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Contents

The Use of Farming Systems Research for Understanding Small Farmers and Improving Relevancy in Adaptive Experimentation

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The major thrust of CIMMYT's economics program is to improve the relevance of adaptive experimentation (i.e., experimentation aimed at providing recommendations for farmers), through the use of farming systems research (FSR) methods, to understand the circumstances of the farmers for whom the experimentation is being conducted.

Nonadoption, partial adoption, and slow adoption of research recommendations by small farmers indicate imperfections in the prevailing concepts and procedures for agricultural research and development. These phenomena have often been brushed off as "small farmer irrationality" (i.e., farmers not knowing what is good for them), but accumulated experience shows that small farmers are, indeed, rational and do a very good job in terms of their own priorities and circumstances. A number of causes of low adoption rates have been specified: (1) changes in economic variables, sometimes precipitated by changes in government policy, render new management methods uneconomic; (2) poor marketing and distribution arrangements for supplying purchased inputs prevent farmers from effectively exploiting new management methods; (3) poor extension effort to teach farmers to manage the new methods; and (4) recommendations on new management methods are inappropriate to farmers' priorities and circumstances and, therefore, are seen as irrelevant by the farmers. The fourth cause is increasingly seen as a major factor responsible for poor adoption rates and, consequently, failures in development efforts. This paper looks at the problem of relevancy of research recommendations, the focus of CIMMYT's program in economics.

Causes of Irrelevance of Research Recommendations

There is a complex of causes of irrelevance in agricultural experimentation; all are historically based upon the evolution of methodology in experimentation and the metropolitan pattern of agricultural research establishments in less developed countries.

(1) The prescriptive tradition in agricultural research and extension: Large-scale commercial farmers have the opportunity and authority to influence research planning, as well as the ability to select from the results whatever is useful to their circumstances. Small farmers are unable to articulate their needs to researchers, who select the "best" results and prescribe these as "improved management recommendations" to the extension service to "teach" to farmers. "I know what is best for you" very much dominates the sequence.

(2) The isolation of researchers from the farmers, their clients: Working at experimental stations, researchers are isolated from their clients. They have no opportunity to develop a rapport with and understanding of the people they work for. This mental isolation compounds the prescriptive nature of the sequence: research, extension, farmer. A great deal is heard about the problem of research/extension linkage, but extension is essentially an intermediary, the real problem is the research/farmer linkage. The isolation is physical as well as mental, with researchers locked in their station enclaves. The physical isolation also contributes to irrelevant experimentation and recommendations. Experiments at research stations are conducted under natural and economic circum-

stances quite different from those under which the farmer has to operate. For example, on small farms soil fertility, soil structure, rotations, and the availability of labour are all likely to be very different from the conditions at the local experimental station. When station-derived recommendations are implemented under farmer circumstances, the results are different; not only are the yields lower but also, for example, with fertilizer experiments, the response functions may be completely different. Yield-gap studies are fashionable; they verify that farmers operate under different circumstances than researchers, whose work priorities are incorrect.

(3) Biological potential, the wrong perspective for experimentation: The exploitation of biological potential has long served as the perspective for planning and evaluating agricultural experiments. It gives rise to output per unit of land (yield) as the dominant criterion for the selection of recommendations for farmers, who *never* seek biological potential. Similarly, yield is a poor criterion for evaluating experimental results; it is *never* used by farmers when deciding how to produce their crops or raise their animals.

The dominance of this inappropriate perspective is, perhaps, the key to irrelevancy in research. Using biological potential as a perspective for planning gives irrelevant experiments. Fertilizers, insecticides, or fungicide sprays, not used at all by farmers, may be applied as blanket treatments across the experiment in order not to inhibit the comparisons between treatments. Fertilizer or herbicide treatments may be pitched at levels of cost per hectare that are equal to 50% of local farmers' gross annual income. This type of irrelevancy is compounded by using yield as *the* criterion in interpreting the results. Relevancy to farmers' needs and circumstances requires a farmers' perspective in planning experiments and farmers' decision criteria to evaluate the results. How does one acquire the farmers' perspective?

