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Farming Systems Research in Eastern Africa: The Experience of CIMMYT and Some National Agricultural Research Services, 1976-81

by

M. P. Collinson

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Department of Agricultural Economics
Michigan State University
East Lansing, Michigan 48824

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FARMING SYSTEMS RESEARCH IN EASTERN AFRICA: THE EXPERIENCE OF CIMMYT AND SOME NATIONAL AGRICULTURAL RESEARCH SERVICES, 1976-81*

by

M.P. Collinson**

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**CIMMYT, Nairobi. The views expressed in the paper are not necessarily those of the International Wheat and Maize Improvement Center (CIMMYT).

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Preface

This paper by Michael Collinson is the third in a series of papers on Farming Systems Research (FSR) in the Third World. The first two papers by David Norman and Gilbert, Norman, and Winch discussed definitional, conceptual, and methodological problems in organizing and carrying out farming systems research. The purpose of this paper is to report on CIMMYT's experience over the 1976-81 period in helping institutionalize farming systems research methods in national agricultural research services in Eastern and Southern Africa. Subsequent papers in this FSR series will report empirical findings by FSR teams in various Third World countries.

Michael Collinson has been a leader in microeconomic research in Africa for two decades. His experience in farm management research started 20 years ago with a series of surveys in Tanzania in 1962. Collinson's Farm Management in Peasant Agriculture (1972) is a standard reference on how farm management studies can help meet the needs of extension workers and local planners. We are pleased that he has taken time to share his experiences over the past five years in Eastern and Southern Africa. The theme of Collinson's paper is the need to develop cost-effective research programs which are consistent with small pools of trained scientists and limited budgets for recurrent expenses.

There are five major lessons from Collinson's experience which might help administrators of national research services in other parts of Africa and in other regions of the Third World. First, Collinson reports how CIMMYT staff members introduced the idea of farming systems research by conducting demonstrations of FSR which produced reports within 7-9 months after the initiation of research. The results of these demonstrations provided administrators of research services with tangible results for evaluating FSR approaches. Second, Collinson describes the use of the exploratory or informal survey as a cost-effective technique for gaining information about farming systems and constraints on improving these systems. Collinson calls the exploratory (informal) survey the "pivotal" step in the diagnosis of the farming system. CIMMYT's exploratory (informal) questionnaire is reprinted on pages 49-60 as a guide for researchers. Third, he discusses the lessons learned in modifying a "strongly compartmentalized research establishment" in Kenya (by posting young economists

on research stations) and candidly describes how difficult it was for junior economists to establish a meaningful dialogue with senior technical scientists on these stations.

The fourth highlight of the paper is a discussion of how the lessons from Kenya were used in drawing up a plan to help reorganize and strengthen the agricultural research system in Zambia. In Zambia, a plan was drawn up in 1980 to establish a two-level hierarchy--Commodity Research Teams working from research stations and Adaptive Research Planning Teams (Farming Systems Research Teams). The Adaptive Research Planning Teams (ARPTs) include a Farming Systems Economist, Farming Systems Agronomist, and a Research/Extension Liaison Officer. The decision to strengthen Commodity Research Teams and to establish ARPTs in Zambia will hopefully eliminate the friction that might arise if young trainee economists are posted in Commodity Research Teams which are dominated by senior technical scientists. This two-level approach has also been adopted by ISRA in Senegal as part of a multi-donor financed program to strengthen Senegal's national agricultural research system.

Fifth, the paper points out the integral link between farming systems research and in-service and short-term training workshops. For example, CIMMYT's Farming Systems workshop in April 1981 was attended by 42 participants (more agronomists than economists) from 10 African countries. CIMMYT now plans to expand its FS training program in Eastern and Southern Africa. CIMMYT's experience thus plays up the value of local training programs which emerge from FSR experimentation within an agro-climatic region.

Carl K. Eicher
Professor of Agricultural Economics
and Co-Editor, MSU Rural Development Papers

1. INTRODUCTION[1/]

Since 1976 CIMMYT[2/] has been developing and promoting Farming Systems Research (FSR) in cooperation with national research services in Eastern Africa. The use of FSR methods has brought benefits not only to farmers, but also to researchers, by improving their efficiency in designing technology appropriate to the needs of small farms. This paper presents a progress report on the experience that CIMMYT has gained in helping introduce and implement farming systems research in Eastern Africa over the 1976-81 period.

The paper is written from the perspective of CIMMYT, which has a program aimed at developing, refining, and promoting FSR methods in order to help improve the relevancy of national agricultural research and extension services. CIMMYT's farming systems program in Eastern Africa has the following characteristics:

(1) It is strictly operational and focuses on procedures appropriate to agricultural research services in many LDCs.

(2) The aim is to improve relevancy of research, not to discover refined solutions.

(3) The program is not 'doing FSR'; its success or failure has to be judged by its impact on national agricultural research procedures and eventually on their relevance to the problems of farmers.

(4) The FSR methods being prompted by CIMMYT are continually being modified and improved as experience is gained through cooperation with agricultural research services.

Throughout eastern Africa there is an increasing political and policy concern for meeting the needs of small farmers, many of whom are extremely isolated from the research process. A quotation from Kenya's 4th Five-Year Development Plan underscores this concern:

> "Research must be of increasing relevance to the farmer's situation. This includes not only the physical environment that confronts him but also the socio-economic setting of his farm activities" (Kenya, 1979).

[1/] I should like to thank all reviewers of the draft of the paper. Some very useful comments were anonymous but those who owned up were: Duncan Boughton, Derek Byerlee, Eric Crawford, Steve Franzel, Peter Hildebrand, Roger Kirkby, Carl Liedholm, Don Plucknett, and Don Winkelmann.

[2/] CIMMYT (Centro Internacional de Mejoramiento de Maiz y Trigo), (International Maize and Wheat Improvement Center), Mexico 6, D.F.

Yet the sheer numbers and variability of small farms and their lack of organization make it difficult for researchers to address their problems.

The isolation of smallholders from national research services not only stems from difficulties of linkage but also from differences in perspective and rationale between them and larger farmers. Agricultural professionals, in both private and public service, understand the commercial goals of large farmers. These goals are generally consistent with the modern agricultural orientation that researchers have received in their university training. Small farmers, on the other hand, have goals and decision criteria which may be regarded as irrational by researchers. Smallholders who are operating close to the subsistence level and have poor resource endowments place a high priority on a secure food supply for their family. The aversion of small farms to the risk of losing their food supply influences their decision making and gives rise to resource allocation and management strategies different from those of large farmers with more favorable resource endowments. For instance, farmers' decisions as to which mixture of maize and beans to select will vary with circumstances. The final decision on the mixture to plant will depend on at least the following three sets of factors:

(1) The relative potential of the two crops in the area.

(2) The preferred use of the two crops in local diets.

(3) The local market demand for: (a) maize, (b) beans, (c) both crops, and (d) other crops grown in the system.

The results of agricultural research services have often not been relevant to the management problems of small farmers for the following reasons:

(1) Researchers have historically placed heavy emphasis on biological potential and yield as the dominant criteria upon which to base recommendations for farmers. But farmers never seek biological potential for its own sake and never make decisions on which crop and animal products to produce on the basis of yield alone.

(2) Governments act on behalf of small farmers by deciding research priorities and which findings will be promoted. Researchers themselves select 'the best' results of experiments and prescribe these as 'improved management practices' which the extension services should teach to farmers. 'I know what is best for you' very much dominates the process.

(3) Researchers on experiment stations are isolated from small farmer clients. Reward systems provide little incentive for researchers to understand the farmers they work for and this isolation compounds the prescriptive nature of the recommendation process. Moreover, natural resources and economic conditions on experiment stations are different from those in which small farms operate. For example, soil fertility and labor supply on an experiment station are likely to be very different from those on local farms.

Farmers' needs and circumstances are always specific to local situations. Relevance in research demands that local farmers provide their own perspectives in planning experiments and their own decision criteria in evaluating the results. FSR attempts to understand the way farmers make decisions and it encourages farmers to participate in the research process. FSR has the capacity to strengthen linkages between researchers and their small farmer clients.

In order to implement FSR, two major developments in research organization and planning are required:

(1) Recognition of the need for both technical and adaptive research.

(2) Recognition of the role a Farm Systems Economist (FSE) can play in the adaptive research cycle.

Technical research, on research stations, seeks new materials and methods which are technically feasible in the environment of the country or region served by the station. Results are additions to a body of knowledge about potential management improvements. On-farm adaptive research selects and tests components of the body of knowledge identified as apparently relevant to the needs and circumstances of target groups of farmers normally within, but occasionally even outside, that general region. A Farm Systems Economist attempts to understand how a farmer allocates his scarce resources of land, labor, and cash between crop, livestock, and off-farm production in a manner which best satisfies his and his family's priorities. This is essentially the economic problem. The FSE's professional task is to understand farmers' decision criteria, and to identify how and why, in managing his farm, the farmer compromises on the optimal technical management of any one enterprise in order to raise the productivity of the whole system.

The six stages in the research process are shown in Figure 1 and can be illustrated as follows:

(1) The description and interpretation of the farmers' situations and the identification of management problems and possible development opportunities.

(2) The identification of improved agronomic practices and farming methods which, if used, have a potential for improving the welfare of farmers.

(3) On-farm testing of potential improvements selected as relevant and feasible for target group farmers, given the conditions they face in production.

(4) The identification of unsolved technical problems of farmers and the incorporation of these problems as priorities in the Technical Research process.

(5) Commodity and disciplinary research.

(6) Body of knowledge.

Locally based adaptive research teams carry out stages 1 & 3. Stages 2 & 4 are links to the technical research programs. The problems identified in adaptive research form the agenda for commodity and disciplinary research (Stage 5). The output of experiment station research is the 'Body of knowledge' (Stage 6) of materials and methods known to be technically viable under experimental climate and soil conditions on the station and in the region served by the station.

In summary, the perspective taken here is that FSR (on-farm adaptive research) can potentially help a research station produce results which are relevant to the conditions and circumstances of small farms.

In the early 1970's, following some adverse commentaries on the Green Revolution, CIMMYT's Economics Program sponsored adoption studies in seven countries in order to identify the most influential factors in shaping the adoption of new maize and wheat technologies. The results of the studies revealed that natural resources (e.g., agro-climatic zone) and economic circumstances of farmers were major determinants of the choice of technology adopted by farmers. The studies also revealed that technologies being recommended by experiment stations were often inappropriate to the needs of small farmers. This mismatch frequently resulted in non-adoption, partial adoption of some components of a technical package, or

