Farming Systems Research & Extension: Food and Feed

Abstracts

Edited by
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FARMING SYSTEMS RESEARCH PAPER SERIES

Kansas State University's Farming Systems Research (FSR) Paper Series is supported by the U.S. Agency for International Development Title XII Program Support Grant. The goal of the Program Support Grant is to increase the University's ability to implement Title XII agricultural and nutritional development assistance programs in less-developed countries. This series is maintained by the FSR Program Associates -- a multidisciplinary team of professors who are aiming their activities at applied research on farming from a systems perspective.

The purpose of the FSR Paper Series is to disseminate information on FSR. Publication categories include updated bibliographies from KSU's FSR data base; proceedings from KSU's annual Farming Systems Symposium; selected papers presented in KSU's FSR Seminar Series; selected papers prepared by KSU's Programs Associates.

Copies of these papers may be obtained from the Distribution Center, Umberger Hall, Kansas State University, Manhattan, Kansas 66506. There will be a charge for selected papers and multiple copies to help defray cost of printing.

Vernon C. Larson
Director

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Farming Systems Research and Extension:
Food and Feed

Introduction

by Cornelia Butler Flora, Kansas State University
Symposium Organizer

Food and Feed is the theme for this year's Symposium. It was chosen to represent the complex of enterprises that make up the farming systems of limited resource farm households around the world and to focus on the interaction of plants, animals, and people. Within this broad theme, we sought papers which specifically addressed crop/animal interactions in farming systems research and extension and commodity research linkages to FSR. Methodological and institutional concerns related to the theme emphasize FSR/extension linkages, farmer participation at all stages of farming systems research and extension, the utilization of rolling research designs that respond to changes in the farming system, the policy and climatic environment, and researchers' awareness of constraints and interactions within the farming system and with the larger environment. In addition, food as a theme is addressed specifically by papers on consumption/nutrition issues in FSR/E at all stages of the process.

The papers submitted in response to our solicitations represent five continents. Individuals involved in the field implementing a farming systems approach to development are the majority of those whose abstracts were accepted for presentation. Because of the large number of submissions and the preference of those submitting to participate in paper sessions, we have eliminated poster sessions this year. Thus, there are more concurrent sessions. The few practitioners that requested poster sessions will be featured in the exhibition area during breaks, thus maximizing their opportunity for interaction with those interested in discussing their work with them. Over 90 different abstracts were received, representing over 50 different FSR projects, as well as a number of pre-project diagnoses and comparative analyses of alternative approaches to FSR/E.

As the systems addressed become more complete, the complexity of the projects increases exponentially. The institutional and methodological adaptions necessary to carry out adequate research that is responsive to the needs of the limited resource farmer are well represented in the papers presented. A number of special sessions address the institutional issues directly, such as that on CEICADAR in Mexico, comparative approaches in the Caribbean, communications in FSR/E, and the Small Ruminant CRSP.

During the six years of this annual event, we have observed an increase in the quality and quantity of the papers presented. In particular, the ever-increasing number of FSR/E practitioners associated with national programs in developing countries has added an important flavor and quality to the undertaking. We are particularly thankful to the leadership of David Norman in setting up the first FSR Symposium, the

International Agricultural Programs at Kansas State University and the collaboration with the Farming Systems Support Project for their financial and intellectual assistance over the years. We look forward to continued collaboration with our colleagues engaged in FSR/E in the future.

++Please note. If an * follows an author, the address listed is for that individual, otherwise the address is for the principal author.

+++If any paper is not found in the published volume of the Symposium Proceedings, the authors' names and addresses are furnished so a copy of the paper may be obtained from them.

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Reconciling Conflicts in Sequential Cropping Patterns Through Plant Breeding: The Example of Cotton and Wheat in Pakistan's Punjab

Farming systems research programs should be regarded as complementary to commodity programs. However, effective linkages and feedbacks are often not well developed; as a result commodity programs lack a farming systems perspective. This paper describes the problems of developing appropriate varieties to fit a sequential double cropping pattern.

Plant breeders in Pakistan have traditionally developed varieties for a particular commodity, independently of other commodity breeding programs, even though many crops are closely linked in multiple cropping patterns. Even when efforts are made to incorporate a cropping systems context in breeding priorities, these are often quickly outdated by the dynamics of change in cropping patterns brought about by factors such as increasing cropping intensity and changing price relationships. The paper describes the case of cotton, a major cash crop and wheat the major food staple, which are each grown on about 1.5 million ha in kharif (summer) and rabi (winter) season in the southern Punjab of Pakistan. Cotton and wheat were traditionally not grown in a sequential double cropping pattern but in a cotton-fallow or fallow-wheat pattern. Cropping intensities have, however, increased rapidly from an index of 113 in 1971 to over 130 in 1983.

A combination of informal and formal surveys have been used to diagnose major factors limiting productivity of the cotton/wheat system and to identify research priorities. In 1985, nearly half of all wheat was grown after cotton, and was the dominant cropping pattern of small farmers. Wheat after cotton was planted on average 19 days later than wheat in other rotations. Indeed nearly 70% of wheat following cotton was planted after December 15th when yields are reduced by a minimum of 30 kg for every day's delay in planting. Farmers appear to rationally weigh the benefits of an additional cotton picking against the loss in wheat yield from late planting. Simple calculations of the economic benefits of the last cotton picking compared to the value of wheat production foregone wheat confirm this. Many factors potentially influence the conflict between cotton and wheat. Those discussed in the paper include changing price relationships between cotton and wheat and the recent stepped up campaign to protect the cotton crop through pesticide use, resulting in higher cotton yields and even later planting of wheat. More importantly, the paper discusses in detail recent plant breeding advances in wheat and cotton which will help reduce conflicts. An early maturing and high yielding cotton variety, NIAB78, was developed by the Nuclear Institute of Agriculture and Biology. While initially not

recommended for release, the variety "escaped" and was quickly accepted by farmers. NIAB78 potentially allows cotton harvesting to be completed two weeks earlier and an increase in wheat yields of close to 500 kg ha.

In developing wheat varieties for the cotton/wheat systems two issues dominate; a) what type of variety performs well for late planting? and b) should breeders attempt to develop separate varieties for "normal" planting and late planting? Traditionally, wheat breeders have selected early maturing varieties for testing under late planting. However, evidence is presented that other longer maturing varieties in fact perform better than early varieties for late planting. In addition most farmers, especially small farmers, plant only one variety. This is despite the fact that farmers generally plant in more than one period because of differences in rotations between fields. Nearly one third of farmers spread wheat planting over a period of four or more weeks. Moreover, wheat planting dates vary considerably from year to year depending on the state of the cotton crop. Hence, there is a strong case for selecting wheat varieties that perform well across a range of planting dates. Two recently released varieties are promising in this respect (e.g. Pak 81 and Punjab 81).

The case discussed in this paper demonstrates the importance of considering the total cropping system in developing breeding priorities for individual commodities. These is a need to explicitly analyse the potential for resolving conflicts through adjustments in one or both crops. Moreover, a dynamic perspective is needed to accommodate changes in cropping patterns and crop management which have implications for varietal performance.

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Evaluation of New Technologies in Burkina Faso in a Risky Environment for Different Recommendation Domains

This paper will consider the feasibility of adoption of new technologies in Burkina Faso, West Africa, taking into account the variability of yields associated with the new technologies. The technologies being evaluated are fertilization and water conservation, which were tested in the farming systems research project in Burkina from 1982-1985. These included fertilization, tied ridges made by hand, and tied ridges made with an animal drawn mechanical ridge tier. Whole farm modelling will be used to evaluate the new technologies under different states of nature, good, poor, and average weather years, to evaluate the impact of risk in production on the adoption of these technologies.

In a survey conducted in 1985, farmers were questioned about the probabilities associated with each state of nature, and this information will be incorporated into the evaluation. While the use of fertilizer is expected to be associated with a large variation in yields from a good to a poor year, the incorporation of tied ridges with fertilizer may reduce that variation and increase the yields substantially in a poor year.

The impact of risk and other factors affecting profitability will be systematically evaluated for the central and the eastern regions of Burkina Faso. The site in the central region studied is characterized as an older settled region where the fallow system has broken down due to man-land pressures. Yields are very low and the crop rotation has shifted to a large proportion of millet due to this crop's greater ability to tolerate lower fertility conditions. The site in the eastern region is characterized as a frontier region where the fallow system is still practiced, yields are higher, and there is more animal traction including oxen. The appropriate technologies for these recommendation domains vary due to differences in resource endowments especially land quality, and in farmer characteristics with respect to capital availability and the propensity to take risks.

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Second Generation Approaches to FSR/E

Acknowledging the achievements of FSR/E activities for more than a decade, the time has come to reassess the first generation approaches and evolve into a second generation.

The underlying rationnale for FSR/E may be traced to the needs for (1) an agenda for agricultural research which would be more relevant to the small mixed farming systems on which most rural families live in Africa, Asia, and Latin America; and (2) more operationally effective coordination among government organizations intervening in agriculture. The record of achievement for both goals has been less than impressive.

Two major aspects of first generation approaches are challenged. First, the basic strategy of a "committee" approach was cumbersome, expensive, and time consuming. Second, when coupled with the arrogant assumption of upstream/downstream research/extension combinations which would deliver rapid results, while highly attractive to "donors," it was not as productive of useful results as had been promised.

Second generation approaches might deploy three alternative strategies toward the original ends. In implementation, FSR/E professionals must credit farm families with having been engaged in FSR for centuries. Second, it could be assumed that a separate and highly respectable task is to describe and understand a farming system (or type of farming system), and that perhaps our highly differentiated and specialized systems of technical agricultural education have room for training some farming systems generalists who would work like Family Practice Specialists among other specialists in human medicine. Third, both the structure and the agenda of agricultural research and extension might be decentralized so that farm family wisdom might have a larger voice.

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Women and Trials Management in Botswana: Experiences with Farmer Groups

This paper reviews experiences of the Agricultural Technology Improvement Project (ATIP) with farmer groups in Botswana. Farmers groups were developed as a trial management strategy in direct response to the special circumstances and problems of women and of female-headed households.

At the beginning of 1985-96 cropping season, ATIP staff memebers helped form four farmer groups, two in one village and one in each of two other villages. Members of the farmer groups implemented several trials during the season. The foci of these trials were sole cropping and post-establishment management practices. Both areas of interventions were not entirely new to the research area but did involve practices being used by half or less of the farmers. Throughout the season the farmer groups and ATIP representatives met on a monthly basis. Meetings generally consisted of three discussion areas: (a) each farmer's situation and problems since the last meeting, (b) trials management and assessment of intermediate outcomes, and (c) "looking ahead" to opportunities to participate in other government (resource transfer) programs or alternatives for future farming systems interventions.

The farmer groups seem to have been effective not only as a trials management vehicle but in creating an opportunity for on-going dialogue about farmer problems and opportunities. Even more important, the groups provided a chance for farmers to discuss among themselves, the advantages of interventions being tested and to generate momentum in favor of those interventions which looked to be promising, and even where a single season's agronomic and economic analysis could not prove the profitability of a recommendation.

Farmer groups may have broader relevance as a trials management strategy outside the particular context in which they have been tried in Botswana.

The first part of the paper clarifies the setting in which farmer groups emerged. The Botswana agricultural story is interesting in itself because of the dominant contribution of women, the low and erratic rainfall environment, and the role of agriculture in national development. Section 2 describes the mechanics of forming and administering the farmer group approach. Section 3 assesses experiences with the group meetings. Section 4 presents an assessment of trials implementation and tentative outcomes of the sole cropping and post-establishment trials. The concluding section indicates where we are likely to go with farmer groups in the future.

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How the Analysis of Cultivation Systems Contributes to a Coherent Agricultural Development Policy: Case Studies in the Mediterranean Region

The laboratory team has been working for several years on development research programs in various zones of Southern France and Algeria.

Research is conducted within the system analysis framework preceeding development policy implementation very similar to the Anglo-saxon concept of "farming system research."

The method consists of a survey conducted among farmers to learn how their farming system functions, thereby establishing a typology of these systems and proceeding to experimentally evaluate the validity of initial projects in close collaboration with representative farmers; researcher and farmer then continue to work in concert, specifying and elaborating on these projects.

The object of the paper is to demonstrate that system analysis establishes coherence between projects on the one hand and the complex physical and social environment of the farming systems on the other.

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Collective Versus Individual Centered Approaches to On-Farm Adaptive Research in the Guinea Savanna Zone of Nigeria

This paper reports results from two studies that took contrasting approaches in investigating the problems of introducing an improved maize production technology package into the farming system in one area of Northern Nigeria.

Following on-farm adaptive studies by the Institute for Agricultural Research (IAR) in 1982 and 1983, it was decided that given the small size of individual farms, it would be advantageous to organize individual holdings into large production blocks. In 1984, 19 farmers started work on a 7 ha production block for maize. Each farmer owned a plot in the block and applied some elements of the recommended production package to his plot. The tillage and ridging of the whole block was done by a tractor organized by IAR. The application of fertilizer and herbicide will be similarly executed in later trials. The major advantages of this block approach was conceptualized in terms of economies of scale and institutional and social gains from this type of utilization of land and group effort.

At the same time, IAR continued with the conventional individual centered on-farm adaptive research by propagating the improved maize technology package on 31 individual plots; 16 of these did their tillage and ridging with the hand-hoe, while the remaining 15 used tractors that they requisitioned individually.

Preliminary results show yields and returns from the block production exercise to be ahead of the individual centered exercises. IAR scientists also found that the production block provided a more convenient and central teaching demonstration forum for participating as well as nonparticipating farmers than scattered plots on individual farms.

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Application of Farming Systems Methodology in the San Luis Valley of Colorado

Farming systems methodology, developed in various permutations over the past decade, approaches agricultural development in a holistic manner, working from an interdisciplinary perspective and emphasizing the participation of client farmers in order to develop improvements which are feasible within the limits posed by constraints within which those farmers operate.

In the application of the methodology in the project area of the San Luis Valley, two interrelated problems were encountered. One was the problem of finding and maintaining a coherent focus in an interdisciplinary and systems approach. A second was the problem of identification of the client, i.e. the limited resource farmer. To reconcile the complexity of the systems approach with the need to be problem solving, and to encourage participation of limited resource farmers (clientele) the SLV team explored the concept of divisibility of technologies. The team concluded that the definition of system was a heuristic process, in which boundaries were drawn according to criteria presented by the particular problem at hand and the potential solutions to that problem. Thus, the dimensions of the system might change according to the divisibility suggested by any particular solution. The team has been less successful in developing a concept of the limited resource farmer. There is conviction that a typology based in the recognition of heterogeneity must be employed, and that we must apply the concept of adaptive strategies if we are to overcome the distortion which comes with trying to locate individual farmers on a continuum of more or less resources.

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A Study of Farming System Constraints and Research and Extension Needs in Transkei

The paper discusses results of a systems approach study of agricultural development problems involving a sample survey of 538 respondents in typical rainfed and irrigated cropping areas of Transkei. The objective was to diagnose problems in the farming system with a view to improving the impact of research and extension.

The study showed that the large gap between farmer yields and best potential yields is caused by both biological constraints in the sense of nonapplication or poor application of technology, and by socioeconomic constraints which prevent farmers from using the recommended technology.

A general lack of draft power, suitable implements and tools was found to be a constraint to improved crop production by individual farmers. Paradoxically, the draft power problem is not one of draft animals per se, but rather a problem of poor or disadvantaged distribution and utilization of draft animals. Cattle and small stock are not effectively integrated with crops in the farming system.

Active erosion and severe depletion of soil is taking place in many instances, owing to poor methods of crop culture, particularly to an inadequate plant population. Data show low rates of adoption of recommended maize production practices with regard to time of planting, use of manure and fertilizer, and of improved seed. Likewise, inadequate insect control and crop rotation practices have all contributed to the appallingly low maize yields. Laborious methods and shortage of labor for weed control was a particular constraint. Despite the fact that this practice is not recommended by extension workers, intercropping of maize with beans and pumpkins was practiced by four out of five farmers (77%) in rainfed areas.

There are considerable differences in the rates at which various maize growing practices are adopted by individual farmers. Some practices appear to be related in that a farmer will adopt all or none, while other practices seem to be adopted relatively independently. This suggests that farmers do not fully understand the operational use of farming practices and the dependence of one practice on another.

Knowledge of crops was found to be the most important variable determining adoption of maize practices, which emphasizes the importance of research and extension providing appropriate knowledge and technology; an important fact reinforced by the finding that farmers generally did not perceive lack of knowledge and poor management as a reason for low yields. Recommendations are made for improving current technology by evaluating intercropping systems, integrating crop and livestock production, and developing technology for improving plant population and weed control.

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Outreach Pilot Project: A Case Study of Small Ruminant Farming Systems in West Java

This paper attempts to address the development, implementation and implications of a FSR/E program whose special focus is livestock. The Outreach Pilot Project (OPP) was initiated by the Balai Penelitian Ternak (BPT) Livestock Research Support Program (SR-CRSP) in West Java, Indonesia. OPP aims at adapting technology packets for improving sheep and goat production at the village level. The basic structure of the program is 1) development of technologies by Indonesian and expatriate scientists on the research station, 2) baseline studies of communities in the region to choose representative villages, 3) placing packets in farmer groups, and 4) testing the validity of these packets through farmers responses as well as analyzing production data. Each farmer group is visited once a month by scientists in order to record production data and to get farmer reactions. OPP has been in operation since August, 1984 and some conclusions are being drawn on both the efficacy of the technologies and the possibilities for continuing and expanding upon such projects.

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Potential of On-Farm Research Trials to Increase Crop Production on Small Farms in North Alabama

In north Alabama, about 77% of all farms are classified as limited resource farms. During the 1985 growing season, three small farms were selected to conduct on-farm research studies primarily to increase crop production through multiple cropping or by adapting new production techniques. To extend the vegetable cropping season on one small vegetable farm, early tomatoes were planted in and under plastic and were then followed by a fall cabbage crop. Black plastic with Tunnel Remay increased earlyness of marketable tomatoes by one week, and the plants yielded 56% more than non-mulched tomatoes. Cabbage planted after tomatoes produced over 2000 kg/ha and the head yields were 30% higher in split applied nitrogen plots than single application by the farmer. For a corn and sorghum grower, on-farm research was conducted to compare grain yield responses of these crops to split application of nitrogen fertilizer to one time application by the farmer. Nitrogen application (half at planting and half at the 4-5 leaf stage) for both crops produced over 33% higher yield in comparison to farmer's rate and method of application. Similarly, to demonstrate yield differences due to row spacing and phosphorus rates, an on-farm research trial was conducted on soybeans. Results showed that soybeans yielded 32% higher in 45 cm row spacing and with 23 kg P_2O5/ha than traditionally (90 cm row with 68 kg P_2O5/ha) planted beans by the farmer. At the request of each farmer, these trials are being repeated in larger plots during the 1986 growing season.

