseem and Lucerne (fodder legumes) were introduced and production performance of fodder was compared with farmer practice. The results showed that with improved seed a yield of 89.70 tons of green feed per hectare was obtained. Farmer seed yielded only 53.03 t/ha (Fig 1).

During Kharif season "S.S. Hybrid" was compared with the farmer practice of growing sorghum and maize. The extra green fodder produced by "S.S. Hybrid" over the sorghum/maize, gave participant farmers a double fodder intervention pay off. The "S.S. Hybrid" not only produced quality fodder but reduced green feed costs per kg of fodder by 75 percent compared with the sorghum-maize system (Fig 2). Moreover, the availability of green fodder was substantially increased around the year.

CATTLE FEED

Balanced and low cost cattle feed was introduced in the project area to reduce the cost of milk production. A comparative study carried out in farmer fields to test the economics of feed and cotton cake (undecorticated) which is a conventional dairy concentrate (Table 4). The cost per kg for the improved feed was Rs.1.60 compared with conventional (cotton seed cake) feed costing Rs.2.30 per kg. Animals also preferred more palatable improved ration over the conventional (cotton seed cake).

Table 4. Feed consumption, milk production and incurred costs obtained from livestock fed cotton seed cake and the university cattle feed rations

Particulars	Cattle Feed	Conventional Cotton Seed Cake
Animals	8	8
Duration of Experiment	90	90
Fodder Consumption (kg)	29.6	30.1
Feed (kg)	2.35	2.51
Average Milk Production (l)	5.91	5.68
Feed Cost/kg (Rs)	1.60	2.30

DEWORMING IN SHEEP

A deworming trial was conducted to demonstrate the benefits of deworming in sheep. Twenty sheep were drenched with Nilzan. The drenching cost was about Rs.2.00/animal. The results indicated that the weight gain per day was 39.58 gm in control group compared with 63.16 gm per day for dewormed group (Table 5).

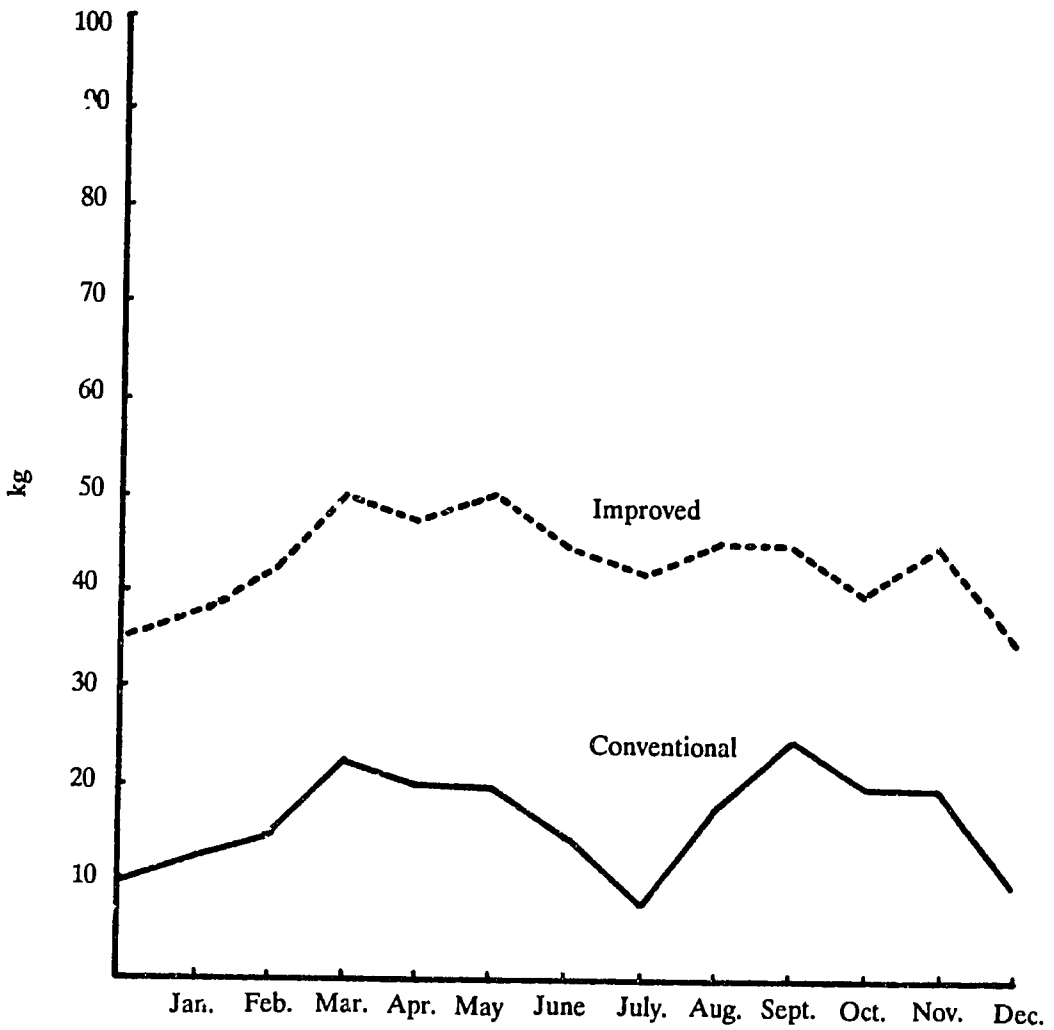

Figure 1. **Seasonal Green Fodder Production Obtained from Improved and Conventional Fodder**