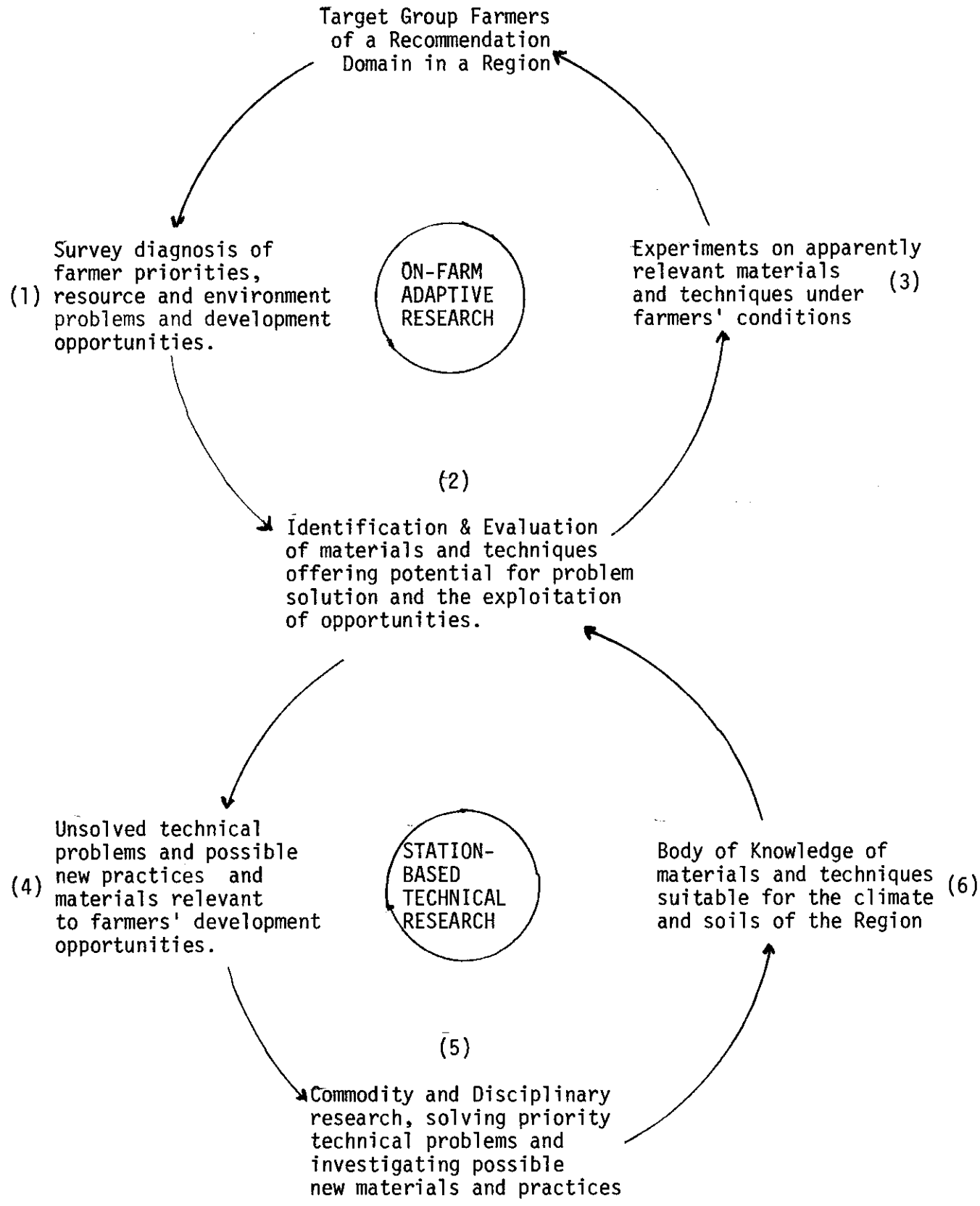

Figure 1. Interactions between Station-based Technical Research and On-Farm Adaptive research.

distorted adoption--that is, adoption of the technology by those subpopulations in a position to exploit it, such as large farmers who were not the primary targets of government policy.

Following the adoption studies, CIMMYT's Economics Program developed more relevant criteria to interpret agronomic experiments, using the same criteria that farmers use when deciding whether a technology is a good choice for them. A manual for the economic interpretation of agronomic experiments was published by CIMMYT in 1976 (Perrin, et al.). The adoption studies also revealed that technical scientists viewed ex post adoption research as essentially negative historical commentaries. It became clear to economists that they should shift their attention from ex post to ex ante evaluation of prospective technologies. It was at this point that FSR was seen to offer methods to describe and understand farmers' situations and to bring this understanding to bear in carrying out ex ante studies.

A set of FSR procedures was drafted by members of CIMMYT's Economics Program with three guiding principles in mind:

(1) FSR should have rapid turnaround time in order to fit in with the annual planning and replanning cycle for experiments.

(2) FSR should get researchers on farms to improve the linkage between researchers and farmers.

(3) FSR should minimize professional manpower.

This second principle was consistent with a longstanding CIMMYT commitment to carry out experiments on farmers' fields and to enlist the participation of farmers in both sides of the Adaptive On-Farm Research Cycle. The steps in the adaptive research cycle are listed in Table 1. Steps 1-3 are preparatory steps which establish a framework for Adaptive Research. Steps 4-17 describe the implementation of the cycle within a Recommendation Domain; 4-11 are the diagnostic side of the cycle, 12-17 the experimental side.

The time required, as set out in Table 1 for each step, assumes that experienced professionals are implementing the procedures as part of an ongoing program and that adequate logistical support, particularly transport, is available. Where new Adaptive On-Farm Research programs are being established and professional staff are undergoing training in procedures, progress will be slower.

TABLE 1

Procedural Steps in the Adaptive Research Cycle

Steps	Time Required
1. Identification of the general region of the country with a priority for adaptive on-farm research	
2. Collation of secondary information on the natural and economic conditions of the region	2-3 months
3. Identification of recommendation domains and target groups of farmers operating a homogenous farming system within the region	2-3 months
4. Review of available background information on the recommendation domain	1 week
5. Informal survey	
- Discussions among farmers	2 weeks
- Conclusions (written)	1 week
6. Design of formal verification survey	
- Sampling and fieldwork plan	1 week
- Questionnaire development	1 week
7. Enumerator training and questionnaire testing	1-2 weeks
8. Formal verification survey--administration of the questionnaire to a sample of target group farmers	2 weeks
9. Post coding, tabulation of data and specification of analyses	1 week
10. Data input and processing	1 week
11. Data interpretation and experiment planning	2 weeks
12. Selection of representative farmers and sites for on-farm experiments	2 weeks
13. Preparation and layout of experiments	crop cycle
14. Supervision and recording of experiments	
15. Harvesting of experiments, measurement and recording of yields	
16. Statistical and economic interpretation of data	4-6 weeks
17. Planning for the next season's experiments	4-6 weeks

2. INTRODUCING FSR PROCEDURES IN EASTERN AND SOUTHERN AFRICA

CIMMYT has established four regional Economics Programs to promote FSR procedures in cooperation with national agricultural research services in the Third World. The first of these was started in Eastern Africa in 1976 with a headquarters in Nairobi and funding from the UNDP.

The steps in the Adaptive On-Farm Research cycle have uncompromising organizational implications:

(1) Adaptive On-Farm Research can only be done effectively with a particular farm situation, and therefore an identified target group of farmers, in mind.

(2) Disciplinary and commodity-based research institutions are often not conducive to farmer-oriented experimentation. A compromise is required on specialists' technical viewpoints if experiments are to address farmers' priority needs.

(3) Experimental results must be achieved under conditions as close as possible to those under which the farmer will implement them to form the basis for sound recommendations.

The full organizational implications, presented cold, could be unacceptable to an existing research institution.

With this in mind, the full cycle of steps can be viewed as a procedural and institutional reform package. CIMMYT's regional economists have been free to develop their own strategies for diffusion. Promotion has concentrated on those components of the cycle; first, which seemed most appropriate to the circumstances of the national agricultural research service concerned; second, which were best suited to the background and experience of the individual economists.

CIMMYT's Eastern African Economics program has concentrated on the promotion of FSR methods through a two-stage strategy. First, in countries where agricultural research administrators expressed an interest in exploring new methods of bringing research closer to small farmers, a demonstration of the FSR diagnostic procedures was mounted in a maize or wheat growing area of their choice. Usually an area was chosen where there were no research recommendations, or where administrators felt the current recommendations were not being accepted by farmers. CIMMYT worked with local professionals in both the biological and economic sciences in organizing and carrying out a demonstration of FSR diagnostic surveys. In

these demonstrations, the CIMMYT procedures were implemented within a homogenous target group. An adaptive on-farm experimental program, tailored to produce new techniques to solve problems and exploit opportunities in the system, was drawn up based on the results of the demonstration.

The initial FSR demonstration in each country was written up as a formal report to promote interest in the new procedures on the part of research administrators and local professionals. Although CIMMYT has usually paid a major part of the costs of these initial FSR demonstrations, it has established a policy whereby subsequent activities would have to be funded by national sources, in an attempt to ensure that further cooperation is more than a gesture. The Eastern African Economics Program's annual budget of US $125,000 is regarded as 'pump priming'. In cases where the administrators of national agricultural research services were satisfied with the outcome of the first stage--FSR demonstrations--then CIMMYT was invited to pursue the second stage.

The second stage of the Adaptive On-Farm Research cycle was the placement of economists in national agricultural research services. In countries in East Africa where administrators have recruited graduate staff as trainee Farm System Economists, CIMMYT has helped to build up their professional capacity through in-service training programs supplemented by formal training. In cases where students have been sent for overseas training, the Ford Foundation has provided the funding.

CIMMYT's strategy for introducing economists into agricultural research services in Eastern Africa was guided by previous experience in other parts of the world which had underscored two problems: First, historically economists had carried out ex post studies of agricultural technology--"coming back from the field" to inform biologists that they had "got it wrong." Such an approach was not only unconstructive but also built up antipathy in research establishments toward these "commentators." As a result, initial CIMMYT strategies emphasize a positive approach, presenting FSR as a methodology for improving the performance of the research system rather than a remedy for its failure. Second, economists in agricultural research establishments have often been isolated in their own units or sections and economists have usually passed their operational and methodological problems through three levels of decision making within the

technical establishment for decisions. At each level, an attitude of 'what is this odd fellow doing in agricultural research anyway' often brought decisions inimical to the effective operation of the economist. CIMMYT has recommended two strategies to overcome the isolation of economists: 1) the avoidance of setting up separate Economics Units on research stations; and 2) the establishment of a direct professional link with senior research administrators through the appointment of a senior economist close to the Director of Research.

In mid-1978, the move began to introduce economists into agricultural research institutions in several countries in Eastern Africa, hence avoiding the establishment of "economics units." The following description of the initial strategies followed is from the working paper to guide implementation efforts, written in 1978.

Initial objectives will be:

(1) To teach the FSE the tools of his trade and expose him to experimental methods.

(2) For the FSE to gain credibility with the technical scientists on research stations that he can improve the relevancy of the experimental programs and research recommendations to farmers' needs and to national priorities.

(3) To foster the ideas of target group focused experimentation and farmer participation in the research process.

The work program strategy will depend on the local situation. So far, in Eastern Africa, technical scientists have little or no idea of how a FSE can help the relevancy of their work. Indeed, relevancy, except as "a good thing," is a hazy concept, a prescriptive mentality often still dominates technical research work. On the whole, strategies can be divided positive and negative. Positive strategies should normally be the basis of the effort made at research stations. Unless used carefully, negative strategies will enhance the barriers between technical and economic researchers. However, if used carefully, negative strategies--essentially criticism of past or present work--can increase the awareness of the technical scientists of what is and what is not relevant. These strategies, with emphasis to be placed where possible on the first positive one, are listed below.

(1) To interest individual technical scientists on stations in the circumstances and priorities of farmers who will be offered the results of their research. The FSE begins to feed information on priorities and circumstances of target group farmers to selected individual scientists outlining the implications for experimental content. Technical scientists who appreciate the need for relevancy and express an interest in cooperation are the ideal.

(2) To review past research results and, by economic interpretation, demonstrate how modified recommendations are more consistent with farmer circumstances. Though a critical strategy, it has proven positive in practice. It can give immediate benefits in revising extension recommendations either by omitting components which are unacceptable to target group farmers, or by modifying treatment levels to bring them within the reach of farmers. The more relevant improvement packages build credibility for the economist with the extension service and with research administrators. It is less painful if the results and recommendations reviewed are from the work of the past researchers and not present incumbents.

(3) Questioning the relevance of ongoing research programs.

   (a) By asking who, which target group of farmers, is the work being done for. Making a strong issue of local specificity and relevance.

   (b) By asking whether target group farmers will be able to absorb the level of changes implied in the management variables being tested.

Both types of questioning under (3) are immediately critical of current research efforts and therefore of the station management and technical scientists. The questions are justified if relevancy is a major issue and sympathetic individual technical scientists cannot be identified. Both types of questioning should be specific, and reviewing experimental programs and investigating target group circumstances will be a prerequisite for the FSE before embarking on detailed discussions along these lines with technical scientists.

In outline, this is how CIMMYT Economics Program became involved with FSR methods.