The Logic Behind Farming Systems Economists Contributing to Experimental Planning and Interpretation

Both natural (temperature, rainfall, soils) and economic (market opportunities, costs, prices) circumstances influence the farmer's decisions on what to grow and how to grow it. Planning and interpreting experiments from a natural and biological point of view are unbalanced because, under farmers' circumstances, the economic influences will always modify, often considerably, the natural influences. Furthermore, even the natural influences on crop growth are important to the farmer only for their economic consequences. The farmer's role as a decision-maker is to allocate scarce resources of land, labour, and cash between crop and livestock production in a way that satisfies the family's priorities. This is essentially *the* economic problem for all of us and the economist's professional perspective immediately parallels the farmer's perspective as a decision-maker. The need to use the farmer's perspective to bring relevancy to the planning and interpretation of experiments is the justification for the role of the farming systems economist in adaptive agricultural research. The professional competence of the farming systems economist can be used to understand farmers' perspectives, which have two central aspects:

(1) Priorities: Small farmers have multiple objectives that are ranked as priorities — a reliable supply of basic foods; a desirable combination of foods; and a supply of cash. The ranking varies depending upon the stage of development achieved, but this order reflects the priorities and identifies the decision perspective of many small farmers.

(2) Limitation: A biological perspective relates decisions exclusively to land as a factor of production, using output per unit area as the predominant decision criterion. For small farmers, however, cash or labour may impose a more severe limitation than land on what they produce and the management practices they can use in producing it. Their decision criteria will be based on whichever factor of production is most limiting. For example, correct time of planting is a common component in an improved management package, but for farm families cultivating with hand hoes the recommended time is often a physical impossibility.

Like the ranking of priorities, these limiting factors vary according to the farmer's natural and economic circumstances. Effective procedures for planning adaptive experiments will reflect the different perspectives and decision criteria of target groups of farmers under different circumstances.

Farming systems research (FSR) methods have been developed by farm economists to investigate farmers' priorities and circumstances, identify farmers' problems, and evaluate development opportunities open to them that relieve or avoid their problems and at the same time respect their priorities. The main advantage of FSR methods, as their name implies, is handling entire farming systems. This requires a perspective synonymous with that of the farmer, who operates the entire farm as a unit. CIMMYT has worked to develop a rapidly implemented, low-cost set of FSR methods to help plan relevant adaptive experiments in research establishments where funds, and especially manpower, are scarce.

FSR Methods Promoted by CIMMYT's Economics Program

The methods promoted by the program first establish a framework of recommendation domains. These are target groups of farmers operating similar farming systems, facing similar problems, and, thus, for whom the same solutions will be relevant. The diagnostic procedures for designing a relevant adaptive experimental program are implemented within an identified target group. Clearly, not all groups can be investigated simultaneously; the selection of priority groups is based on their relative potential to fulfill government policy objectives. The sequence of diagnostic procedures acts like a sieve. Each stage funnels the diagnosis toward solutions to key problems of the farming system and the circumstances of target groups of farmers. Each stage cuts away unimportant facets and irrelevant research issues. There are four stages:

(1) A review of secondary data on the target group of farmers: Taking about 3 working days, this first stage reviews available information on climate, soils, markets, and prices. The researchers seek clues to management problems presented by those circumstances within which the target group of farmers operate.

(2) An exploratory survey: Taking about 20 working days, this survey involves both the farming systems economist and biologists, who through talking to target groups of farmers learn about the farmers' circumstances and the system they follow; develop an understanding of why they farm in the way they do — their priorities and constraints; and review possible technical improvements that are seen as relevant to farmers' problems and circumstances.

(3) A formal verification survey: Taking about 60 working days, this formal sample survey is aimed at verifying the homogeneity of the target population; verifying the description and interpretation of farmers' circumstances obtained in the first two stages; and verifying the relevance and acceptability of the possible technical improvements identified.