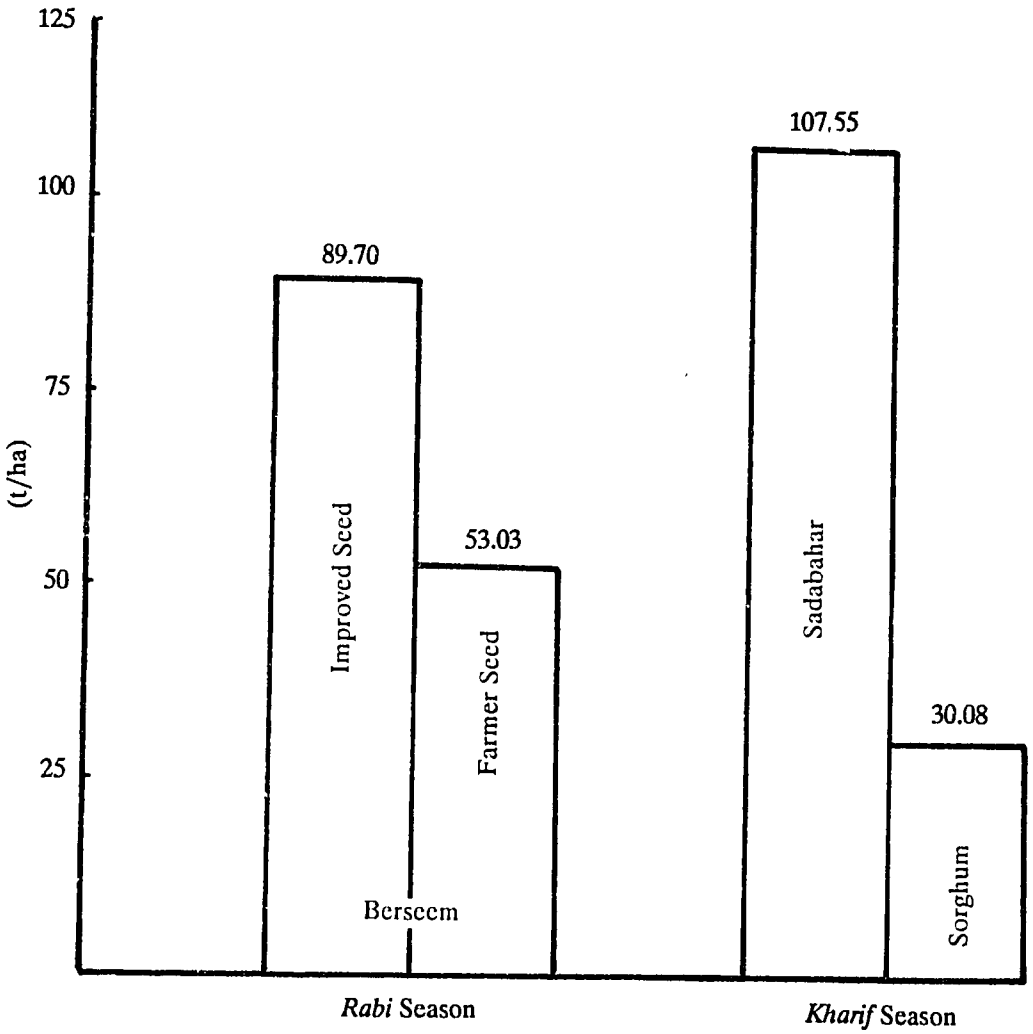

Figure 2. **Average Seasonal Fodder (Berseem/Sadabahar/Sorghum) Obtained from Improved and Farmer Seed Sources in the FSR Target Area**

Table 5. Response to deworming sheep in terms of weight gain and costs

Particulars	Control Group	Dewormed Group
Number of Sheep	20	20
Duration of Experiment (days)	120	120
Drenching Cost/head (Rs)	-	2.00
Average Weight Gain/head (kg)	4.75	7.58
Average Weight Gain/head/day (gm)	39.58	63.16

AGRO-FORESTRY

Fodder trees and grasses were introduced at farmers fields to increase the fodder availability. The fodder trees were planted on the field boundaries and on water courses. Several grasses and fodder trees have been introduced and studies on feeding and production are underway at Livestock Experiment Station, Proka (Table 6).

Table 6. Promising agro-forestry species under trial

Grasses

1. B. N. Hybrid (Bajra Napier Hybrid)
2. Guinea grass
3. Silk grass
4. Sucro
5. Dallis grass
6. Buffal grass (*Cenchrus ciliaris*)
7. Green panic
8. Tall panic
9. Setaria anceps
10. Lemon grass
11. Khabbak grass (*Cynodon dactylon*)

Fodder trees

1. Iple Iple (*Leucaena leucocephala*)
2. Acacia nilotica
3. Acacia arabic
4. Mullberry (*Morus alba*)
5. Beri (*Ziziphus jujuba*)

FARMING SYSTEMS RESEARCH PROJECT, SHAHKOT

Dr. Asghar Jalis[1], *Mohammad Arshad*[2], *Mohammad Younas*[3], *Saeed Ahmad*[4], *Mohammad Latif Shah*[5]

Abstract: The FSR project at Shahkot has produced very tangible and encouraging results. Not only has the productivity and income of small farmers in the target area been increased but interdisciplinary research among scientists from different organizations has become integrated.

Through a diagnostic survey, constraints to productivity were articulated through scientists and farmers interviews. Partial replacement of wheat with lentils has been enthusiastically adopted by farmers as a profitable system intervention to maximize limited irrigation water. Farmers have also benefited from earlier sowing of S.S. Hybrid, with extended supply of quality fodder. These, as well as the availability of a protein rich food source are some of the other perceived advantages of this intervention.

Introduction of "Basmati-385" has made possible earlier sowing of wheat, resulting in a significant increase in yield. A zero tillage intervention has further decreased turn around period between rice harvest and wheat sowing. Chemical weed control intervention has given very encouraging results specially when applied to vegetable crop.

INTRODUCTION

Whatever is going to be presented as the results and achievements of this project, during the next twenty minutes or so, are the fruit of the combined efforts of a large number of workers hailing from diverse disciplines like Agronomy, Plant Physiology, Soil Science, Entomology, Agricultural Economics, Statistics, Agriculturl Engineering, Plant Breeding etc. Scientists drawn from Animal Sciences like Veterinary Science, Livestock Management and Nutrition, from an integral and equally important part of the FSR team.

One thing which FSR project has been able to very clearly demonstrate and establish is that given common commitments and shared goals, the scientists representing different disciplines and even different organizations can be molded into smoothly.

GEOGRAPHIC LOCATION

The Farming Systems Research project near Shahkot, is situated about 12 kilometers from the town, straddling the Shahkot, Dhaban Singh Road. In this area a command water management project is also located, a fact which was one of the considerations in its selection as a project area.

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DIAGNOSTIC SURVEY

A preliminary diagnostic survey of the area was carried out in March, 1987, followed by a more detailed and in-depth survey, during the following months. Information was collected on the soils, climate, irrigation sources, socio-economic set-up which encompassed marketing, land tenure, farm size, family structure, gender-wise distribution of farm work, availability of credit and power source.

Information on occupation of land by different crops, important cropping systems (based upon principal crops), cropping intensity, sowing frequency, pest control practices and yields of various crops. Fertilizer use was also collected apart from information on crops, information apropos of the livestock component was also collected and processed.

PRIORITY CONSTRAINTS

Through the diagnostic survey a list of priority constraints of the area was prepared. These have been set forth below:

(1) Water shortage
(2) Fodder scarcity
(3) Low yields due to:
    (a) Delayed wheat sowing
    (b) Weed infestation
    (c) Inferior varieties
    (d) Unbalanced fertilizer application
(4) Low productivity and health of farm animals.

In the time allocated it is possible to address only the more important of these problems in order to show what has been done to find solutions using Farming Systems Research approach.

WATER SHORTAGE

Although it is a command water management project area, still the complaint most often heard, relates to water shortages.

There was an initial reluctance of farmers to partially replace wheat with lentil. The FSR team was able to convince some farmers that brought risk would be reduced. Successful crops of lentils can be grown with just one irrigation (in addition to the soaking dose) given at the flowering time. If there are timely rains, even that irrigation is not required.

The other perceived advantages were:

(1) Increased total income from the wheat + lentils intervention.
(2) Earlier vacation of the plots under lentils (by 3 weeks) to enable earlier planting of S.S. Hybrid, for fodder.
(3) Saving of fertilizer in the lentil crops and subsequent enhanced fertility throughthe legume/lentil.
(4) Earlier cash income through the sale of lentils compared to wheat. Better prices and easier marketing.
(5) Availability of a protein-rich food source to the farmer's family.

(6) Availability of earlier lentil 'bhoosa' to supplement a diminishing supply of wheat "bhoosa".
(7) Possibility of the use of lentil 'bhoosa' as mulch in summer vegetables like aubergines, resulting in a further saving of water and addition of some organic matter.