3. FSR PROCEDURES DEVELOPED BY CIMMYT FOR CARRYING OUT ADAPTIVE AGRICULTURAL RESEARCH

The FSR procedures developed by CIMMYT are low cost and have a rapid turnaround in order to accommodate the scarce manpower situation that exists in many research establishments in LDCs. The first step is to identify target groups of farmers for whom the same research and development effort will most likely be relevant. CIMMYT calls these target groups "Recommendation Domains." The second step is to undertake a diagnosis of the farming systems in the Recommendation Domains which have been selected as a priority for intensified research and development (Byerlee, Collinson et al., 1980). The diagnosis sequence concludes with a planned set of

on-farm experiments. In the second half of the Adaptive Research Cycle, the experiments are carried out under the operating conditions of the Domain to ensure that recommendations emanating from the work will be accepted by farmers.

3.1 Identifying Recommendation Domains

Inevitably, there has to be a compromise between research for an individual farmer, which is far too expensive, and for the heterogenous conditions of the country as a whole, which is far too generalized. A framework of Recommendation Domains forms the basis for research planning and for identifying priority adaptive research Foci. In order to identify recommendation domains, farmers are grouped into relatively homogenous Domains according to their existing farming systems. The farming system is used as a basis for an initial grouping for three reasons:

(1) The existing farming system is a manifestation of a weighted interaction between natural, economic, and cultural circumstances and his own priorities and resource capabilities. The present farming system reflects, better than any single criterion, the balance of factors important in identifying homogenous groups of farmers.

(2) Farmers operating a similar system have similar problems and development opportunities.

(3) The existing farming system is the starting point for development--the base onto which productivity improvements have to be grafted.

A short questionnaire is developed to collect descriptive information about farmers, with the smallest local administrative division as the enumeration unit. A sample questionnaire is shown in Figure 2. It draws upon the experience of educated local people. Where extension staff in the Ministry of Agriculture are used, foreknowledge of their likely biases should help ensure balanced information. A prior review of ongoing credit and extension programs is useful for identifying biases. For example, if the investigator knows in advance that 5 percent of farmers in the area have received credit for the purchase of dairy cows this information can be used to evaluate the validity of information supplied by extension agents.

DISTRICT_____ WARD NO._____ HIERARCHICAL GROUP_____

A. Animal kept by most farmers	1. Two main types of animals kept	1		
		2		
	2. If cattle main purposes for keeping	1		
		2		
		3		
B. Foods grown (G) or bought (B) by most households	1. Starch staples ranked in order of importance	1		
		2		
		3		
	2. Relish crops to flavour staples	1		
		2		
		3		
	3. Animal products for food	1		
		2		Overall ranking
C. Main cash sources for most farmers (rank overall) (1st, 2nd, 3rd)	1. New cash crops and % growing	1		
		2		
	2. Crop sales as cash source	1		
		2		
	3. Livestock as a cash source	1		
		2		
	4. Off farm cash source	1		
		2		
D. Land use methods and time of preparation by most farmers	1. Years cultivated	1		
	2. Typical area (Ha)	1		
	3. Main methods of land preparation	1		
		2		
	4. Main months of land preparation	1		
		2		
E. Hire and purchase of resources by most farmers	1. Types of hired labour & payment	1		
		2		
	2. Work done by hired labour	1		
		2		
	3. Main inputs	1		
		2		
		3		
		4		

Figure 2. Farm System Zoning Questionnaire: Central Province, Zambia

The aim in data interpretation is to identify different farming systems. The key step in interpretation is to identify dominant enterprises, timing of activities, and husbandry methods, which play a significant role in shaping the farming systems. This methodology provides a low-cost means of identifying Recommendation Domains of relatively homogenous groups of farmers. The questionnaire in Figure 2 was used over a population of 75 wards (the smallest administrative division) in Zambia. Seven Recommendation Domains were identified in a three-month period covering some 70,000 farm families. In terms of professional time, three stages can be distinguished in identifying recommendation domains:

(1) Preparation (10 man-days)
    (a) Developing and testing the questionnaire.
    (b) Arranging the program of visits.
    (c) Preparing background material and maps.
(2) Data collection (10 man-days)
(3) Identification of Recommendation Domains (15 man-days)
    (a) Interpreting the data.
    (b) Specification of Domains, preliminary mapping of the geographical boundaries, and description of their hierarchical characteristics.

It is important to emphasize that these are preliminary groupings. As the diagnostic sequence is implemented within these identified target groups, the characteristics of each domain will be more fully understood. For example, variations in natural potential, such as amount of rainfall, may have been overshadowed by other factors in the initial identification. New technologies, however, may allow differential exploitation of this variation, and the preliminary domains, based solely on the homogeneity of the existing systems, will need further division.

3.2 Diagnosis of Farming Systems

After the recommendation domains have been identified, the next step is to carry out a diagnostic sequence in selected priority domains in order to identify key farmer problems and some preliminary ideas on how to help solve these problems. This information will provide the content for Adaptive On-Farm Experiments in the second half of the cycle. An example may

help clarify the adaptive research process. In some semi-arid areas in Eastern Africa, farmers have major problems in producing a reliable supply of their staple foods such as maize. Researchers often recommend they '<u>should</u>' plant before the rains start to give the crop full use of limited moisture, but their oxen are often in such poor condition that the animals cannot break the land. Hence, farmers frequently wait until the condition of their oxen improves which occurs when the oxen feed upon the new grass brought by the same rain which softens the land and reduces the power required to break it. "Plant on time before the rains" addresses a symptom and not the problem. Hence, farmers often compromise and plant the maize crop late, a situation they are forced into because their animals are in poor condition at the end of the dry season.

The 'Body of Knowledge' from technical research in a variety of disciplines can be tapped to try to solve the interrelated problems of the weak condition of animals, delayed planting, and unstable maize yields. The 'Body of Knowledge' listed below provides examples of potential solutions to these problems.

(1) Animal Production
  (a) Improve the feed supply in the dry season
    (i) By planting types of grass which will persist throughout the dry season
    (ii) By planting high bulk forage grasses in local low-lying areas where there is residual moisture
    (iii) By purchasing feed
    (iv) By underplanting grain crops with a forage legume
    (v) By selecting grain varieties and management practices which emphasize the use of residues for fodder
  (b) Reduce stocking rates and thereby reduce competition for dry season grass
    (i) By providing artificial insemination services which reduce the need to carry male animals
    (ii) By opening up market opportunities for male calves
    (iii) By encouraging the use of cows for draught purposes, thus reducing the conflict between keeping oxen for draught and cows for milk

(iv) By using A. I. services to improve the conformation of cows for draught purposes.

(2) Engineering
   (a) Yokes giving improved power transfer
   (b) Equipment requiring less power to break the land

(3) Plant Breeding
   (a) A shorter-term maize variety which can be planted late
   (b) Alternative crops known to be less susceptible to drought

(4) Agronomy
   (a) Minimum tillage techniques which, with or without the use of herbicides, will allow early planting
   (b) Land preparation at the end of the previous rainy season while the land is soft and animals are in good condition

These techniques, in contrast to unhelpful advice to plant early, are positive and potential methods of solving problems of local farmers. Further understanding of the farmers' present system is needed to determine which of these apparent solutions have resource demands that are within the endowment of target group farmers and are compatible with the resource allocation requirements of competing enterprises.

Implementing some of the above suggestions will lead to the situation where the classic output per unit of area criterion of researchers is compromised in return for lower but more stable grain yields. For example, underplanting grain with a forage legume, selecting grain varieties for their fodder output, or using a shorter-term maize variety may improve the reliability of yields but may actually reduce average grain yields. Similarly, animal equipment requiring less power, minimum tillage techniques, and winter ploughing may also compromise grain yields. But this is an example of how a research system can address a real problem of farmers in Eastern Africa--achieving a reliable supply of their staple food.

3.2.1 Step 1: Collecting Background Information on the Circumstances of Target Farmers

Diagnosis of the farming system has three major steps. The sequence acts like a sieve. It progressively sifts out unimportant facets of the system and, with them, irrelevant research issues. Each step funnels the

diagnosis towards key circumstances of target group farmers, key problems of their farming system, and the identification of appropriate development opportunities. The first and second steps use cheap diagnostic procedures to focus subsequent, more expensive procedures onto key issues.

As shown in Table 1, the first step for the Adaptive On-Farm Research Teams is to collate secondary data on the natural and economic circumstances of the target farmers in order to identify management problems posed by the local circumstances. The focus of enquiry is on the resource allocation decisions of the farmers. The following types of secondary information can be helpful to the research team:

(1) Natural circumstances
  (a) Rainfall, amount, and reliability to determine
    (i) The length and timing of the growing season
    (ii) Uncertainties caused by periods of excess rain or drought
  (b) Seasonal temperatures, to indicate
    (i) Growth rates of plants
    (ii) Frost incidence
  (c) Soil characteristics and topography, to determine
    (i) Potential erosion and soil fertility problems
    (ii) Possible locational advantages and disadvantages, flooding, and the use of residual moisture
  (d) Pest and disease incidence as a source of uncertainty of crop output

  Rainfall uncertainty offers a very common example of the usefulness of this kind of review. If, in examining the monthly rainfall probabilities, the researcher finds that the third month of a five-month rainfall season is unreliable (e.g., it has 4 out of 10 years below 70mm of rain), he has identified a major management problem for local farmers. The management strategies used by farmers to meet this uncertainty will be examined in the second diagnostic step, the Exploratory (Informal) Survey.

(2) Institutional circumstances
  (a) Types of marketing and supply channels
  (b) Types and reliability of food distribution channels

(c) Extension and credit programs: the types of programs, the numbers and types of participants

(d) Land tenure arrangements

(e) Farmer groups, whether voluntary, organized, official or unofficial, and their planned and actual functions

This information describes the available physical infrastructure. Information on marketing and government intervention programs allows some assessment of the content and degree of penetration of the local institutions, while information on land tenure and farmer groupings describes part of the institutional environment which will influence farmer decision making.

(3) Economic circumstances

(a) Population numbers and density, and the pattern of settlement

This information gives an indication of the scope for the intensification of production. Different settlement patterns have different implications for access to water and grazing.

(b) Available acreage and production figures

These figures give an idea of the relative importance of the various enterprises in the Farming System.

(c) Marketed products

(i) Volume and trends for outputs sold and inputs purchased

(ii) Foods purchased, relative volume and trends over the years and between seasons

(iii) Prices, trends over the years and over the calendar, and marketing margins

Information on marketing helps to highlight how things are changing in local farming communities.

The review of secondary information is a two- or three-day task for the research team. Where data is limited, as it often will be, it should be supplemented by extra time in the target group area discussing these same aspects with businessmen and local officials. The review aids in understanding how the local production environment influences the management of farms.

3.2.2 Step 2: The Exploratory (Informal) Survey

The Exploratory (informal) Survey is the pivotal procedure in the three major steps in the diagnosis of the farming systems. The survey is carried out by a team consisting of an economist, agronomist, and other specialists who talk with target group farmers on their farms over a period of ten to fifteen days. Through this process, the economist comes to understand the farmer's perspective on production decisions and the biological researchers identify major shortcomings and compromises in management that appear to under-exploit the biological potential of the area. Interaction between the economist and biological scientists identifies new management practices which would better exploit biological potential and help farmers meet their priorities from within their resource endowments.

The Content of the Exploratory Survey

The first step in understanding the problems of target group farmers is to realize that empirical research throughout the Third World has shown that farmers are rational and purposive in their behavior to satisfy the following priorities:

(1) The social and cultural obligations of their community
(2) A reliable supply of preferred foods day in and day out
(3) A supply of cash to provide additional basic needs
(4) Extra cash

Although the order of these priorities is fairly firm, the weighting of each of the four will depend on how close to the subsistence level the farmers are operating and the cultural milieu. At the subsistence level, (1) and (2) will normally be very dominant and a farmer will pursue management strategies to satisfy these priorities.

A systems perspective is used in the exploratory survey in order to understand how farmers choose enterprises, growing period, and when and how they use the product. This information gives the analyst a preliminary weighting of farmers' priorities and an understanding of decision criteria for each enterprise. There will be seasonal changes in the relative size of enterprises, in the timing of enterprise activities, and in the use of the output. Manipulating these factors gives farmers the flexibility to react to seasonal changes in natural and economic circumstances.

