Approaches to On-farm Client-oriented Research: Similarities, Differences, and Future Directions

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Introduction

Over the last ten years or so there has been a steady development in procedures for a particular kind of research, currently called on-farm client-oriented research (OFCOR) (Merrill-Sands and McAllister, 1988). As procedures have been developed, numerous approaches to AFCOR have emerged, for example, cropping systems research, farmer-back-to-farmer, or on-farm adaptive research.

In one sense, this diversity in approaches to OFCOR is healthy. It stimulates discussion among practitioners and thus may accelerate the advance of science. However, for many scientists and research managers it is becoming more and more difficult to sort out and come to terms with the increasing abundance of concepts, tools, and methods available for crop OFCOR.

This paper argues that the different approaches to OFCOR are subsets of a single, more generalized approach. It goes on to suggest specific ways of improving OFCOR's efficiency. Objectives of the paper include:

1. Define OFCOR and show how it differs from other types of farming systems research (FSR) and from on-farm research (OFR).
2. Compare selected approaches to OFCOR showing similarities in the underlying principles, and explaining the differences that do exist in terms of differences in researchers' circumstances.
3. Describe a generalized approach to OFCOR incorporating elements common to the various approaches.
4. Discuss issues in OFCOR, largely touching on efficiency, which merit further development.

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OFCOR, FSR, and OFR

What is OFCOR and how does it differ from FSR and OFR? Merrill-Sands and McAllister (1988) define OFCOR as follows:

> OFCOR is a research approach designed to help research meet the needs of specific clients, most commonly resource poor farmers. It complements, and is dependent upon, experiment station research. It involves a client-oriented philosophy, a specific research approach and methods, and a series of operational activities carried out at the farm level. These activities range from diagnosis and ranking of problems through the design, development, adaptation, and evaluation of appropriate technological solutions. Farmers are directly involved at various stages in the process.

FSR is a general category of activities that includes OFCOR as a subset. Over the past few years a number of authors have commented on the range of activities that have been described as FSR (Gilbert, Norman, and Winch, 1980; Byerlee, Harrington and Winkelmann, 1982; Merrill-Sands, 1986). There have been recent efforts to categorize the different kinds of farming systems research (CIMMYT, 1984; Simmonds, 1986).

A major source of confusion was found to be a failure to distinguish between the underlying goals of FSR (Simmonds, 1986):

- FSR for its own sake (studying farming systems as a subject matter, with no intention of solving problems).
- New farming systems development (NFSD) (the development of whole new systems as a radical solution to major resource constraints). While supported by some researchers, NFSD is seen by many as being incapable of addressing the varied objectives of limited resource farmers, who often farm under highly variable conditions. This approach has been criticized as containing little of the flexibility so characteristic of (and vital to) small farmers (Sumberg and Okali, 1988).
- On-farm research with a farming systems perspective. This is the type of FSR that we are calling OFCOR. Of late, FSR has increasingly been interpreted as a perspective rather than a defined set of procedures or methods (Stoop, 1987).

Finally, the term OFCOR is preferred to OFR because the latter in itself does little more than describe the location of research, though it is frequently interpreted as a shorthand reference to OFCOR. In fact, OFCOR activities may require on-station or laboratory research. Equally, not all research conducted on-farm qualifies as OFCOR; for example, standardized regional trials sent out as part of a national plant breeding program.

Approaches to OFCOR: Similarities and Differences

Numerous institutions and programs have contributed to the develop-

ment of procedures for OFCOR. The list, which is far too long to mention, includes numerous national agricultural research systems, universities, donors, and international agricultural research centers.

A number of distinct approaches have emerged as a consequence of the multitude of institutions cooperating in the development of OFCOR procedures. Some of the more prominent approaches include: cropping systems research (Zandstra et al., 1981); farmer back-to-farmer (Rhoades and Booth, 1982); and on-farm adaptive research (Byerlee, 1987). Some researchers argue that farmer participatory research (Farrington, 1988) and agroecosystems analysis (Conway, 1986) also merit mention as partial approaches to OFCOR.