Partial budget analysis comparing the lentil interventions with sole wheat (Table 1) revealed a "R-1454" income benefit per ha in favour of introducing lentil into the farming system. If the likely benefits enumerated above are also considered the increased benefit will be still more.

Table 1. Increasing wheat yield and net farm income through lentils

Parameter	Introduced Wheat 0.75 ha	System Lentils 0.25 ha	Farmer System Wheat Alone 1 ha
Grain Yield (kg)			
Site I	2235.00	279.50	2779.00
Site II	2628.75	304.00	3288.00
Site III	2448.75	275.75	2825.00
	2437.50	286.42	2964.00
Partial Budget			
* Av. yield (kg)	2437.50	286.42	2964.00
* Adjusted yield (kg)	2193.75	257.78	2667.60
* Field price per kg(Rs)			
Grain	1.50	8.75	1.50
Bhoosa	0.30	0.20	0.30
* Gross field benefits (Rs)	3948.76	2307.13	4801.68
* Gross field benefits/ha(Rs)		6255.99	4801.68
Variable Cost (Rs)			
* Cost of seed	187.50	50.00	250.00
* Cost of weedicide	180.00	--	240.00
* Labour for spraying	37.50	--	50.00
* Labour to haul water	45.00	--	60.00
* Labour for hoeing	--	75.00	--
* Water rates	75.00	50.00	100.00
Total	525.00	175.00	700.00
* Total variable cost/ha (Rs)		700.00	700.00
* Return above variable cost (Rs)		5555.90	4101.68
* Increased benefits (Rs./ha)		1454.22	

FODDER SCARCITY

The diagnostic survey indicated that the animals are an important component of the farming enterprise. But animal productivity is constrained due to inadequate nutrition. There is pronounced fodder shortage at the beginning of summer(May - June) and in the winter (October - November) months. The conventional fodder crops such as maize and sorghum requires at least two annual planting dates to provide seasonal fodder.

Apart from expenditure on land preparation, seed, fertilizer and extra irrigation, there is always the high risk of poor stand or a partial crop failure. Untimely rains and insect/weed infestation are contributing factors. Fortunately "S.S. Hybrid", a multi-cut summer fodder appears as a reliable source of quality fodder during an extended growing season. The farmers were skeptical about it in beginning. But gradually the advantages of this new fodder crop were realized.

Data recorded from five sites Table 2 shows that while sorghum and maize yielded a combined total of 73.88 tonnes per hectare, the introduction "S.S. Hybrid" yielded 142.14 t/ha. There was an increase of 92.4% in fodder yield while production costs were only rupees 200.00 per ha for the improved fodder

Table 2. Improving fodder availability through S.S. Hybrid in Kharif season

Fresh Matter Yield (t/ha)	Improved System (S.S.Hybrid)	Conventional System Sorghum	Conventional System Maize	Total
Site-I	143.00	55.60	30.30	85.90
Site-II	140.25	60.20	25.20	85.40
Site-III	142.65	45.15	20.75	65.85
Site-IV	144.94	39.26	22.33	61.63
Site-V	139.98	46.25	24.38	70.63
	142.14	49.29	24.59	73.88

Partial Budget Analysis

* Average fodder yield (t/ha)	142.14	73.88
* Adjusted fodder yield (t/ha)	127.93	66.49
* Variable costs (Rs/ha)		
* Cost of seed	440.00	600.00
* Cost of land preparation	395.00	790.00
* Cost of sowing	148.00	494.00
* Cost of fertilizer	1645.00	786.00
* Cost of hoeing	210.00	-
* Labour cost for fertilizer application	72.00	36.00
Total	2910.00	2708.00
* Percent increase in fodder yield	92.40	-

Apart from the total fodder increase the farmer has also the option of making his fodder last until the end of November or alternatively use surplus fodder as silage.

Preliminary observations have shown the possibility of inter-cropping "S.S. Hybrid" with Egyptian clover at the end of September to the beginning of November. This stratagem may ensure an almost uninterrupted supply of fodder.

LOW WHEAT YIELDS DUE TO DELAYED SOWING

Delay in wheat sowing is one of the important cause of low yields. Experiments carried out at the Wheat Research Institute, Faisalabad have indicated that the yields suddenly decrease if sowing is delayed beyond the middle of November.

To remedy this situation "Basmati-385", an early-maturing, short-duration variety was introduced into the project area.

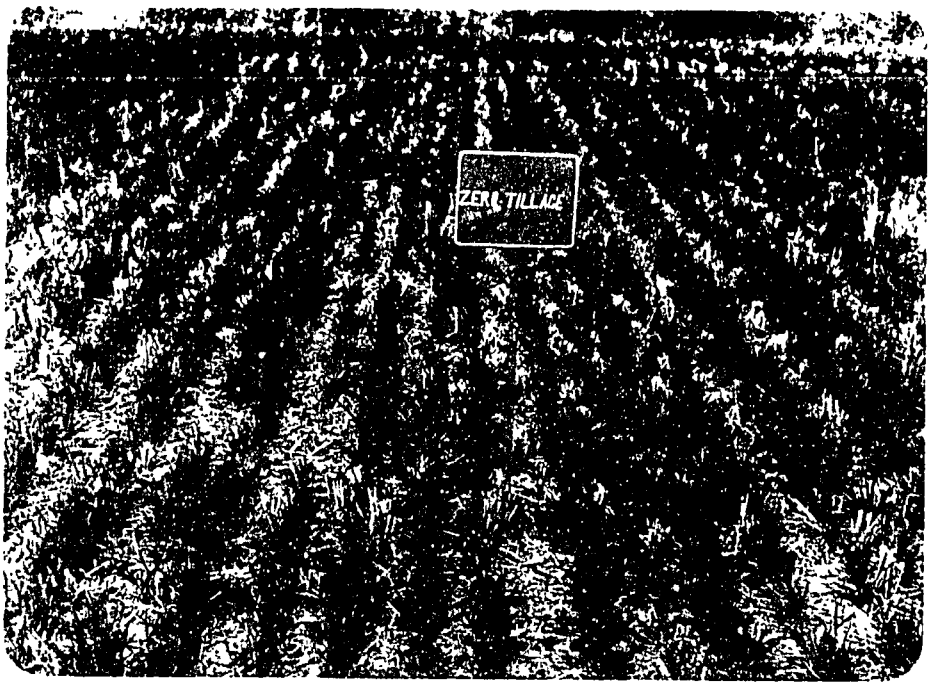
The introduction of variety "Basmati 385" resulted in an average saving of 16 days, making it possible to sow the wheat crop earlier. While the average yield of wheat sown after "Pak-Basmati" was 2.11 t/ha, it was 2.79 t/ha, after"Basmati-385" Table 3. Moreover, the "Basmati-385" gave 0.40 t/ha higher yield compared with "Pak-Basmati". Inspite of the slightly higher costs incurred an increased benefit of rupees 230.00per ha was realized by the farmer Table 3. An additional advantage due to the early maturity of "Basmati-385" Table 4 enabled the farmer to plant his wheat at the appropriate time. Sowing wheat directly after the rice harvest has been made feasible through recent development of an improved zero till planter.