The understanding of the priorities of farmers and the way these are met is deepened by observation and discussion with farmers. Farmers have limited amounts of resources at their disposal. The pattern of enterprises over space and time, and description of the production methods used for each, allow an assessment of how they have allocated their resources in order to satisfy priorities. For this, the analyst needs a knowledge of the labor and cash requirements for alternative techniques of production for different enterprises. For example, hand hoeing may require 40-50 man-days per hectare. The FSE needs this kind of input information to construct approximate land, labor and cash use profiles for the farming system by relating the size of each enterprise, the pattern of each enterprise activity over the year, and the production techniques used in each enterprise activity. Each technique implies a resource requirement; the timing of its implementation denotes the farmer's commitment of those resources to that enterprise at that time.

By relating resource allocation to endowments, the economist begins to understand the limitations on the farming system and its development. The limiting factors represent management problems to the farmer and also leverage points for introducing new materials and techniques to improve the system. The agronomist uses his disciplinary knowledge to understand the ideal technical management of the key enterprises under local conditions. He then identifies agronomic practices used by farmers and records this information in his field notes.

The day-to-day interaction between the adaptive research team need not result in the preparation of reports or even field notes. Whether the sequence of collecting information is more or less formal, it has the same essential steps: identification of problems of farmers, and the appraisal of potential solutions by both the agronomist and the economist. The economist and the agronomist may feel a need to call in specialists such as Entomologists, Veterinarians, Animal Production Specialists, Anthropologists, and Sociologists. The information gained by the adaptive research team forms the content for subsequent On-Farm Experimentation with a range of new agronomic practices and materials including new varieties, fertilizer, pesticides, machinery and equipment, and even new enterprises. New practices could cover one or any combination of the management components involved in producing one or more enterprises: seedbed preparation, time

and method of planting, crop arrangement in the field, weeding timing, frequency and intensity, and many other components relevant to crop production. Innovations in livestock enterprises could include housing, breeding, health, and feeding management.

Carrying Out the Exploratory Survey

The Exploratory Survey is carried out by the economist and agronomist through unstructured interviews with target farmers within the Recommendation Domain. The interviews are best conducted during the growing season and preferably one to two months before the harvest period. The discussions with farmers represent a recursive learning process. Guidelines setting out the areas of information which may need to be covered are divided into "bite sized" sections. The researchers interview a farmer on one or more sections and make field notes; they may interview the same or different farmers on the same sections. At the end of the day, after talking to perhaps three farmers and covering various sections of the guidelines, researchers meet as a team and evaluate the information obtained. This interaction between researchers at the end of the day is essential in furthering their understanding of local farming. Farmers are further interviewed on the same sections until researchers are confident that they understand those aspects of local farming. At this point, each researcher makes detailed notes on each heading of that section of the guidelines. Gaps in the information are identified and filled in through subsequent interviews. Wherever possible, interviews are carried out in farmers' fields, with visible evidence of farmers' management before the researchers. These visits present an opportunity for researchers to interact with their clients.

The output of the Farming Systems Economist from the exploratory survey is in two parts. The first part consists of field notes organized in the format of the Detailed Guidelines (see Annex. 1) which covers the sections on systems. The second part is a "System scenario" which:

(1) Describes the enterprise pattern and output uses; sets out calendars for crop production, human food use, and livestock food use; and discusses variation in these features year to year;

(2) Specifies what farmers are trying to achieve with each enterprise and what decision criteria they use;

(3) Specifies the longer-term and the seasonal constraints on the expansion of the farming system;

(4) Explains management strategies used by target group farmers to achieve their priorities

  (a) In the face of uncertain natural and economic circumstances, and

  (b) In the face of their resource limitations;

(5) Explains how these strategies influence production methods, including the timing of production activities, for the major enterprises; and

(6) Specifies major points of leverage on the system in order to guide the search for new materials and practices.

The agronomist's output is Field notes, organized in the format of the Detailed Guidelines and covering the sections on husbandry, repeated for the key enterprises. The notes should detail the compromises made between present practice and what the agronomist judges as the ideal technical practice, given local circumstances of climate and soil.

The joint output of the Exploratory Survey is a recommended set of on-farm experiments which the agronomist believes will better exploit biological potential and which the economist perceives will be compatible with the goals and resources of the farmer.

3.2.3 Step 3: The Verification (Formal) Survey

The Exploratory Survey is followed by a verification or formal survey to determine whether the understanding gained from informal discussions with selected farmers is indeed valid for the target population of the Recommendation Domain as a whole. This survey may also seek deeper understanding of particular facets of the system and may measure those parameters crucial to the efficient planning or interpretation of experiments.

Verification

The initial facet to be verified is the homogeneity of the Recommendation Domain. Survey questions cover the variables by which the Domain has been specified and demarcated. The responses are tabulated to show the sample distribution across these variables. Hypotheses are explored for

subpopulations which emerge, and a redefinition of the boundaries of the Domain may be necessary. Important facets to be verified are farmers' priorities, decision criteria for each enterprise, resource limitations, the degree of uncertainty, and the relationship of these facets to resource reallocation.

Measurement of Inputs, Outputs, and Other Parameters

A major consideration in developing the sequence of FSR procedures has been to stress rapid turnaround of information, and to keep costs low, especially in terms of professional time. The need for measurement of parameters has been minimized in the surveys carried out to date in Eastern Africa (see CIMMYT, 1977). The main analyses are the computation of frequency distributions across the population of those characteristics being verified by the survey, and cross-tabulations to explore hypotheses or differences among subpopulations. Usually the viability of a proposed set of experimental treatments is contingent upon interactions within the system. As a result, the measurement of some of these interactions may be crucial for a proper interpretation of experimental results. Three examples of important types of interactions which may need to be quantified in the verification survey are:

(1) The amount of seasonal labor required to implement improved management techniques in the experimental enterprise;
(2) The amount of cash needed to purchase inputs for the experimental enterprise; and
(3) The impact of labor released by the use of a new practice--e.g., herbicides for weeding--on the rest of the system.

The measurement of these interactions can be achieved by methods consistent with the goals of low-cost and rapid turnaround. Cost route data collection, based on frequent visits to the farm throughout the season, cannot be justified for the verification survey. For example, seasonal labor peaks are a major constraint on improving the farming system of many farms in Eastern Africa. Such peaks limit either the area cultivated or the standards of husbandry applied and thereby often limit the profitability of purchased inputs. Quantification of the enterprise combinations that lead to seasonal lead peaks enhances the planning and interpretation of on-farm experiments. Researchers can use labor input coefficients from

cost route surveys carried out in comparable farming circumstances. If credible labor input data is not available, it can be collected in the course of the Verification survey. A questionnaire designed to collect labor input data through a single visit to a sample of farms is shown in Figure 3.

CROP: _____ ESTIMATED SIZE OF FIELD: _____HA.

Operation	Month Done	Week 1--4	By Operation		No. Days Taken for Field
			Normal Work Group	Daily Hours in Field	

Figure 3. A Single Visit Crop Labour Input Questionnaire

Innovators

The better farmers in any population already may have identified many practices to improve their farming system. These practices can be identified in the verification survey. Farmers who appear to have developed management strategies which relieve constraints should be followed up after the verification survey, with a view to understanding how their solutions could be incorporated into on-farm experiments and subsequently diffused to other farmers.

Method

A single- or perhaps double-visit survey methodology is used for the Verification Survey. Since a Recommendation Domain has a homogenous target population, it will only be necessary to include about 30 farmers in the verification survey. To allow for the emergence of subgroups and the possible need to redefine the Domain, fifty or sixty farmers will be safer.

The verification questionnaire is developed from the output of the Exploratory Survey and it is completely location-specific and highly selective in content. Many of the foci--for example, farmer priorities, resource limitations, and management strategies--will be common across many target groups, and standard question sequences can be employed to elicit the information. On the other hand, the content, i.e., the enterprises followed and the actual practices used, will vary across Domains.

As always with a single- or double-visit survey, it is important to enlist the support of local leaders and ensure that the selected respondents are participating in an activity which has the backing of the community. Training of enumerators, careful pretesting of the questionnaire, and a level of supervision which evaluates each completed questionnaire while still in the field, are all essential for achieving good quality data. Hand tabulation and analysis of initial surveys will enable researchers to gain familiarity with the data. But the formal survey lends itself to easy computer processing.

3.3 On-Farm Experiments

The second half of the adaptive cycle, the On-Farm Experiments, are planned on the basis of the information collected in the sequence described above. The output from the verification survey is the verified content which will be used to design a set of on-farm experiments. These experiments will include management changes which the biologist believes will improve the exploitation of local biological potential and, which, at the same time, the economist believes will enhance the achievement of farmers' goals. The range of levels over which these variables will be tested is decided by the farmers' flexibility in managing the resource allocation implicit in the changes. For example, where it is found that animal manure is cheaply available to local farmers and the best way to maintain soil fertility, the amount of manure to apply and the timing of the application might be the two major variables studied.

The levels of farmyard manure to be applied will be dictated by the availability of manure to target group farmers. The timing of application will be decided by other factors, such as when the manure is to be applied during the rotation, when labor is available during the cropping year (the

carrying and application of manure are labor-intensive), and the best timing from the standpoint of the quality of the manure under present methods of storage. All such information is fed from the exploratory and verification surveys into the planning of on-farm experiments. Once the use of manure emerges as a relevant experimental variable in the course of the Exploratory Survey, further discussions with farmers will focus on these and other factors that must be considered before on-farm experimentation can take place. The level of non-studied variables is of equal importance in planning relevant experiments. In traditional on-station experiments, non-study variables are often fixed at levels which will not inhibit the effects of the study variables; complete insect control, unlimited labor for weeding, and optimal timing and method of planting are some common examples. Clearly, these may be completely irrelevant to Domain farmers. Hence, the variables to be studied in on-farm experiments are selected with the farmers' management ability as a paramount consideration.

Other variables have been rejected because the resource allocations implied are either beyond farmers' endowments or would precipitate major clashes with allocations in the present farming system aimed to meet farmer priorities. The On-Farm Experiments must show whether productivity will increase if the changes represented by the study variables are introduced into farmers' management regimes. Thus, non-study variables and the control treatment in the experiments will be at farmers' existing management levels; these are the only relevant baselines from which to measure improvements in performance. The Verification or Formal Survey will identify criteria to be used in selecting representative farmers and representative locations for the On-Farm Experiments. The farmers themselves will best be able to determine the management of the non-study variables appropriate to the circumstances of the season and location of the experiments. Similarly, the Formal Survey identifies the sources of costs and benefits within the farming system which determine the viability of the management changes for Domain farmers. Consideration of all relevant sources of costs and benefits allows proper interpretation of the on-farm experimental results.

4. PROGRESS IN INSTITUTIONALIZING FSR PROCEDURES IN NATIONAL AGRICULTURAL RESEARCH SERVICES

CIMMYT's Regional program was established in Nairobi in January 1976 with funding from the UNDP. Phase I covered the 1976-1979 period. Following a program review in late 1978, a Phase II was funded to the end of 1983. Demonstrations of the FSR procedures were the main program activities carried out through mid-1979, when the emphasis switched to in-service training of young FSR researchers. However, with a recent proliferation of donor-financed FSR programs (at least twelve planned, from the Sudan south to Botswana), CIMMYT's economists may increase its support for the planning and implementation of donor-financed FSR programs.

CIMMYT's Eastern African Economics Program was mandated in Phase I to work in six countries: Kenya, the host country; Ethiopia; Uganda; Tanzania; Zambia; and Malawi. Phase II extended this mandate to all interested countries in Eastern, Central, and Southern Africa.

CIMMYT economists discussed FSR with senior agricultural civil servants, including research administrators, in Kenya, Uganda, Ethiopia, and Tanzania in 1976, in Zambia and Malawi in 1977, and in Zimbabwe in 1980. CIMMYT has provided assistance to national research services in Kenya, Tanzania, Zambia, and Zimbabwe. Consultation and cooperation in training has extended to 13 countries through the region. CIMMYT's experiences with promoting FSR over the 1976-81 period are discussed below.