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Weed Management Studies in Intercropping Systems in Trinidad and Tobago

Manual methods of weed control are commonly employed in intercropping systems in Trinidad and Tobago but are often expensive and inefficient. Data from a 3 year survey describe the extent and timeliness of weed control by small farmers growing intercropped pigeon (Cajanus cajan (L.) Millsp.) in Central and South Trinidad. Field trials conducted in association with farmers have shown that careful selection of intercrops can significantly reduce weed infestation, with corn (Zea mays L.) and cowpea (Vigna unguiculata (L.) Walp) being the most efficient weed suppression crops. The potential for the adoption of safe and effective herbicide treatments identified in specific intercrops is reported. The improtance of integrated approaches to weed management which take into account ecological and biological interactions between the crops and the weeds is highlighted.

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Complementing Plant Breeding with a Farming Systems Approach

Plant breeding is a method used in agricultural research which produces improved cultivars for use by farmers. Farming Systems Research and Extension (FSR/E) is an approach to improving the lot of rural households which attempts to identify important farmer problems, assist to increase the efficiency of solving these problems, and finally, assist to disseminate solutions to groups of farmers via extension. Using as an example the pedigree method of plant breeding, a simple model is developed which demonstrates that the efficiency of such a breeding approach may be increased by as much as 33% if it is complemented by a simultaneous FSR/E approach. This means that an improved variety may be available to farmers in 10 rather than 15 years, considering the total number of years involved in any specific breeding pipeline.

In addition, breeder/FSR/E practitioner teams have several advantages over either station-based breeders or FSR/E teams which work solely at the farm level. (1) Genetic screening and evaluation in farmer's fields can be advanced from the F6 or F7 generation to the F5 generation. (2) One or two years can be substituted for the five years formerly required for the final field test of advance lines. (3) Farmer-collaborators can be explicitly involved in the selection process at a much earlier stage in the breeding process. (4) Farmer evaluations of genetic materials on an informal basis can supplement breeder's field observations and formal analyses of differences between families. (5) The normal burden of production problems encountered in any national seed multiplication effort can be spread across the nation to selected farmers in many distinct research domains.

Such a working combination, plant breeder/FSR/E practitioner team may provide a further precedent for ways in which the FSR/E approach can make conventional agricultural research and extension more efficient. Similar arguments can likewise be made for FSR/E/IPM, FRS/E/livestock/crop interactions, and FSR/E/agroforestry (human ecology). FSR/E is much more than just an interesting approach to research and extension. It can make conventional agricultural research approaches more efficient at earlier stages, saving time, funds and, of most importance, human lives.

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Crop Livestock Interactions in Northern Pakistan Farming Systems: Maize as a Dual Purpose Grain and Fodder Crop

Maize researchers in northern Pakistan have traditionally only considered grain production when developing and disseminating improved maize technology. Recent evidence, however, suggests that farmers have rejected many of the recommended maize practices, such as lower seed rates, line planting, and early thinning. In particular, researchers have frequently complained about plant densities in farmers' maize fields that are considerably higher than "optimum" densitites. This paper presents evidence on farmers' management of plant density over the season to produce grain, and green and dry fodder. Farmers' practices are compared to recommended practices by estimating the economic value of both grain and fodder production in each system.

Data was generated from a number of sources. Small samples of farmers were visited at three-week intervals in four agroclimatic zones in northern Pakistan to obtain information on plant densities in maize fields and the composition of fodder given to animals in the preceding week. At harvest time, detailed maize production surveys were undertaken and grain and dry fodder yields and plant stand were measured in the field. Finally, a physiological model of the maize crop was used to predict partition of dry matter between grain and green and dry fodder production.

Livestock was found to be an important component of the farming systems with maize thinning contributing a high share of the fodder requirements in some months in some agroclimatic zones. In particular, in the irrigated mid-altitude valley of Swat, maize fields support livestock at the rate of six adult buffaloes or cows per hectare. At least 75,000 plants ha were removed for green fodder in this area. Farmers' management of plant stands is also found to increase dry fodder production at harvest time with only modest sacrifices in grain yields.

Different methods were used to value green and dry fodder but whichever method was used, the total value of fodder production is roughly equivalent to the value of grain production, especially in the Swat valley.

Comparisons of farmers' management with recommended practices suggest that in the irrigated Swat valley, farmers are maximizing productivity through broadcast planting at high densities and then progressively removing plants for green fodder. There is little or no advantage of the recommended practices. However, in a lowland rainfed environment where farmers have difficulty in obtaining target plant densities and where moisture is often limiting, there appear to be

significant advantages to planting separate grain and fodder crops with grain managed according to recommended practices.

This research has not only helped change recommendations so that they are more appropriate to farmers but has also fed back important criteria for development of maize varieties that meet farmers' grain and fodder needs and that perform well under farmers' plant density management.

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Crop/Livestock Systems Research in Asia: Design and Testing OFR

In the Asian Rice Farming Systems Network (ARFSN) which is coordinated at IRRI, a cropping systems research (CSR) methodology has evolved. Collaborators in national research programs follow the format of: site selection, description, design, testing, pre-production and production programs.

By consensus in the ARFSN, the shift from CSR to FSR is to use existing research site(s) and/or incorporate livestock as an additional farm component. This transition, instead of considering everything in the system all at once, was done to: (a) facilitate interdisciplinary effort, and (b) focus on more direct crop/livestock interdependence, e.g., use of fibrous crop residues as animal feed, recycling animal manure as fertilizer and utilizing animal draft power. Other animals and farm enterprises may be considered later.

With financial support from IDRC, five countries initiated one crop/livestock systems research project (CLSR). On-going projects are in Philippines, Thailand, and Indonesia. Projects in Sri Lanka and China are being finalized. In Nepal, an AID assisted cropping systems project with the Department of Agriculture also expanded work into FSR in one site to include milking buffaloes.

One major objective of the collaborative crop/livestock project is to elaborate on the methodology. This was to infuse interdisciplinary teamwork among researchers and to involve farmers in research design and testing. Monitoring tours of on-going projects facilitate critical assessment and interaction among collaborating scientists.

Each on-going project narrowed down on a livestock component of unique importance to the area. In the Philippines, it is cattle fattening; in Thailand, artifical breeding for producing F^1 Holstein x Brahman grade dairy heifers; and in Indonesia, a combination of cattle breeding, goat, and native chicken production. In Nepal, researchers are interested in improving milk production of milking buffaloes. Integral cropping systems work are addressed to increased grain and fodder yields.

After one year, difficulties in designing clearcut interventions and conducting field research were discussed with some possible solutions, especially in:

a. Improving crop/livestock interactions or complementarity;

b. Better understanding of socioeconomic issues and farmers' goals, and involving farmers more in research design;

c. Simplification of data needs and data gathering techniques, especially minimizing farmers' assistance;

d. Including farm stability and sustainability concerns into more short-term increased productivity.

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Expanding the Franchise: Curriculum and Training for Institutional FSR/E with a Ministry

Cornell University, the Philippines Ministry of Agriculture and Food of Region VIII, and the Visayas State College of Agriculture (ViSCA) have been working cooperatively on the Farming Systems Development Project - Eastern Visayas (FSDP-EV) since 1982. The focus during the past five years has been on the establishment of an organizational framework and procedures for a farmer problem-centered approach to generating technical solutions. Substantial progress has been made in improving research and administrative staff capability for working closely with farmers in developing technology in six research sites in the region.

Recently, attention has swung to the need for integration, regionalization, and institutionalization of FSR and FSE. A short course was conducted in July, 1986 for provincial and municipal (district) administrators, extension subject matter specialists, experiment station personnel, university faculty, and regional staff not previously involved in the FSDP-EV for the purpose of sensitizing them to the nature and purpose of FSR/E and to improving relevant knowledge and skills in research, extension, training, and communication basic to carrying out an effective region-wide FSR/E program.

The course was conducted as a cooperative endeavor by Cornell-MAF/Region VIII - ViSCA and the International Institute of Rural Reconstruction (IIRR) and consisted of four modules, each of one week's duration:

Week #1: Defining the what, why, and how of FSR/E.
Week #2: The Farmer: participation, indigenous knowledge, local organization.
Week #3: Functional integration of research, extension, and farming.
Week #4: Training and communication methods in FSR/E.

Formative and summative evaluations of the course were conducted and the results used in charting a schedule for an ongoing staff development program. The proposed symposium presentation will focus on principles and lessons learned from this educational approach to spreading and institutionalizing the FSR/E franchise.

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Farmer Participation in On-Farm Research and Extension
Some Farmers Still Say "No":
Lessons from the Farming Systems Development Project Eastern Visayas (FSDP EV)

Two separate cases of farmer participation in problem identification, on-farm testing of possible multipurpose crop/livestock solutions, and technology evaluation are examined in this article. Despite roughly similar levels of farmer involvement, the results from two cases are markedly different, with farmers rejecting the technology and, in many cases withdrawing from the further involvement with the research in one instance; in the second, farmers quickly assumed control of the trials themselves, transferred the technology to their own fields despite second generation problems, and became pivotal figures in a "farmers teaching farmers" extension outreach program.

The disparate results in the two cases are analyzed in terms of varying levels of technical soundness and social appropriateness of the test technologies, conflicts between trial design and local land use patterns, cultural preferences for group vs. individual risk-taking, and degree of prior fit with the local production system of the experimental technology.

Tentative conclusions are drawn from the two cases on how FSR/E researchers can promote better farmer participation and avoid farmer misunderstanding and abuse in on-farm research.

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Liaison Between Research Priorities in a Farming System Research Project and the University

In the FSR/E approach, it is expected that researchers base their activities on the necessities and linkages between the components of the farming system being investigated.

In the highlands of Mexico, where the Prototype Project of Plan Puebla in the state of Puebla, Mexico is located, deciduous fruit trees intercropped with annual crops are a component of the farming system of small farmers. In general, the quality of fruits being produced under these conditions is low, not because small farmers do not understand the value of fruits with a higher quality, but because in many cases there are specific problems that in order to be solved it is necessary to require the involvement of the university.

As an example, it can be mentioned that in the area of the project, the pear cultivar, "Paraiso" is one of the major fruit species, because its fruit is tasty and it is an early cultivar so its price in the market is high. Furthermore, being an early cultivar it is a material well suited for the intercropping system. The growing season of "Paraiso" goes from February to the end of June, meanwhile corn as the intercropped crop, goes from mid-April to the end of October. In 1985, Paraiso at harvest time (end of May to mid June) was $0.33 U.S. dollars for one Kilo, which is a very good price. However, the small farmer only can sell half or less of the production every year because Paraiso has the problem of fruit craking.

Small farmers a long time ago learned that this problem is related to the rootstock being used and that there are others which "do not crack" the fruit. Nevertheless, farmers do not use these rootstocks, because they also have learned that their ability to root is low as compared with the rootstock commonly used.

Small farmers are not familiar with the scarification process used to germinate fruit seeds, or the effect of hormones to promote rooting of cuttings, etc. University researchers many times ignore the availability of this plant material well adapted for intercropping systems and subsequently there is not sufficient information about their response to propagation methods and to management practices.

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A Quantitative Model of the Livestock System Component of a Bangladesh Farm

Many good qualitative diagrams or models of farming systems are found in publications depicting the multitude of interconnections. Less common are references that give quantitative connections between and among the various components. These interrelationships are numerous and complex, but must be better understood by the researchers in farming systems if alternative technologies are to be effectively tested for their relative value to the total system. To attack the total system is beyond the scope of this paper. What we have done is to focus on a simple version of the livestock component with the objective of developing a few composite parameters which might be used to study the interactions with other components of the total farming system such as the cropping pattern, the homestead, the market and others.

This paper describes an attempt by the authors to quantify the various connections within the livestock component of a traditional totally integrated Bangladesh farm. The livestock component, in this case, is defined by the direct linkage between the nutrient sources and the resulting animal products. On this medium size traditional farm of three acres, the cultivated area provides 87% of the nutrients, while embankments, roadsides, and waste land (both on- and off-farm) provide the remaining 13%. The animal productions are draft power, meat, milk, eggs, manure, and skin/hides from an approximate combination of one bullock, one cow with calf, one two-year-old heifer, one goat with twin kids, four hens, and four ducks. The cultivated crop area which provides nutrients as crop residue and weeds is almost totally dependent on livestock for draft power.

The connecting links between the nutrient sources and the products are each defined by quantitative values for the supply and demand relationship for dry matter, metabolizable energy and digestable crude protein. These numerous quantitative links are combined on each side to define a seasonal supply and demand balance. The use of these quantitative links to measure the interactions caused by technological changes in the cropping systems, etc. is discussed in light of how they can help us better understand the total farming system.

The parameters used for these quantitatives links are only rough estimates taken from a variety of local and international references which may or may not be most accurate. The main purpose of this paper is to demonstrate the use of the model and to encourage livestock/FSR team members to try them and improve both the model and the parameters.

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Economic and Social Values of Cattle in Gambian Mixed Farming Systems

The Gambian Mixed Farming and Resource Management Project devoted much of its effort over five years to improving the management, nutritional status, and productivity of cattle maintained under semi-pastoral conditions. During this work, a considerable volume of information was collected on the Gambian cattle herd, including data on crop/livestock interrelationships in agriculture. These relationships will be quantified and analyzed in the context of production economics theory. The cattle marketing model developed by Shapiro and Ariza-Nino for sub-Saharan Africa is specifically calibrated with Gambian values and productivity data. Predicted age structures for marketed animals are compared with parameters actually measured at Gambian abbatoirs. The effective interest rate achieved by investing in cattle as a store of wealth is developed. Finally, the relative order of magnitude of the social value of cattle is imputed by the residual needed to perfectly balance the Shapiro/Ariza-Nino model.

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Sorghum Variety Adoption Test on Farmers' Farms

The reaction of farmers to adopting some newly released varieties of sorghum for production in Daudawa village (11°38'N 7°9'E) Nigeria, was investigated on farmers' fields. Randomly selected farmers participated in the study which had five newly released varieties tested in 1984 and four in 1985. An already adopted variety, SL 187 was included as a control in each of the two years. Each participant was to manage their farm in their own way with the only interference from us being guidelines given to ensure fair comparison between the tested varieties and the control. The general conclusion of participants on the performance of the different varieties was that the farmers foremost interest in adopting a variety is based on high grain yielding ability. On the basis of this, two varieties KSV 8 and SSV 9 which yielded about 83 and 75% respectively of the expected yield, were selected for adoption by the farmers.

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SR-CRSP Farming Systems Research on Family Life Strategies in the Peruvian Sierra

Although peasant families in the Peruvian sierra share a general, limited resources survival strategy, there are significant differences among them. Identification of the farming systems within a given micro-region allows us to understand some of these differences in families' available resources, production strategies, and limiting factors. The SR-CRSP/INIPA life-strategies study correlates socioeconomic variables with families' differential production and productivity, relative reliance upon crops and livestock, and so forth. This approach also addresses family and interfamily dynamics, producers' subjective values, experiences, and attitudes, and their receptivity to technological change. This paper reports research in progress with 50 families in four Cuzco communities.

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Corn Yields Seasonal Variability in Plan Puebla's Area: An Assessment of Weather and Recommended Practices

Plan Puebla was started in 1967 to develop, field test, and refine a strategy for increasing yields of a basic crop among smallholders. On-farm agronomic research was a required element of this strategy with a goal to develop technology that complements the traditional cropping practices in order to increase the productivity of land, labor, and capital.

After reviewing the information on farmers practices, available research findings, and soil and climate characteristics, on-farm research was emphasized on agronomic practices. As knowledge on the regional variability was gained, recommendations were refined in successive approximations and by 1972, a set of recommendations were made for sixteen different production systems. They were designed taking into account the risk involved in their use, the precision level, and the marginal productivity of the factors included. For each system, two recommendations were given, one for limited and one for unlimited capital.

In the area, corn yields are prone to vary yearly, mainly as a result of rainfall amount and distribution which in turn also affects the performance of the recommended practices. Therefore, a question was raised on how much of the observed variability was due to weather effects and to the effects of the recommended practices.

In order to answer this question, a research project was started in 1974 in which unreplicated trials were established every year in each production system. These trials included a set of treatments representing the recommendations for the respective system as well as other treatments. The yields of the recommended treatments allows estimation of the area corn yield potential can be compared to on-field estimated corn yields as a means to assess how far the area is from its yield potential. Some of these results will be discussed in this paper.

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Commodity Research Team/Adaptive Research Team Linkages: A Zambian Example

The effectiveness of the linkages between central research station personnel and farming systems personnel in the field is vitally important in shaping the experimental programs of both groups. A high level of interaction between scientists in each category is necessary for a smooth flow in the development, testing, and implementation of technologies appropriate for a given farming system. Weak linkages can lead to a duplication of efforts of each team. Interaction and cooperation between commodity and FSR/E researchers is often restricted when distances between them are great and communications difficult, or when members of commodity research teams are not familiar with or do not believe in the farming systems approach. The structured meetings, cooperative trials, and reciprocal trial visitation that characterizes these linkages in the Agricultural Research Branch of the Zambian Ministry of Agriculture and Water Development are outlined. An example of how the Zambian system functions in the development and execution of a cooperative trial between a Commodity Research Team and Adaptive Research Planning Team is given and the results of the trial briefly discussed.

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The Effect of Gender-Related Production Management on the Design and Implementation of Participatory Technology Validation

Andean farmer/herders define production problems from the perspective of their management responsibilities and experience. Their participation in the validation of historical and introduced technologies depends on the identification of male/female management groups as well as on the development of understandable trial designs. The distribution of management roles between areas of animal and crop production are related to the interaction of gender groups within the production unit. The definition of problems and the validation of solutions depend upon an adequate identification of those in charge of specific production areas as well as of those who must carry out related tasks. The appropriate design of experiments must be based on an effective communication with the producer to ensure that he/she can relate the proposal for systematic validation to previous experience enabling him/her to understand the steps to be carried out in the process. The implementation of the experiment must allow for the division of labor and technical methods in practice.

The paper analyzes a multidisciplinary experience in two highland villages of the Mantaro Valley of Peru where over the past three years, participatory research and validation with men and women producers have resulted in the adaptation of experimental designs which take into consideration the organization of the production system. On the basis of short case studies, we will consider the social and technical factors involved and demonstrate some of the most useful designs worked out with the farmers for trials on crop and animal production techniques.

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Alpacas and LLamas in the Andean Trapezoid

This paper discusses the ways in which development programs can begin to apply their accumulated knowledge of livestock-raising in the high Andes to assist one of the poorest Andean zones. Poverty is analyzed as a product of asymmetric structural relations in which pastoralists are exploited. Possibilities for introducing changes which will alter these relations are explored.