Table 3. Improvement of rice-wheat system through early maturing rice cultivar Basmati-385 in FSR project area, Shahkot

Partial Budget Analysis	Improved System Basmati-385	Traditional System Basmati-Pak
* Average grain yield of rice (kg/ha)	4.50	4.10
* Adjusted grain yield of rice (kg/ha)	4.05	3.69
* Average grain yield of wheat (kg/ha)	2.78	2.110
* Adjusted grain yield of wheat (kg/ha)	2.51	1.899
* Field price/kg (Rs)		
Grain) Rice	3.25	3.50
Straw)	1.20	0.25
Grain) Wheat	1.50	1.50
Straw)	0.30	0.30
* Gross benefits (Rs/ha)		
Rice	13,972.50	13,837.50
Wheat	4,518.00	3,418.20
Total:	18,490.50	17,252.70
* Cost of seed (Rs)	44.00	39.00
* Total cost that vary (Rs/ha)	18,446.50	17,216.70
* Increased benefit (Rs/ha)	1,229.80	

Introduction of lentils has proved to be a very successful intervention with multi-faceted advantages of water saving, a higher net farm income per unit area with no loss of wheat production on less land area.

S.S. Hybrid, a multicut green fodder has gained great popularity in the project area and has been instrumental in reducing chronic fodder shortage during stress periods of late summer and fall.



Zero tillage has shown great promise in lessening turn-around time from paddy to wheat and reducing preparatory tillage costs.

Chemical weed control methods have caught on in the area in carrots, peas and wheat.

ZERO TILLAGE INTERVENTION

The possibility of saving of an additional week has been indicated by the zero tillage intervention, by decreasing the turn around time between rice harvest and wheat sowing. Reduced cultivation and sowing costs associated with the improved zero till compared with traditional land preparations provided significant cost saving to the farmer. The overall benefit in the first year's trial resulted in an increase of Rupees 1065.40 per hectare Table 5.

Table 4. Improvement of rice-wheat system through early maturing rice cultivar Basmati-385 in FSR project area, Shahkot

Average grain yield and days to maturity

	Improved System (Basmati-385)		Traditional System (Basmati-Pak)	
	Grain Yield (t/ha)	Days to Maturity	Grain Yield (t/ha)	Days to Maturity
Site-I	4.90	101	4.20	116
Site-II	4.60	102	4.60	119
Site-III	5.00	104	4.30	122
Site-IV	4.00	103	3.80	115
Site-V	3.90	100	3.60	120
Average:	4.50	102	4.10	118

Average grain yield of wheat sown after Basmati-385 and Basmati-Pak

Site-I	2.80	2.30
Site-II	2.45	1.90
Site-III	2.93	2.10
Site-IV	3.25	2.25
Site-V	2.50	2.00
Average	2.786	2.110

The introduction of "Basmati-385", coupled with zero-tillage intervention may well combine to reduce costs, and sustain high productivity of the entire rice-wheat system. Long term effects on weeds, insects, soil and irrigation practices are some of the problems which have to be studied following continued use of the zero till planted wheat.

WEED CONTROL

Weeds constitute an important constraint to production and cause appreciable yield losses apart from fertilizer, moisture and quality losses and enhancement of production costs.

Gradual decrease in the availability of agricultural manpower further complicates the problem.

Table 5. Improving wheat yield and farm productivity through zero tillage adaptation

Partial Budget	Improved System (Zero Tillage)	Farmers Practice (Fine Seedbed)
• Average grain yield (kg/ha)	2940	2670
• Adjusted grain yield (kg/ha)	2646	2403
• Field price/kg (Rs)		
• Grain	1.50	1.50
• Bhoosa	0.30	0.30
• Gross field benefits (Rs/ha)	4762.80	4325.40
• **Variable Costs (Rs/ha)**		
• Cost of land preparation	-	395.00
• Cost of seeding	137.00	247.00
• Labour cost for putting seed and fertilizer in drill	15.00	-
• Labour for broadcasting seed	-	45.00
• Labour for broadcasting fertilizer	-	45.00
• Labour for bund making	-	48.00
Total:	152.00	780.00
• Return above variable cost (Rs/ha)	4610.80	3545.40
• Increased benefits (Rs/ha)	1065.40	-

Table 6. Improving farm productivity through chemical weed control (Carrots)

Partial Budgeting	Improved Practice (Treated with Stomp-330E	Farmers Practice Untreated
• Average yield (kg/ha)	61600	39950
• Adjusted yield (kg/ha)	55440	35955
• Field price/kg (Rs)	0.80	0.80
• Gross benefits (Rs/ha)	44352	28764
• Vairable costs (Rs/ha)		
• Cost of chemical	656.25	-
• Cost of labour for spray	49.00	-
• Cost of labour to haul water	15.00	-
Total:	720.25	-
• Return above variable cost (Rs/ha)	43631.75	28764.00
• Increased benefit (Rs/ha)	14867.75	-

Chemical methods of weed control were tried in carrots, peas and wheat, with encouraging results.

Preliminary results from this intervention suggest a considerable return of Rs.14,867.75 per hectare (Table 6) from use of the herbicide on this cash crop.

ORGANIZATION AND INSTITUTIONALIZATION OF FSR AT NARC

Dr.M. Yousaf Chaudhri[1]

A more definitive statement by Pakistani scientists on the scope of research and the role of extension in Farming Systems Research (FSR) programs would be helpful. Let not the FSR program be merely a band waggon activity from which we disengage as popularity diminishes. Nor should component and commodity research be replaced by FSR. Rather FSR has a two way function. The testing with farmers improved innovations and the feedback of researchable problems to the experiment station. Each is of equal importance in FSR. The FSR approach has been adopted at NARC. In collaboration with the FSR coordinator and institute directors, interdisciplinary scientists participate in on-farm system studies.

At NARC we identified a FSR team of three senior scientists, (crop production specialist, animal scientist, agricultural economist and three junior scientists. They together with a female scientist, make up the FSR cell. Those scientists will be assisted as required by researchers from commodity programs and specialized disciplines. Major thrusts will address diagnosed *barani* problems of major farming systems. Interdisciplinary research, which emphasizes moisture conservation, integrated pest control, soil fertility and resource economics to sustain an improved productivity will be emphasized. The overall aim is to improve the welfare of the small farmer and his family.

The recently developed NARC Master Plan includes an important FSR perspective. All six research institutes of NARC will have some scientists engaged in FSR project activities. Multidisciplinary scientists will participate in both on-farm studies and experimental stations research.

ON-FARM AND NARC EXPERIMENT STATION RESEARCH

The complementary activities of conventional and FSR are recognized at NARC. The *barani* target area of Fatehjang has been selected as the initial FSR domain. Our approach and methods have involved the recognized FSR steps. We started two years ago with a baseline study and a diagnosis of farmer constraints.

Constraints to production and marketing were prioritized. Approximately 40 participant farmers now are collaborating with an interdisciplinary team of NARC scientists. At the NARC experimental station, scientists have initiated research designed to address problems brought back from experience gained working with farmers. While most research is interdisciplinary and component research is also encouraged.

NARC MASTER PLAN YEAR 2000

An important feature of the newly developed NARC Master Research Plan is to focus on interdisciplinary studies which emphasize a FSR approach. Attention has been given to the allocation of manpower, and budget resources to reflect this emphasis. Internalization of FSR is being expanded. Already several NARC research programs incorporate the FSR approach and methods.