4.1 Kenya

Almost inevitably, more effort has been put into Kenya, the host country, where there is a strong political and policy emphasis to increase the prosperity of the mass of the rural population. FSR procedures were demonstrated in two areas in 1976: one in Siaya District on the shores of Lake Victoria, the other in Kwale District on the Coast. Since Kenya did not have any farm economists in its Scientific Research Division of the Ministry of Agriculture, economists from Egerton College and biologists from the research services helped carry out the FSR demonstrations. The Siaya demonstration was written up as a formal report and was well received by senior research administrators in 1977. A one-day seminar for senior research staff at the Faculty of Agriculture, University of Nairobi, in

June 1977, provided an opportunity to discuss the procedures and the concepts behind the demonstrations. Other demonstrations were undertaken and two examples show how the use of FSR procedures help to orient research efforts:

(1) In Siaya, Western Kenya, hand cultivation predominates and maize plantings are spread over a period of three months. Plantings made over the last half of this period are susceptible to failure due to the ending of the rains. An earlier maturing variety, although not exploiting biological potential as effectively, would be a more flexible management tool for farmers, given their resource constraint on seedbed preparation. An earlier maturing variety would also enhance the reliability of production of their staple grain--a major priority of small farmers (CIMMYT, 1977).

(2) Vihiga, Western Kenya, is an area with small holdings and two growing seasons a year. Over 75 percent of farmers were estimated to be growing the recommended maize hybrid (H 614C) in the long rainy season. With a 180-day maturity period, this hybrid was often kept in the field until August or September. Because land is scarce, the second rains crops must be planted on the same land. Even the shorter-term local maizes cannot be established and grown properly in the second rains unless they are planted by early August, due to dry weather in January. The focus of the FSR surveys was to determine how to increase maize production from the system as a whole. A possibility is to grow a shorter-term hybrid in the long rains and harvest it in July to allow timely preparation for the second season and enhance the viability of using purchased inputs for this second crop. At present, this short rains crop is considered too unreliable to risk the use of purchased inputs. A second possibility is to retain the higher potential, longer-term variety for the long rains and to experiment by relay planting it with the second rains crops (Lihanda, 1978).

Following the FSR demonstrations and review of the findings in early 1978, the Government of Kenya asked CIMMYT for help in building a capacity to use FSR procedures for planning research experiments within the

agricultural research services. An Economic Advisor to the director of Research was appointed and he cooperated with CIMMYT in developing an in-service training program. Six agricultural graduates, two of whom had a Master's degree in Agricultural Economics, were recruited in August 1978 and six more were recruited in August 1979. It was planned that the agricultural graduates would spend 12-18 months on research stations to gain experience with diagnostic survey procedures and some familiarity with experimental methods. During this period, they were helped in planning their work programs and in implementing field work. The trainees also attended two week-long residential workshops on FSR methods, mounted jointly by CIMMYT and the SRD. After this in-service training period, those holding first degrees were sent for Master's degree training in Agricultural Economics.

When a Farm System Economist (FSE) trainee was posted to a research station, he was introduced at a meeting of the station scientists and his possible contribution to the work of the station was discussed. During the meeting, agronomists were identified who expressed an interest in improving the relevancy of research for small farmers. The program planned for the FSE trainee was aimed to dovetail with the ongoing experimental program of an agronomist. The trainee's initial program of work was designed to increase his ability to understand farmers' situations and to incorporate this information into the planning and interpretation of experiments. Emphasis was placed on Exploratory Survey work, with some limited effort in Domain identification and in Formal Verification surveys.

On the whole, good progress has been made in building up an FSR capability among trainees. The best trainees have a good grasp of the spectrum of methods available for data collection and their relative suitability for various needs and situations. Most trainees are now able to contribute to improving the planning and interpretation of experiments. Two examples illustrate how this process worked:

(1) Exploratory Surveys of farmers growing intercropped maize and beans in Eastern Kenya threw new light on the interpretation of experiments in alternative mixture patterns. The surveys identified an acute labor shortage during crop establishment and showed that returns to labor required to establish the crop mixture would be a key criterion in appraising experimental

results. Labor data which was collected from large plot experiments designed as a randomized block with five replicates produced results which are shown in Table 2.

TABLE 2

Returns per Unit Area and to Planting Labour

System	Yield kg/ha Maize	Yield kg/ha Beans	Yield Value US$ per ha	Planting Labour Hours/150 sqm	US$/hr Plant. Lab.
A: pure maize	4339	--	542	3.58	2.24
B: pure beans	--	1723	754	9.39	1.13
C: recommended	3444	768	766	17.15	.63
D: farmers	2800	331	495	3.11	2.34
E: D modified	3231	371	566	5.48	1.55

Source: Gathee, 1981.

Recommended planting patterns for maize/bean mixtures (Treatment C) require five times more planting labor than simulated farmer pattern (Treatment D) which gave almost four times the return to the planting labor used. In the farming systems of target groups growing maize/bean mixtures, which have a short rainy season and where land is not limited, there are often intense labor peaks at the time of crop establishment. For such target groups, return to seasonal peak labor used may be a more appropriate criterion than return per unit area in comparing results from experimental treatments.

(2) Exploratory and Verification Survey work was carried out in an area of Western Kenya with high population density and an acute scarcity of land. The results revealed a marked interaction between crop and livestock enterprises in the use of crop residues as byproducts for feeding local animals kept for milk. The data are shown in Table 3.

TABLE 3

Sources of Feed for Local Dairy Animals

Source of Feed	% of Farmers	Ranked in Importance (%) 1	2	3	4	Less Important
Grazing: own farm	100	100	-	-	-	-
: commonland	79	-	25	4	4	46
: other farm	67	-	-	-	-	67
Maize : green stalks	96	-	42	42	8	4
: dry stalks	83	-	4	29	17	33
: leaves	25	-	-	-	-	25
Banana leaves & stems	42	-	-	-	-	42
Sugarcane tops	50	-	-	-	21	29

Source: Wangia, 1980.

The dominance of maize as a source of cattle feed, both green and dry material, led to proposals for two adaptive experimental programs which were designed to examine:

(a) What increase in maize plant population would be possible so that fodder production could increase without penalizing grain yields, in both the long and short rains, and

(b) The effects of alternative timing of picking the leaves and tops of maize, on grain and fodder yields.

The second major leg of program strategy was to build up the credibility of the Farm Economist with technical researchers, particularly agronomists. Here the program has had limited success. Many of the problems encountered in establishing a close working relationship were features of the research organization, particularly the strong compartmentalization, upheld by everything from disciplinary loyalty to parallel compartmentalization in the layout of government estimates and fund votes.

The authority of Research Station Directors, both to influence research planning within disciplines and to control operations, was badly underestimated. It had been foreseen that the cost of on-farm trials would be an obstacle to the introduction of this component, but budgetary factors also proved to be a barrier to moving Farm Economists and biologists from research stations to work among farmers. Station Directors were loathe to release transport and travel funds in disproportionate amounts to new, junior research officers. Despite their involvement in briefing sessions on all stations at which economists were introduced, Directors were often not clear on or convinced of the role of the trainees. At the same time, they identified 'money related' jobs on the stations to be the responsibility of an economist. These jobs ranged from costing the station dairy herd or vegetable production to assessing future market prices for a new crop currently under observation. While an economist can carry out these responsibilities, the danger is that he will be detracted from his role of helping carry out adaptive research.

The marriage of the economist and the biologist has proved to be an extremely difficult one to consumate in Kenya for the following reasons:

(1) The specialist orientation of the technical scientist was perceived to be diluted and his professional peer group status threatened if he cooperated with economists. Similar penalties exist in working close to the farmer, where science is "less pure."

(2) Technical researchers are locked into a series of experiments which are programmed and budgeted over a period of years. Additional commitments are difficult to reconcile with these programs and supplementary budgeting is an awkward procedure.

(3) When any series of experiments is concluded, the established mechanism for deciding new commitments comes into operation. Attempts by the economist trainee to override this creates conflicts within established channels. Hence, his interventions, given his junior status, are usually squashed.

(4) The junior status of the trainee economist strengthens the impression of "unjustifiable intrusion" in two ways: (1) Cooperative efforts with "senior" biologists are awkward because the trainee is the underdog, and (2) the trainee has a poor command

of his new profession and cannot put his case in a convincing way.

Overall, the introduction of FSR procedures into research planning and interpretation seems to be seen as an attempt to promote the agronomist and economist, perceived traditionally as playing service roles to disciplinary researchers, to central and pivotal roles. The establishment feels threatened and the social scientist, seen as the intruder, is rejected.

While these problems of implementation have occurred at the local station level in the last two years, major institutional changes in agricultural research have taken place in Kenya. In 1979, a reorganization divided the Ministry of Agriculture into two ministries, with the new Ministry of Livestock Development taking over responsibilities for livestock economists. A bill was passed by the parliament in 1979 to establish the Kenya Agricultural Research Institute (KARI), a parastatal to carry out all crop, animal, and forestry research. The new institute has not yet taken up the full role intended for it. At the same time, not all the major personalities presently in charge are convinced that social scientists and FSR procedures have any role in agricultural research. Little progress has been made in expanding the adaptive research capacity since early 1980.

4.2 Zambia

When CIMMYT economists made contact with Zambian agricultural administrators in 1977, the administrators expressed a strong concern for the need to assist small farmers because the historical emphasis on copper and large commercial farms was not meeting food needs and the political needs of the country. Administrators were aware that small farmers operated under different circumstances than large farmers and that a new orientation to research and extension was necessary. The government was interested in CIMMYT's interdisciplinary approach and a demonstration was implemented near Serenje, a small town in the maize growing area in the Central Province 300 kms north of Lusaka. The demonstration was carried out by an economist from the Rural Development Studies Bureau--a research unit attached to the University of Zambia--and biological scientists from the Central Research Station at Mount Makulu. The field work was carried out in the first half of 1978 and the final report was accepted by a meeting of

the Program Steering Committee in December 1978. The Committee then charged CIMMYT with the responsibility to develop a capacity for implementing FSR within the research services. Two new graduates were recruited for the program and joined the research services as trainee FSEs in July 1979. Throughout, CIMMYT has been responsible for helping to plan and supervise their work programs and has sponsored their participation in the in-service training workshops mounted in association with the Government of Kenya. At the request of the Steering Committee, a further demonstration was implemented during 1979 which divided Central Province, one of nine major administrative units in Zambia and covering some 116,000 square kilometers, into Recommendation Domains. The final report showed the potential uses of a Recommendation Domain framework in research and development planning.

During 1980, a plan was drawn up to establish a two-level hierarchy to strengthen agricultural research in Zambia--Commodity Research Teams and Adaptive Research Planning Teams (ARPT). Under this plan, Commodity Research Teams, working from established research stations, would be complemented by Farming Systems teams which were called Adaptive Research Planning Teams. A Senior Farm Economist was appointed at the end of 1980 to coordinate the development of the ARPT Program. Currently, three agronomists and one trainee economist are attached to the ARPT program. The current pre-occupation of the ARPTs is to identify Recommendation Domains for two more of the nine Provinces and to implement Exploratory surveys to be used in planning on-farm experiments for three Domains during the 1981/82 crop season.

The decision to adopt a two-level hierarchy--Commodity Research Teams and Adaptive Research Teams--was influenced significantly by the problems CIMMYT experienced in Kenya in trying to modify a strongly compartmentalized research establishment. A two-level hierarchy provides an opportunity to build an adaptive research effort through young professionals trained from the start in this approach. Under this system, it is hoped that conflicts between senior technical scientists and trainee economists will be eliminated and there will not be a need for the new discipline of economics to break into ongoing disciplinary programs. Since all the young professionals will be learning their roles simultaneously, this will avoid the imbalance created when a new economist has not yet accumulated the experience to demonstrate his usefulness to the established biologist.

A major problem in developing Adaptive Research capacity in Zambia is the scarcity of agricultural graduates. While continuing to seek trainees from the ranks of agriculturalists graduating from the University of Zambia, the Government of Zambia is asking donor agencies to provide technical assistance personnel to strengthen commodity research teams and to help staff ARPTs.