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Dynamic Integration of Research and Extension: Igniting the SPARC

The integration of research activities carried out by producers, extension specialists, and researchers is described through implementation of a model called SPARC (System for Producer -- Ag extension -- Research Cooperation). Conceived as an adaptation of farming systems research and development methodology to the unique resources and people in the midwest U.S. and the landgrant system of universities, this model sorts out researchable questions into those most logically answered on experiment stations and those most efficiently studied on farms. Such questions as optimum crop densities, planting dates, row widths, fertilizer levels, and variety adaptation to specific cropping systems are likely candidates for testing on-farm. Other research areas such as developing models of water movement through soils, nitrogen cycling, crossing and evaluating early generation progeny of crop varieties are logically carried out on station. There is a range of questions between these two extremes which could be studied in either location or both. By combining resources of farmers, county extension offices, and state level researchers, a number of these questions can be addressed quickly and efficiently through on-farm research. When a portion of the total research activity is accomplished on farms with producer collaborators, there is a strong chance for the results to be understood and accepted by these collaborators and moved to other clients in the area. A large part of the extension work will already be done during the research phase. This model needs to be tested further, fine-tuned to each environment, and adapted to the available resources and interest of researchers, extension specialists, and producers in the midwest.

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Assessing the Yield Gap for Alfalfa Production in Larimer County

A farmer-oriented approach to agricultural research was employed in 1985 to understand why experiment station alfalfa yields surpass average farm yields in Larimer County by more than 2.0 t/a. The hypothesis was that current irrigation practices and phosphorous deficiency are major production constraints for alfalfa in Larimer County. The objective of the study was to develop improved management practices for these constraints that would fit into the grower's management system.

Nine farmers in northeast Larimer County representing eleven irrigated, established alfalfa fields, participated in the study which consisted of coexisting descriptive and on-farm research phases.

Informal discussions with the participating growers were used to identify the primary constraints for alfalfa and potentially acceptable solutions from their perspective. Also, various field measurements and daily monitoring of field activities were conducted to better understand the current management practices.

In the on-farm phase, and based on the soil test, phosphate was spring broadcast on eleven P deficient fields. The fields represented flood, side roll sprinkler, and center-pivot sprinkler methods. Yield and percent P response were expected to depend upon the effectiveness of P applications under different irrigation methods.

The growers ranked untimely rainfall at harvest, under irrigation, and P deficiency as major production constraints. They emphasized that solutions to these constraints must be cost effective. Seasonal crop water requirements surpassed seasonal water supply by at least 9.2 inches, irrespective of irrigation method. Although all fields were P deficient according to the soil test, only two fields showed significant yield increases to broadcast P, and there was no relation to method of irrigation. An economic analysis showed broadcast P on established alfalfa was acceptable when the soil test accurately predicted a profitable return. Farmers were not inclined to practice maintenance fertilization as generally recommended.

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Sustained Improvements in Nutritional Status After Small-Scale Intervention in Poultry Production

The More and Better Foods Project, carried out over a 6 year period in Kafr-el-Khadra village, Menoufia Governorate, Egypt, was a multifaceted effort involving transfer of low resource agricultural technology and information as well as attention to the nutritional status of the villagers. One subproject focussed specifically on home based production of chickens. Beginning with 2 families in 1980, the project extended by 1985 to 100 families who were producing almost 100,000 chicks/year for sale and local consumption. Almost half the responsible farmers were housewives. A survey of the nutritional status of village children conducted in 1982 showed that iron deficiency anemia was a major problem, affecting more than 30% of school aged children. Direct iron supplementation programs through the school produced transient improvements. These short-term interventions were stopped in 1984. Nevertheless, a survey in 1985 showed a reduction in age specific anemia prevalence to about half the 1982 rates. At the same time, poultry consumption in the village had increased substantially, raising the availability of dietary iron and animal protein which in the baseline period were limited in household food supplies. We hypothesize that household level food production targeted to limiting nutrients may have had a more sustained effect on nutritional status than more direct but short-term supplementation programs.

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Diagnostic for the Research and Transference of Technology in Agrosystems

Research with a multilevel approach with the following requirements was conducted:

- Epistemologic type for conceptualization and knowledge of flows between different levels of organization,

- Determination of levels as a function of the operative unity of the Ministry of Agriculture development district, the nested levels are operational unities for FSR/E as a function of the available methodological resources, and

- The planning of research as a product of important necessities with the aim of improving efficiency of research resources.

The reference level development district with 193.10^3 ha had corn in 93% of the area. To the interior, 6 agrosystems were identified, and two of them were selected for the purpose of the study. The inferior levels: Production System (PS) and Crop System (CS) were characterized by means of a survey.

Most of the PS's were less than 3 ha. With respect to CS, the problem of fertility can be handled reducing the sale of acid fertilizers. Here, the problem is that the soil is strongly acid, which inhibits the available phosphorus, decreasing the efficiency of fertilizers.

Field Research was conducted to:

- Determine in the laboratory, the liming rate to increase the pH and experiment with phosphoric stone-liming,

- Utilize biotechnology to identify biologic catalysts of *Endogonaceae spp.* in order to create favorable conditions for phosphoric stone-mycorrhiza interaction, and

- Survey the PS in order to analyze the coherence between technology and natural resources, from the farmers point of view.

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Market Interactions of Select Baggara Transhumants during Drought and Post Drought Periods
The Case of South Kordofan, Sudan in 1985

During the period 1983 through 1985, an extended drought affected the people of Southern Kordofan Province in the Sudan, Africa. Among the people are a group known as Baggara transhumants (cattle owning people who migrate along defined routes on a seasonal basis). These people raise livestock for sale, consumption, and as a liquidity preference.

Much of the staple food consumed in the transhumant household is purchased in the market rather than produced on permanent farms. During times of severe drought, purchases of staple foods require large expenditures to meet household demand. This occurs due to the large divergence in prices between livestock and nonlivestock staple foods.

This paper will investigate the effects of drought and postdrought marketing of livestock by the Baggara transhumants on the transhumant household.

The following specific objectives will be discussed in the paper:

1. Document the trends in prices at the subregional and regional marketing levels to measure price differentials which exist between locations for both livestock and nonlivestock staple commodities.

2. Use the information of objective 1, in combinations with other primary data, to describe the effects on nutritional intake of individuals in Baggara transhumants' households resulting from loss of purchasing power.

3. Build on objectives 1 and 2 to identify a method and timing for intervention in the production system. This would be accomplished through the provision of improved market information and educational programs set up and disseminated by agricultural extension workers and farming system project scientists.

The paper will provide a simple procedure for FSR/E project staff to build credibility with predominantly livestock producing clientele groups in Sudan. The educational process will result in more timely marketing of livestock and higher nutritional levels in the transhumant households during periods of drought. Initially, dissemination of this information would be carried out by extension personnel in conjunction with FSR/E technical scientists. In latter programs, extension personnel would act as the conduit for transfer of technical packages to the transhumants of South Kordofan Province in the Sudan.

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Sequential Program Planning and Adaptive Research: An Application in the Nuba Mountain Area of Sudan

The Nuba sedentary farming system of South Kordofan, Sudan is characterized by limited availability of physical capital and reliance on human labor for production activities. Labor constraints affect productivity in agriculture on a seasonal basis.

During 1983 - 1985 the Western Sudan Agricultural Research Project undertook sequential experiments designed to investigate and integrate an animal draft component within the sedentary farming system. This paper documents the adaptive nature of those experiments in a chronological format and explicitly deals with issues concerning flexibility required in a FSR/E program design. It will provide an understanding of the dynamic forces at work which lead the FSR/E staff from the introduction of draft power for tillage and hauling, to the transport of commodities and finally to the development of a village level credit system.

Specific objectives of the paper are the following:

1. Review the results of three years of adaptive research with special emphasis on the need for an extension capability in the dissemination of technical information and training.

2. Provision of technical coefficients for labor savings among women, rental value of oxen power and general welfare benefits associated with the use of draft power for transport of local commodities.

3. Provide an overview of the status of the program at the conclusion of technical assistance contracts.

Research program refinements which arise through interdisciplinary team efforts are easy to see in these adaptive research activities. The advantages of this approach due to structured flexibility and adaptive team efforts are clear. Missing components, such as an effective extension capability, force all research dissemination to concur through technical staff contact with producers during farmer-managed trials. The disadvantages associated with limited scope for technology introduction resulting from lack of extension staff is also clear. Finally, the potential savings of labor, provision of revenues for village credit, and the transfer of knowledge capital reveal the size of the benefits which may accrue from integrated FSR/E project activities.

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Linkage Success and Failure Examples on Feed Production Trials in the Kingdom of Lesotho

Lesotho is a mountainous kingdom approximately 3 million ha in area, completely surrounded by South Africa. About 12% of the area is classified as being arable lands while 80% is classified as range. Examples are presented illustrating the linkage between trials conducted at the research center to a prototype area. Finally, a success story of the linkage between farmers of two prototype areas is illustrated as well as a failure that may be avoided on future FSR projects.

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Communications in FSR/E Projects: Can More Effective Communication Strategies Increase Project Success?

One of the key characteristics of a farming systems project is that it tends to involve many individuals from a number of different areas. It seeks to involve farmers, extension agents, experiment station researchers, and team members from a variety of disciplines. Communication research has shown that whenever diverse groups of individuals are involved, especially when they may represent different economic, political, and social priorities, there are likely to be problems in both understanding each other and coming to an agreement about what should be done.

Project success may be increased by documenting and disseminating the results of perceived and identified areas in which projects have experienced some degree of communication problems.

This panel will present areas in FSR/E projects that have been identified by project personnel as problems, and present the results of other agricultural development projects that include communication components in the project design.

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Rice, Meat and Milk - System Components in Northeast India

The paper will examine the relationship between two components of a rice based farming system in northeast India. Drawn from a program attempting to make available new technologies to resource poor producers operating under rainfed conditions, intrahousehold information collected will be used to show that a consideration of time allocations, decision-making and labor use can help both in the development of a particular technology and in intervention in other areas so that the productivity of more than one system component can be enhanced.

Specifically, in this location, labor was found to be an important research issue for several reasons. Because of cultural norms there is quite a rigid sexual division of labor; there also tends to be a shortage in supply during transplanting, weeding, and harvesting of rice. Men are involved in field work, women in rice processing, and storage. Female members of the community are generally those who tend livestock.

This paper suggests that consideration be given by the biophysical scientists to varieties and techniques that stagger timing of peak activities. It will also illustrate that by improving fodder resources, and thereby affecting women's time budgets, women will then: (a) be free to deal with the larger harvests hoped for by the biophysical scientists, and, (b) have the opportunity to take advantage of the increase in productivity of the time spent with livestock to either generate income or allocate their time to other activities.

It shows that social and economic data can be used to assist in technological research, carried out with a concern for both equity and efficiency, by demonstrating the interaction between different elements in the system.

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Alfalfa Introduction, Animal Management, and Land Tenure in an Andean Village

Since the early 1960's, alfalfa has been introduced into the agropastoral economy of Lari, a peasant community in the highlands of the Department of Arequipa in southern Peru. This process has led to significant changes in the management of animals and the agricultural regime, in particular, a shift from communal grazing on harvested fields to private, fenced, fields with no provisions for communal grazing. The changes and their implications for crop and livestock management are explored.

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Generating Ecology and Class Specific Research Priorities: Socio-Ecological Perspective on FSR

Under the rubric of FSR/E a large variety of approaches are being used to redirect the research system toward more holistic concerns. Major emphasis seems to be on ensuring participation of small farmers in the process of generating research priorities as well as action plans through on-farm experimentation. Undoubtly, most projects are designed and funded by donor agencies. Experts are seldom selected by host agencies.

We report an experience from Bangladesh where the expert was identified by the local leaders of a research system and the research agenda was developed through close interactions with local scientists. The methodological innovations tried at different sites were the outcomes of individual initiatives supported by expatriat scientists. The key insights reported in this paper are: 1)conflict between skills and status; 2)the use of basic statistics as a means to draw valid inferences; 3)using spatial (mapping) techniques to understand the ecological basis of technological diffusion and validation of these maps by extension workers and farmers; 4)attempts to disentangle the contribution of ecology and class specific factors in generating research priorities and practices; 5)generation of hypothesis about physical resource use through case studies and separate village meetings with poor and rich farmers; 6)politics of FSR/E involving junior scientists, poor farmers, and landless peasants, and consequent organizational dynamics: 7)conflict between ongoing command research and locally derived research plans; 8)challenges inherent in institutionalization of the FSR/E approach without developing appropriate linkages with on-farm research and on-station research; 9)problems of too much donor support for highly segmented research converting FSR/E into a sectoral activity rather than a way of doing research; 10)advantages of a socio-ecological paradigm over conventional FSR/E in which the political, institutional, and organizational aspects are either ignored or underplayed.

The paper will include empirical examples and case studies with lessons for future research in Bangladesh as well as other countries.

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Women and Farming Systems: The IITA Experience

The International Institute of Tropical Agriculture (IITA) is implementing an integrative program for the greater consideration and inclusion of women in research and training programs. A collaborative program with UNICEF has started on household food production and nutrition with 1986 activities in Nigeria, Rwanda, and Tanzania. A roundtable on nutrition and agricultural research was held (28-29 May 1986) to orient IITA scientists toward a better appreciation of the overall nutritional implications of the Institute's research and training. With greater attention on post harvest technologies, a regional course on food crops utilization and nutrition was initiated in 1986 with funding from the Netherlands Government, FAO, and UNICEF. Thirty-nine participants from eleven African countries attended with a record number of women participants (65%). IITA is the recipient of the FAO Andre Mayer Fellowship--the research topic is on nutrition and farming systems.

The compound-backyard garden as an important survival system of farming systems has been studied in two Nigerian states. Follow-up on longer term studies has been developed. A program strategy on soybean utilization in Africa was adopted by the Tropical Soybean Workshop (October, 1985). Baseline data on the potential adoption of soybeans had been collected in three Nigerian villages. Research on soybean utilization has been a collaborative project with the Kersey Childrens Home in Ogbomosho, Nigeria.

Household economics is receiving greater attention as a necessary component of on-farm research to more efficiently consider the total farm household as a unit of study. New strategies in reaching rural women and introducing IITA technologies have been developed with women managed farms, a program designed with the State Women and Development Associations and the Federal Ministry of Agriculture. A grant from the Ford Foundation for African women scholars has been received to increase the number of women in IITA group training and masters and doctoral research at IITA.

A collection of nearly 1,000 references on women and farming systems themes with particular attention to women's involvement in the production and use of IITA mandated food crops has been placed in the IITA Library and computerized documentation center. Video has been extensively used to document and report on the women and farming systems programs.

Lessons learned and strategies for integrating rather than isolating women's role in farming systems will be highlighted.

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Research and Development Programs Orientation in Mauritania

The study of horticultural crops represents a very diversified discipline. Several species are studied at the three following levels:

1. The station level,
2. The on farm with feedback element level,
3. The implementation level.

1. The Station:

The different requirements for experimental station trials (equipment, location, etc.) are discussed. The discrepancy between these requirements and the center (CNRADA)'s lack of resources and infrastructure is pointed out. A number of problems related to potatoes, onions, and tomatoes are noted and some recommendations have been made. Mixed crop systems and irrigated crop systems have been suggested as potential solutions to the difficulties faced in Mauritania with respect to horticultural crops.

2. The On Farm Level:

At this level it is suggested that the results obtained from research are to be transmitted to the farmer. The two contacts considered are the individual producers and cooperatives. It is pointed out that part of the program regarding research at the station level is completed and the results are to be tried on farms.

3. The Implementation Level: (real milieu)

To increase horticultural productivity two ways are considered:

- improve productivity of existing crops,
- expand the area under cultivation.

Four major elements are discussed which are: a) intensification of production; b) expansion of cultivated areas; c) commercialization of products; d) provision of seeds.

Conclusion:

The report deals with research, development, and liaison. These three phases of the agricultural development process are currently going on in Mauritania. Three elements are to be emphasized:

1. The Liaison Research - Development,
2. Input-output aspects of development,
3. Provision of seeds and commercialization of products.

The Liaison Research-Development may be sponsored by the CNRADA (The National Center of Agronomic Research and Agricultural Development). Some developmental sectors may need special programs. The Horticultural branch of the Center is ready to answer any questions, can establish detailed projects regarding the Liaison Research-Development and fully participates in the elaboration of development projects.

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Dietary Consequences to On-Farm Research in Swaziland

Practitioners of FSR/E have increasingly expressed interest in nutrition/consumption issues as they relate to FSR/E. Much of that interest has centered around the problems of changing crop mix and reduced variability of crops grown, particularly with the introduction of cash crops. The need to purchase substitutes for foods previously grown is seen to have potential nutritional and economic consequences for the rural household.

This paper discusses the experience of the Swaziland Cropping Systems Research and Extension Training Project in adding a food consumption component to its program of research. The realization that improved farming practices advocated by the project might alter food availability prompted the addition of this research component. The introduction of soybeans and the whole field application of herbicides were thought particularly likely to have an impact on diet. As a result, a year-long dietary monitoring survey has been undertaken on cooperator households for whom agricultural labor and expenditure data are also being collected. Theoretical and methodological considerations involved in such a survey are discussed in light of our preliminary results.

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Use of Farming Systems Research/Extension Methods to Establish Priorities for the Horticulture Unit in The Gambia

The Ministry of Agriculture of The Gambia has established a long-range plan to revitalize its agricultural research and extension system. A major part of this plan is called the Gambia Agricultural Research and Diversification (GARD) project. This places a strong emphasis on using Farming Systems Research/Extension (FSR/E) methodology as means of better identifying priorities for commodity research on-farm and on-station.

There is considerable scope for the improvement of the productivity of horticultural crops in The Gambia. Strengthening horticultural research has 3 objectives: to increase the income of horticultural producers, who are predominantly female farmers; to improve the nutrition of rural farm households; and to contribute to the national balance of payments by reducing imports and expanding exports of horticultural crops.

From January through March 1986, the horticulture unit organized a multidisciplinary team to conduct a rapid rural reconnaissance of 13 villages in the western half of The Gambia. The team included persons from horticulture, soil and water management, entomology, plant pathology, human nutrition, governmental extension, non-governmental organizations, and rural sociology.

A planning session was organized to help the team identify options, weigh advantages and disadvantages, and make decisions about alternative approaches to rapid rural reconnaissance. The main decisions involved:

1. How to assess the commodity focus area in the context of the overall farming system: whether to start from the commodity focus area and work out to the overall system through linkages, or start with the overall farming system and probe from responses towards the commodity focus area.

2. How to balance the risk of imposing problems versus the risk of losing completeness: "blank mind" versus topic guidelines approach.

3. Single versus repeat interviews.

4. Individual versus group respondents.

The team applied the sondeo approach of interview pairs, pair rotation, and group discussion in a 2-stage reconnaissance survey. Stage I used the "blank mind" approach, started from the overall farming

system, and had group respondents. Stage II was an informal verification survey using topic guidelines with individual respondents chosen to represent women's group leaders, high-management producers, and low-management producers.