[1]*Director General, NARC, Islamabad*

NATIONAL FSR PROGRAM

Nationally FSR projects originate at institutes and universities in each province. Planning, policy implication and operations reside with the province. Program coordination of FSR is located at NARC. The centre's scientists and facilities are available to support the province FSR projects and associated training.

It would seem desirable to also establish a FSR cell at the agricultural universities to function as the NARC model. Moreover, extension and adaptive research should become more active partners in FSR programs. Systems interventions which apply to significantly large areas and which can effect major changes in productivity and net farm income of small farmers are needed. Impact will be measured over the entire system and for the long term. Adaptive research on the other hand primarily concerns a commodity approach and is mainly for short terms results. There is a splendid opportunity for FSR and adaptive research to work together.

Farming Systems Research institutionalization will likely vary by province. The FSR cell unit organization may not be the best organization structure throughout Pakistan. It is important that the roles of research, education and extension be identified so that resources can be most effectively utilized. Certainly the FSR program encourages an integrated and interdisciplinary research on priority farm problems.

CURRICULA AND TRAINING FOR FARMING SYSTEMS RESEARCH/EXTENSION

Sadaqut Hayat Hanjra[1]

Pakistan's recent interest in FSR has emphasized the urgent need to train scientists of the public and private sector in the approach and methods of FSR/E. It is now generally accepted that raising productivity and net farm income can be realized when scientists and farmers become partners in problem diagnosis and analysis and testing improved cultural practices by the small farmer will also require strengthening the linkage between research and extension.

The existing agricultural information /extension system must be updated to address conditions which can effect rapid change over into more modern methods of farming. At present three agricultural universities in the country impart different levels of training in agriculture/animal husbandry/veterinary sciences and allied fields. Typical agricultural university syllabi and schemes of studies are presented in Annex.1. Several agricultural training institutes produce middle level workers for agricultural/animal husbandry employment. A three-fold approach in Pakistan is suggested for Pakistan to produce the necessary scientists, extension and other staff in FSR philosophy, concepts and practices of FSR:

i. Training a small group in FSR
ii. Development of incountry training programs for research, extension and technical assistance
iii. Strengthening the research-extension linkage

INITIAL EXPOSURE (IN-SERVICE TRAINING)

The scientists associated with FSR may receive their training from expert/teams engaged in this type of work. Initially this method was adopted by PARC where experts from IRRI, CIMMYT helped train Pakistani scientists in target areas of each province.

Several institutes in the world have now programs to train FSR teams. Centres like CATIE, CIAT, CIMMYT and IRRI provide such training. Countries with on-going FSR programs offer another good opportunity for intership experience. Guatemala, Indonesia, Senegal have such facilities available. A group of trained personnel can work with FSR specialists from other countries to develop national FSR programs.

Further training may be imparted by this core staff at the national level. Trainees get an opportunity to learn the practical concepts of FSR in the setting in which they will eventually find employment.

DEGREE LEVEL TRAINING

The growing complexity of farming and the need for accelerated farm production increases demand for qualified young scientists with a practical understanding of the small farmer circumstance. The FSR/E approach development among interdisciplinary scientists who understand well

[1]*Assistant Professor, Department of Livestock Management, University of Agriculture, Faisalabad*

the farmers resources and constraints deserve to be enhanced. Changes in agricultural undergraduate training will be necessary. Improved university curricula and facilities which encourages such training is imperative.

Initially it would be very difficult to introduce drastic changes in existing degree programs. However, small changes in the program may be incorporated. For instance in the present eight semesters animal husbandry program, the four credit hours allocated to practical training could include student on-farm visits. Students would, with farmers assistance, analyze the present farm resources and management.

An introductory one-semester farming systems research course (Annex-2) would support the present farm practicum. Internship training on farms that provides senior students experience in problem diagnosis and the testing of improved technology should be initiated. To accompany this farm practice, senior students may take a farming system and farm management course through the final year (Annex. 3). In addition to agronomy, agricultural economics, animal husbandry and soils, team teaching should include agricultural education and extension. A modified semester VIII on farm extension work (Annex. 4) may be instituted.

SUGGESTED PRACTICAL WORK SHOULD INCLUDE:

- Not less than six weeks farming under three different systems of contrasting cropping patterns and livestock management.
- Approval to substitute upto 12 weeks of student practicum in the agricultural service sector including research and/or extension.
- Complete statement by student of work performed on prescribed formats.

A proposed scheme of study for B.Sc (Hons) farming systems appears in the Annex. 4. The proposed degree would prepare the undergraduate for leadership positions in the public and private sectors as well as for advanced training.

POSTGRADUATE TRAINING

Curriculum and training towards a postgraduate degree in FSR would emphasize quantitative management methods in selected farming systems. Students may enter the FSR postgraduate scheme with an agricultural, livestock, economic or education extension background.

Thesis work in each instance would include studies within FSR target areas. Multidisciplinary postgraduate team research would be encouraged. It is proposed that once postgraduate FSR interdisciplinary thesis research has been established, the university would initiate the advanced farming system and management analysis course.

PROGRAMS FOR TECHNICIANS
(AGRICULTURAL ASSISTANTS/STOCKMEN/ VETERINARY COMPOUNDERS)

Understanding the farmers socio-economic circumstances, recognizing important farm operations and diagnosing problems are important FSR functions required by site assistants and field workers. Technicians should spend more time with the farmer to acquire agronomic and livestock husbandry skills. Middle level workers may also be trained in record keeping, data collection, crop cuts, sampling, animal measurements and related tasks. The technician teams may include persons with training in agriculture, animal husbandry, animal health, etc. Periodic refresher courses and workshops for technicians must be made available.

FARMERS TRAINING

An accelerated change by farmers from centuries old practices to improve farming systems requires training in modern technology, management skills and in improved crop and livestock

husbandry. Field days, farm visits, workshops and travelling seminars can impart practical training to farmers. Farmers have already enthusiastically participated in low cost silage making and in treating *bhoosa* with urea to improve livestock feeding practices.

WOMEN COMPONENT

Rural women play an important role in agriculture/livestock production. They too can be trained in basic skills of animal health (care and management of preventive vaccination, etc.) at the village level in small groups. A poultry vaccination program by selected rural women in several other developing countries has been enthusiastically received.

FSR INSTITUTIONALIZATION ISSUES AND RECOMMENDATIONS

Conference work groups in research, education and extension advanced important issues and recommendations to institutionalize FSR in Pakistan.

RESEARCH GROUP

Institutionalization of FSR according to the research groups requires:

Initially the establishment of an FSR unit directly under the DG (Research) or Dean has merit. A small interdisciplinary team of three senior scientists (agronomy, animal science, agricultural economist) with junior assistance and support staff will suffice. Experience in the field will demand additional scientists being allocated to FSR projects as needs arise.

An operational budget including funding of Rs. 150,000/- annually has, under the MART project often been adequate to support an effective FSR project in a target area. A micro computer with accessories and normal office supplies would be needed.

During the first two years each FSR organization cell should receive support under MART Project.

Each institute/university/agency in each province will need to commit scientific manpower, technical assistance support staff, an adequate budget and space to effectively conduct FSR at respective target areas.

Complex problems of the small farmer must be tackled by a team of interdisciplinary scientists. Problem diagnosis, experimental design and inter-actions between soil, plant and animal, favour an FSR approach.

Pakistan has an agricultural research system in place. Now it is time to build on its strengths to better serve farmers. Success depends on a commitment to an FSR/E approach and development of leadership to organize and manage it.