At first glance, each of these approaches seems quite unlike the others. The vocabulary, suggested research steps, and diagrams used to illustrate the research process tend to be highly individualized. There are also differences in breadth and time frame of research activities proposed by the different approaches.

One cannot help but be struck, however, by the broad similarities among OFCOR approaches. Hidden behind the wide variation in terms and suggested research tools are strong similarities in underlying concepts and procedures (Chambers and Ghildyal, 1985; CIMMYT, 1984; Stoop, 1987; Lightfoot and Barker, undated).

The concepts which we consider basic to all OFCOR approaches include the following:

- A diagnostic function which influences the selection of research priorities.
- The conduct of much of the research and development on farm, given the importance attached to representativeness and understanding of system interactions.
- A strong role for farmers in assessing new technology.

Fundamental similarities notwithstanding, the different approaches to OFCOR do demonstrate a marked individuality when it comes to the selection of specific research tools. The cropping systems research approach features comparisons between the farmers' cropping pattern and alternative, improved patterns. The farmer-participatory approach and the farmer-back-to-farmer approach feature a strong role for farmers in problem definition, and technology adaptation. The on-farm adaptive research approach features an explicit process of setting priorities and the use of a variety of research tools (some of them researcher managed) to develop and test hypotheses.

In each of these cases, research procedures were strongly influenced by researchers' circumstances, that is the production environment and problem area being addressed by researchers when procedures were being developed. The procedures developed might have been quite different had researchers been working in another environment. In the following sections we will

illustrate the relationship between researchers circumstances and the methods that emerged for four approaches to OFCOR.

The Cropping Systems Research Approach

The cropping systems research approach is often associated with the International Rice Research Institute (IRRI) and with its collaborative activities with national programs in Asia, especially in the Philippines and Indonesia (Morris, 1984; Siwi et al., 1986), and with the Asian Cropping Systems Research Network (Zandstra et al., 1981).

IRRI's interest in cropping systems research was founded on the feeling that there was an unrealized potential to further intensify rice-based cropping systems – that the number of crops produced per year on tropical rice lands could be increased, and that this would contribute to improved farm family welfare. This hypothesis was founded on two prior research experiences – controlled studies indicated that up to 5 crops could be grown per year by using relays and related practices and the development of new rice cultivars with dramatically earlier maturity. This spurred interest in intensifying rainfed cropping systems by using field slack time to add another rice or upland crop. Other practices were identified that could contribute to pattern intensification, such as direct seeding methods, portable threshers, and so forth.

A distinguishing feature of the resulting approach is the emphasis on the cropping pattern. In the procedures, component technology development is seen as a critical element, and researchers are encouraged to identify ways to improve the management of component crops. The overall focus of the effort, however, is on the performance of the entire cropping pattern.

The production environment for which research procedures were developed was that of lowland rice. The major problem area faced by researchers was intensification of cropping patterns. It is not surprising, therefore, that procedures development emphasized tools to measure and improve cropping pattern performance, for example, cropping pattern trials, superimposed trials, monitoring of farmer cooperators, and so forth.

The cropping pattern focus was suitable for wetland rice ecosystems but may be less relevant to highly diverse upland ecosystems (Lightfoot, De Guia, and Ocado, 1988). Crop sequences in wetland rice-based systems are uniquely simplified since crop choice is constrained to rice during the wet season due to its adaptation to waterlogged conditions. Intensification potential revolves around a seasonally fixed crop which limits the number of crop combinations.

This is not the case for many upland systems where scores of possible cropping patterns are observed and cropping patterns may change from year to year in response to complex biophysical and market factors. The relevance

of a search for optimum cropping patterns in such diverse circumstances is questionable compared to improving the production technology of the dominant crops.

The Farmer-back-to-farmer Approach

The farmer-back-to-farmer approach (Rhoades and Booth, 1982), shares many similarities with the cropping systems research approach described above. Both approaches call for the identification and definition of problems and opportunities, and considerable research on-farm with farmers' participation.