The team developed several techniques to assist in assembling, recording, and carrying out qualitative analysis of the information gathered. These included:

1. Charts with rows for activities and columns for type of producer (female, male, or joint male-female).

2. A scoring system for priorities across villages.

3. A scoring system for identifying domains based on key characteristics.

Design is focused on marketing as the most frequently-cited farm household priority for the focus commodity. Possible solutions include on-farm trials on:

1. Planting dates, staggered plantings, and cultivars with differing maturities or improved storagability, to spread production over a wider period.

2. Diversification to reduce risk associated with dependence on one or two existing crops.

3. Storage techniques to lengthen harvest-to-market time.

4. A consumption study for quantification of the volume and times of consumption, to identify potential "windows" to target the timing of production.

An approach to farmer-based experimentation is proposed where farmers from a village with more intensive, diversified intercropping would help design trials with farmers in a village with less intensive, less diversified, monocropping. The trials could also include plantings on plot edges of vegetables high in nutrients needed in the diet.

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A Typology of Peruvian Peasant Community Production Systems.

About half of Peru's rural population are members of legally recognized peasant communities, located throughout the slopes and valleys of the Peruvian Andes. Through support of the SR-CRSP, rural sociologists at the University of Missouri together with staff from Peru's Direccion de Comunidades Campesinas y Nativas (DCCN) have been engaged in a reanalysis of a study of 2716 of Peru's peasant communities conducted by the Peruvian government in 1977. The DCCN data is unique, since no other study has managed to conduct a systematic survey of such a large number of these rural Andean institutions. The primary usefulness for this data for the SR-CRSP was in discussing the importance of mixed livestock and crop producers for the national livestock picture. However, equally interesting is the same database viewed from the crop perspective, in which the importance of these same agropastoral communities is also clear.

Using data from the 1977 DCCN survey, which included a total of 2716 legally recognized Peruvian peasant communities, this paper develops a typology of community production systems using summary measures of their agricultural and livestock inventories as its basis. Cluster analysis techniques were used to arrive at a set of 14 relatively distinct community production systems. Nine of these categories were based in the Peruvian Andes, and concerned varying combinations of scale of production, agricultural, and livestock concentration.

The importance of these findings lie in the fact that agropastoral producers have a very different set of physical, economic, and social constraints than do those who are only involved in livestock or crop production. The SR-CRSP is currently involved in validating technologies in both agropastoral and livestock communities in Peru.

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Cultivation of Maize and Land Shortage: The Case of Mgeta in Tanzania

The administrative area of the village of Nyandira, in the Mgeta zone, extends over an altitude of between 1300 and 2000 m. The food crops system may be divided into two main groups.

Below 1600 m, maize is grown with bean. Sowing is carried out simultaneously in October at the start of the rainy season. Bean is harvested at the end of January to the beginning of February. Maize is harvested in March. A second bean crop is sown in April and harvested just over three months later.

Above 1600 m, the maize cycle is lengthened by the low temperatures and may extend to up to eleven months at 2000 m. The culitvation of pea is possible, but the second bean crop in the cold season becomes very risky for the same reason.

In the context of chronic land shortage, it is strange that maize, poorly adapted ecologically to these altitudes has not yet been replaced by a crop with a shorter growing cycle. Wheat and potatoes have far shorter growing cycles than maize at these altitudes.

Potato is consumed in the region but is little cultivated. A thematic survey made it possible to identify the constraints to the extension of this crop, the main ones being: the presence of late blight and the absence of varieties not sensitive to this disease.

Wheat is cultivated and consumed by extremely rare "originals". A simple survey revealed that most of the farmers are ready to attempt these crops but that the main constraints are the nonavailability of seed and poor technical level of the cultivation.

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Integration of Pig Husbandry with the Cultivation of Vegetables: The Case of Mgeta in Tanzania

In the Mgeta zone, farming is based on the cultivation of maize with bean and aroides. Fertility reproduction is assured by allowing plots to lie fallow after several years of cultivation. These are grazed by sheep and goat herds.

The second half of the century saw the agrarian system rapidly evolve in response to two main changes: a significant increase in population which overran the capacities of traditional methods of exploiting the environment and European colonization that introduced the region to a market economy. At the level of farming systems, this evolution has resulted in the following:

- a drastic reduction in surfaces lying fallow (today less than 1% of the cultivated surface),
- a concomitant reduction in the number of sheep/goat herds,
- the appearance and development of vegetable gardening, and
- the appearance and exponential development of zero-grazing pig husbandry (during the 1950's there were no pigs, at present 40% of farms claim to raise at least one pig).

The first two points explain the disappearance of the traditional policy of fertility reproduction. This has had dramatic consequences, in particular for the evolution of yields; a negative evolution accelerated by the kaolinitic nature of soils in the zone (that is to say a very low cation exchange capacity).

No clear answer has been found to this dangerous evolution which threatens the very reproductive capacity of the agrarian system. However, the last two points listed above may lead to possible solutions.

The study of vegetable gardening systems permits the following description. Cabbage and cauliflower represent 90% of the vegetable crop. The technical level for this cultivation is more than satisfactory and the use of pig manure at transplantation, chemical fertilizers, and phytosanitary products is almost systematic. Twenty-five percent of the plots in the zone grow cabbage in rotation with food crops. Although only 10% of plots grow nothing but vegetables, nevertheless, from a dynamic point of view, farming systems are moving towards this specialization.

From the horticulturalist's perspective, the progress of vegetable growing is satisfactory through the good use made of inputs and the tendency to develop pure cultivations. The approach in terms of agrarian systems, focusses attention on the central role of pig husbandry in the new policy of fertility and on the transfer of fertility from the land cultivated for vegetable production.

This paper shows to what extent a diagnostic survey of the farming systems, incorporating a historical approach, characterizing the main evolutive tendencies can assist in making possible the identification of the restrictions in a precise and rapid manner. The intervention of specialists in different disciplines (zootechnician, agronomist, horticulturist, and agrarian systems specialist) will find solutions, the efficacy of which is assured by constant reference to the realities of the farming systems encountered and through continuous dialogue with farmers. Rather than speak of several solutions, one should seek solutions linked in a complex fashion to the whole which alone can positively modify the evolution described above. The introduction of fodder crops and cultivations in rotation are the main lines brought out by researchers and the originality of their proposals resides in the methodology chosen.

- follow-up of plots and animals by farmers supplemented when necessary, by experiments on-station,

- discussions with farmers with the aim of passing on training and information but also to submit work carried-out by researchers for their critical appreciation, and

- valorization with students through teaching focussed on work carried out in the fields.

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Women's Food Production Activities in an Egyptian Village Undergoing Socioeconomic Transition

Kalama, an Egyptian village in the rich Nile delta region, is located 25 km from the heart of Cairo. Kalama is best described as a village undergoing rapid socioeconomic transition. Its proximity to Cairo is but one factor facilitating change. The village is also bisected by the major highway which connects Cairo to Alexandria. In addition, Kalamans communicate regularly with family members working in the oil rich gulf countries; many residents own television sets and/or radio cassette equipment.

The village economy is mixed. In 1982, 24% of the 1,470 households derived its subsistence largely or solely from farming, 65% from commercial and governmental occupations, and 9% from a mixture of the two sources. Despite this economic mix, women's food production activities remain unaltered. This is not surprising since village culture supports economic diversity at all levels of social organization. Economic diversity is particularly evident in extended households.

This paper will describe women's food production activities in the various types of households. It will also provide a cultural analysis of village life to illustrate how cultural expectations of women support their involvement in a wide variety of food production activities. Socioeconomic factors such as household economic resources and amount of formal education appear to have less influence on women's food production activities than do cultural expectations.

Our data support the need for a comprehensive cultural analysis of change processes in transitional or mixed economies in order to determine the rate and direction of change for specific elements of a culture. We hypothesize that maintenance of traditional food production activities is closely linked to maintenance of food habits, food consumption patterns and nutrition. If so, there are important policy implications here.

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The Use of Action Variables in Determining Recommendations Domains

Early Farming System Researchers believe that this research methodology would generate the type of information useful to policy makers in solving the problems of limited resource farmers. The new methodology has produced an abundance of detailed information and descriptions of the biophysical, socioeconomic and financial environment in which the farm households function. In spite of this, there is still no evidence, in countries where Farming Systems Research Departments have long been established within their ministries of agriculture, that the data generated have been effectively used to alleviate the misery of small farmers. The question asked is how can policy makers use the research results in making broad policy decisions? Can researchers provide policy makers with a selected number of "action variables" which could be used in policy decision making to improve the lot of small farmers? In this study an attempt is made to study the problems encountered in using a few socioeconomic "action variables" in determining recommendation domains.

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Strategies in Designing the Second Year of On-Farm Vegetable Trials in Virginia

Virginia Tech, Virginia State University and the Virginia Cooperative Extension Service are working together on a FSR/E project in East Central Virginia. Beginning with 40 farm family interviews, the project identified a strong interest in growing vegetables as a supplement to tobacco production, where acreages and profits are declining. On-farm testing began in 1985 to test the effects of numerous cultural practices on bell pepper and cherry tomato.

In 1986, the trials are designed in response to the results of the 1985 trials, including comments by the families, with particular emphasis on reducing input costs. For example, plastic mulching was shown to significantly increase yields, however, families expressed concern over the initial costs. More affordable methods of mulching, including straw mulching, will be investigated this year. Cherry tomatoes, last year yielded fruit even under adverse conditions. Cherry tomato trials this year will emphasize lowering input costs, particularly transplant and fertilizer expenses. Confounding designs, needed last year to accommodate the large number of treatments, were confusing to the families. Simpler experimental designs, looking at fewer treatments, will be used this year to enhance the educational utility of the trials.

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The Crucial Role of Various Aspects of Agricultural Mechanization in Farming Systems Research and Extension

Production of food and fibre involves a series of operations ranging from land preparation to final utilization of product raised. At each stage, some mechanical device (be it manual, animal, or motorized) is necessary to carry on a specific needed operation. The device is in essence an 'input' to all other 'inputs' like seed, fertilizer, water, etc. and is often noted as a limiting constraint. Farm mechanization, though recognised as vital, is seldom built-in as a component in the overall FSR/E project. Often the much advocated interdisciplinary team on FSR/E never incorporates the mechanization aspects from planning to excution stage. Isolated cases of introducing machines for a particular operation only (instead of for the system) has generally tended to imbalance the existing system with more attendent problems. Similarly, the role of women and agricultural technology, especially in developing countries, is not fully appreciated.

This paper discusses the above situation using data and information as available and pleads for incorporation of farm mechanization aspect more vigorously, considering its crucial role in all improved farming systems approaches.

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Responses of Wheat to Different Environments and Agronomic Practices in Context of Pakistan Cropping Systems

This paper summarizes research findings of over 200 experiments from two years of on-farm research with a cropping system perspective in irrigated and rainfed environments of Pakistan.

A FSR/E approach has been used in which wheat has been viewed as an integral part of a cropping system and changes have been evaluated in terms of productivity of the system. Constraints on wheat production and opportunities for change has been analysed at the farm level. These on-farm trials were conducted on clayey to clay loam soils with soil pH ranges from 6.8 to 8. The cropping systems in the irrigated areas are very complex considering the biological interactions between crops and livestock. The competition and complementarity in resources use between enterprises in meeting farmer's multiple objectives is examined.

Climatically, both 1983-84 and 1984-85 were dry hot years, but stress occurred at different critical growth stages influencing responses of wheat to different agronomic practices. Variety, planting date, tillage, land type, cropping pattern, weed control, and N:P fertilization significantly influenced wheat yields. An N and P incomplete factorial experiments provided response surface data for calculation of economic recommendations using multiple regression coefficients. Previous crop and plowing affected the wheat response curves significantly.

Deep plowing with a moldboard plow as a primary tillage gave 52% (1.3t/ ha)and 36% (0.7t/ha) higher yields than shallow plowing with the traditional cultivator under rainfed conditions in 1983-84 and 1984-85 respectively. The cost of one moldboard was equal to or less than the cost of the farmers' traditional practices of 7 shallow plowings.

Differential responses to fertilizer application by crop rotations has been consistently found in wheat. The implied economic optima from these response curves varies from 65 kg/ha for wheat after maize to 170 kg/ha for wheat after sugar cane. Wheat sown continously in Rabbi cycle of rice/wheat cropping system has a serious problem of grassy weeds, especially wildoats and phalaris minor, where as wheat sown continuously after maize or cotton has a serious problem of grass as well as broad leaf weeds.

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Homestead and Homestead Crop Linkages with Livestock at Jamalpur (Bangladesh) Farming Systems Research Site

Livestock and homestead crop improvement will be the next logical step in FSR/E. Livestock are an integral part of the homestead and are tightly linked with the homestead composition, space, structures, members, and crops. Their interactions and complimentarities, and the balance maintained, are much more profound and important than with field crops.

Development strategies evolved are consequent to direct interactions with farmer families, surveys, and field experience.

New technologies like the poultry rearing system have been rejected by all farmers. Livestock health is inferior, a consequence due to poor nutrition and grossly inadequate veterinary care. Agricultural machinery for draft is virtually non-existant. Even cows are used for draft. Women play a more active role in managing livestock.

There is an interaction between farmer type (land holding and income basis) and number of livestock owned, and preferences for different livestock. Goats are more popular among marginal, small and medium farmers. Pigeons are not reared by landless and marginal farmers. Poultry is most preferred by all farmers as they provide rapid returns to low investment and an evenly distributed cash flow. Ducks and buffaloes are few for agroecological reasons. Small local breeds of cattle are preferred because they are adequate for local farm operations and are easily managed by women. Mortality rates are the highest (up to 45%) in poultry, disease epidemics being the primary cause, and the least in goats.

A wide range of annual and perennial crops are grown in the homesteads which occupy most of the available highland. The choice of crops are primarily dependent on their ability to co-exist with livestock. Rice straw accounts for 90% of cattle feed. Homestead residues come next in importance as livestock feed. Land is too scarce to set aside any for fodder or pasture.

Goats, cattle, and poultry should be given priority for development. There is limited scope for improvement by genetic upgrading (except in the case of poultry), which if undertaken could have disastrous consequences. The best strategies will be to improve nutrition by methods such as urea treated straw and emphasizing biomass production in crop research, and improving health and veterinary care. The right crops should be selected for improvement. All these must be done without disturbing the existing linkages and interdependencies between the production systems.

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The Amazon Basin Food Project: An Integrated Approach

Tropical vegetables were grown in the Amazon Basin, where recent immigrants were not accustomed to eating vegetables. People refused to buy the tropical vegetables, so the project changed its emphasis to marketing and food preparation. The author recommends that the problems with marketing, nutrition education, and food preparation should be resolved before engaging in any new, expensive farming endeavor.

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The Farming Systems Research/Extension Linkage: Experience from Mali

FSR/E in Mali was initiated in 1977, and has focused mainly on the country's major productive zone for rainfed agriculture, "Mali-Sud". In 1985, another important production zone was included, "Haute Vallee".

The Mali-Sud area, 92,000 km^2, has 2.2 million inhabitants and is situated in the Sudanese climatic zone (rainfall 700 to 1,200 mm/year). It is relatively well covered by a rural extension, development, and marketing organization, the CMDT (Malian Textile Development Company). CMDT is a mixed company, and its extension credit and marketing functions are vertically integrated. It plays a preponderant role in rural development in the southern region of Mali. At the national level, it is recognized as a leading extension agency both in terms of organization, management, and technology transfer.

While cotton is the main cash crop, the CMDT also promotes other crops, especially maize, rice, groundnuts, and animal husbandry. It provides necessary inputs on short-term credit, and renders many other services to farmers, e.g. adult education, promotion of pre-cooperative societies, training of blacksmiths, development of women's activities, etc.

FSR/E is carried out by the Institut d'Economie Rurale (IER), the agency under the Ministry of Agriculture responsible for agricultural research in Mali. A special Division, Farming Systems Research Division (DRSPR) was created in 1979. Most other agricultural research, especially on crops, is carried out by another Division, the Division of Agronomic Research (DRA). Thus, Mali has opted for a "down-stream" FSR/E approach. The institutional setting, especially the important position of the CMDT, has largely influenced the way FSR/E is carried out in Mali-Sud.

In addition to this, there is a strong preference to do applied research, leading to applicable results in a relatively short time. Faced with this institutional and factual situation, FSR/E developed a few clear-cut guidelines:

- FSR/E in order to be "accepted", should try to develop practical propositions, responding to major constraints felt by farmers, and recognized by the development agency (CMDT).

- The problems created by the development process (ecological and socioeconomic desequilibriae), need careful, long-term investigations, and therefore require strong support and

involvement of other branches of agricultural research with FSR/E practitioners.

- FSR/E propositions (recommendations) should be institutionally feasible, as regards to the possibility for extension by the development agency.

- FSR/E should try to involve, as much as possible, the development agency (CMDT), at the different stages of research and implementation through staff training, and organizing exchanges, visits, etc.

According to its relative "lateness", it took rather much time (2 to 3 years) for the FSR/E in Mali to get in "speaking terms" with the already much more experienced development partner (CMDT), during which period in-depth knowledge and experience had to be obtained about the area.

Once accepted as a "knowledgeable" group of persons, common activities developed, a new platform for cooperation between FSR/E and the development agency emerged, which was called "pre-extension". The terms of this pre-extension research cooperation are described in the paper, and some examples of major activities are given. Both the organizations (FSRD and CMDT) signed an agreement on pre-extension, which became institutionalized.

The emergence of pre-extension activities created a new dynamic situation for the FSR/E team. It needed a new flexible attitude on methodology, and sometimes unorthodox procedures had to be developed and followed.

The rapidly increasing demand for FSR/E results (solutions to problems) by the development agency, made it also necessary to adapt the FSR/E apparatus, to enlarge the team, to raise new budgets, etc.

Distinction had to be made between activities still in the phase of applied research (though always under farmer's conditions), and others, in the phase of pre-extension. In the latter case, with the aid of trained farmers and personnel of the development agency, research findings can be tested under a much wider range of circumstances, and help the FSR/E team to identify new constraints, and discover other solutions. The common activities undertaken with the FSR/E team, enable the development agency to diversify its technical advice according to a rather simple farm classification, to improve many technical messages, especially in the fields of animal traction, tillage, and animal husbandry, and to improve its program to meet the credit needs of farmers who have not yet adopted animal traction. A completely new activity has started in the field of erosion control.

The difficult problem of the transfer of results from research to extension has found an appropriate solution in the case of Mali-Sud by the creation of a common platform called "pre-extension", enabling both institutions to work together in the same place, with the same farmers, on the same problems and constraints. Among the factors which have

contributed to this achievement, most important were: the existence of an efficient, well established development agency, the full recognition of this fact by the FSR/E policy makers, the choice for a "down-stream" FSR/E approach having as main objective the production of applicable results, and the acceptance, by the FSR/E team members to keep a low profile during the early years.

