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METHODOLOGICAL ISSUES FACING SOCIAL SCIENTISTS IN ON-FARM/ FARMING SYSTEMS RESEARCH*

1.0 Introduction

There has recently been a substantial effort on the part of practitioners of Farming Systems Research (FSR) and On-Farm Research (OFR) to pool their knowledge and share their experiences. It is possible that this effort was sparked by the appearance of the TAC Stripe Review on FSR (Dillon, 1978) or the Gilbert, et al paper (Gilbert et al, 1980). Equally, it may merely be the case of an idea whose time has come.

One example of this recent effort to share experiences was the Workshop held at CIMMYT on April 1-3, 1980, and attended by practitioners of FSR/OFR from national agricultural research programs and international agricultural research centers (IARC's).[1/] This workshop focused on a number of methodological issues that confront social scientists in their effort to participate in FSR/OFR. These issues include:

- Issues of general relevance (the role of the social scientist, the use of research results for alternative purposes, the cost-effective of FSR, assumptions on the policy context in which research is conducted, definitional issues)

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* Report prepared by Larry Harrington on a Workshop held at CIMMYT, April 1-3, 1980. Only for use at the CIMMYT-IDIAP meeting. Although not all workshop participants were consulted in the writing of this report, an effort was made by the author to include divergent opinions on the methodological issues herein discussed.

1/ See Annex I for the list of Workshop participants and their institutional affiliation.

- Issues relative to the farmer as the researchers' client (criteria for selection of target areas, criteria for stratifying farmers into relatively homogeneous groups, research on the whole system versus research on a target crop in the context of the system, formulation of technological "packages" versus "pieces").

- Issues relative to the acquisition of information on farmer problems and circumstances (use of background information, informal surveys, formal surveys, observations in farmers' fields).

- Issues relative to the design, testing and evaluation of technology (methods of pre-screening technological alternatives, issues in on-farm experimentation, economic analysis of experimental data from both private and social viewpoints, farmer assessment of technology).

- Issues relative to the institutionalization of FSR/OFR in national research programs.

In general, workshop participants achieved a remarkable degree of consensus on many issues, at least when the decision-context was carefully specified and the relevant alternatives clearly spelled-out. The following discussion will identify such areas of methodological agreement, but will also note areas of disagreement and the different positions taken.

2.0 General Issues

2.1 Terminology

The terms "farming system research" and "on-farm research", and other terms used in such research, often mean different things to different people. To insure fruitful discussion on common topics, it was first necessary to deal with a few issues of terminology.

Workshop participants were generally in agreement with the definitions presented by Norman (Norman, 1980). A distinction between "farming-systems research" and "on-farm research" was accepted by most workshop participants. This stemmed from a realization that not all farming-systems research need be conducted on farmers' fields (e.g., prototype solutions to broad problems may be developed on experiment stations) and that not all research conducted on farmers' fields is FSR (e.g., traditional fertilizer trials conducted on-farm but in isolation from farmer problems and circumstances).

Workshop participants accepted the following characterization of FSR: 1) The farm as a whole is viewed in a comprehensive manner. 2) The choice of priorities for research reflects the initial study of the whole farm. 3) Research on a farm sub-system is legitimate FSR provided the connections with other sub-systems are recognized and taken into account. 4) Evaluation of research results explicitly takes into account linkages between sub-systems. 5) As long as the concept of the whole farm and its environment is preserved, not all factors determining the farming system need to considered as variable -- some may be treated as parameters. Therefore, FSR may be called FSR-in-the-small (low ratio of variables to parameters) or FSR-in-the-large (high ratio of variables to parameters).

There was less agreement among workshop participants on the proper terms for different types of FSR programs. This occurred in spite of a consensus on the need to distinguish between types of programs. Norman used the term "upstream FSR" for that FSR that seeks prototype solutions to major constraints to crop or agricultural improvement. This type of FSR is not meant to provide results for immediate adoption by farmers, but rather contributes to a general body of knowledge upon which "downstream FSR" may draw. This "downstream FSR"

is research for the purpose of formulating technological improvements useful in the short run to target groups of farmers.

Workshop participants agreed on the conceptual distinction, but were unhappy with the "upstream versus downstream" terminology. Several alternatives were offered: "support research versus applied research", "generation research versus adoption research", "developmental research versus adoptive research", "source research versus adoptive research". No consensus, however, was evident.

The remainder of the Workshop dealt with methodological issues facing social scientists in "downstream" (or applied, adoption or adoptive) farming systems research.

2.2 The Role of the Social Scientist

The role of the social scientist in FSR, especially that of the agricultural economist, came under close scrutiny. All workshop participants, agronomists and social scientists alike, agreed on the need for participation by social scientists in FSR.

The social scientist was seen as responsible for incorporating the "human element", or socio-economic problems and circumstances that affect farmers' decisions, into the design and evaluation of new agricultural technology. As a member of a multi-disciplinary team responsible for FSR activities, he must take as much responsibility for research decisions as an agronomist or a plant breeder. Indeed, some argued that the agricultural economist was particularly well suited to coordinate the work of an FSR team, because his discipline ("the science of allocating scarce resources between competing ends to maximize utilities") parallels the activities of a farmer in decision-making on resource allocation (Collinson, 1980A).

In research planning or technology design, the agricultural economist was seen as using his acquaintance with farm survey techniques and his sensitivity to opportunity cost and the economic value of time to aid the agronomist in answering such questions as: 1) What is a representative farmer? 2) At what level should non-experimental variables be set? 3) What are high-priority problems in production? 4) Which possible solutions to production problems seem most feasible in the context of farmer goals and circumstances ("pre-screening")? 5) How may resource constraints be eased or system flexibility be employed to increase farmer income and meet other farmer goals?