The farmer-back-to-farmer approach was developed in the context of research on potato seed storage in Peru. In this case, research was characterized by:

- *Controversy about the problem addressed.* Initially, researchers felt that the potato storage problem could best be described as shrivelled and spoiled potatoes. Other researchers found that shrivelled and spoiled potatoes were useful as animal feed and had a significant economic value, and that farmers preferred to define the problem in terms of excessive sprouting of seed potatoes which causes a deterioration in seed quality and increased labor for cutting sprouts.
- *Adaptation of available technology.* Once the problem had been defined as excessive sprouting of seed potatoes it was found that technology was available off the shelf to solve the problem as natural, diffused light reduces sprouting. This practice was found to work well on-station and on-farm. However, farmers could not afford the potato seed storage structures used by researchers, so adaptive work on this theme was done with farmers and, spontaneously, by farmers.

The specific research steps developed under the farmer-back-to-farmer approach emphasize, not surprisingly, the need for farmer participation in problem definition and a need for farmer adaptation of technology originally developed on experiment stations. Once again, researchers' circumstances had a heavy influence on the development of a specific approach to OFCOR.

The On-farm Adaptive Research Approach

The on-farm adaptive research approach also referred to as on-farm research with a farming systems perspective has much in common with the two approaches described above. All three call for diagnosis and problem definition, followed by development of solutions for well-defined problems, with appropriate levels of farmer participation.

The on-farm adaptive research approach is associated with a number of institutions, including ICTA (Hildebrand, 1976); International Center for Tropical Agriculture (CIAT) (Woolley et al., 1988; Ashby, 1987); Inter-

national Maize and Wheat Improvement Center (CIMMYT) (Byerlee, et al., 1980; Collinson, 1987); and, through the yield constraints studies, IRRI (De Datta et al., 1978). CIMMYT has played an active role in the development of this approach, especially through collaboration with National Agricultural Research Systems (NARS) in Latin America and Africa (Martinez and Arauz, 1983; Moscardi et al., 1983; Collinson, 1987).

This approach has a number of distinguishing characteristics:

- Research is restricted to subsystems, often to component technology research for particular crops which may be selected as part of the process of setting priorities.
- A farming systems perspective is incorporated into research by means of a structured planning and evaluation process (Tripp and Woolley, 1988; Harrington, 1988) which traces through farming systems interactions which cause major problems and uses this understanding of interactions to suggest possible solutions. Farming systems parameters also enter into scoring models to prioritize problems and screen possible solutions.
- Research activities use a sequential approach in that future research plans are heavily influenced by what has already been learned during previous cycles of research.

Researchers' circumstances have had a strong influence on the development of procedures under this approach. Much of the early work in on-farm adaptive research was conducted in the following kinds of production environments:

- Rainfed systems where maize, beans, or wheat were dominant crops and where obvious opportunities existed for improving the management of these crops: weed and pest control, land preparation, soil fertility management, variety selection, and the like.
- Systems characterized by complex and dynamic farmer enterprise management practices and strategies, for example, staggered planting and swidden agriculture.
- Systems characterized by a limited growing season, due to limited moisture (for example, Eastern Africa) or low winter temperatures (as high-land areas of Latin America). This dramatically limits the opportunities for intensifying cropping patterns.
- Regions as Latin America and Africa where population densities are far below those found in Asia, and where land scarcity and the urgency of intensifying cropping patterns are relatively less important. In some areas, labor is the scarce factor and extensive farming is used.
- Given these researchers' circumstances it is not surprising that the development of research procedures focused on component technology; that it highlighted the importance of system interactions in identifying problems and solutions; and that it has tended to neglect opportunities for intensifying cropping patterns.

The Farmer Participatory Research Approach

Farmer participatory research (FPR) may not be a separate approach to OFCOR (Tripp, in process); nonetheless, the example is instructive. FPR was developed as a response to perceptions that normal cropping systems research or on-farm adaptive research are inefficient or inadequate when dealing with certain very complex kinds of technologies (Lightfoot, et al., 1988). Complex technologies are those in which large numbers of decisions have to be made in defining an experimental treatment.

Summary and Implications for Researchers

The intention of the above descriptions is to illustrate the consistent effect of researchers' circumstances on the development of procedures for different approaches to OFCOR.