4.3 Tanzania

The FSR procedures were presented in a proposal to the National Crop Research Planning Committee of Tanzania in October 1976. The Committee gave CIMMYT permission to approach Directors of Research Stations and to seek their interest in a demonstration of FSR procedures. Two Directors were approached, one at the Central Research Station, Ilonga, and one at Uyole Agricultural Centre, Mbeya; and subsequently, FSR demonstrations were mounted in cooperation with the staff from both stations in 1977.

Although Tanzania has a history of farm economists on its research stations, there was no economist working at the Central Research Station in 1977. The FSR demonstration, in the drier areas (less than 1000 mm per year) of Morogoro and Kilosa Districts, was carried out by biological scientists from the station and farm economists from the Faculty of Agriculture of the University of Dar es Salaam, Morogoro. The Exploratory and Formal Surveys were completed in early 1977. A draft report and proposals for experimentation were discussed in October 1977 and the final report was presented to the Chief Research Officer in the Ministry of Agriculture in December 1977. The major recommendation was to begin experiments on short-term maize selections which required about 45 days to tassle, 20-25 days less than varieties presently used in the area. The report concluded that a maize selection tasselling in 45 days would have the following benefits for target farmers:

(1) The most reliable period of rainfall is early March to mid-May, a period of 70-75 days. A variety tasselling in about 45 days, planted on the first good March rains, would make the best use of this period of rain and would increase the reliability of their preferred staple.

(2) The shorter-term maize variety would enhance the farmers' ability to react to contingency situations--such as late starting

rains or a marked gap in the rains or rains finishing in early May. These contingency situations were mentioned as key hazards by a high proportion of farmers.

(3) Maize is already used to supply food early in the new season. A variety tasselling in about 45 days would produce food 3 weeks earlier than present varieties.

(4) The shorter variety planted earlier in these areas would free the wet low-lying locations some 3 weeks earlier than the existing varieties, which has several possible ramifications:
   (a) An increased probability of getting a bean crop from these areas,
   (b) An increase in the number of low-lying areas where a bean crop could be attempted, and
   (c) The possibility, in the better low-lying areas, of growing other crops with a slightly longer growing season than beans.

(5) The introduction of a short-term maize crop, capable of giving a reliable supply of the favored staple from an early or mid-March planting, will have two more important and interacting repercussions on the farming system, both of which should improve the scope for cash crop production by target farmers.
   (a) The later planting date will spread the demand for labor into late March/early April (weeding the maize planted).
   (b) Increased reliability of the maize crop will reduce the need to plant sorghum as an insurance. Labor will be freed from sorghum establishment and weeding in the January/February peak labor season.

Both situations will improve the flexibility of target group farmers by:

- Allowing them to reduce their cash outlay on labor and tractors needed to give them the required area of crops (2/3 of all farm expenditures), thus permitting the use of cash for other purchased inputs;
- Or allowing an increase in the area cultivated by maintaining their present outlay or hired labor and/or tractor services;

- Or allowing more timely planting over a larger area of cotton or other crop grown for cash.

The second demonstration in Ufipa District in Southwest Tanzania was carried out by an economist and technical scientists from Uyole Agricultural Centre, a parastatal with responsibilities for agricultural research throughout the southern highlands of Tanzania. Fieldwork took place in late 1977. The final report, delayed due to an abortive attempt to develop a computer processing link with the University of Dar es Salaam, was discussed with all Centre scientists in mid-1979.

Since then, little progress has been made in obtaining a commitment by national agricultural research services in Tanzania to utilize the demonstrated FSR procedures. While the procedures have been used extensively by Uyole Agricultural Centre for diagnostic survey work in the Southern Highlands, the linkage with On-Farm Experimentation has been limited. One ongoing research program at Uyole is the diagnosis of the same farming system by three techniques of data collection: the Exploratory Survey, the Exploratory plus Verification Survey, and a frequent visit cost route survey. This research is designed to quantify the incremental costs and benefits of the three techniques. In addition, the Crop Science and Rural Economy Departments at the Faculty of Agriculture, Morogoro have cooperated in using FSR procedures to plan experiments in a program funded by the International Development Research Centre (IDRC). The new national research parastatal, Tanzania Agricultural Research Organization (TARO), is planning to use an FSR approach to research, although implementation has not yet started.

4.4 Zimbabwe

With the independence of Zimbabwe in 1980, contact was made with Research and Specialist Services (R + SS) in the Ministry of Agriculture. Both R + SS and the Department of Agricultural Development (DEVAG), charged with the development of agriculture in the Tribal Trust land, showed an interest in using FSR procedures to plan appropriate experiments. A demonstration of FSR procedures was undertaken in the Chibi District of the Victoria Province, some 400 km south of Salisbury, in the first half of 1981.

The demonstration highlighted an increasingly common phenomenon in Africa: increasing population densities are demanding more arable land and are imposing pressure on grazing land. In the Chibi District of Zimbabwe, these pressures are jeopardizing the ability of farmers to maintain their cattle, which they value as a source of draft power, milk, and as a last resort, cash. The reduction in grazing particularly exacerbates the dry season (4-5 months) feeding problems, and hence the animals are in poor condition for draft work by the beginning of the new rainy season.

Farmers in the area have already adopted the following strategies to counter these pressures:

(1) New maize varieties are giving better results on the low fertility soils than the millets or their traditional maizes;
(2) Manure is being used to help maintain soil fertility;
(3) Winter ploughing uses animals when they are in their best condition after the rains and minimizes draft requirements in October and November when animals are weak;
(4) Maize stover, groundnuts haulms and, in a few cases, grass are harvested and preserved to maintain a satisfactory condition through the end of the dry season;
(5) Cows are being used for draft purposes;
(6) Some farmers establish maize or millet late, from January to March, even after harvesting their groundnuts, to provide extra dry season fodder.

These strategies bring their own problems. Because crop residue is now heavily used for dry season feed, it is scarce for making manure or for ploughing back in the fields. The poor condition of cows suffering from low nutrition and overuse as draft animals for as much as five months of the year leads to low fecundity, poor calf nutrition, and increasing mortality. Indeed, many more farmers in the area will find themselves without their own draft animals, unless the downward spiral is arrested. In the extreme, hoe cultivation will be established in many parts of the area, as arable encroachment finally absorbs the grazing area. Even now there is increasing migration to towns in the area, as people's expectations can no longer be realized from the land and available animals.

This key problem area of increasing the productivity of animals in the farming system is one of four foci identified for priority research at both

technical and adaptive levels. Within this focus, three thrusts were proposed:

(1) Increased dry season feed
   (a) Raise maize density to increase fodder
      - examine fodder/grain balance
      - examine the interaction with drought tolerance
   (b) Test bulk fodders or a forage legume, or both intercropped, to plant after groundnuts (the earliest harvested crop)
      - examine the possibility of a shorter season groundnut
      - examine the possibility of an earlier harvest of existing varieties, with stooking to avoid sprouting. Either would give late fodder plantings a longer period with moisture.
   (c) Undersow the maize crop with a forage legume
      - examine alternative planting patterns for maize to encourage forage legumes

(2) Improvement of cows as draft animals
   (a) Timing of service and calving alternatives to give better calving intervals, with cows used in draft from September to November and March to May
   (b) Service cows by A.I. or standing bulls to give them better conformation for their ploughing role, which also removes the need to hold male calves and reduces grazing pressures (an offtake for male calves would be an incentive)

   Both measures to improve cows as draft animals were felt to be contingent upon the farmer's ability to recognize heat and on a stronger inclination on their part to control service. Presently, with low nutrition affecting both bulls and cows, farmers are happy to have their animals serviced under any circumstances.

(3) Improve stover management
   (a) Examine the time of cutting of maize stover, balancing the full maturity of grain with the nutritive value and palatability of the stover
   (b) Examine methods of holding and feeding of both groundnut haulms and maize stover

With the demonstration of FSR procedures recently completed in Zimbabwe, it remains to be seen whether the Ministry of Agriculture will accept such procedures as a means to improve relevancy in research for Tribal Trust farmers.

4.5 Lessons From Country Experiences

The emphasis on in-service and short-term training has preoccupied CIMMYT staff members since the middle of 1979. By late 1980, Kenya trainee economists and significant numbers of agronomists had attended various training programs. With a growing demand for FSR training throughout East, Central, and Southern Africa, it was decided to broaden the scope of the training and cover both the Diagnostic Survey sequence and the On-Farm Experimentation sides of the Adaptive Research Cycle. Workshop time was increased from one to two weeks. The first workshop with a regional emphasis was held in September 1980 and covered the FSR procedures for Diagnostic Survey work. The second workshop with a regional emphasis was held in April 1981 and covered procedures for the planning, management, and interpretation of On-Farm Experiments. There was an overwhelming demand for this workshop; it was attended by 42 participants, more agronomists than economists, from ten African countries. On the basis of our experience to date, we think that CIMMYT's Regional Economics Program should expand its training activities and also work closely with FSR-oriented programs sponsored by various donors.

Lessons have also been learned from working with national research services. The most important is the recognition of the need for a flexible and pragmatic approach to different institutional situations and to the personalities involved in each situation. A major strategy is to focus on research services where there is already a strong awareness that research relevance is a problem. Within such establishments, if authority is strong, it may be helpful to introduce FSR procedures. Where direction is weak or conservative or where organization is poor, new procedures can be seen as an added source of confusion--a nuisance. In such circumstances, only a bottom-up approach, working through the station and with individual scientists, seems feasible. Ideally, top-down authority and a bottom-up approach working through individual researchers can be complementary.

A clear distinction has emerged between technical and adaptive research. Technical research is the solution of technical problems on research stations organized along disciplinary and commodity lines. Adaptive research is a selection and testing, from the range of potentially relevant technical solutions, of a partial or whole solution to a particular problem that has been established as a priority by a target group of farmers. A revised implementation strategy then is to establish adaptive on-farm research teams, whose members build up their experience together, drawing on both the existing body of knowledge and on older disciplinary oriented specialists for potential solutions to identified systems problems. Once established, adaptive teams begin to channel unsolved technical problems back to the specialists. This process continues until problems identified on farms preoccupy both adaptive and technical researchers in the research hierarchy.

5. CURRENT ISSUES IN FSR PROCEDURES

This section sets out some current issues in the use of FSR procedures for improving relevancy in agricultural research. It moves from concepts through procedures to promotion strategies. The first issue is the need to reconcile national and local priorities to plan effective research and development programs.

5.1 A Framework of Recommendation Domains as a Link Between National and Local Priorities

A framework of Recommendation Domains of farmers provides an interface between national and local priorities. The framework of recommendation domains can assist in developing more effective development programs by linking top-down policy objectives with local needs as revealed by the exploratory and verification surveys. The four common steps in planning agricultural development programs are:

(1) National policy objectives dictate that a commodity should be promoted. For example, government policies dictate that cotton should be grown for local industries as a substitute for imported raw materials.

(2) Areas are selected with suitable natural growing conditions.

(3) Areas are selected which have infrastructure and institutions onto which programs and marketing services can readily be grafted. (Alternatively, the necessary infrastructure and institutions form part of the development program.)

(4) A package of practices is specified that aims at attaining optimal technical management of the commodity under the climate and soil conditions of the chosen area.

There is now substantial evidence in Eastern Africa that this sequence fails to give adequate attention to both the priorities and the economic circumstances of local farmers. Yet these factors are crucial to the success of agricultural development programs because recommendations which are incompatible with the priorities of farmers will be unacceptable to them.

Some device for coordinating the efforts of policy makers, planners, researchers, and extensionists is long overdue. A framework of

Recommendation Domains has the potential of helping select research priorities, and promoting communication between farmers and the bureaucracy and between departments in the bureaucracy. On the basis of using FSR procedures in Eastern Africa, we believe that the zoning questionnaire, background information, and the exploratory and verification surveys can provide information that will help evaluate the suitability of each Domain for programs designed to meet one or several national policy objectives. In addition, the diagnostic sequence can be used to identify needed changes in policies and institutions to support local development programs.