The FSR project objective should be clearly stated in terms of research. Once farmers have tested the technology a pilot-to-production phase should be initiated. Scientists must quantify farmer adoption of improved technology.

The director of research in agriculture, livestock and water management should be consulted for practical field collaboration in an FSR domain. Subsequent extrapolation of farmer tested improved technology should be carried out by developing FSR links with adaptive research and extension.

Feedback problems for experiment station researchers is an important product of FSR.

Success stories in raising productivity of the small farmer using low investments that sustain improved family welfare should be regularly made available to policy makers and planners.

EDUCATION GROUP

The work group on education agreed that education was critical to the longer-term institutionalization of farming systems research in Pakistan. To date, the educational institutions have had limited experience in the approach, but this is changing rapidly, especially at Faisalabad and Tandojam. The special features needed to be installed in staff and students are the goal-oriented and multidisciplinary nature of FSR. Well institutionalization teaching and experience in FSR at universities and colleges of agriculture will encourage much greater understanding of the approach and develop the philosophy in all involved.

The philosophy of FSR should be introduced to students early in the curriculum. Then a formal course or set of courses should be given in the third or final year of undergraduate training. Practical training with field visits, diagnosis and conducting of on-farm trials as a multi-disciplinary team should be emphasized.

Course work on system analysis may be introduced at the graduate and undergraduatge levels.

A post graduate minor course in FSR ought to be offered at universities. Agricultural colleges should teach practical examples based on FSR project experience.

EMPHASIS ON PROBLEMS SOLVING

All involved in FSR at universities should emphasize diagnosing and solving key problems of farmers and business related to agriculture.

Special training of teachers of FSR will be required initially. Such training should best be coordinated by NARC/PARC, and involve those who have FSR experience. Training of teachers should be shared by provinces and universities benefiting from such training.

SCHOOLS OF EXCELLENCE IN FARMING SYSTEMS

FSR understanding and capabilities could be accelerated by establishing in Pakistan "schools of excellence in farming systems". Such schools of excellence would take a broader perspective on systems approach. They would interact with other professions where systems thinking has developed.

Systems education must involve all components of dominant farming systems, and attempts should be made to establish more than one center of excellence in each province. PARC/NARC should take a lead in identifying such opportunities. Livestock, agro- forestry, horticulture, fisheries together with cropping systems should be included.

A STRATEGY FOR INTRODUCTION FSR

Initiate a pilot study involving all agricultural institutions. Assess system needs for individual provinces based on socio-economic conditions, agro-ecological zones, economic and policy thrusts.

Request a joint Pak-overseas FSR expert team to review possible systems curricula in Pakistan.

Develop strong linkages with selected International Universities and Centres through FSR programs.

EXTENSION FSR BECOMES FSR/E

The work group on extension agreed that FSR/E activity should become an integral part of the work of the extension service. Exactly how the involvement of extension is to be organized was

considered to be less important than to develop an awareness of the desirability of developing workable multi-disciplinary and inter-agency cooperation.

Extension should be involved from the very beginning of the farming systems research work and be a full partner all the way from problem identification through problem solving to delivery of the recommended technology. The adaptive research farms provide a splendid opportunity to link FSR with extension:

- Initiate collaborative projects between FSR and adaptive research in the Punjab and Sindh. The NWFP and Balochistan also have adaptive research farms. Each farm is staffed with a team composed of an agronomist and a farm management specialist.

- Strengthening linkage between FSR and Assistant Director of the department of livestock and dairy development.

- Other possible FSR/E collaborators from both the public and private sectors can collaborate with FSR/E.

- Establish an informal provincial coordination committee composed of the heads of the various agencies involved.

- FSR/E training should be placed with the provincial coordinator committee who should organize the short term training sessions for extension workers.

- The principles of farming systems research and results of FSR work should be made a part of provincial boards educational program to facilitate farmer adoption of improved technology. The FSR becomes Farming Systems Research/Extension.

FSR INSTITUTIONALIZATION OBSERVATIONS AND CONCERNS

Dr. Curtis Nissly[1]

The PARC/MART project has particular concern for programs such as Farming Systems Research (FSR). Indeed, we aim to improve the lot of the small farmer through FSR. Specific observations and concerns which emerged from the conference deserve comment.

OBSERVATIONS

1. The calibre of administrators, scientists and extension officers attending/participating is very high and signifies the success of FSR.

2. The particular relevance of FSR and the importance it can have to elevate the small farm family welfare through increased production is gradually being appreciated.

3. While the scope of FSR varies from province to province its approach is common and system perspective is accepted.

4. The conference has encouraged dialogue between research and extension, between social and natural sciences and between livestock and agro-forestry.

5. To date FSR project participation of the research/extension community in Pakistan is as yet minimal while the opportunity to expand FSR is considerable.

6. FSR/E is gender neutral but female participation in FSR remains to be developed.

CONCERNS

I believe it is appropriate for a donor agency to enquire whether the conference will:

1. Articulate critical factors to ensure sustainable FSR projects.

2. Assist FSR to develop as a significant factor in improving the National Agricultural Research System performance.

3. Define the distinct role of research in FSR but linked to extension.

4. Advance clear strategies and a schedule to internalize FSR and/or FSR/E in provinces and suggest the necessary changes in curriculum and training (staff and students) at the universities.

5. Promote interest and incentives which will ensure local public (and private) bodies commit resources to FSR and FSR/E at their respective institutions.

6. Articulate how, where and by whom donor agencies like USAID can best assist and support an effective FSR program.

7. Define the follow-up necessary to implement the conference recommendations.

[1]*Advisor, USAID*

PARTICIPANTS

1.	Dr. Amir Muhammed	Chairman, PARC
2.	Dr. M. Yousaf Chaudhri	Director General, NARC
3.	Dr. M. H. Qazi	Member (Crop Sciences)
4.	Dr. A. Q. Ansari	Chairman, University Grants Commission
5.	Dr. Rehman Khan	V.C. NWFP Agric., University, Peshawar
6.	Mr. Mehfooz Ali Shah	Director General, Agric. Extension, NWFP
7.	Dr. Khalid Mehmood Siddiqui	Director General, Pakistan Forest Institute, Peshawar
8.	Dr. Badruddin Soomro	Director General, Agric. Research Sindh
9.	Mr. Agha Aftab Ahmed	Director General, Agricultural Extension, Sindh
10.	Dr. A. R. Azmi	Director Atomic Energy Agric. Research Centre, Tandojam
11.	Mr. A. R. Khattak	Director Out-reach, NWFP Agric. University, Peshawar
12.	Mr. Siddique Khan	Director Research, NWFP Agric., University, Peshawar
13.	Dr. Rafiq Khan	Dean Agric. University, Faisalabad, Punjab
14.	Dr. Asghar Jalis	Director, Agronomy AARI, Faisalabad
15.	Mr. Bashir Sabir	Director, Adaptive Research, Punjab
16.	Dr. Munir Nayyar	Director, Sugarcane AARI, Faisalabad
17.	Dr. G. H. Memon	Associat Professor Sindh Agri.University, Tandojam
18.	Mr. Noor Mohammad Miano	Sindh Agri University, Tandojam
19.	Mr. Gulfam Khan Jahangir	Regional Director Out Reach, NWFP
20.	Dr. A. Majid	Coordinator (FSR), NARC, Islamabad
21.	Dr. Pervaiz Amir	Agricultural Economist, Islamabad