At this point it is tempting to conclude that researchers should select a research approach in line with the circumstances described above. However, that would probably be misleading. Researchers should not look at the different approaches to OFCOR as unique and competing entities but as sources of a rich array of research tools and procedures. Indeed, some research tools have benefited from contributions made by practitioners of several different OFCOR approaches. For example, exploratory survey, joint trek, field transect, informal survey, sondeo, and RRA techniques have been developed with contributions from many of the different OFCOR approaches.

Researchers should not feel constrained to adopt a particular approach as such but rather should choose whichever research tools are most appropriate for the task at hand. We call this a toolbox approach to research. Each approach has its own favorite research tools. In a sense, each approach is somewhat restrictive, preferring its own tools to those developed by others. Yet a generalized approach to OFCOR need not be as restrictive as each individual approach. The relevant question is: What are the appropriate research tools to be used under specific conditions and circumstances?

Towards a Generalized Approach to OFCOR

In an integrated, generalized approach to OFCOR, researchers should select research tools, kinds of surveys, trials, monitoring activities, laboratory tests, and the like in accordance with the hypotheses that are being developed and tested.

We suggest that an appropriate format for a generalized approach to OFCOR is one which emphasizes **functional processes** not structure (Fig. 1). In this generalized approach, there are no steps labelled diagnostic surveys or experimentation because these do not represent functions, but rather research tools.