5.2 FSR--Carte Blanche or a Predetermined Focus?

The issue is whether, in trying to identify farmers' needs, the diagnostic survey sequence should or should not be pre-focused onto one enterprise such as maize.

It is a major issue. FSR proponents themselves base their case against traditional experimentation on compartmentalized research establishments and heavy disciplinary specialization. The breeder believes variety is the main problem, the soil scientist fertility, the entomologist insects, and so on. The farmer will have his own list of problems, many interrelated. If research effort addresses those well down on his list, missing say his top three, he will regard such changes as irrelevant to his priority needs and will be unwilling to commit his limited resources to their adoption. The question is does a systems approach which is pre-focused onto one enterprise fall into this same trap of treating, what may, for the farmer, be secondary issues.

It will almost always be found that one enterprise offers the best leverage on system problems and forms a focus for experimentation and development. But it is clear that investigation from a whole system orientation may focus research on quite a different enterprise from one which is pre-determined. Ideally, the investigation and planning process should be initiated carte blanche from a whole system orientation with the intention of focusing experimentation on key problems and the enterprise, or enterprises, offering best leverage for the solution of those problems. The examples given in the paper featuring starch grains and livestock show how crucial the system interactions are in dictating the relevant development opportunities for a particular enterprise. They also show,

incidentally, that FSR procedures for diagnosis handle crop and livestock with equal facility. Though whether livestock or indeed tree crops can be handled effectively on the On-Farm Experiment side of Adaptive Research cycle is an unanswered question. In CIMMYT, the mandate for work on maize and wheat has demanded a compromise from a full system orientation. This has been made in Eastern Africa by locating demonstrations in areas where maize is the major enterprise in the local farming system. With subsistence and semi-subsistence farmers, the major starch staple is almost inevitably their priority crop, and, as the one which absorbs the most resources, is the crop which gives best leverage for the development of the whole system. At the same time, the funnelling nature of the diagnostic sequence allows confirmation at the Exploratory survey stage, before costs are significant, that the pre-focus on maize or wheat is consistent with effective leverage on the whole system.

Operationally, when trying to introduce FSR procedures into an essentially commodity-oriented policy and planning environment, a pre-focused approach is more readily compatible with existing institutions and procedures. A whole system approach may be much more difficult for incumbent professionals to accept.

5.3 Can LDC Research Manpower Handle a Large Number of Recommendation Domains?

It was emphasized earlier that research planning is a compromise. Ideally, research and development efforts would be tailored to the circumstances of each individual farmer. This is clearly impractical. It is equally impractical to mount the same R & D effort for all farmers in a country, as their circumstances are so diverse. We have argued in this paper that one must search for homogenous farming systems or recommendation domains as a working compromise. But let us see whether it is a compromise within the grasp of the significant number of LDCs with limited research resources. First, what is the likely size of a recommendation domain? In Zambia, we established an average of 10,000 farms per Domain, ranging from 3,000 to 23,000 farms in the seven Domains identified. The numbers will vary according to the variability of natural and economic circumstances and with the density of population. In Zambia, the climate and soil were fairly homogeneous; economic factors, particularly access to

markets, were variable; and population density was very low, at 3 or 4 people per square kilometer. Extrapolating the 10,000 farms per Domain in Central Province gives some 60 or 70 Domains for the Zambia agricultural sector as a whole. The Zambian Research Service plans to field an ARPT team of an agronomist and economist in each of the 9 Provinces for a total commitment of some 18 professionals. This implies that each team would be responsible for some eight Recommendation Domains.

The next step is to make assumptions about the workload for the agronomist and economist to determine whether each team has the ability to cover eight Domains. The main responsibility of the agronomist is to manage, supervise, and interprete the on-farm experiments. He will also help the economist carry out the Exploratory Survey work. The agronomist's workload is assumed to be the following:

(1) With support staff he will be able to supervise 24 on-farm sites each year.

(2) He must cover six sites across each Domain to obtain 'Domain wide' results.

(3) He will need three years' experimentation at each site.

These assumptions would allow the agronomist to gradually cover the eight Domains of his region over a six-year period.

The Diagnostic Survey sequence is the main responsibility of the economist. He must also participate in discussions with the agronomist, extension staff, and farmers at the experimental sites. He will be responsible for the economic interpretation of the experimental results, and the collection and collation of economic data from experiments on Domain farms. To match the rate of coverage of the agronomist he will need to implement the Diagnostic Survey sequence in three new Domains every two years.

Under these assumptions, the Adaptive Research cycle would require six years before returning for a second round, including an evaluation of the extent to which first-round recommendations were adopted by Domain farmers. The estimated rate of coverage seems adequate in Zambia. With some exceptions, the manpower commitments of two adaptive agricultural research professionals per 80,000 farms seem within the reach of the countries of East, Central, and Southern Africa.

The above figures are useful for purposes of arithmetic but should not obscure the flexibility in organization and management that is inherent in an Adaptive On-Farm Research program. For example, a breeding effort cannot be justifiable for the needs of one Recommendation Domain. But as the needs of many Domains are accumulated, this information can be transmitted to the breeders. Likewise, fertilizer trials may range across similar soil types and cover many target groups; yet the interpretation of the results will be geared to the needs of each target group.

5.4 Is Modelling a Farming System Worth the Extra Cost?

The FSR procedures promoted by CIMMYT in Eastern and Southern Africa have been designed with major problems of LDC institutions in mind: limited funds and limited manpower. The procedures allow researchers to gain an understanding of the farming system of a target group of farmers over a 2- or 3-month period. Costs are low and turnaround time is rapid. Among farm economists working in LDCs, a major controversy centers upon the intensity of investigation and analysis required to understand the systems. A spectrum of data collection methods is available, from single-visit surveys to cost route methods in which farmers are visited regularly over the agricultural calendar. Similarly, a spectrum of analytical tools is available, ranging from simple cross-tabulations to sophisticated variants of mathematical programming. The CIMMYT procedures are close to the rapid and cheap end of the collection and analysis continuum, with a turnaround time of 2 to 3 months for any one target group of farmers, compared to 12 to 24 months for frequent-visit data collection and programming analysis.

Cheap and rapid FSR procedures can gain an initial understanding of 4 to 12 target groups in the time period that a single target group can be studied by frequent-interview research methods. Where research manpower is scarce it is assumed that the benefits from this initial understanding of 4 to 12 target groups will be much higher than those obtained from an increased understanding of one target group through detailed data collection and the use of sophisticated modelling techniques for system analysis. Furthermore, mathematical programming cannot effectively represent real life situations, and, in practice, the level of control of enumerator and respondent error in cost route data collection techniques is usually poor. The conclusion is that the sophisticated methods of data collection

and analysis at the far end of the spectrum are not cost effective and useful in serving thousands of small farmers in the typical country in Eastern and Southern Africa. Certainly, increments in understanding gained from modelling farming systems are acquired at a very high cost, particularly in terms of the understanding of other systems foregone due to the scarcity of farm economists working at the micro-level in LDCs. This is the rationale behind CIMMYT's emphasis on low-cost rapid procedures for farming systems diagnosis.

CIMMYT's experiences in implementing the diagnostic sequence raise questions about whether even the Formal Verification survey is necessary. This is the most complex and expensive part of the survey sequence, absorbing 60-70 percent of the turnaround time. Verification Surveys in Eastern Africa have never seriously contradicted the findings of the Exploratory Surveys. The Formal Verification Survey results have been used for two main purposes:

(1) To provide numbers to support the diagnosis of the Exploratory or Informal Survey, which is important where the FSR procedures are being demonstrated to new institutions.

(2) To provide data to improve the detailed planning of experimental treatments and the fuller interpretation of experimental results.

It has become clear from CIMMYT's experience to date that the Exploratory Survey is the key stage in diagnosis, bringing a systems perspective to bear on a farming situation, and the biological and social scientists into direct contact with the farmers. And it is probable that the collection of data from Domain farmers during the period of on-farm trials can be used to verify or modify the findings of the Exploratory Survey and to develop the experimental program. If this change were made, the sequence would bear a much closer resemblance to that developed at the ICTA in Guatemala (Hildebrand, 1976).

5.5 Outstanding Issues in Promoting FSR for Agricultural Development

Some outstanding issues arise in the wider mobilization of FSR procedures for agricultural development. These could usefully fill further papers in this series.

FSR procedures which are carried out as part of an Adaptive Research cycle offer an excellent device to bring farmers into the technology development process and to close the gap between research and extension. The use of FSR procedures by research establishments would be enhanced if the motivation of both technical and adaptive research scientists could be closely related to the benefits their work brings to farmers.

Training for would-be researchers, and perhaps more generally for Third World agriculturalists, is a second urgent issue. All professionals working in smallholder agriculture need a systems perspective. A major output of CIMMYT Economics programs is manuals and study reports now widely used as training material. The operational procedures of the manuals would be much more meaningful if the concepts had already been digested in formal diploma and degree courses. All diploma and Bachelor degree training should include courses which give students an understanding of how small farmers operate their systems. Not only would this be a foundation for building relevance in research, program planning, and extension, but it would also help dissipate the attitude among agricultural professionals that small farmers are irrational. Fieldwork is an essential complement to learning concepts in the classroom. Fieldwork could include both surveys and on-farm experimentation, again not only to teach methods, but to inculcate a healthy attitude toward working <u>with</u> farmers in their fields. It is difficult to think of a better way to equip Third World professionals for a down-to-earth role in agricultural development, a role often shunned within the existing educational value system. Finally, an awareness should be fostered at senior research levels, and even at senior political levels, of the narrowness of traditional criteria used to select technology and of the opportunities opened by a farming systems perspective. Political exhortation itself would be a more effective engine of development if the content were relevant to the needs of the exhorted. There is a scope for promotional work at the highest levels to provide leverage on recalcitrant personalities and institutions. In this same, wider context, FSR procedures can serve as a link between local and national priorities and between the farm and its infrastructure and can provide insights to develop improved policies and programs to help small farmers.

GUIDELINES FOR EXPLORATORY (INFORMAL) SURVEYS

These guidelines are quite long. A - F are sets of questions for discussion with farmers, each of which should occupy 1-1 1/2 hours on the farm. In the course of an Exploratory survey, three or four farmers may be asked each set of questions. However, for some the researcher may feel clear and confident about those facets after talking to two farmers, other sets may benefit from discussions with five or six farmers. It is profitable, after a set of questions has been discussed with two farmers, to write up detailed notes in the same numbered format as the Guidelines. Gaps in the information for that set can be filled by questioning further farmers and their answers will complete the notes on that set.

It is useful to decide on several specific, introductory, questions to establish that the new farmer is indeed in the Recommendations Domain investigated. The questions will refer to key characteristics of that target group.

It will also be useful for researchers to interact after a day's interviewing and combine impressions of sets of questions covered during the day. They may have visited the same or different farmers. It is important that both production agronomist and farm economist are in the field together for this informal survey work. The two disciplines will interact strongly in covering sets E and F.

SET A: Questions seek to describe the farming system through the enterprise pattern and use of products and to identify recent changes in the relative importance of the enterprises farmed. Questions (1) and (2) are preliminaries for all respondents.

ENTERPRISE PATTERN, OUTPUT USE, AND SYSTEM TRENDS

(1) List the crops grown and livestock kept by local farmers. Note whether each enterprise is farmed by most or just a few, and, if only a few, what is special about those few.

(2) Obtain rough estimates for each enterprise.

a) the number of fields devoted to it; b) the total area involved; and c) the output the farmer would usually expect from this commitment.

(3) For each major crop, list the varieties grown. Make it clear whether each farmer grows more than one variety.

(4) For the major crops, crop varieties, and animals, list the end uses to which they are put. In the case of crop varieties, this includes the fruit and any other part of the plant used as a byproduct. Animal products and byproducts are equally important.

(5) For each identified end use, detail the sequence from the field through harvesting, storage, preparation, processing, and use, including timing; when it is taken in the life-cycle of the plant and the timing of stages through to use.

(6) (a) Note crops, crop varieties, or livestock that used to be widespread among farmers of the area but are now disappearing. Assess why such enterprises are losing popularity.