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Research Methodologies for Conducting On-Farm Livestock Research

Various research methods used while conducting on-farm livestock trials in African sedentary farming systems are outlined. Methodologies originated from case studies in ruminant nutrition and animal traction. While each trial had unique problems and solutions, the methodologies are applicable under varying conditions. The objectives are: (1) analyze conditions and constraints when the procedures are used, (2) outline the methods, and (3) discuss the strengths and weaknesses.

Methodologies and topics are presented in ten different categories: (1) selection of the research area; (2) target group participation; (3) evaluation of alternative technologies; (4) crop/livestock interactions; (5) data collection; (6) control of environmental effects; (7) statistical analysis; (8) data analysis; (9) cultural interactions, and (10) computer applications. Recommendations for future investigations to improve the effectiveness of livestock on-farm trials are offered.

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FSR/Commodity Research Linkages: A Case Study of the Tanzanian Farming Systems Project

Farming systems research is a relatively recent approach to agricultural research activities in Tanzania. One of the main objectives of the Tanzanian Farming Systems Project has been to develop a unit within the Tanzanian Agricultural Research Organization (TARO) which would complement rather than duplicate the on-going activities contained within the existing commodity research programs.

This paper examines in detail the relationship which has developed over the last two years between the FSR unit and the main commodity research units. Comparisons are drawn between this institutional set up and one in which FSR units are not in close contact with commodity researchers.

In examining more closely the FSR/commodity program relationship the differences and similarities between the two are detailed over the following characteristics:

1. Mandate,
2. Research priorities,
3. Research methods,
4. Personnel,
5. Sources of financial support,
6. Relationship to other institutions within the agricultural sector, and
7. Relationship to other institutions in society.

Although numerous problems have been encountered, the paper concludes that good progress has been made in defining complementary roles for these two research approaches. A final section provides suggestions for continued success.

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A Short Methodological Account of a Dynamic Systems Field Experiment: The Case of Legume Enriched Fallows for the Restoration of Soil Fertility, Eradication of Imperata, Improvement of Pasture, and Reduction in Labor for Cultivation, in the Philippines

This paper examines on a methodological level, a partially completed dynamic systems field experiment that tests forage legume enriched fallows for the restoration of soil fertility, eradication of Imperata cylindrica , improvement of pasture, and reduction in labor for cultivation. The label 'system' is used for several reasons: this experiment has objectives in several components of the whole farm system, it examines interactions between components, and it is conducted within an on-going farm system. Here, the systems objectives aim to: eradicate Imperata, improve pastures, hasten soil fertility recovery, and reduce labor in cultivation. The experiment is labelled 'dynamic' because during the process of experimentation it immediately repeats parts of the experimental processes, and it immediately modifies parts of the treatments in response to farmer and data findings. This experiment started with design and labor use surveys on the establishment by plowing and planting of Centrosema pubesense in Imperata cylindrica dominated fallow. The results showed that plowing is too laborious for most farmers. Our immediate response was to reduce plowing by either planting Centrosema directly into the last cassava crop before the land is fallowed, or directly into cogon which was either burnt or underbrushed. Thus, the second round of dynamic experiment repeated design and establishment surveys and went on to measure competition between Centrosema and Imperata. The results of percentage ground cover data and farmers' responses indicated that Centrosema growth was unacceptably slow. Our response here was to overseed with the faster growing Pueraria species. This brought us to our current third round which is repeating design, establishment, and competition work with the intention of extending into assessments of soil fertility and pasture quality. However, even though our experiment is uncompleted important methodological issues have been raised. Many difficulties were encountered in implementation within on-going farm systems, like putting the plots in the wrong place and grazing off, all because we did not fully understand customs of land use. Furthermore, compared with conventional science, dynamic systems experiments fail to reach acceptable levels of uniformity between replicates, control over confounding effects, precision of biological data, and use of farmer responses. On the other hand, examination of this experimental process shows how field experiments can put into practice those so widely held holistic, multidisciplinary, dynamic, and participatory principles of FSR/E.

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FSR/E in the World System for Agricultural Research and Extension

The author contends that we must understand the role of FSR/E in the context of the world system for agricultural research and extension which operates mostly on a research, develop, and deliver basis. Having done so, we can:

1. Evaluate FSR/E in terms of what it is capable of doing locally.
2. Avoid unrealistic claims and expectations.
3. Enhance its potential for improving the lives of farm people by-passed by technological innovation in agriculture.
4. More meaningfully define the role of communication specialists in the farm information generation - distribution process.

The focus is on FSR/E as an interface between the world system for agricultural research and extension on the one hand and the farmer in the field on the other and on the requirements for achieving technology generation and use. Two interface options with the advantages and disadvantages of each are noted along with the necessity for both FSR/E and RD and D.

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Farmer Participation in Farming Systems Research: A Jamaican Experience

This paper examines the participation of farmers in the Jamaica Farming Systems Research Program. The concepts and procedures of Farming Systems Research and Extension are briefly outlined. Against this background the Jamaica Farming Systems Research Program is discussed taking cognisance of social, economic, and cultural characteristics of the target group. Five levels of farmer participation in project implementation are analysed. Finally, farmer evaluation and acceptability of the program are reported on. It is concluded that farmer participation at all stages of farming systems research is critical to generating agro-technologies which are acceptable to farmers.

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Evaluating On-Farm Trials of Millet-Cowpea Intercrop in Niger

On-farm trials were installed for the first time in 1985 by the National Institute of Agricultural Research of Niger (INRAN) on 75 farms located in three distinct recommendations domains.

A factorial design was used to test the 1984 on-station research results at the farm level. Improved millet varieties were intercropped with cowpeas at two density levels with and without fertilizer. These were compared with traditional varities and densities. For millet, ANOVA showed a significant increase in grain yield for improved varieties in 2 out of 3 sites. Recommended densities with improved varieties and fertilizer performed best in yield. When fertilizer was not used, the farmer's traditional density performed better than the recommended one.

For cowpea, there was no pod yield due to the late-season drought. However, cowpea hay yields were significantly higher with recommended densities, with and without fertilizer, than the traditional low density on all sites.

Economic analyses consisted of : 1) partial budgets, 2) dominance analysis, and 3) sensitivity analysis. Partial budgets and dominance analysis showed the high-density, fertilized treatment to be superior in two of the three sites. In the third, where rainfall was poor, the treatment with low density, no fertilizer and improved millet variety was most profitable. Partial budget results were shown to be very sensitive to the price of cowpea hay.

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Designing Cropping Pattern to Improve Human Nutrition

Five cropping patterns were evaluated for two years in farmers' fields situated at 27.3° north latitude and 84.4° east longitude at an elevation of 95 m above the mean sea level. The purpose of the investigation was to evaluate the available crop production technology under farmers' management conditions and to measure the degree of increase in terms of production and nutritional values. The experiment was conducted in a completely randomized design with five dispersed replications in 1000 m^2 each under irrigated conditions. The crop yield sample was taken from 20 m^2 and appropriate standard methods were used to determine nutritional parameters. The soil was a silty clay loam with mean pH value of 6.9. The annual total rainfall was 1451 mm. The mean annual maximum temperature was 36.3°C and minimum 19.7°C. The average farm size was 0.85 ha and family size was 5.5 persons. The rice-maize-mungbean cropping pattern with sabitri variety of rice followed by Rampur composite variety of maize and Pusha Basisakhi variety of mungbean gave the highest land utilization index (94%), produced highest grain yield (11.07 t/ha), edible food yield (9.68 t/ha), protein yield (1008 kg/ha), calorie yield (33.9 X 10^6 cal/ha), carbohydrate yield (5.13 t/ha) and gave the highest value cost ratio (4.2). The additional investment (US $166/ha) was 68% higher than farmers' predominant rice-wheat cropping pattern but gave 325% higher net return. This cropping pattern produced the highest quantity of balanced combination of carbohydrate and protein which could improve the human nutrition.

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Basic Ideas and Strategies for CIMMYT Micro-Level Policy Research

Most farmers in the tropics and subtropics face joint consumption-production decisions based on a set of variables which include input prices, crop output prices, opportunity cost of household members' time, institutional restrictions, etc. The site specificity of agriculture in these settings adds another dimension to this complexity. What works in one location may not work in another due to agroecological differences or to the fact that farmers may confront different socioeconomic circumstances.

CIMMYT OFR procedures represent a simple yet powerful tool to cope with this complexity in terms of technology generation and transfer. These procedures have been institutionalized in a considerable number of national research programs. Experience with these procedures has shown that problem identification at the planning stage of OFR often results in the identification of policy induced constraints, limiting productivity and income of representative farmers. Those policy induced constraints are frequently associated with services or inputs embodying potential or actual technological developments.

The decision to advance in an exploratory stage in Micro-Level Policy Research (MPR) emerged from the conviction that policy formulation or implementation could be improved if decision makers had more information about farmer circumstances and about opportunities for increasing productivity through biological research and policy.

With methods and experiences yet to be developed, the basic idea of MPR is to use survey data and experiments to: 1) identify narrowly defined policy issues (i.e. policy induced constraints), 2) relate issues to consequences for productivity and income, and 3) assess benefits and costs (private and/or social) of alternative policy options.

The present paper offers some initial ideas and strategies for CIMMYT MPR (being presently discussed at CIMMYT), as well as a brief description of two MPR cases currently under way in Haiti and Mexico. Both the basic ideas and the experiences coming from the implementation of the cases may contribute to define the specific nature, the conceptual framework, and the methodology of future MPR activities in CIMMYT.

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Factors Related to the Introduction of Improved Bean, *Phaseolus vulgaris*, L., Cultivars for Small Scale Farmers in Morogoro Region, Tanzania

A bean improvement program (Bean/Cowpea CRSP) was initiated in 1980 through USAID funding to the Tanzanian government. The objectives of the project were to produce (through breeding) high yielding, widely adapted, multiple disease and insect resistant cultivars of beans which are acceptable to the subsistence farmer and consumer. This research project is more than five years old, as a result some research objectives have been revised as new knowledge accumulated. For example, as a result of socioeconomic analysis of the farming systems in some regions where beans are grown, it was realized that several different varieties will be needed for different climatic and geographic locations. It also became apparent that consumer preferences for beans vary within the country.

In the course of project implementation, two cultivars (Kabanima and TMO 101) have been recommended for adoption by farmers due to their desirable characteristics viz. high yielding, drought, insect, and disease resistant. However, TMO 101 is still susceptible to most insects and diseases so that further selection is needed.

Prior socioeconomic data was collected to characterise the farmer circumstances and provide basic information to guide the crop scientists in developing other bean cultivars that would be acceptable to farmers and consumers. In Morogoro region, studies were carried out in Mgeta and Magole divisions. Mgeta is a high altitude rainfall area, ranging between 1200 to 1800 m above sea level with average annual rainfall between 760 to 1600 mm. Magole is situated in the plains at altitudes between 500 and 1000 m above sea level and average annual rainfall less than 1000 mm.

The present study analyses factors related to the introduction of the improved bean cultivars (Kabanima and TMO 101) in the two contrasting farming systems in Morogoro region. Kabanima requires cooler, high altitude rainfall areas while TMO 101 does well in low altitude rainfall areas. In 1985, the two promising cultivars were tested in farmers fields, Kabanima in Mgeta and TMO 101 in Magole. A shortage of seed and unreliable transport to the villages constrained the number of farmers that could be involved to test the new cultivars. Despite the above mentioned problems, the On-Farm Trials (OFT) undertaken indicated promise towards acceptance and adoption of the High Yielding Varieties (HYVs). Farmer's evaluation indicated that the cultivars possess desirable qualities, high yielding, pest and disease resistance (only in the case of Kabanima), drought tolerance, and physical appearance of the plant. Drought, pests, and disease were singled out as major problems in

traditional bean production. Thus, it is for the advantage of small scale farmers to adopt the HYVs since they possess all these qualitites.

The HYVs out yielded the traditional varieties by about 70%, but the variation in yield from farmer to farmer was very high. Since the sample size was very small and due to the other problems mentioned earlier, further OFT will be conducted this year with a view of getting more reliable results about the performance of the HYVs.

In both Mgeta and Magole division, a sample of villages, 4 in Mgeta and 3 in Magole were selected. Ten farmers[1] from each village were randomly selected. All farmers were given the HYVs seeds to compare with traditional bean cultivars. The HYVs plots were of equal size with those planted with traditional beans. The essence being to obtain results in both plots that could be compared and a conclusion about performance differences be drawn. The only other bean husbandry recommendations given to the farmers were spacing, monocropping, and weeding. Since prior socioeconomic surveys have shown that farmers in the area do not apply expensive inputs such as fertilizers and pesticides, the minimal recommendations were meant to approximate farmers conditions as much as possible. Planting dates for Mgeta and Magole are March and April respectively and harvesting is done 4 months later. We therefore, expect the test results in July/August 1986.

The study is not expected to provide final recommendations for adoption by small scale farmers. It will however, enhance further testing and breeding. In the end, the success of the program will depend on the efficacy of the seed multiplication service and the extension service to extend HYVs.

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[1]Our small scale farmer is defined as one obtaining 1/2 or more of their income from farming and have a farm size less than 10 ha.

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Integrative Strategies of Labor Organization for Crop/Livestock Production in an Indigenous Andean Community

Crops and livestock are in direct competition for scarce human labor in many Andean farming systems. This is due to the differing schedules and demands of raising multiple species of plants and animals in a complex vertical ecology, under nuclear (as versus extended) family management. This paper describes and analyzes extrahousehold socio-organizational strategies which peasants employ in recruiting, allocating, and synchronizing labor for daily herding in the face of harvest time and other labor "crunches." These strategies consist of a variety of small-scale, dyadic-contract associations which pool herds across households. These associations vary in: historical antecedents (Incaic, Spanish); socioeconomic bases (informal/formal, reciprocal/contractual); sociostructural relationships among participants (kin, fictive kin, friend and neighbors, "outsiders"); secondary functions (e.g., not only acquisition of pastoral labor, but also improved health and husbandry of herds, hidden inheritance agendas, subsistence support of "surplus" children); and still other factors. What all these strategies share, however, is that they spread the burden of daily herding more broadly, thus freeing more household labor for cultivation. Implications of these findings for development work in mixed farming systems are also explored.

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Transhumance and Agropastoral Complementarity Among Berbers in Morocco's Western High Atlas

In the Western High Atlas mountains, steep topography, poor soils, and low rainfall together limit arable land to the narrow, irrigated valley bottoms. Agriculture based solely on this irrigated area cannot meet the current human population's needs. The productive area is increased by grazing small ruminants over the mountain ranges. Due to winter snow at higher elevations or summer drought at lower elevations, the mountain range at any one place cannot support livestock throughout the year. Herders avoid these extremes of environmental stress by transhuming, or moving their flocks in a regular seasonal pattern up and down the range of vertical ecology of the mountain/plains complex. They supplement their flocks with their limited, irrigated forage at critical times in the yearly production cycle when high nutritional needs in the flock coupled with a lack of transhumant options results in a temporary range/forage bottleneck. Transhumance complemented with a small agricultural forage source allows Berbers to produce more from their harsh environment than would be possible from irrigated production alone.

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Maize Grain and Stover Production and Use for Human and Livestock in Small Farming Units of Puebla

Year-round and plentiful maize stover and seasonally limited amounts of fresh alfalfa, are the basic ingredients of dairy, beef, and draft livestock's diet in traditional farming systems of Mexico's highlands. Maize grain is used for human and other monogastric animals. Maize production technology developed by the Puebla Project in the 70's, views grain as the main product and stover as a by-product with very little value. This conception apparently differs from that of a section of the traditional farming systems of the same area. Research was conducted in 1981 and 1982 with the objective of understanding whether optimizing processes based on grain only or on both grain and stover would yield different recommended fertilizer and population density treatments. Digestable energy and protein and commercial value of stover were used as alternative criteria to judge the value of maize stover, while support price was used in the case of grain. When the first criterion was applied to six field experiments both optimization processes coincided in five. When the commercial value of stover was used along with grain support price, both optimization processes coincided only in two cases out of six.

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Basic Interviewing and Note Taking Skills for the Informal Survey in Farming Systems Research/Extension

This paper identifies and discusses basic interviewing, note taking skills, and techniques for use in the informal survey or sondeo in FSR/E. The paper is based on several training workshops, including two in the Gambia, and on discussions with persons involved in FSR/E projects in West Africa. Suggestions for training exercises are included.

The specific interviewing skills discussed include asking open-ended questions, the appropriate use of how, what, when, where, who and why questions, and dealing with discrepancies in information. The differences between group and individual interviews are also examined, with suggestions about the application of interviewing skills to these different situations. The last section of the paper gives suggestions and techniques for effective note taking in the sondeo situation.

The following issues are included in the paper: (1) clarification of objectives for the informal survey, (2) making decisions about whether to use unstructured or more structured interview methods, (3) integration of group and individual interviews, (4) asking initial questions which facilitate a good interview, (5) the effective use of probing questions, (6) recognizing and using discrepancies in information in an informal interview, (7) how to minimize limitations of working with an interpreter, and (8) a team approach to effective note taking in an informal survey. Each of the above issues are discussed in three ways. First, specific skills are identified. Second, examples of the application of those skills are given and third, training exercises for skill development are presented.

This paper is a synthesis of ideas and experiences in a variety of field settings, both from training and project work. The skills included are basic to the informal survey methods in FSR/E. It is hoped that organizing the material in this fashion will provide a good resource for future training and project efforts.

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Controlling Stored Grain Instects by Grain Temperature Management

An estimated 15 to 20% loss of wheat harvested in the United States is due to insect and mold damage. Aeration technology for the past 40 to 50 years is used to control moisture migration by equalizing grain temperatures. From 1982 through 1986, entomologists and agricultural engineers at Oklahoma State University developed a new grain temperature management process used to control stored grain insects. Field research at 30 to 40 farm storage sites in the Oklahoma wheat belt used side-by-side treatment and check bins. Thermocouples and insect readings were taken at one to two week intervals throughout the summer and early fall and at one month intervals the balance of the year.

Recorded grain temperatures from bins were compared to insect activity from the time of harvest through the following spring. Freshly harvested grain is stored in the 80 to 90°F range. During the summer, grain temperatures in non-aerated bins gradually climb to the 90° to 100°F range, temperatures unfavorable for insect activity. As the weather beings to cool in September, the outer grain mass temperatures beginning to drop. As grain temperatures drop below 90°F, insect activity begins to increase.

Thirty year weather data were plotted, summarizing the number of hours in October and November when air temperatures of 50°F or less were available. Temperatures below 50°F were selected for rapid grain cooling.

After studying the weather, grain temperature and insect activity data, a management plan was developed to control grain temperatures above or below temperatures that are favorable for insect activity. The grain was stored without aeration during the summer months; as soon as the weather cooled to below 50°F, aeration fans were run as long as air temperatures were below 50°F for an amount of time needed to cool the entire bin. Automatic controls were developed and installed at 6 to 8 sites in the 1984-86 period to run the aeration fan(s) at or below preset temperatures of 50°F for early fall and 40°F for early winter.