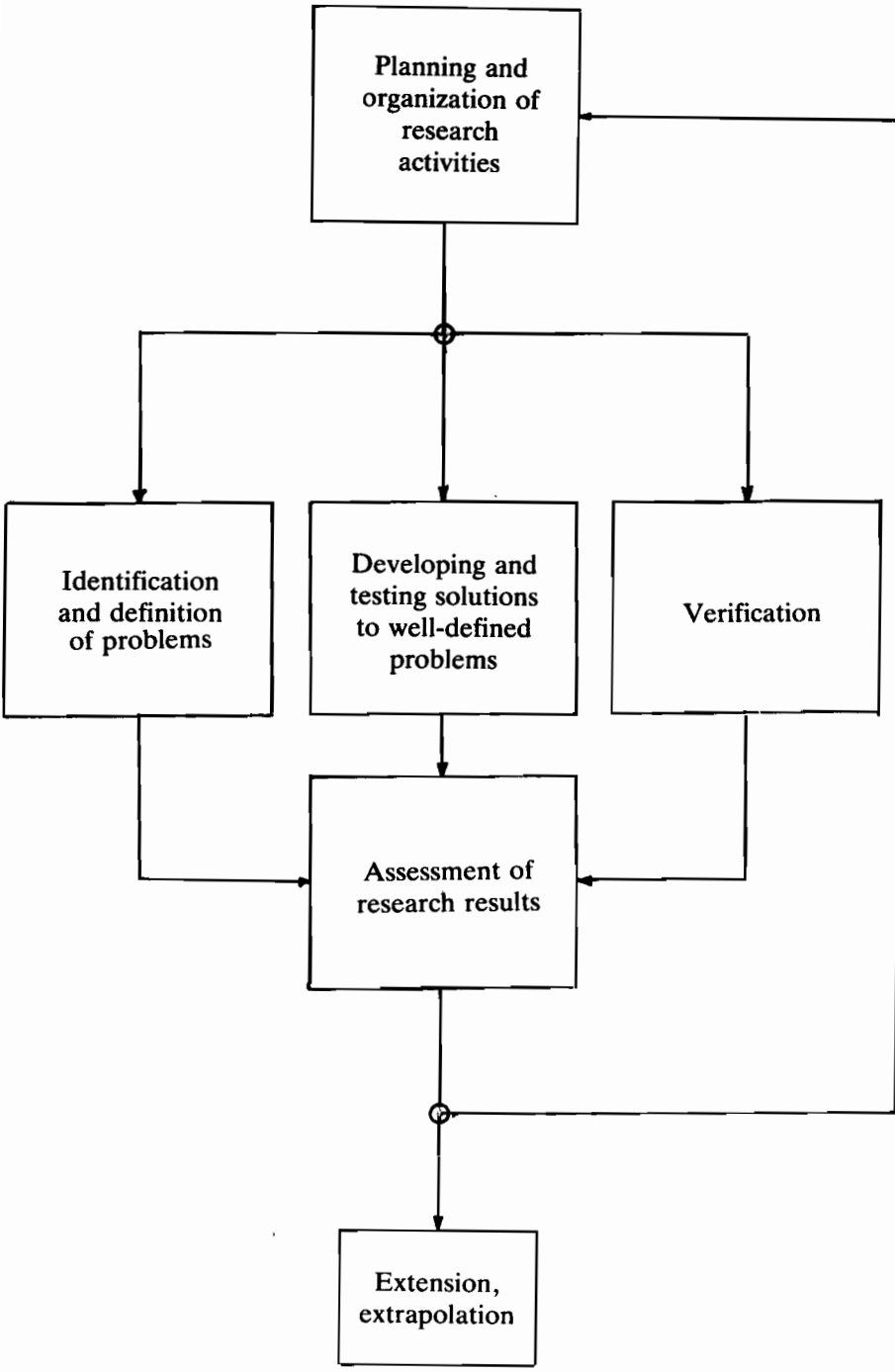

Figure 1. A generalized approach to OFCOR, featuring functional processes, with emphasis on the functional processes.

Planning and Organization

Planning and organization are discussed as a function because all activities must be planned and organized – even exploratory surveys carried out in the first cycle of research.

Planning is a process whereby researchers, extension workers, and other participants meet to review what is known about the study area; develop and review hypotheses on problems and their causes; determine where insufficient data exists to understand and solve problems; and set research priorities and establish a specific program of work. In conducting planning, researchers have access to a number of tools such as including pattern analysis, problem-cause diagrams, scoring models, and breakeven budgets.

Planning and organization need not be limited to the planning of OFCOR activities. It can be broadened to include issues of coordination between OFCOR and other kinds of research; the use of OFCOR results to influence research resource allocation within the larger research institute; the packaging of information from OFCOR that might be of interest to policy-makers; issues of institutionalizing OFCOR; and the like.

Problem Identification and Definition

By problems we mean: problems which directly reduce crop yields or enterprise productivity; problems which reduce the efficiency of inputs regardless of the effect on yields; problems of cropping pattern productivity or enterprise selection such as efficiency of use of farmers' resources land, labor and cash; and problems associated with sustainability.

Activities in problem identification and definition aim to answer the following kinds of questions:

- Is (insert possible problem here) a problem?
- What is the productivity loss (broadly defined) resulting from the problem? (severe? moderate? negligible?)
- What is the frequency of occurrence of the problem (percent of farms affected by the problem; percent of farm area affected, per farm; probability of occurrence over time)?
- What are the major causes or chains of causes of the problem? An understanding of the causes of a problem often suggests solutions. How do farming systems interactions affect the problem and possibilities for solving it?

In most approaches to OFCOR, problem identification and definition begins with a review of secondary data and an exploratory survey, also known with some variations in field technique as a rapid site description, joint trek, rapid rural appraisal, and so forth. Agroecosystems analysis can be used as a particularly thorough kind of exploratory survey. These tools have the

advantage of placing senior researchers in direct contact with farmers and extension workers, in situations where they can observe and discuss enterprise management and problems.

In some relatively simple, straightforward cases an exploratory survey may be all that is needed to identify and define problems. Usually, follow-up activities are required. An immense range of tools is available for these follow-up activities. The challenge facing researchers is to match the questions to be asked with the appropriate research tools (data gathering method, analytical method).

For example, in the farmer-back-to-farmer approach it was found that a structured dialogue between farmers and researchers was needed when addressing a problem about which farmers were knowledgeable. In other cases, such as nematode or micronutrient problems, this procedure may be less useful than the proper analysis of well-selected soil samples.

Here is partial list of some of the tools available to researchers for follow-up activities in problem identification and definition:

- analysis of secondary data exploratory surveys.
- formal surveys and farmer monitoring.
- laboratory tests.
- direct observations in farmers' fields.
- on-farm trials.

In some cases such as clearly inefficient cropping patterns or dramatic cases of soil erosion problems may be relatively obvious; the additional benefits or quantifying the problem are fairly minor; and the cost of conducting exploratory trials solely for the purpose of defining a problem is relatively high. In these cases, a single set of trials might have the dual purpose of problem definition and testing solutions.