(b) Note crops, crop varieties, or livestock that are becoming increasingly widespread recently. Assess why such enterprises are gaining popularity.

SET B: Questions seeking further description of the farming system through specification of the enterprise calendar, food preferences, and facets of the food calendar.

ENTERPRISE CALENDAR, FOOD PREFERENCES, AND FOOD CALENDAR

(7) For each crop and, where different varieties are grown, for each crop variety establish:

(a) The usual time of first cultivation

(b) The usual time of planting

(c) The latest possible time for a viable planting

(d) Reasons for varying the planting time of the crops

(8) Assess the major reasons why local farmers use different varieties, and, if relevant, plant them at different times.

(9) For each crop, and crop varieties where appropriate, establish the usual time for direct harvest for use from the field (if relevant) and the usual time of final harvest.

(10) For each livestock type establish:

(a) The usual timing of births

(b) The usual period producing milk and dry

(c) Any special periods for the consumption of meat

(11) Detail the main dishes eaten by farm families in the area, the preferred constituents, and the preferred state of each constituent.

(12) What dishes, with what constituents, are eaten when preferred foods are not available?

(13) Using a table like the one below, list preferred and substitute foods in the left-hand column. Against the calendar show:

(a) Months when supplies of each food are readily available <u>every year</u> - Shade out the months

(b) Months when supplies of each may be uncertain in some seasons - cross hatch these months

(c) Months when supplies are <u>never</u> available - leave blank

MAJOR LOCAL FOODSTUFFS		J	F	M	A	M	J	J	A	S	O	N	D
MAIN STARCHES													
SUBST. STARCHES													
MAIN RELISH													
SUBST. RELISH													

(14) Identify whether any new foods are becoming popular and replacing traditional ones. Assess why old foods are receding and why new ones are gaining popularity.

(15) Are there main foods which are purchased by many families:
a) All the year round; b) at certain periods (specify when)

(16) Are there main foods which have to be purchased at certain periods in poor years? If so, for each food:
a) How frequently does this occur; b) what is the usual reason;
c) when did this occur last for most families in the area?

(17) What are the prices of the major foods just before and just after the main harvest?

SET C: Detailed questions on variations in output and its causes on TWO major products on the farm. Questions on the main methods used to produce these two products. Take one at a time.

CAUSES OF OUTPUT VARIATIONS, MAIN PRODUCTION METHODS

(For each selected crop in turn questions 19, 20 & 21.)

(18) With which two of your crops is the loss of output in a season most serious for you and the family?

(19) In Q. 2 you said you would normally expect this level of output.
(a) What is the lowest output you remember?
(b) What year was this?
(c) What factors caused this low output then?
(d) Can other factors also strongly influence output?
(e) How soon in the season can you tell output will be poor?
(f) When you see this, do you take any action to look for other sources of food/cash?
(g) If output is poor - for example in the year you mentioned - how did you manage for food/cash?

(20) In Q. 2 you helped us estimate what you usually grow.
(a) Does this area change much from year to year?
(b) Which year was the smallest area you grew?
(c) Why was the area small that year?
(d) Which year did you grow a lot more than usual?
(e) Why was the area grown large that year?

(21) What methods do you mainly use in growing this crop?

(a) Cultivation;
- (i) How many are done and what method is used for each?
- (ii) Do you ever use other cultivation methods? Under what circumstances?
- (iii) When did this happen last and how do you assess it?

(b) Weeding;
- (i) How many are done and what method is used for each?
- (ii) Does the number vary from year to year?
- (iii) What factors cause the number to vary?
- (iv) Have you ever used any other method? How do you assess it?

(c) What items do you usually buy for this enterprise (seed, fertilizer, herbicide, insecticide, fungicide, hired labor, or machinery, etc.)?
- (i) Source of purchase
- (ii) Quantity purchased, price paid
- (iii) Year started purchases for this crop

SET D: These questions elicit information on the level of endowment of land, labor, and cash, and seek clues to factors constraining system expansion.

LAND, LABOR, AND CASH AVAILABILITY

(22) Can you get more land if you feel you need it?
- (a) How would you get more land?
- (b) Would it be near or far away?

(23) Will all the crops you grow do well on all your fields?
- (a) Detail the characteristics of soil and/or location most suitable to your main crops.
- (b) Do you change crops depending on the season?

(24) Do you grow the same crops in the same places year after year? If not, what rules have you about moving crops to different places?

(25) (a) How many people do you have in the family?

(b) How many work on the farm?

(i) Full-time

(ii) Part-time

(c) Which work on which crops is done only by:

(i) Men

(ii) Women

(iii) Children

(d) Are there special responsibilities for:

(i) Water

(ii) Fuel

(iii) Cattle herding and feeding

(26) (a) Which is the busiest month of the year for farming in this area?

(b) What work, on which enterprises, is going on at this time?

(c) Is there a second busy period?

(d) What main work goes on then?

(e) Are these two busiest periods every year? If not, how do circumstances change?

(27) (a) Do you and other local farmers hire any labor during the year:

(i) Permanently hired

(ii) Casual hired

(iii) Customary labor

(b) When casual labor is hired, or customary labor used, what months are these, and what work is mainly done?

(28) (a) Do you and other farmers hire any machinery during the year?

(b) If so, which crop/operations is it mainly used for and at what time of the year is it hired?

(29) What are the main sources of cash income for local farmers?

(30) Do many families have members working off the farm

(a) Permanently - what are the locations and types of work?

(b) Temporarily - what kind of work is temporarily taken up? Is it taken up at this time because

(i) Opportunities arise then

(ii) Farmers need cash then

(31) What is the most difficult period of the year for cash for local families? Is it because income is scarce or expenses are very high? If expenses are high, what are the major items absorbing cash?

This is the end of the initial phase of investigation and initial analyses are now made.

1. Derive labor allocation constraints.
2. Identify resource constraints.
3. Identify farmers' priorities and decision criteria for each enterprise.
4. Identify farmers' management strategies.
5. Identify potential points of leverage in the farming system, major factors contributing to low productivity, and specify the enterprise and production activities involved.
6. Work out approximate levels of return to present cash outlays.

SET E: The following questions provide information on the compromises in production methods and timing of production activities on crop enterprises which are identified as points of leverage in the farming system.

CROP HUSBANDRY

(32) How does the farmer decide where he will plant his crop? What factors does he consider in the decision?

(33) Land preparation:

- (a) What is the method of land preparation?
- (b) When does the preparation start in relation to the start of the rains and to planting time?
- (c) What sequence of work is involved if there is more than one operation?
- (d) How does the farmer work; does he prepare a whole field before planting, or prepare and plant a bit the same day, or what?
- (e) What is the final form of seedbed?
- (f) Are there alternative methods of land preparation?

(34) Planting:

(a) What is the arrangement of plants in the field, the main crop, and any mixtures?

(b) Where other crops are mixed in it will be important to describe in what sequence all the crops are put in the ground.

(c) How do farmers plant in relation to rainfall; dry planting before rain, the same day as rainfall, within a limited period after rains?

(d) Do farmers just make one planting of the crop each season or are there usually several?

(e) Do farmers commonly have to replant?

(f) What is the method of putting the seed in the ground, and how many seeds are put per hole?

(35) Weeding and Thinning

(a) What implement or implements are used for weeding?

(b) How soon after planting is the first weeding done? Does the timing vary very much with conditions; if so, how much and which conditions?

(c) How many weedings will normally be done? Will this vary with the date of planting, the weather, or the soil in the field selected?

(d) Do they thin the plants either in the row or from each planting hole? If so, at what age? Do they use the thinning for cattle feed?

(36) Pest control, if any

(a) Major pests for which control is sought

(b) Timing and method of control

(c) Assessment of proportion of local farmers using pest control

(37) Use of fertilizer, if any

(a) Type of fertilizer, source

(b) Usual rate, method, and time of application

(c) Assessment of proportion of local farmers using fertilizer

(38) Use of leaves, top, and stalks for cattle feeding
  (a) Proportion of local farmers using
  (b) Method of feeding to animals
  (c) For leaves; number of pickings made, number of leaves taken, and the timing in relation to plant growth
  (d) For tops; stage of plant growth that the top is taken. Is this critical time for cattle feed?

(39) Method and timing of harvesting and storing
  (a) At what stage does harvesting begin?
  (b) What method is followed in picking, shelling, and disposing of stover?
  (c) How is the crop stored; is any preservative used?

(40) Seed selection and preservation
  (a) Do the farmers usually select seed in the field or from their stored harvest? If from stored, when is it selected?
  (b) What criteria do local farmers use when they choose next year's seed from their own crop?
  (c) Do they process and preserve the chosen seed in a special way?

(41) Is the crop treated in any other way, either while in the field or in the household? Are there resources used in growing the crop in a way not covered here?

SET F: These questions seek to detail the compromise in production methods and the timing of production activities in livestock enterprises which are identified as points of leverage on the farming system.

LIVESTOCK HUSBANDRY

(42) (a) Ask what the composition of the herd is and relate this to major uses of the livestock enterprise.
  (b) Does he own his animals or are they loaned to him?
  (c) In a crisis, when they need food or cash, which type of animal is sold first?

(43) (a) What are the main ways of disposing of animals; consumption, sales to neighbors, loans to neighbors, sales to butchers?

(b) What disposals from the herd were made over the last year?
(c) What types of animals and through which channels?
(d) Are some categories of animals difficult to sell?

(44) (a) Has the farmer had any animals die over the last year?
(b) What are the main causes of death?
(c) Does he do anything to prevent these problems?
(d) What steps did he take to treat?

(45) (a) Which month of the year do your animals usually calve?
(b) Is it the same month every year? If not, what does the month of calving depend on?
(c) Does calving at this time bring you any problem:
(i) With the calves?
(ii) With the mothers?
(d) What period of the year would you prefer to have calves?
(e) What benefits would this bring:
(i) To the calves?
(ii) To the mothers?
(f) Do you exercise any control over the time when your cows are serviced?

(46) Discuss with the farmer the calving history of his female animals.
(a) Age at first calving
(b) Number of calves born
(i) Died as calves
(ii) Survived
(iii) Disposition of survivors
(c) Calving interval

(47) How are his calves reared?
(a) What access do they have to their mother?
(b) Up to what age do they continue to suckle?
(c) Is any special food or treatment given to encourage weaning?
(d) Do the calves run with the herd?

(48) What is the milking regime?
(a) Who milks the animals?
(b) How many times a day?

(c) What period of the year are animals dry? Are they all dry together? If not, then what means are used to maintain a continuous supply of household milk?

(49) (a) Where is the source of water for the animals? Does this vary with the season?

(b) Are the animals taken to water or is water brought in?

(c) How frequently are animals watered in the dry season? How far must they be walked to water?

(d) If water is brought in, does the farmer give more to some animals than others; if so, which type?

(50) (a) What are the major types of feed used over the year (e.g. grazing on commonland, grazing on own farm, grass or other fodder carrried to animals)?

(b) Does the community exercise any control over the grazing of commonland?

(c) Which are the most difficult months for feeding the animals?

(d) How far will animals move to grazing in the dry season?

(e) Are these feeds given to all animals or do some types get priority?

(51) (a) Who herds the animals during the day?

(i) Are all animals herded together or is the herd split up?

(ii) Is there any communal herding?

(b) Who decides where the animals will go for grazing at various times of the year?

(c) How are the animals housed at night? Are they all together?

(52) (a) Is the cattle manure used on the fields?

(b) Is it mixed with any material in the night shelter?

(i) What materials?

(ii) When are they mixed in?

(c) At what time of the year is the manure moved out of the night shelter?

(d) Is it handled or 'managed' any way prior to application to the fields?

(e) Is the night shelter a reasonable site for storing manure without too much loss of quality?

(The detailed description of management practices and the comparison of present with technically ideal practices will have identified compromises and provided points of potential intervention in the System. Possible new materials and methods to exploit these leverage points are prescreened for viability in the system and their acceptability to the farmer. As a final part of the Informal Survey, farmers' attitudes to new materials and methods are tested. Unless such tests show antipathy to the ideas put forward, these materials and methods will form the content of local adaptive experimentation.)

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