Most bins in the wheat belt have aeration fans sized to provide approximately 1/10 cfm per bushel. To completely cool a bin of wheat using 1/10 cfm per bushel, approximately 120 to 160 hours or 5 to 7 days of aeration are required, depending on the amount of fines and trash in the bin. With 1/10 cfm per bushel, part of the grain is cooled from 95 to 100°F to below 50°F, while part will be in the 70 to 90°F range, ideal for insect activity. Another cooling front may not come through the area for another 1 to 3 weeks, delaying the completion of the cooling.

Aeration airflow rates of 1/4 to 1/2 cfm/bu., 2 1/2 to 5 times faster than 1/10 cfm/bu., which will cool a bin in 24 to 48 hours, are recommended. Full advantage of a cold weather front can be obtained by using the high aeration airflow rate with an automatic temperature controller.

Two cooling operations per year are recommended; one early aeration process in early fall to quickly cool the grain to below 50°F for early initial insect control, then a second aeration cycle to the 30 to 40°F range in December or January. Then, the aeration systems are turned off, unplugged, and the fan covers are sealed, so that cold air will not leak out and draw in warm air allowing the grain to warm.

The cost of operating aeration fans in October and in December/January runs approximately 1/4¢ per bushel per aeration cycle or a total of 1/2¢ per bushel per year, compared to chemical pesticide costs of 3 to 10¢ per bushel (usually applied after some grain damage has occurred). The OSU faculty believe that a high aeration airflow rate will not only restrict insect activity, but may also cause death to many insects due to the fast cooling shock effect.

Based on the field research, an indepth formal three year research program has been established at Oklahoma State University which will involve thrusts in three directions, an intensive laboratory study of the effect of airflow rates and temperatures on the temperature tolerance of stored grain insects, a large scale laboratory study in heavily instrumented 2,000 bushel bins at a research facility on the OSU campus, and a continuation of the study of field storage sites with automatic temperature controls.

The OSU stored grain research faculty firmly believe that stored grain insects throughout the high plains area can be controlled by grain temperature control using improved aeration techniques integrated with a minimal insect scouting and pesticide application program.

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Minimum Tillage Technique for Cowpea and Maize Production: BIRD's Experience

The paper first gives a brief summary of the geographical and socioeconomic characteristics of the project area. It points out that, agriculture which is the major economic activity of the rural people (according to the 1984 Preliminary Census Report, those in agriculture form about 69% of the total population), has been underdeveloped. While the dismal performance of agricultural programs remain a characteristic feature accounting for rural poverty, the rural areas continue to shoulder the burden of providing food, foreign exchange, development, and employment creation. For decades, agricultural production has failed to keep pace with food demand and Ghana imports food it could produce locally.

With an average annual population growth of 3.0% and a projected population of 21 million by the year 2000, the Government has given priority attention to agricultural development. Because of the importance of small scale farmers in the Ghanaian agriculture, it has become necessary to focus attention on how to improve the farming techniques of the small-scale rural farmers.

In a search for appropriate strategies and the formulation of pragmatic rural agricultural policies to off-set food shortages and adverse situations in agriculture, BIRD directed much attention to research in agriculture by experimenting with the minimum tillage technique for cowpeas and maize production. The target audience for BIRD's research was small-scale rural farmers who normally relied on hired labor for their farm operations.

The report, which is based on personal observations, captures two years experience of field trials and experiments with the minimum tillage technique for cowpea and maize production.

The project objective was to introduce rural farmers to a farming system which is less labor intensive; develop suitable methods and techniques to be applied for successful operations in cowpea and maize production, increase small-scale farmer's output per acre and, consequently, their income levels, and provide information which will form the basis for prospective farmers who would use the technique.

The research has brought out some important issues in spite of the failure of rural farmers to adopt the technique. First, the study has shown the economic and technical principles and practices that support cowpea and maize production, using the minimum tillage technique. It has also brought into sharp focus, the importance of planting at the right

time to take advantage of the rains, especially in areas like Ghana where irrigation facilities are unavailable to the rural farmer.

Considering the cost involved in the acquisition of chemicals, the technical know-how required to apply them, and the scarcity of the chemicals in Ghana, the technique has been found to be unsuitable to the rural farmer. The characteristics of herbicides and their effectiveness in controlling different types of weeds have become clear and prospective farmers have been advised to make a careful study of the weeds on their holdings and the herbicides available to them and to choose the most appropriate herbicide in order to avert the wastage of chemicals, time, and funds.

The report which summarizes BIRD'S experience in the use of the minimum tillage technique for cowpea and maize production provides a unique opportunity for rural farmers to learn the cultural practices to improve cowpea and maize yields and highlights the major problems rural farmers are likely to face in adopting the farming system.

The recommendations include the application of cymbush for pre-flowering spray and post-flowering of perfekthion EC20 to increase yield. It is hoped that if priority is given by farmers to the issues raised in the report there is a high probability that those who adopt the minimum tillage technique for cowpea and maize production would achieve increased yield per acre in the long run. The farming system could also become an effective strategy for agricultural development in other crop regions of Ghana.

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Socioeconomic Control of Schistosomiasis in a Farming Community in Ghana

Schistosomiasis is a disease afflicting at least 200 million people in more than 70 countries. Current estimates indicate that more than 600 million people are exposed to the disease worldwide. In Ghana about 5 million people, mostly rural dwellers in farming and fishing communities, are exposed to the disease and 20 to 30% of these are affected. This number is steadily increasing. The disease is spreading in Ghana because of dams and irrigation canals built in the past 20 years to provide energy and boost agricultural development in the country. These dams and canals create new habitats for schistosoma infected snails.

The disease has important socioeconomic implications for the individuals and community as a whole. It can cause reduced productivity of workers who become tired easily or miss work days. This can significantly reduce total agricultural production if the disease is not controlled. Schistosomiasis may also complicate or cause other diseases like hypertension and urinary tract infection with their consequences on farm output.

Traditional methods of controlling schistosomiasis have been medical technology, mainly chemotherapy and snail control, through application of molluscides. Despite these efforts the disease still persists in many rural communities. People who have undergone treatment and apparently been cured contract the disease later. It is therefore difficult to effectively control schistosomiasis by using only medical technology. There may be social, economic, and cultural factors that aid the transmission of the disease in an endemic area. A better understanding of the socioeconomic characteristics of the population can be helpful in devising a control program for the disease.

The study set out to investigate the social, cultural, and economic factors which are associated with the transmission of schistosomiasis among the population in three endemic areas along the Densu River in Ghana with the hope of formulating a socioeconomic model of control that can be replicated in other parts of the country.

The study involved collecting baseline information associated with the transmission of schistosomiasis as well as the prevalence of the disease among the people and the distribution of the snail host. Specifically, three surveys were conducted, namely:

1. Socioeconomic survey,
2. Snail sampling, and

3. Urine surveys.

In the socioeconomic survey, background characteristics of the study population were collected by means of a questionnaire. Information was sought on the social, cultural, and economic characteristics of the people as far as they affect the knowledge, attitudes, and practices with regard to schistosomiasis. Survey results were augmented with personal observations and informal discussion about the community's feeling and ways of life to gain further insight into the habits of the people regarding the disease and water use. In addition to questions on water use, special observers were used to make observations on water contact and contamination behavior of the inhabitants. It was anticipated that any meaningful health education program must be based on a deep knowledge of the community's beliefs and attitudes towards health and water.

Results indicated a high degree of prevalence of the disease in the three locations selected. There was a need for basic health and hygiene education to change the attitudes of the people about their water use and waste disposal. It was made clear by survey results that in addition to education, the provision of social amenities like a good source of water, public places of convenience, and an improvement in the economic position of the people and the communities were vital in reducing the prevalence of schistosomiasis and other allied diseases that affect rural people.

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The Place of Agroforestry Systems in FSR: The Case of Initiated Agroforestry FSR and Development Program in Ghana

In traditional agriculture systems throughout the tropics, there is a widespread occurrence of useful forest trees. This provides evidence of the benefits that farmers obtain from their presence. This paper explains a program which employs the FSR/E approach in the design and analysis of on-farm research of agroforestry systems.

Ghana's agroforestry FSR/E program is introduced as farm-based, problem-solving, comprehensive, interdisciplinary, complementary, iterative, and dynamic responsible to the Ghanaian society's present and future agricultural/livestock and forestry products needs. The method for a free and balanced interplay of private and local organizations to be utilized at the rural level in order to implement the program efficiently at and with benefits to rural farmers is briefly explained.

Types of appropriate on-farm research design and analysis to be monitored, evaluated, and assessed by an interdisciplinary field research monitoring team are illustrated. Methods are explained for utilizing the land equivalent ratio to measure yield advantage during a survey of intercultural practices and pair treatment analysis of variance of with and without forest tree components. Possible application of managment by results concept in managing the program is briefly explained and illustrated.

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On-Farm Testing Of Improved Technologies in Southwestern Nigeria: The IITA Experience

One of the major objectives of IITA's on-farm research (OFR) is to test improved technologies developed at the research institute under farmers' real field conditions in a range of ecologies, assess their adaptation, and identify new research needs. The OFR activities are carried out in collaboration with the national agricultural research centers and extension service.

In Nigeria, selected technologies or innovations are tested in pilot research areas to address major problems and potentials which are initially identified through informal exploratory surveys. The pilot areas are located in the forest, forest savanna transition, and savanna zones. In each pilot area, the OFR activities follow a standard procedure of exploratory surveying, technology testing, and pilot scale extension.

This paper describes the OFR activities in a pilot area in southwestern Nigeria under the forest savanna transition zone. OFR activities involved exploratory surveying and on-farm testing of selected IITA technologies.

An exploratory survey conducted in November 1984 provided the following information useful for planning and establishing on farm trials in 1985:

1. Two target groups were identified: farmers whose farmland is mostly in the derived savanna, "savanna farmers" and farmers whose fields are in the forest, "forest farmers". Both groups were found to grow the same crops, but slightly differ in their crop management and cultural practices.

2. The principal arable crops grown in the area are maize, cassava, yam, and vegetables. Maize and cassava intercropping is the most common cropping system.

3. Among the major agronomic constraints identified were: a) low inherent soil fertility and inadequate fertility maintenance, b) erratic late season rains and nonadapted crops and varieties leading to frequent crop failures in late season, c) build-up of weeds over the years, d) grasshopper damage in cassava, and e) maize streak virus disease.

4. Shortage of labor for land preparation and weeding, lack of cash and credit, and weak input supply and extension services were cited as the common socioeconomic constraints in the area.

Agronomic on-farm trials were designed to address soil fertility constraints, erratic late season rains, and low yielding crop varieties. The first set of on-farm trials involved use of improved maize and cassava varieties in an intercropping system, use of fertilizer, alley cropping, and growing of short season crops like soybean and cowpea during the second season.

Preliminary results of farmer-managed on-farm trials conducted in 1985 indicated that improved maize varieties were better in yield than local maize. The use of fertilizer may or may not increase maize yield depending on the level of native soil fertility which is in turn determined by the length of fallow period and cropping year in a traditional bush fallow farming system. This condition necessitates further subgrouping of farmers according to fallow period and cropping year.

Soybean and cowpea are crops adapted for growing during the second season when rainfall is erratic and short in duration. Soybean production is more profitable than cowpea because the latter requires more cost of chemical spraying for insect pest control.

Few farmers established hedgerows of leguminous trees for alley cropping trial as they were not certain on the benefits of the system. Poor germination, slow establishment, and weed competition were among technical field problems encountered in the alley cropping trial. A researcher-managed trial was established for on-farm demonstration of alley cropping.

It is too early to assess the adoption of improved technologies introduced and tested under farmers' conditions with only one year of on-farm trials results. However, farmer participation in on-farm trial increased by 50% from the previous years indicating more interest in the use of improved technologies. Problems and issues in agronomic trial design and data collection will be discussed.

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Crops and Goats in Piura: Integration Vs. Conflict

The Department of Piura in northwestern Peru can clearly be divided into two production zones: the river valleys with modern irrigated agriculture and the scrubland plains (despoblados) where goat herding is the main subsistence activity. Nevertheless, farmers from the valleys do raise goats (among other types of livestock while herders from the despoblados attempt to cultivate small fields whenever environmental conditions allow it. Integration and conflict may occur on two different levels: the household and the region.

For agriculturalists, the herd may serve one or more purposes: a complementary source of food or income, a source of seasonal credit for the cropping enterprise, a savings vehicle for surplus capital occasionally produced by cropping, a safety mechanism for time of crisis, or a management tool (recycling stubble, producing manure). On the other hand, raising livestock competes with the limited labor resources of the family, may force part of the family to migrate seasonally far from the cultivated fields, and can evoke conflicts between neighbors over rustling or over damage caused by goats. The specific use of goats by a farmer depends on his/her overall economic state, the size and nature of his/her agricultural enterprise, and the ecological setting of the farm. Herders engaged in cropping may enjoy additional income, a supply of fresh produce, and a source of fodder for their livestock. The cost of farming by herders are the conflicts over allocation of family labor and the restriction on mobility which may effect animal productivity.

On the regional level, agricultural fields serve either as part of the livestock forage resource (seasonal migration) or as a refuge during droughts. However, such sectorial integration requires special social mechanisms to overcome problems stemming from land tenureship or conflicts between different interset groups. The relationships between crops and goats are discussed in this paper in view of the organizational, environmental, and economic context of the production process and with an emphasis on the strategies employed by different peasant groups to cope with factors limiting the agricultural production or with hazards risking their subsistence.

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Decision-Making in Developing and Implementing a Work Plan by FSR/E Teams

The success of an FSR/E approach depends on an effective system conducive to making well-balanced decisions. Permanent and effective interaction among station-based research, on-farm research and evaluation, and technology dissemination must be established. Joint work sessions among all involved parties provide opportunities for exchange of information and are critical to the decision-making process.

FSR/E projects should have a close linkage between senior personnel from research stations, extension, and other related programs with the field level FSR/E teams throughout all stages of the approach. In traditional ministries of agriculture, this can be accomplished by using a bi-level FSR/E team organization. The senior level team should include four to six high ranking biological and socioeconomic scientists, extensionists, and other related specialists. At the field level, various FSR/E teams would carry out the implementation and monitoring of the on-farm trials. These trials would be defined at each field team's location, through a farming systems approach involving diagnosis, identification of constraints, and research alternatives established through joint work sessions of the senior and field teams.

These joint work sessions should be conducted at three major occasions during the on-going program: conducting diagnosis, drawing up the work program, and analyzing results.. A summarized description of these work sessions are included in the table below. Meeting dates and call for participants need to be defined and announced with ample time to assure participation of key personnel and preparation of documents by field teams.

ACTIVITY	DURATION	OBJECTIVE	PERSONNEL	PRODUCT
Diagnosis	1-2 Weeks	Identify constraints and initial recommend-ation domains	Senior and field FSR/E teams plus commodity and research staff from other re-.ated entities	A report including target area description, definition of recommendation domains and prioritization of constraints.
Drawing up the Work Program	3-5 days per field team	Definition of research alternatives and detailed activities	Senior and field FS/E teams plus relevant commodity and discpline researchers.	Schedule of activities and allocation of resources and personnel.

Analysis of Results	3-5 days	Report and discuss research results	Senior and field FSR/E teams plus commodity and discipline specialties.	Conclusions from trial analysis and recommendation for next cycle activities.

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Paddy Napier and Milk Cattle: A Farming System in a Drought Prone Area of Southern India

Chittoor, a drought prone district of southern India is marked by small land holdings. Of the total 1.63 lakh holdings, 51% are less than 1 ha and 26% are over 2 ha in size. The district receives an average annual rainfall of 828 mm the major source of irrigation being tube wells. Soils are primarily a red loamy and sandy type, with paddy and groundnut being the principle crops. The majority of farmers keep Jersey crossbreds (Jersey x Punganur) which form an integral part of the farming system.

Presented in the paper is a case of paddy/Napier/milk livestock system with subsystem interactions in terms of nutrition, labor absorption, and income accrual. The data, based on a field study of five farmers, was collected in three rounds during the year 1985-86. The findings, however, are preliminary and are a part of a long-term FSR project.

The mean land holding is 1.17 ha. Of this, 1 ha is under paddy and 0.17 under Napier grass. Two crops of paddy are taken in a year while the Napier grass is taken on a separate strip as a perennial crop. An open well with a capacity to irrigate 1.5 ha is the sole source of water. The average livestock size is 8 of which 2.5 are in milk, 2.5 dry and the remaining young stock. The average family size of the farmers is 5.31; 2.31 are workers and 3.0 dependants.

The labor utilisation across three subsystems, crop, livestock, and off-farm indicate that of the total days deployed, 30% are absorbed in crop production, 36% in livestock production and 35% in off-farm work which is mainly wage employment. On the farm, 77% of the labor is contributed by the family and the remaining 23% hired. The total labor requirement for livestock production is taken care of by the family. The yearly distribution of labor indicates that July-August, October-November, and February-March are busy months.

The total annual income of the family is Rs 15,256 ($1,272). Of this 52% is contributed by the crops, 42% by the animals, and 6% by off-farm work. The crop income accrues at two points in a year, November and March, animal income is regular and is almost evenly distributed round the year. The wage income though, accrues throughout the year, most of it is in July, October, and November (55%).

The crop component accounts for 89% of total dry matter intake of bovines; 62% in the form of green fodder; 25% as straw and 2% bran. The animals, in turn, provide 36% of the value of the inputs in the form of

manure. The energy requirements of agriculture, are however, met by hired tractor. While the use of wage income for purchasing agricultural inputs is obvious, the less tangible farm/off farm interaction is through green grass obtained by the family as part of wages, which supplements the fodder input for animals.

The need for a secured food supply, insurance against crop failure, regular source of income round the year, and limited recharge of water from the well entailed the present paddy/milk animal/wage employment system. It is interesting to note that in the present farming system, technology is brought to bear upon, through improved seeds and crossbreds but the symbiosis between the two subsystems is intact. The implications are discussed.

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Institutionalizing Farming Systems Research and Extension in Rwanda's Buberuka Highlands: A Case Study

Rwanda is the most densely populated country on the continent of Africa. Over 90% of the Rwandan labor force is engaged in agriculture, with an estimated one million farm families operating complex farming systems on an average of 1.15 ha of land. Until now, food production has kept pace with increasing population growth by bringing more land under cultivation. Land shortages and declining soil fertility have made it imperative to increase production per unit of land.