In other cases, problem definition may be more challenging; for example, do rice nematodes reduce wheat yields in areas of South Asia where the rice-wheat pattern is common? Similarly, the identification of causes can at times be complex: Are observed plant stand problems due to insect attack poor seed quality? soil pathogens? poor soil tilth? waterlogging? In these cases, it may be necessary to conduct a considerable amount of research specifically dedicated to problem definition.

Usually, farmers and farmers' fields are the best sources of information for defining problems. Ironically, however, for some purposes of problem definition, OFCOR practitioners may have to rely on researcher-managed trials, on-station trials, or laboratory tests; for example, for identifying micronutrient deficiencies, identification of pest species, estimation of the frequency of moisture stress, and so forth.

In summary, researchers should take a broad view of problem identification and definition. All of the approaches to OFCOR tend to be overly restrictive in the activities they recommend for problem definition. OFCOR researchers may need to become familiar with a wider array of research tools and procedures in order to effectively carry out this crucial research function.

Developing and Testing Solutions to Well-defined Problems

After a problem is reasonably well understood and has received a high priority in research planning and organization activities, researchers can begin to develop and test alternative solutions. As in problem identification and definition, researchers can choose from a wide array of research tools and sources of information in assessing solutions:

- *Review of past literature on the subject.* There may be information on how similar problems have been solved elsewhere.
- *Indigenous technical knowledge.* A subgroup of farmers may have already identified possible solutions to a problem.
- *On-station trials.* Though not a mainstay of OFCOR, on-station trials may be necessary under certain circumstances, such as long-term trials with a 10 to 15 year time horizon to examine alternative solutions to problems of soil nutrient depletion.
- *Surveys.* Yield-cut surveys in which management practices are used to explain variability in yields can at times be used as a substitute for on-farm trials in quantifying the productivity gain from a particular practice or treatment.
- *Farmer opinion.* The farmer participatory approach has demonstrated that farmers can often be left to decide some dimensions of an experimental treatment by themselves.
- *On-farm trials.* The question of on-farm trials is a major theme in itself. The literature describes an immense variety of on-farm trials classified in terms of function, scope, subject matter content, design, and parties primarily responsible for implementation. The selection of type of trial in terms of a generalized approach to OFCOR is extremely important if OFCOR is to be implemented efficiently. In principle, researchers should choose whatever design is best suited for collecting the type of data needed. Detailed discussion of this goes beyond the scope of this paper.

In summary, experimentation and developing and testing solutions to well defined problems are most certainly not the same thing. Trials can be used for other functions such as identifying and defining problems. Equally, other sources of information such as indigenous technical knowledge combined with farmer assessment; yield-cut surveys can be used to develop and test solutions.

Verification

A fourth research function is verification. This function blends into the previous one but has a sufficiently marked character of its own to warrant being listed separately.

By verification we mean the process whereby best-bet solutions like varieties, livestock breeds, cropping patterns, and soil fertility management systems to well-defined problems are compared to the farmers' practices in many locations. The verification function is essentially a continuation of testing – testing for stability over space and time and continued testing for farmer acceptability.

As with previous functions, the verification function can be met through trials, farmer-managed tests or farmer assessment surveys.

Assessing the Results of Research Activities

Assessing the results of research activities probably warrants more attention than it usually receives. The selection of analytical methods depends on the data collection method and on the hypotheses being tested. Agronomic interpretation, statistical and economic analysis, farmer assessment, analysis of non yield dimensions of a technology like risk and complexity, may all be needed.

The process of assessing research results and testing hypotheses fades gradually into the planning and organization function, as information on problems causes and solutions becomes necessary in conducting planning activities.

Further Developments Needed for OFCOR

In addressing the questions of future directions and research needs, we take as a point of departure the observation that OFCOR is, in general, widely recognized as useful by research managers and donor agencies but that it is extremely important to further improve the efficiency of OFCOR activities.

Matching Research Tools to Questions and Hypotheses and Researchers' Circumstances

Considerable progress has been made over the last ten years in developing procedures for OFCOR. The different approaches to OFCOR have developed an astounding variety of surveys, trials, and other sources of information useful in understanding and solving problems. These problems are broadly defined to include cropping pattern efficiency and sustainability as well as crop yields.