22.	Dr. Dyno Keatinge	MART/AZRI - Quetta
23.	Dr. Derek Byerlee	CIMMYT, Mexico
24.	Jim Longmire	CIMMYT, Islamabad

PROGRAMME

May 29, 1989

First Session/Inauguration

1700	Arrival of the Chief Guest		
1705	Recitation from Holy Quran		
1710	Purpose of the Conference by M.D. Dawson		
1720	Keynote Address by Derek Byerlee		
1815	Response	1.	Bill Wright
		2.	Abdul Majid
1845	Inaugural Address by Amir Muhammed		
1915	Role of Radio/TV in Agricultural Development by Cordell Hatch/Anwar Hassan		
	Dinner		

May 30, 1989

Second Session

Chairman: Dr. Amir Muhammed
Pakistan Agricultural Research Council

0800	NARC/Fatehjang by Abdul Majid
0835	N.W.F.P./Mansehra by Abdur Rauf Khattak
0900	Sindh/Hala and Tando M. Khan by G. H. Memon
0930	Punjab/Shahkot and Proka by Asghar Jalis and M. Akram Raja
1010	Discussion
1045	Tea

1100	FSR Organization at NARC by Dr. M. Yousaf Chaudhri
1120	Discussion
1140	Curricula and Training for FSR/E by Dr. Sadaqat Hanjra
1200	Discussion
1300	Lunch

Third Session

Chairman : Mr. Nasiruddin Ahmed
Secretary (Agriculture) Balochistan

Work Groups

1400	Instructions by M. D. Dawson

Research
Leader : Dr. M. H. Qazi

Rapporteur: Dr. Derek Byerlee

Extension
Leader: Syed Mehfooz Ali Shah and Bashir Sabir
Rapporteur: Taki Izuno

Education
Leader: Agha Sajjad Haider
Rapporteur: Bill Wright

Reports and Discussion

1730	**Research Leader:** Dr. M. H. Qazi
1800	**Extension Leader:** Syed Mehfooz Ali Shah
1830	**Education Leader:** Agha Sajjad Haider
1900	Discussion
1930	Dinner

Fourth Session

Chairman: Dr. Abdul Qadir Ansari
University Grants Commission

0800	Observations and Concerns by Curtis R. Nissly
0830	Recommendations and Action Plan - Group Leaders
0930	Conference Recapitulation by Dr. M. Yousaf Chaudhri
1000	Concluding Remarks by Session Chairman
1030	Visit to Experimental Station(s) and/or AZRI

SCHEME OF STUDY FOR THE DEGREE OF B.Sc. (Hons.) ANIMAL HUSBANDRY

Course No.	Title	Credit Hours
First Semester		
(a) Major Courses		
ABG-301	Introductory Genetics	3 (2-2)
LM-311	Livestock Management-I	3 (2-2)
AN-321	Fundamentals of Animal Nutrition	3 (2-2)
PH-331	Introduction to Poultry Husbandry	3 (2-2)
(b) Supporting Courses		
V.AN.301	Veterinary Anatomy	3 (2-2)
Bio-Chem-301	Elementary Biochemistry	4 (3-2)
ENG-301	Introductory Exercises in Reading, Comprehension and Communication Skills	2 (2-0)
FRW-302	Range Management	3 (2-2)
SSH-302	Pakistan Studies	2 (2-0)
Second Semester		
(a) Major Courses		
ABG-302	Principles of Heredity	3 (2-2)
LM-312	Livestock Management-II	3 (2-2)
AN-322	Metabolism of Primary Nutrients	3 (2-2)
PH-322	Breeding and Selection in Poultry	3 (2-2)
(b) Supporting Courses		
ZOOL-301	Inland Fisheries and Games	3 (3-0)
ENG-302	Introductory Exercises in Reading, Comprehension and Communication Skills	2 (2-0)
AGRON-305	Fodder Crops (Forage Grasses and Legumes)	4 (3-2)

**Alternate Course to Islamic Studies (for Foreign Students)*

V. Ph. 311	Veterinary Physiology	3 (2-2)
I.S. 301	اسلام کے عقائد و ارکان	2 (2-0)
*SSH-301-A	Ethics	2 (2-0)

Third Semester

(a) Major Courses

ABG-401	Genetics of Farm Animals	3 (4-2)
LM-411	Sheep Production	4 (3-2)
AN-421	Minerals and Vitamin Metabolism	4 (3-2)
PH-431	Incubation Principles and Practices	4 (3-2)
NUTR-423	Farm Practices	1 (0-2)

(b) Supporting Courses

RS-402	Introductory Rural Sociology	2 (2-0)
FT-403	Technology of Meat, Eggs and Milk Products	3 (2-2)
SSH-402	Pakistan Studies	2 (2-0)

Fourth Semester

(a) Major Courses

ABG-402	Genetic Principles in Animal Breeding	4 (3-2)
LM-412	Goat Production	4 (3-2)
AN-422	Measurement of Body Needs and Feed Values	4 (3-2)
PH-432	Poultry Farm Management	4 (3-2)
PH-434	Farm Practices	1 (0-2)

(b) Supporting Courses

AE-301	Introduction to Agric. Economics	2 (2-0)
STAT-401	Statistics for Animal Sciences	4 (3-2)
I.S. 401	اسوۂ حسنہ	2 (2-0)
*SSH-401-A	Pakistan Culture	2 (2-0)

Fifth Semester

(a) Major Courses

ABG-501	Theory of Animal Breeding	4 (3-2)
LM-511	Principles of Dairy Cattle Management	4 (3-2)
AN-521	Nutrient Requirements of Farm Animals	4 (3-2)

PH-531	Poultry Housing and Equipment	4 (3-2)
LM-513	Farm Practices	1 (0-2)

(b) Supporting Courses

VAR-580	Reproduction in Livestock	5 (3-4)
FM-501	Planning for Livestock Production	3 (3-0)
SSH-502	Pakistan Studies	2 (2-0)

Sixth Semester

(a) Major Courses

ABG-502	Breeding Systems and Plans	4 (3-2)
LM-512	Principles of Milk Secretion	4 (3-2)
AN-522	Feeding of Farm Animals	4 (3-2)
PH-532	Poultry Feeding Practices	4 (3-2)
ABG-503	Farm Practices	1 (0-2)

(b) Supporting Courses

V.Md. 562	Introduction to Veterinary Medicine	4 (3-2)
AM-502	Marketing of Livestock, Poultry and their Products	3 (3-0)
I.S. 501	تعمیر سیرت و کردار	2 (2-0)
*SSH-501-A	Islamic Culture and Civilization in Pakistan	2 (2-0)

Seventh Semester

(a) Major Courses

ABG-601	Selection Production Traits in Farm Animals	4 (3-2)
LM-611	Range Livestock Production	4 (3-2)
AN-621	Principles of Poultry Nutrition	4 (3-2)
PH-631	Poultry Hygiene and Disease Prevention	4 (3-2)

(b) Supporting Courses

RD-602	Rural Development (Project Studies)	1 (0-2)
FMP-650	Farm Equipment, Structures and Processing	4 (3-2)
VAR-680	Animal Reproduction Clinic	1 (0-2)
SSH-602	Pakistan and the Modern World	2 (2-0)