(4) Designing adaptive experiments: Experiments are designed to establish the effects of the identified possible technical improvements on farm productivity. This takes 2-3 working days and involves selecting variables for experimentation based on the identified possible technical improvements; fixing the levels of the selected variables within the target group of farmers; and specifying farm management methods for all non-experimental variables.

The first of these four stages is very cheap and very rapid. The second and third stages are increasingly expensive and time consuming, but at the same time are more and more closely focused by the earlier stages. The sequence can be completed over a period of 3-4 months within an identified target group. In the context of farming systems research methodologies, it is a low-cost set of procedures aimed at understanding, rather than measuring and modelling, the farming system.

Biologists and Economists: A Key Interaction for Relevancy

A vital thread running through this sequence of procedures is the interdisciplinary interaction between biological and social scientists. The biologist brings to the process a perception of the likely ideal technical management for crops under the climatic and soil conditions under which the target group of farmers is operating. It is based on accumulated knowledge from previous research, either locally or under similar conditions elsewhere. The farming systems economist brings to the process an understanding of farmers' priorities and the constraints that limit the ways in which they can modify farm management. Brought together in the sequence of procedures, the interaction between the two disciplines identifies new techniques that the biologist believes will increase output and that, at the same time, the economist believes are compatible with farmers' priorities and circumstances. The interaction occurs at several places in the sequence.

(1) The biologist evaluates the background information under natural conditions to assess crop potential and management factors that are likely to be important. The economist evaluates background information on economic and institutional conditions.

(2) During the exploratory survey, the biologist looks at farm management practices, evaluating ideal changes required to realize maximum biological potential. The economist develops an understanding of why the farmer is doing things a certain way at present. In interpreting the survey work and hypothesizing on possible solutions, the

two interact; the biologist puts forward ideal changes in management to promote improvements in yield, the economist assesses the possible profitability and compatibility of these changes with farmers' priorities.

(3) The biologist helps formulate questions for the verification survey, particularly on present management practices to be confirmed, and on proposed management improvements.

(4) The biologist and economist interact to decide upon the experimental variables, treatment levels, and levels of nonexperimental variables.

(5) The biologist and economist interact with farmers to evaluate the experimental treatments for compatibility with farmers' priorities and work methods while the experiment is in progress.

(6) The biologist and economist interact in interpreting the results of the experiments.

Relevant experimental variables are born out of the interaction during the exploratory survey, as are treatment levels compatible with farmers' circumstances. Farmers' practices, as the logical basis for check treatments and for the management of the nonexperimental variables, are detailed and confirmed in the verification survey.

An Example of the Interaction Between an Agronomist and an Economist in the Farming Systems Research Process

The following example of an interactive sequence is centred on the time of planting of maize, a common component in farmer recommendations and a common variable in maize experiments.

When examining rainfall data for the area of the target group of farmers, the biologist observes a unimodal rainfall profile with no marked periods of uncertainty. The profile indicates that a 180-day variety of maize, planted at the beginning of the rains, would offer the maximum biological potential for the area. During the course of the exploratory survey, the biologist observes that farmers are planting their maize over a period of 2-6 weeks after the start of the rains. During the same exploratory survey, the farming systems economist gains an understanding of the reasons for the delays in planting. In designing adaptive experiments on maize, relevant to the target group of farmers, the two sides of the picture are brought together.

(1) The biologists's contribution: Early planting is important for optimal yields from a 180-day maize variety, which will fully exploit the rainfall profile of the area. Farmers are planting an average of 4 weeks after the start of the rains. This offers a major opportunity for yield improvement through early planting of a higher potential variety.

(2) The economist's contribution: The soil is hard and farmers, working with hand hoes, must wait for the first rains to soften the ground before they start cultivation. Hand cultivation is slow and the average local family labour force takes 2-3 working weeks to prepare and plant 1 ha. There is no local labour for hire at this time and tractors cannot work economically in the area. There is no immediate prospect of farmers being able to prepare a maize seedbed before the rains to ensure planting immediately after the rains.