When researchers select an inappropriate research tool, research efficiency goes down. To improve research efficiency, more work is needed on practical guidelines for selecting research tools to address particular questions, given such researchers' circumstances as the environment in which research is being conducted, the problems being addressed by researchers, the crops or enterprises being studied, the complexity of the farming system, the level of research infrastructure, the mandate of the research institute, the availability of research resources, and the like.

Needs for Further Development of Research Tools

Although OFCOR practitioners have developed a large array of research tools, new tools are still needed for certain research areas. One of these areas is **farmer participatory research.** Tremendous progress has been made in identifying ways in which farmers can more productively contribute to the research process, especially when dealing with very complex technologies like agroforestry research. More of this is needed and new research tools coming out of this need to be made readily available to a wider spectrum of researchers.

Another such area is **long-term research including research on sustainability issues.** Here, research procedures are not well developed. More work is needed on such topics as:

- methods of defining sustainability problems. Frequently, it is difficult to measure long-term declines in productivity attributable to degradation of the resource base because of the variability in aggregate productivity estimates due to changes in land use, and changes in relative crop prices, and in the relative prices of inputs and products.
- design and implementation of long-term trials, and long-term monitoring of farmers, and the appropriate roles for each; the proper role for crop modelling.
- appropriate use of economic analysis. Discounting of streams of costs and benefits, analysis of the effects of externalities, possible roles for dynamic programming; and so forth (Harrington, 1988b).

Needs for Improvements in the Interpretation of Research Results

We feel that the interpretation of research results is an area that is often neglected with the result there are severe penalties for research efficiency. Few research programs sufficiently emphasize:

- the need to subject trial data to a number of different kinds of analysis (agronomic, statistical, economic, farmer assessment for non-yield characteristics, and the like).
- the need to combine different sources of evidence (surveys, trials, laboratory tests, field observations, farmer assessment, and so forth) to test specific hypotheses on problems, causes, and solutions.

- the need to employ the accumulated evidence to date to take hard decisions on research dynamics (Harrington, 1988a): adjustments in problem definition, selection of best-bet solutions, major changes in research priorities.

A Need to Widen the Audience for OFCOR Results

OFCOR's strongest contribution has been in developing new technologies for defined groups of farmers. However, OFCOR results are not fully utilized by other potential audiences, including:

- Commodity and disciplinary researchers who ought to use OFCOR results in priority setting for applied research.
- Research managers who could more effectively use OFCOR results as a source of information in taking strategic decisions on research resource allocation.
- Policy-makers, who could more effectively use OFCOR results as a source of information for improving specific valuable policies or the implementation of policies that impinge on the ability of farmers to adopt new technology.

Implementation

At a more fundamental level, the most important way of improving the efficiency of OFCOR may not lie in using a wider range of tools or even in developing more new tools. The most important contribution may lie in improving the implementation of on-going activities. Issues include:

- improved utilization of the skills of all OFCOR participants: commodity and disciplinary specialists, systems specialists, extension workers, and the like.
- creation of institutional forms that allow OFCOR practitioners sufficient flexibility to address major problems, while providing incentives for high quality results.
- development and institutionalization of training activities such as including training in OFCOR procedures as a part of the curriculum of universities; improvements in the capacity of NARS to continuously strengthen OFCOR practitioners in useful research tools, development of the corresponding training materials; and the like.

Conclusions

OFCOR is increasingly seen as a major component of any agricultural research system. Although many useful approaches to OFCOR have been developed and many useful research tools and procedures tried, tested and documented, much remains to be done in developing new procedures and increasing the efficiency of ongoing activities.

We feel that OFCOR practitioners should see their work as part of a larger whole. The different approaches to OFCOR are not really that different and are largely explicable in terms of differences in researchers' circumstances during an earlier period. Different OFCOR approaches serve similar functions. Researchers using one approach to OFCOR should consciously try to learn about the tools used by other approaches. This will broaden the array of research tools available to researchers and increase the ability of OFCOR to meet future challenges.

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