Eighth Semester

(a) Major Courses

ABG-602	Animal Breeding Practices	4 (3-2)
LM-612	Beef Production Practices	4 (3-2)
AN-622	Animal Feed Industry	4 (3-2)
PH-632	Poultry Industry	4 (3-2)

(b) Supporting Courses

AEE-601	Agricultural Extension	2 (2-0)
I.S. 601	اسلامی نظریۂ حیات	2 (2-0)
*SSH-601-A	Islamic Culture and Civilization in Pakistan	2 (2-0)

INTRODUCTORY FARMING SYSTEMS RESEARCH

Duration: 1 Semester
Offering: Department of Agricultural Economics, Department of Agronomy and Department of Livestock Management
Level: Junior year students from agriculture and animal sciences

Course Objectives

- to introduce students to the philosophy of systems research
- to provide an understanding of the crop-livestock interactions and develop a framework for farm-level development
- to teach analytical approaches required in the description, diagnosis, design, testing, and evaluation of new farm technologies
- to provide opportunity to work directly with farmers and develop a senior paper that demonstrates the basic skills required for farm-level research

Note: *The course will be a joint offering. The relative emphasis on crops versus livestock will depend on whether the student is enrolled for a B.S. in agriculture faculty or animal sciences faculty. Instruction will be by an inter-disciplinary team of instructors.*

COURSE OUTLINE

A. A Farming Systems Perspective to Research and Development

1. Definition of FSR
2. Scope of FSR
3. Differences between FSR and traditional research approaches
4. Philosophy of FSR in an international perspective
5. International agricultural research system
6. Overview of the course

B. System Framework

1. *System methodology*
   a. Description
   b. Diagnosis
   c. Technology design
   d. Technology testing
   e. Evaluation

2. *Crop-livestock interactions*
   a. Crop-crop

b. Crop-livestock
c. Crop-orchard
d. Crop-labour
e. Livestock-labour
f. Crop-livestock-off-farm
g. Other

3. *Soil-water-land-animal-man biosystems*
   a. Understanding farmer circumstances
   b. Farmer decision-making under constrained environments
   c. Implications of interactions on systems productivity

C. Study of Crop Component

1. Approaches to effective problem diagnosis
2. Describing the crop component on a farm
3. Analyzing farmer constraints and identifying possible technology interventions
4. Quantitative approaches to crop evaluation
5. Qualitative approaches to crop evaluation

D. Socio-Economic Methodologies for System Evaluation

1. The role of the social scientist in biological research
2. Socio-economic methods of understanding farmer circumstances
3. Pre-screening technologies
4. Evaluation of farm level data for inducing change
5. The technical-social scientists partners in research

E. Major Farming System of Pakistan

1. Farming systems of Punjab
2. Farming systems of Sindh
3. Farming systems of NWFP
4. Farming systems of Balochistan

F. Field Practice for Social and Biological Workers

Notes:

1. *Teachers should be given orientation and chance to develop training material at NARC. Teachers should be selected in groups and provided 1-2 week orientation and the necessary training.*
2. *Students normally take one course which covers the basics of production economics and farm decisions.*

FARMING SYSTEMS AND FARM MANAGEMENT

(Final Year Undergraduate Course)

Animal Husbandry, Agronomy, Agricultural Economics, Soils and Extension Seniors and M. Sc. Students

Objectives

- to develop an understanding of ongoing farm systems and diagnose production/marketing constraints
- to understand the options available to accepted management practices and develop an ability to conceive, research and analyse alternative options
- to develop an ability to understand a farmer's objectives and capacity for management to communicate with and advise a farmer to understand what a farmer wants to do
- to investigate plausible improved technological and managerial (economic and structural reorganization) interventions into traditional farming systems
- to develop an appreciation of the functions and importance of the industries servicing agriculture and diagnose how their performance can be enhanced
- to develop an ability to work as inter-disciplinary teams to exchange views and to constructively comment on other views and other decisions
- to question and to be questioned: why, how, where, when, what and who; management must be dynamic, but use the past as a guide
- to enable a student to become technically and professionally competent in FSR approach and perspective

Subject Areas

- The farming systems approach – describing the farm, the management, the finances and drawing up management interventions based on priority constraints to improve productivity and farmer welfare
- The farmer as an individual and his family
- Soil and water management
- Cropping patterns and field husbandry
- Livestock husbandry
- Feed assessment, evaluation and budgeting
- Financial management and cash flow budgeting
- Accounts analysis – cash
- Ownership structure
- Development and economic issues

Field Trips

Projects will be set for all farm visits. Discussion topics also may be set during or at the end of a visit. There will be two groups for field trips and tours. Question masters will be appointed on a rotational basis. Their duties will include finding the way to farms, compiling climate and soil maps, and other secondary data.

Study Selected Farms under the Following Systems:

- Barani agriculture – Chakwal target area
- Moderate rainfall – Fatehjang target area
- High rainfall – Mansehra target area
- High country – mixed farming sheep/goats
- Irrigated – wheat rice
- Irrigated wheat cotton – mixed farming milk
- Horticulture and irrigated orchards
- Poultry – broiler chicken – integrated industry
- Fishing industry – marine, aquaculture

Study Tours

- Livestock/crop experiment stations
- Fodder/agro-forestry sheep/goat experiment stations
- Multicrop experiment station(s)
- Horticultural experiment station(s)

Projects

Projects will be assigned for every field trip. These projects will be discussed and collected for marking. All project marks will be included in the year's final assessment. Students should do all projects on an individual basis unless otherwise directed. Where groups work on a project collectively, the names of all members must be shown. Students will be allocated their farm project during semester one.

Examinations

The mid-year test consists of a written paper. The final examination in this course consists of a written paper. The possible weighing of marks over the year is as follows:

Final written examination	30
Major farm project	40
Mid-year test	10
Projects	20
Total:	100

DEPARTMENT OF AGRICULTURAL EDUCATION AND EXTENSION

Semester V

AEE 501	Introduction to Communication	3 (3-0)
AEE 502	Educational Psychology	4 (4-0)
AEE 503	Extension Education in Pakistan	4 (4-0)
AEE 504	Teaching Methods in Agriculture	4 (3-2)

Semester VI

AEE 505	Audio-Visual in Teaching	4 (2-4)
AEE 506	Program Development	4 (3-2)
AEE 507	Principles of Education and Curriculum Development	3 (3-0)
AEE 507	Administration and Supervision	4 (4-0)

Semester VII

AEE 602	Approaches to Rural Development in Pakistan	4 (3-2)
AEE 603	Project Development and Report Writing	3 (2-2)
AEE 604	Preparing Rural Youth for Agriculture	4 (4-0)
AEE 605	Research Methods in Education and Extension	4 (3-2)

Semester VIII

AEE 606	Lesson Planning and Practice Teaching	5 (1-8)
AEE 607	On-farm Extension Work	10 (2-16)
AEE 608	Writing and Presentation of Report on Field Experiences	5 (0-10)
AEE 609	On-farm Extension Work-I	5 (1-8)
AEE 610	On-farm Extension Work-II	5 (1-8)

Note: *Semesters I to IV remain unchanged in the Calendar of University of Agriculture, Faisalabad.*