(3) Joint decision: In the immediate future, farmers are locked into their present planting date for maize. Time of planting is not an appropriate experimental variable.

(4) Consequences for experimentation: To be relevant to the circumstances of the target group of farmers, adaptive experiments on maize should be planted 1 month after the start of the rains. A 150-day variety is most appropriate for these farmers and use of viable levels of fertilizer is likely to be influenced by both the variety potential and the delayed time of planting.

Similar interactions evaluate all other management components for maize, focusing adaptive experimentation on those components with *both* biological potential and economic relevance. This interactive process is crucial for modifying the perspective of biological potential, when planning experiments, to one that is consistent with farmers' decision criteria.

Conclusions

Thinking back to the causes of irrelevance in research recommendations, the procedures outlined here are aimed toward improvement of the research/farmer link. Not only is the limited perspective of biological potential modified but incorporating a farming systems economist into the research teams and using these procedures also breaks the prescriptive tradition in research, and with it the mental isolation of biological researchers from their clients, the farmers. It also helps alleviate the physical isolation by getting biologists out onto farms. Complete alleviation of the physical isolation demands that adaptive experiments are carried out within farming communities and farmers' fields, with experimental stations being reserved for more basic work.

The integration of the farming systems economist into adaptive research planning is often seen as a threat to the establishment, and it certainly challenges the traditional compartmentalized organization along disciplinary lines. The issue of relevancy, however, is an old one; where the establishment has the will and enterprise, FSR methods offer the opportunity to do something about relevance. Farming systems research used in planning experiments is new; suitable methods have only crystallized over the last 10 years. It should not be presented as an alternative to traditional agricultural research but as a development in planning procedures that can improve the service research establishments give to the mass of farming populations within less developed countries.

Discussion

Gunasena (question): In selecting new technologies as variables, do you rely on applied research alone in research institutes or on a survey conducted in this area of operation? Do you also use managerial packages of various levels and simulate farmers' practices with the new technologies?

Collinson (answer): One would look at how crops grow under the natural circumstances and prevailing economic conditions of the farmer and how these can modify the body of knowledge such that the cycle farmer, researcher, farmer will operate.

Edje (question): In your opening remarks, you advocated rewarding researchers according to the number of farmers that accept their recommendations. If you were given an opportunity to implement your own proposal, how would you go about it?

Collinson (answer): It would be difficult. Researchers would be rewarded by promotion, not through conference attendance or papers.

Lightfoot (question): Because farmers have social, political, and biological needs, as well as economic needs, is there not a need for a social component in addition to technical and economic components in the formulation of adaptive research work?

Collinson (answer): Social scientists are also involved. One should speak of social/biological science and not separate the two.

Mansfield (question): Does the farmer still regard returns per input of labour as the main criterion in a land-shortage situation, where yield per unit area becomes relevant.

Collinson (answer): Relevance of decision criteria changes with the group of farmers. The net return per unit of labour may be relevant under certain circumstances. In the cases of a land-hungry area, a research crop, e.g., maize, may have failed because of labour constraints.

Mills (question): Would you provide further comment on the final statement of your paper "It should not be presented as an alternative to traditional agricultural research. . ."?

Collinson (answer): It should be stressed that farming systems research must be operated with strong applied research effort. In Dr Nadar's paper, he clearly defines a problem and through research he provided a solution, which was then translated to the farmers' level of production — a very commendable approach.

Giltrow (question): Are the agricultural and other teaching institutions in East Africa and elsewhere currently breeding the robust, locally adaptable variety of economists and social scientists that are required for FSR?

Collinson (answer): Attempts are on in Kenya. Difficulties at the MSc level are being faced and few universities do this. Courses in FSR are few. Furthermore, the universities are centres for excellence and do not train people for jobs.

Mills (question): Farming systems research is not new. What would be its benefits?

Collinson (answer): To improve farming practices in groups of target farmers. It is pointless to do adaptive research where there is no real improvement envisaged.