September 1986, marked the beginning of FSR/E in Rwanda's North Central highlands. The Farming Systems Improvement Project carries a mandate to increase food production in the project zone and to institutionalize farming systems research. This paper reports how the FSIP team put theory into practice using a problem solving approach. From project area entry to the establishment of the first 46 on-farm trials the paper reports how the FSIP team maintained farmer involvement and an informal collaborative relationship with the local extension cadre. Subjects covered include (1) building a multidisciplinary team, (2) developing appropriate linkages, (3) working without formal arrangements and inadequate manpower, (4) tailoring the FSR/E cycle to meet planting season deadlines.

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Enclosures and Involutions: Crops, Livestock, and Communities in Western Kenya

Transformations in crop, livestock, land use, and socioeconomic systems in densely settled areas of west-central Kenya during the 20th century have been multiple and intense. Previous patterns of crop and livestock husbandry have been substantially affected both by new opportunities for agricultural production and labor migration, and by pressures from increasing human population and land enclosure, fragmentation, and shortage. The net effect of these changes have been declining potentials for food crop and livestock production, and marginalization of the human communities themselves. The context and character of these changes are documented and their development implications explored in this paper.

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The Evaluation and Institutionalization of a Farming Systems Research and Extension Project in Southside Virginia

Virginia State University, Virginia Polytechnic Institute and State University, and the Virginia Cooperative Extension Service have an on-going collaborative FSR/E program initiated in 1985 that has focused on limited resource farm families in southside Virginia. After the diagnosis state, the project implemented on-farm trials with cherry tomatoes and green peppers as an alternative crop to tobacco. The second year will continue the vegetable trials and introduce a livestock component dealing with swine. This paper highlights three social science components of the project we feel were particularly valuable in support of the technological intervention:

1. Intrahousehold Dynamics - Throughout the project, intrahousehold dynamics were considered and, based on the findings, technologies were modified to better meet the needs of the families.

2. Family Participation - A major concern of the project, was farm family participation at all stages of the project. We even began using the word "farm family" instead of "farmer" as we found "farmer" often narrowed our perspective to only one member of the family, usually the adult male. Because of our focus on the whole family the educational aspects of FSR/E became a defined objective in the second year.

3. FSR/E and Extension - Finally, we had as a major objective the institutionalization of farming systems methodology within extension. This involved not only training but an analysis of extension structures that impeded the FSR/E process.

Overall, the project followed the sequential experiment design demanded by FSR/E methodology and it carefully considered all three components of farming systems, livestock, cropping, and household.

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Livestock Production in the Farming System in Bangladesh

This paper discusses the present system of livestock production and its importance in the agricultural economy of Bangladesh. Livestock provides not only meat, milk, manure, hides, and skin but also draft power. The importance of draft cattle to crop production is emphasized and potential improvement to the system, such as improved feeding and draft equipment are discussed. Emphasis is also given to small ruminant production especially for landless and marginal farmers in the villages.

It is essential that livestock research be carried out in a farming system context under village conditions where the stresses and strains experienced by animals are often very different to those on experimental station.

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Livestock Technology Validation and Transfer: A Case Study

Farming systems research (FSR) is continously challenged to develop a dynamic flow of validated alternatives to farmers. Yet, the very process of validation often constrains the adaptability of the technologies developed. Where alternatives must, by the nature of the production system, be adapted to the existing farm resources, an acceptable alternative is often best defined in terms of a decision tree as opposed to a fixed recipe. This is especially true for livestock systems. Factors such as multiplicity of outputs, flexibility of farmer strategies, mobility of animals and their long life cycles, variability of experimental units, and high statistical variation aggravate the process of on-farm validation of improved technologies. Responses to components designed to increase reproductive efficiency through reduced age at first parturition and/or reduced calving intervals take several years to manifest their economic effect. For most livestock technologies, the entire farm must be included in the treatment. Thus, treatment and location effects are often confounded. Where the farm is the experimental unit, cost factors often preclude adequate sample sizes to statistically test alternatives across farms within a given cycle. Farmer participation in implementation and validation phases combined with adjusted time series tests within individual farms often give a better indication of technology acceptability. Experience in Panama has allowed the development of a methodological hydrid where some components can be tested across farms within a given year while the validation of the complete alternative is based upon time series data within given farms.

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The Celistina: The Impact of a Social Forest on Food Consumption and Nutrition in the Dominican Republic

The Celistina social forest program is a pilot project within Plan Sierra, an integrated rural development project of the Dominican Republic government. The program was established to stabilize a forest that had deteriorated due to indiscriminate misuse and to teach the families living within the forest to use it to satisfy their basic needs while at the same time restoring it. Activities carrying out these objectives were divided into two categories: forest management and social services. A lumber industry was created to inventory, selectively cut, process, and market timber and charcoal concurrent with a program of cleaning, planting, and care of new trees in the forest. Social services helped organize the five communities within the forest, provided assistance in building new houses, improving agriculture and gardening practices, and in strengthening health and education programs. The forest management activities provided jobs for families at the same time that social activities provided assistance in improving their standard of living. The positive impact of this project on food consumption, nutrition, and general standard of living of the Celestina will be reported in this paper. Findings will be compared to previous nutrition and food consumption studies in the entire Plan Sierra. Differences in nutrition and food consumption between Celistina families and those living near, but not participating in the project will also be examined.

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An Institutional Building Adaptive Research Prototype: A Case Study of Farming Systems Research/Extension Training for the Bay Region, Somalia

The training described in this paper was conducted in Somalia for the Bay Region Research Project 649-0113 (Wyoming). The expatriate research staff there had begun working closely with the nearby extension training center and responded positively to our offer to provide institution building development to establish a FSR/E programing prototype that could be generalized to other areas of Somalia and, with appropriate modification, transfer the prototype to other developing countries. Establishing a cooperative relationship between extension and research staff was an important goal for the training program. Providing a participatory development effort for agricultural production development that did not appear to involve this component was a second purpose of the training. An institutional building process to promote teamwork and trust through production experience was conducted.

The training program provided extension personnel opportunity to work cooperatively with research personnel in harvesting station test plots. Research counterparts, alternatively, participated in extension theory and needs assessment sondeo efforts with extension personnel. Extension counterparts were given opportunity and encouragement to prepare and supervise local agents during monthly training to conduct a sondeo at the conclusion of the training program. Farming system research was an important topic of instruction as an alternative or as support for the T & V extension methods already practiced by extension in the Bay Region Project.

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A Study of the Role of extension in Farming Systems Research in Tanzania

This paper reports on the preliminary investigation into the potential role of extension in farming systems research programs in Tanzania. The study was conducted by the authors in Tanzania in 1985 as a supplement to the research conducted by the Tanzania Agricultural Research Organization's (TARO) Farming Systems Research Project. Interviews were conducted with a purposive sample of ten extension and training specialists in Dar es Salaam, Kilosa, and Dodoma.

The study supports the important potential role of extension in all phases of the technology development and delivery process. Although cost effective, FSR/E cannot be pursued without adequate resources. Extension personnel, if provided with specialized short-term training, transportation, and travel funds can provide the manpower resources necessary to permit relevant and cost effective interaction between researchers and farmers.

Specifically, the involvement of extension personnel in the FSR/E process provides the following advantages:

- permits a wider area of impact as a result of utilizing the trained humanpower existing in villages and districts within the extension service;

- ensure that a socioeconomic perspective is considered in the diagnostic process of identifying constraints and opportunities at the farm level;

- ensures adherence to the reality of farmer circumstances when reviewing new technology design, and

- allows researchers to increase the number of on-farm trials and ensures closer supervision and management of farmer and researcher-managed on-farm trials, thus building extension workers into the process of developing and adapting technology.

The study concludes that although current institutional mandates complicate the mechanisms for cooperation between research and extension in Tanzania, a number of measures can be taken which will begin to overcome these problems.

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A Participatory Approach in Developing an Appropriate Farming System in Eight Irrigated Lowland Villages

This paper summarizes the five years (1981-85) work of the Agency for Community Educational Services (ACES) community organizers in 8 villages of Nueva Ecija in Central Luzon. With the project halfway through, the ACES team developed what it calls PARTICIPATORY TECHNOLOGY DEVELOPMENT STRATEGY as an approach to make the farmers and the rest of the community participate in technology development.

The paper starts with a critical overview of the government programs aimed at increasing farmers' income and improving their quality of life. Despite the rigorous implementation of Land Reform and Liberal Credit Scheme, the building of National Irrigation Systems, and the extensive use of High Yielding Variety Technology Package since 1972, farmers remain heavily indebted to banks and informal lending institutions. Water is abundant when not needed but is not enough when required. The resultant cropping pattern virtually transformed the diverse farming system into a rice monocrop system. The adverse effects of the monocrop system and the extensive dependence on near mono-varietal rice hybrids is discussed as an appendage.

To make these government programs work, the action adapted by the farmer's organization came to a halt with the government bureacracy. This prompted the organized farmers to take the development of an appropriate farming system into their own hands.

An important part of the paper is the step by step discussion of the methodology employed in the Participatory Technology Development Strategy. It consists of 6 overlapping and cyclical steps that may guarantee systematic adaption of proven technologies, enhance the development of indigenous technology and know how, and ensure the use of currently preceived inappropriate technologies on a scaled down basis. Reference point to the appropriateness or inappropriateness of a technology is always from the viewpoint of the user and priority is given to micro needs rather than to national macro needs.

Embodied in the paper is a case study which describes a number of technologies that were experimented on and of which some are beginning to be widely used as this paper is being written. The notable trend is the farmer's idea of an appropriate farming system directed towards the systematic diversification of land use. The crops which are still appropriate, taking into consideration new agronomic and soil conditions, and existing skill and market is the main determinant of a farmer's decisions. The role of community organizers namely, to facilitate these decision points is discussed alongside each step of the processes and is integrated in the case study.

The paper ends by giving some pointers as to how scientists, technologists, researchers, and extension workers can adapt the approach to their present work. Included are ways to overcome old habits and beliefs which needs to be replaced by new ones.

Participatory Technology Development, as it is now called by the agency, does not always contradict the national needs and priorities. The point is for national leaders to realize that a strong and satisfied agricultural sector is a prerogative to the attainment of national needs.

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The 1986 FSSP Gambia Workshop
Diagnosis, Design, and Analysis

A farming systems workshop was held in The Gambia, West Africa from April 7 through April 25, 1986. Thirty participants attended the workshop representing The Gambia and five other West African countries.

The focus of this paper is on the dynamic process of the workshop experience, lessons learned, and the relationship between the workshop's activities and the FSR/E component of the G.A.R.D. project. G.A.R.D. facilitated valuable field experience for the workshop participants and the participants output from field exercises provided additional information for G.A.R.D.'S upcoming plans. The workshop was structured to consist of one week of diagnosis, one week of design of on-farm trials, and one week of analysis of the results of on-farm trials. Training was based on a combination of lectures, case studies, practical exercises, and extensive field team exercises.

Resource persons from The Gambia, Senegal, Nigeria, the Philippines, and Latin America provided first-hand case study examples of FSR/E methods. The field exercises were carried out by four participant teams that were organized based on disciplines and language abilities. Each team conducted diagnosis and design activities in a different village.

Different skills were taught at each stage. Training for diagnosis focused on formal, and informal survey methods, "open" vs. "topic guidelines" approaches to informal surveys, and the use of open-ended questions. Using these interview techniques, each team conducted a two-day sondeo in their village. They then summarized the results of the sondeo in oral and written reports using crop, feed and food calendars, division of labor charts, and structural models of the farming system.

During the second week of the workshop, training focused on the design phase of FSR/E, using data from the sondeo exercises. Group tasks included identification of a priority problem for trial design, development of a treatment objectives statement, development of treatment options and their reduction to a manageable treatment subset, assessment of field size and diversity, and selection of an appropriate experimental design. Participants then returned to the villages to get farm household input into their preliminary trial designs. Each team gave oral reports and prepared written reports explaining how they had arrived at their preliminary designs and how they had modified these based on farm household input.

The third week of the workshop focused on trial implementation and analysis of trial results based on biological, economic, social, and

cultural criteria. Case studies from the Philippines and Paraguay were used to demonstrate implementation skills. Participants completed an implementation exercise using the treatment designs from the previous week. The participant teams practiced specific analysis techniques including ANOVA, partial budgeting, and environmental index based on on-farm trial data from The Gambia. Each team was given a slightly different assignment, and they gave oral reports of their analysis on the last morning.

An important component of the workshop was evaluation of the FSSP training materials as they currently exist. Valuable feedback about these materials was obtained.

The trainers were aware throughout the workshop of the dynamics of the training process and the need for flexibility in their original plans. Additional time allocation, altered sequencing of topics, added unplanned sessions, were all required to flow with the momentum of the workshop. Some of the experience of this workshop, its successes, and lessons learned will be discussed. We recognize that each workshop is unique and requires tailored planning and flexibility, however, some of the basic approaches will be helpful to others interested in training in FSR/E.

In retrospect, the trainers felt that it might have been more appropriate to give a different structure to the workshop. That is, diagnosis, and design could have easily occupied the entire three weeks. We felt that if we scheduled a diagnosis and design workshop, in a similar spring setting, that following the growing season, a workshop on analysis could be held in the late fall or early winter.

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Producer Participation in Livestock Systems Research in the Subhumid Zone of Nigeria

Producer participation in the research process is a key feature of farming systems research and extension (FSR/E). Through the involvement of the intended beneficiaries, it is expected that more appropriate and acceptable technologies will be designed. Most of the experience with FSR/E comes from cropping-based systems. Research on livestock systems, which deals with mobile stock of long generation intervals and great management variations, presents different issues to the implementation of participatory programs.

The Subhumid Zone Program (SHZP) of the International Livestock Center for Africa (ILCA) has been conducting livestock systems research among settled Fulani agropastoralists in central Nigeria since 1978. A multidisciplinary team works in case study areas of contrasting settlement and land use patterns. Poor livestock nutrition during the six month dry season is the research problem. The research team has conducted on-farm trials involving feed supplementation, forage legume introduction into crop and fallow lands, crop improvements to increase crop residue yields, and helminthiasis treatment in calves. The most promising technology is the fodder bank a small, fenced pasture of improved forage legume established and managed by the individual herd manager.

This paper presents the experience of the SHZP in its implementations of a participatory approach to technology development. It discusses the SHZP's approach to livestock systems research, the inherent problems and potentials of producer participation in livestock research, and the involvement of the target group in the design, implementation, and redesign of the fodder bank technology. From 1983-1984, a formative evaluation was conducted to understand the varied reactions of the Fulani cooperators to the fodder bank trials. This feedback served as a major input into research decision making and points to the contribution of ethnographic techniques to technology development.

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Institution Building for Agricultural Production Systems Research in Developing Countries

The approach, techniques, and organization of "Production Systems" Research is probably of more importance to developing countries than to the developed countries which have developed research organizations and more resources, both human and financial with which to work. Although they do, developing countries should not be engaged in agricultural research which does not try to solve immediate and economically important problems and restraints to increasing production. If "systems research" is properly organized, it assists in identifying problems, solving, and testing the solutions and monitors how well the solution works at the farmer level in terms of social and economic acceptance.

Organizing and initiating systems research programs in developing countries meets with difficulty because of, among others, the following reasons:

1- Lack of understanding of the "systems" approach;

2- Already structured research organizations which resist change;

3- Shortage of trained scientists in disciplinary fields, let alone those who can think outside of their own discipline;

4- Lack of incentives for scientists in terms of salary and working conditions including operational recurring expenses to properly conduct research, whether disciplinary or multidisciplinary, and

5- Lack of research funds, in general, from government and what's just as important, the lack of assurance that the research funds will be continually forthcoming, year after year, until a project is completed.

Several developing countries are in the process of reorganization of their national agricultural research programs. Although there is a lack of understanding of the procedures of systems research in many developing countries, it is the "in" approach, and, probably the most correct approach, if it can be properly instituted. Where national research organizations presently exist, they are usually departmentalized by disciplines and the idea of multidisciplinary research may be good in theory but difficult to implement in practice. Examples of such national endeavors are in Saudi Arabia (Al Jouf, National Animal Production and Range Research), Sudan (Western Sudan Agricultural Research Project), and Bangladesh (Bangladesh Livestock Research Institute). The International Livestock Center for Africa (ILCA, Addis Ababa, Ethiopia) has taken systems research as its basic approach while continuing research on

important commodity and disciplinary problems. Several of the other International Agricultural Research Centers have embarked on Farming Systems research (FSR) programs. All of these institutions and their research programs are organized somewhat differently and offer some good experiences in the organization of systems research. There are also important differences in the approaches and definitions of systems research. The unique differences between national research problems and their environments must be taken into consideration in organizing the institutions.

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A Farming System Development that Worked and Some that Did Not

A farming systems component of a natural resource project in the Dominican Republic began with an emphasis on reduced tillage based on the use of herbicides. The collapse of the peso made these practices uneconomical and unacceptable. As a result of a "sondeo" made in May, 1984, it was discovered that although nearly all the farmers had animals of some kind, almost none had sufficient feed for them. We pushed the use of "supermerker" (elephant grass) as a dual-purpose conservation strip - cut and carry forage. The acceptance was more rapid than the extension program could diffuse the information.

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Contribution of Cropping Systems Program's Research and Extension on Rural Poor: A Case Study of Ratnanagar Cropping Systems Site

This study aimed at assessing the influence of cropping systems program (CSP) research and extension activities on the small and marginal farmers (having a farm size of less than 0.5 ha) of Ratnanagar Cropping System Site (representing Inner Terai) of Nepal. Forty nonparticipant farmers (not participating in the CSP) and 15 participant farmers (participating in the CSP) were randomly selected and interviewed on various aspects of farming systems activities of Ratnanagar. New crop species and varieties were grown by both participant as well as nonparticipant farmers at present as compared to five years ago. Several types of cropping patterns were adopted by these farmers under different land situations. However, the adoption was more in case of participant farmers as compared to nonparticipant farmers. Livestock played an important role in the farming systems of the farmers. The size of livestock holding tended to be related to farm size. Participant farmers were raising more livestock as compared to nonparticipant farmers. Summary and conclusion, recommendations and policy implications are also included in the paper.

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Some Experiences and Achievements of Cropping Systems Research in Nepal

About 75 articles dealing with on-farm research work from 1977-85 for six cropping systems sites of Nepal were reviewed. These sites included Parsa (representing Terai or plains), Ratnanagar (representing Inner Terai), Lele (representing valleys of hills), Pumdi Bhumdi, Chauri Jahari, and Khandbari (representing hills). While reviewing experiences and achievements on varietal and cropping patterns testing in the sites, and pre-production verification trials (PPVT'S) pilot production and production programs in different parts of the country were noticed and recorded. Multiple Cropping Indices (MCI) increased dramatically in both Terais and hills but the intensities were higher in the former than the latter. For most of the cases in all the sites, either one or two crops could be successfully added in the existing farmer's cropping patterns. The key to increasing the cropping intensities in Terais as well as hills was the inclusion of early maturing and high yielding crop species and varieties. PPVT'S, pre-production and production programs proved to be useful and effective tools for disseminating the cropping systems technologies and increasing the food production in Terais as well as hills of Nepal. Finally, a summary of the work completed in the cropping systems program during 1977-85 is given and some suggestions for future research needs for FSR/E in Nepal are given.

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Basic Components in Developing Effective Extension Programs in Sudan

Introduction

Whatever the extension approach used, it should also be viewed as only one of several complementary inputs needed to increase agricultural production. While extension is a powerful tool, when used adequately, it is never a panacea. Neither extension or any other organizational input will be able, in Kordofan Province, to provide a quick, simple, or radical solution to the complex human, social, technical, economical problems of millions of farmers in their constant struggle to move out of subsistence farming. Agricultural experts involved in agricultural development in Sudan generally agree there is no simple solution in solving Sudan's problems. The agricultural sector has for too long been neglected, in terms of adequate policy, in resource utilization for agricultural research as the means in transferring technology to farmers which is useful.

Basic System

There are several basic components needed for linking approved production possibilities to the chief target to Kordofan Province, the farmer. These major components are: 1) the potential productivity of the resource base, 2) enabling organizations which provide policy, mandates, and funds, 3) functional support organizations for extension, 4) the knowledge creation organizations: private and public, 5) knowledge transfer agencies, and 6) the farming system: basic building blocks for extension systems. These basic components need to be considered to set the backdrop for developing specific recommendations for improving the research/extension linkage. These components involve designing research systems, planning transfer mechanisms, training personnel, identifying investments, and implementing transfer systems.

Most agricultural professionals in Sudan are aware of these components needed to improve the linkage between research and the user. First, a careful analysis of the potential productivity of the agricultural base of the enabling organizations which provides policy and mandates, control funds, and provide incentives is necessary where extension is needed. Second, an analysis of the quality, quantity, and stability of the functional support organizations such as extension is essential. Third, extension or research programs need to be organically linked to provide improved production possibilities. Therefore, the research organizations which create useful knowledge are central. The Western Sudan Agricultural Research Project is a specific case in point. Fourth, the knowledge transfer organizations which include the extension service, mass media, agribusiness, and other means of knowledge and skill

transfer can provide useful and timely information to farm families. Finally, the key component is the farm system and farm clientele. This is the final production activity upon which the worth of any agricultural research and extension system must finally be evaluated.

Conclusions

In designing extension programs in Western Sudan, the basic building block is sadly lacking in terms of designing farmer involvement, farmer organization, and feedback in farm and farming knowledge to centers concerned with research and policy making. In all fairness, it should be pointed out that extension in Kordofan Province hardly has the support in terms of a resource base to design even a minimal type program. Also, agricultural research organizations need increasingly to be built with more top-to-bottom linkages to overcome the perennial isolation of researchers from the realities of farm level realities. The strong research focus of the Western Sudan Agricultural Research Project of on-farm trials is a positive step in this direction.

Developing local organizations with links to extension in training local leaders is important if the objective is to create local initiative and confidence. To achieve this, field staff need training in leadership development, program planning, farmer organization, and program implementation. Most extension workers report little training in these areas since their university work. Certainly this is a crucial need. Also, far too often the methods completely ignore the role of women and training of women who play a substantial role in Kordofan farming systems. The recruitment of women extension agents may be a partial solution to this problem.

There are many complexities of transferring knowledge to farmers. Leagans (1980) said, "Technology has no inherent value in itself and no value to society until it is applied for the purposes for which it was created. The central question then is what kinds of delivery systems and policies are needed to bring positive impacts to intended clients since reduced the negative impacts for externalities on non-intended audiences." The critical issue of the research/extension connection if solved, can improve production possibilities with the chief client, the farmer, and basic building block of any agriculture production system. The focus of both in research/extension must continue to be on the farmer and farm family.

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Strengthening Research/Extension and Farmer Communication Linkages in Kordofan Province, Sudan

Background of the Study

There are more than half a million subsistence farmers in Kordofan Province, Sudan. Recent efforts of the World Bank, USAID, and Washington State University have been focused on the establishment of a farming systems research program to disseminate agricultural technology to the farmers in the region. Norman Borlaug points out the challenge is great. He estimates that new agricultural technology has reached only 10 to 15% of the world's 3 billion farmers. At best, only a very limited number of farmers in Kordofan Province have been impacted by new agricultural technology.

The writer worked with the external funding agencies during the summer of 1985 to: 1) investigate communications linkages between the Western Sudan Agricultural Research Projects Research Programs, Regional Extension Programs, and other information dissemination mechanisms, and 2) identify the types of formal/informal communication channels scientists and extension workers utilized to disseminate research findings from the farming systems research project.

Methodology

Interviews with research scientists, extension workers, merchants, and vendors, representatives of the international agricultural development community, and farmers were conducted to identify the formal/informal channels utilized to disseminate agricultural information both within agricultural and professional groups and with farmers. A formal/informal information dissemination scale developed at Washington State University was utilized in the study. Recommendations were made to strengthen communications linkages in the technology transfer process.

Finding

In general, there were more informal contacts between agricultural professionals than within a formal network. There were many more contacts with agricultural extension and research professionals than with professionals in other agricultural agencies. Most of the contacts involved extension personnel contacting researchers about new varieties and cultural practices.

Agricultural professionals were asked to indicate the type of contacts or situations in which they communicated with representatives of agricultural agencies. Not surprisingly, individual contacts represented

the major type of avenue for communicating between researchers and other agricultural representatives. Contacts appeared to be heavily weighted toward subject matter, related questions or problem solving situations where a professional needed assistance. In terms of use, group meetings ranked second as a means of communication. Field trips to inspect on-farm trials were frequently mentioned as a type of contact between international scientists and extension personnel.

Scientists and other agricultural representatives made little mention of communications contacts through mass media. The province has a literacy rate of only 5%. Radio, at this time, has limited possibilities because the one broadcasting station within the province has an effective broadcasting range of only 10 km. Radio seems to offer a potential since there are at least 10 to 15 radio sets per each 100 households in the Province. Although many of these sets may be inoperable, the basic fact is they are the only type of mass media device found in most villages in the Province

Contacts with merchants, periodic vendors, and mobile merchants were identified as playing an important role in the diffusion of agricultural technology. These individuals operate in the informal system yet have contacts in almost all the villages in Kordofan. The initial source of many new varieties come through these individuals. These merchants represent a built- in distribution system that could be potentially tapped into reaching an expanded number of farmers throughout the Province.

Conclusions and Implications

A survey of the inter-organizational communication patterns between researchers and representatives of agricultural units in Kordofan Province was conducted. Evidence indicated that the majority of the contacts made between professionals was on an informal basis and generally limited. Formalized inter-organizational linkages need to be made to formalize program and communication patterns between the various agencies.

Little evidence was apparent in terms of utilizing merchants or vendors as potential sources of information for farmers. The experience for a number of other developing countries shows that there are a number of alternative and complementary approaches that show some promise at promoted technology transfer in agriculture to increased use of private sector channels. These include the delivery of information of services concerning agricultural technologies and recommendations and concerning selective interventions to improve agricultural production. These experiences in other countries need to be studied to see if they can be adapted to fit into designing a more effective dissemination program for agricultural information in Kordofan province.

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Recommendation Domains: Some Considerations for the Design of On-Farm Research and Extension in Lesotho

This paper describes the results of our study of the economic and social stratification of the rural population of Lesotho and its possible implication for research and extension planning. The approach is similar to that suggested by CIMMYT where recommendation domains are identified and become the basis for grouping farmers into somewhat homogeneous target groups who share most of the same agricultural constraints and problems.

The criteria used to define the recommendation domains were the ownership of three basic agricultural resources: land, oxen, and tillage equipment. Households were further differentiated according to whether the household head was resident or migrant. Migrants were defined as those who had taken long term contracts for wage work in South Africa.

The largest percentage of the rural population fell into the group lacking all three agricultural resources, 32% of the population. The group having ownership of all three resources made up 6% of the population and controlled 12% of the land. A relatively large percentage, 22% of the households were found to own oxen and land, but not a basic complement of tillage equipment.

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Fertilizer Rates for Alfalfa Grown under Rainfed Conditions and Milk Cows' Alfalfa Requirements in the Pubela Project

In the Puebla Project region, milk cow production is related to irrigated alfalfa production which provides the required forage for the winter season. As the irrigated fields are limited, the possibilities to increase milk cow herds and milk production are restricted. For this reason, research has been done to study alfalfa crops under rainfed conditions in order to: a) measure alfalfa yields under rainfed conditions; b) study this crop's phosphorus and potassium requirements, and c) calculate the extension of land necessary to produce the amounts of alfalfa required to feed different numbers of cows. To achieve these goals, an experiment with fertilizers on alfalfa under rainfed conditions has been conducted. Three phosphorus and potassium levels were applied in a complete factorial design. Six different treatments which included 4 alfalfa varieties and application of cow manure were also evaluated making 15 treatments in all. The treatments were replicated four times. After the first year, plots corresponding to each treatment was divided into four subplots, each one receiving P and K fertilization on an annual basis. The alfalfa yields were evaluated each month and a half.

The results show that alfalfa yields are not greatly influenced by fertilizer levels but by environmental conditions. Maximum yields are obtained during the rainy season, however yields close to 0 are obtained during the winter months. Alfalfa growing under rainfed conditions requires P and K in the same amounts (100-100) kg/ha. The problem of seasonal production can be solved by cutting and drying the forage to be provided to the cows during the winter season. Different extensions of land were calculated to grow alfalfa in order to provide the required forage for different number of cows.

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Performance of An Underground Granary in a Subhumid Tropical Region of Mexico

Traditional technology for maize storage in the ejido Juan Jacobo Torres, Veracruz, Mexico, involves sun-drying, mixing the grain with either a lindane-based insecticide or with limestone, and storing it within the house in plastic or jute bags which are stacked so as to allow for air circulation. As the rainy season sets in, grain moisture increases and allows for molding that (1) may contaminate the grain with aflatoxins, and (2) will diminish its viability as a seed. Rats will damage the grain, and also increased grain temperature, insecticide dusts, and competition for living space will prevent any non-essential long term storage. Local maize prices were recorded weekly for five years beginning in 1982 in an attempt to devise grain storage strategies which would increase farmers' income. Also, an underground granary based on both local traditional know-how and modern technology was tested during the rainy season, and results were compared to those obtained with the current storage method. It was found that local maize prices reach a relative maximum in the second half of August of each year. This is followed by a sharp decline of 33% to a relative minimum in mid to late September. Prices will then gradually increase until the next relative maximum. The underground granary prevented any further damage caused by insects Sitophilus zeamays and Sitotroga cerealella, maintained the development of Aspergillus flavus and A. glaucus at very low levels and preserved the seed viability, in a year with a May to October precipitation of 1604 mm. Moisture content of the grain remained at 10.5%. The best storage/marketing strategy would be to harvest in January, store in the underground granary, and sell in August. Such a strategy would have yielded an average net gain of $4.09 pesos per kilogram (constant pesos of 1983) as compared with $0.13 pesos per kilogram obtained by selling in November.

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Refining and Adapting an Advanced Traditional Farming System of the Mexican Highlands to an Ejido of the Subhumid Tropics

A conceptually advanced traditional farming system developed by farmers of Puebla state involves rainfed maize and beans intercropped with deciduous fruit trees, irrigated alfalfa, Holstein cattle, hogs, and chickens under total confinement, on smaller than 5 ha holdings. Both Indian and European technological precursors of the system are obvious. The fundamentals of this farming system and the concepts of watershed land management and animal drawn equipment developed by ICRISAT, have been put together in a process of adaptation to an intensive, annual crop oriented, traditional farming system of the Papaloapan basin, in Veracruz state, since 1980. Five objectives are simultaneously being pursued: (1) increased land productivity, (2) increased labor productivity, (3) land and water conservation, (4) integrated plant and animal husbandry, (5) improved post-harvest management. Eight ejido families composed of 2^2 factorial experiment (family head under and over age 40, 6 and 12 ha holdings) replicated twice were involved in the adaptation process tnat progressed as follows: (1) Developing farming equipment and production technology for a multiple cropping maize and dry bean pattern, grown in a permanent broad bed system with reduced tillage. (2) Developing year-round maize stover management, building infrastructure for total cattle confinement, acquiring dairy cattle under credit, and farmer training. (3) Developing technology for citrus orchards on steep slopes and for strip cultivation within maize fields. (4) Developing maize and dry bean ground storage technology. Plans are being made for small forest management, and for adapting supplementary irrigation for maize in the near future. The project staff consists of two postgraduate agronomists, one agronomist, one part time anthropologist, and two intermediate level professionals. This team is supported by national commodity programs. Only four of the original families completed the six-year process and are very probably going to continue to be involved in the project. They have been exposed to criticism from non-participant farmers for being the only recipients of the project. Prestige of the dairy cattle technology is high and increasing among non-participating farmers, while prestige of the farm equipment has only begun to develop. Labor is expensive and scarce. Records of milk production, maize and dry bean yields, labor and input, and infrastructure costs are being systematically recorded.

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Maize On-Farm Research in East Java

The paper describes the on-farm research (OFR) program with a farming systems perspective for maize-based production systems in the Malang district, East Java Indonesia, 1984-1986. This program is carried out by staff of the Malang Research Institute for Food Crops (MARIF). The MARIF's research mandate includes maize and other non-rice food crops.

Main objectives of the maize OFR program are:

1. To develop procedures for on-farm research suitable for the MARIF.
2. To execute on-farm trials on priority issues identified by field surveys.
3. To formulate recommendations appropriate for adoption by farmers.

The MARIF maize OFR program was initiated in January 1984, with an exploratory survey. Since then, the OFR team has conducted five crop cycles of on-farm trials, a maize production survey and other surveys and investigations on specific issues, while a sixth cycle of on-farm trials is being planned for October 1986.

The MARIF maize OFR program follows a research approach developed by CIMMYT and adopted to local conditions and the institute's needs. The interdisciplinary team, conducting the program, consists of plant breeders, crop protection specialists, agronomists and agro-economists. The team cooperates closely with farmers and extension service in the study area.

A dominant aspect of the approach is the close link between surveys and on-farm trials and the sequential nature of the process, whereby each activity is based on the findings of the preceding activities of the program.

The result of the program to date, is that the farmers cooperating in the on-farm trials are able to raise their maize yields from 1.8 ton dry grain per hectare for traditional varieties and management to 4.8 ton per hectare with improved varieties and management. A benefit:cost analysis of these results show that a participating farmer can receive an additional return of 12.5 dollars for each additional dollar invested. These improvements are obtained with only modest increases in inputs and simple improvements in management practices. It is believed that these improvements are within the scope of most farmers in the study area, as all aspects of the improved management practices are easily understood by the cooperating farmers, whose conditions are representative for the study area.

In view of the basic themes of the Kansas Farming Systems Symposium 1986 special sections of the report describe in more detail:

1. The crop/livestock interactions encountered in the study area in East Java.
2. The MARIF OFR team's experiences with the crucial linkages between researchers, farmers, and extension staff in the research process.

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Complementary Nature of Crop/Animal Research

The production of crops for human consumption has traditionally been the first objective of developing countries. Although animals are used for meat, milk, fiber, and work, they are frequently of lower priority in terms of care and management. Opportunities exist to improve animal productivity while also improving crop production. The breeding and selection of plants with a higher quality forage component shows great promise. The University of Nebraska is researching corn and grain sorghum residue forage quality characteristics. Grain sorghum stalklage from plants selected for high digestibility supported greater steer gains (.52 vs .39 kg/hd/day). Pasture grasses selected for higher forage digestibility have been shown to significantly increase beef production over presently used varieties. A switchgrass selection now released (1985) as the variety Trailblazer produced about 50 kg more gain per hectare than the conventional variety Pathfinder. Chemical treatment of low-quality forage such as wheat straw with anhydrous ammonia significantly increases digestibility, intake, and animal gain. Genetic alteration of plants to enhance forage quality may be the most effective method available to increase animal performance. This type of cooperative effort belongs with farming systems research and can be used to improve animal productivity and human diets in all countries of the world.

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Extension Sondeo in Antigua

The Caribbean Agricultural Extension Project has adopted a sondeo approach to identifying extension, research, and policy change priorities in select districts in seven English speaking Eastern Caribbean countries. The priority focus on these sondeos is extension. The assumption is that there is existing technology to extend until new technology is developed. An interdisciplinary team spends ten days in the field doing qualitative analysis through interviews, observations, and secondary data analysis.

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Private and Common Property Sources of Protein: A Dilemma for FSR/E

Farming systems research and extension (FSR/E) is conceptually well suited to the study of crop/animal interactions. Although headway is being made in the consideration of livestock and cultivated plants, little work has been done in FSR/E on the role of common access resources such as lakes and forests. The use of such resources may have a significant impact on household concerns such as nutrition, labor allocation, and income generation.

This paper examines the interaction between private property resource use (conventional farming systems) and common property resource use (lakes) in Lake Balinsasayao, the Philippines. The purpose of the paper is to examine the effects of these interactions on household nutrition. Information on interhousehold differences in fishing practices, fish yields, farmers' expectations about resource productivity, and nutritional data from three sequential studies are analyzed in the context of a FSR/E agroforestry and soil conservation project.

The analysis shows that fish and corn are the farmers' major sources of protein; nevertheless, certain households suffer chronic protein deficiencies. Some households do not utilize local fish despite open access to the lake; some households do not cultivate enough corn to meet their family's consumption needs. The paper explores the possible reasons for this differential protein status among households. It is suggested that: (1) fishing competes with more productive tasks such as wage earning activities or crop production. (2) access to lake resources is not equal since (a) some households are technologically better equipped to fish more efficiently, and (b) there is an unstated, ambiguous and irregularly enforced rule that certain parts of the lake "belong" more to one family than another. The differential may also be explained as a result of variable corn yields, both among households and among sites. Some households have more labor and land than others. Some sites are more vulnerable to the risks of pest infestation, unpredictable moisture conditions and wind damage.

Households have developed strategies to balance corn production and fish yields in order to meet protein needs. The strategies tend to emphasize overuse of the lake and more calculated use of the land. Such patterns may bode ill for the future integrated management of both these resources. The paper concludes that the Balinsasayao FSR/E project, now in its fourth year, needs to consider crop and fish production in order to effectively increase household welfare, particularly in the long-term. The common property resources are indeed functional elements of the farming system.

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Modes of Farmer Participation in FSR/E

Farmer participation in the philosophy and dynamics of farming systems research and extension (FSR/E) is both central and vital to the agricultural development process. Attaining the degree of participation which makes a strategy truly FSR/E in nature, and not something else, is a time consuming task. However, accomplishments in this arena can be most rewarding. Washington State University faculty members on assignment in Lesotho over a seven year intervention have identified several ways in which farmers achieve maximum participation. These are 1) as collaborators, 2) as cooperators, 3) as learners, 4) as adopters, 5) as teachers, and 6) as evaluators.