In evaluation of research results, agricultural economists were seen to examine similar issues: Is the new technology profitable? What are the constraints to adoption posed by input or product markets, or by inadequate infrastructure? How do farmers themselves assess the new technology? Does the new technology meet social as well as private goals?

Some workshop participants pointed out that the character of individual team members is as important as their disciplinary training. Team members must be willing to engage in problem-solving research to meet a common team objective: the development of new technology usable by farmers. That is, they must be "task-oriented".

In this connection, it was noted that some training in inter-disciplinary research for prospective team members could be useful. This training would focus on the questions that one disciplinarian may fruitfully ask of another. (Bartlett and Akorhe, 1980).

Finally, the role of the non-economic social scientist, especially the anthropologist, was examined. It was felt that the anthropologist could play an important part through his experience with informal methods of data acquisition.

2.3 Alternative Users of FSR Results: Farmers, Policy-Makers and Experiment Stations

"Downstream" FSR is normally couched in terms of its usefulness to farmers, that is, its primary objective is commonly considered to be the delivery of new, usable technology to farmers within a relatively short period of time. Workshop participants pointed out, however, that farmers are at times not the principal direct users of downstream FSR results. Downstream FSR activities often lead to a realization that previous recommendations are not usable by farmers and that none of the "improved" inputs or practices currently available offer any improvement, in the context of farmer goals and circumstances, over the current farmer practice. In such a case, it must be determined how either upstream FSR or traditional, reductionist research may be oriented to provide new, useful inputs or practices. Downstream FSR can usually provide some detail on the required characteristics of a new input (e.g., a white maize variety with less than 110 days to maturity that has good husk cover and can support climbing beans). Many Workshop participants pointed out, however, that the feedback linkages between downstream FSR and either upstream FSR or reductionist research are rarely well defined. There appears to be an under-utilized potential to use downstream FSR to orient more "basic" research.

Policy-makers were also noted as potential users of downstream FSR results. This is, again, a case where the use of research results is potentially significant but where linkages are currently not well developed.

FSR results should be of interest to policy-makers because they can often be used to measure the costs (in terms of foregone agricultural production) of current policies and to predict the impact of alternative policies on farmer decision-making. This is not to say that FSR results can be used to decide on correct agricultural policy. Rather, research results provide necessary (but not sufficient) information upon which to base such decisions. Examples of such a use of downstream FSR are, however, rare.

A related issue discussed in the Workshop was to what extent the policy environment should be viewed as fixed versus variable. When should new technology be designed to fit current policies and when should it be designed to fit expected changes in policy? No consensus was apparent, although participants were unwilling to restrict FSR activities to either of the two alternatives.

2.4 Cost-Effectiveness of Downstream FSR

The issue of the cost-effectiveness of "downstream" FSR will likely gain in importance in the near future, as donors begin to examine the impacts of past expenditure on FSR. Although few cost-effectiveness studies are available, there was a general consensus among workshop participants that "downstream" FSR can be a cost-effective research tool. This consensus was reached despite the fact that FSR is commonly viewed as costly to implement.

Three arguments were forwarded in support of the cost-effectiveness of "downstream" FSR. First, given that most FSR activities are conducted on farmers' fields, recurrent expenses increase for such items as travel and per diem. Such recurrent expenses impinge more severely on the current budgets of research administrators and cash flow problems arise. Research administrators, however, find it relatively easy to ignore the opportunity costs of resources

embodied as fixed capital on experiment stations. That is, FSR may not be more expensive than traditional research but the structure of costs, recurrent versus fixed, may increase the administrative burden.

Similarly, "downstream" FSR was seen as more efficient than traditional research in terms of "technology adopted per unit of money spent". Workshop participants held a general belief that traditional on-station research in developing countries had led to little adoption of new technology by small farmers.

Finally, it was observed that much can be done to reduce the costs of "downstream" FSR. The acquisition of data on farmer problems and circumstances provides one area of possible cost reduction. Informal, non-probabilistic surveys and well-focused, single-visit, small-sample formal surveys were seen as generally preferable to large-sample surveys or frequent-visit surveys in this connection. The criterion for the selection of survey instrument should be that of "the lowest possible cost commensurate with the degree of understanding that is necessary" (Norman, 1980).

Another area of possible cost reduction is that of expanding the universe for which downstream FSR results are applicable. This may be performed by determining the transferability of one set of results to other similar environments. In this fashion, some (but rarely all) of the steps in downstream FSR may be skipped.

Finally, it was pointed out that it is unnecessary for FSR to produce the "best" new technology for farmers. Insofar as it discovers anything "better" than the current farmer practice, it will be useful. That is, FSR need not engage in the fine tuning of the farming system, but rather may concentrate on seeking the best of readily available solutions to important problems.

3.0 The Farmer as the Researcher's Client

The farmer is normally considered the primary client of "downstream" FSR, although both policy-makers and "upstream" FSR may also be regarded as clients. Insofar as research is aimed at helping farmers, some insight into how to deal with the farmer-client is needed in planning research.

3.1 Target Groups of Farmers: Recommendation Domains

One such issue on "dealing with farmers" that was discussed in the workshop was that of the identification of target areas and target groups of farmers. A target area is merely a geographical area selected by policy-makers and researchers to be a priority area for FSR. Workshop participants recommended that policy-makers use several criteria in selecting a target area, including research costs, likelihood of successfully developing new technology, and likely impact on such national goals as income distribution, employment, or savings of foreign exchange.

Within a target area, it was pointed out, the next necessary step is the delineation of target groups of farmers or "recommendation domains". This step is necessary because both possible alternatives (conducting research for individual farmers, or conducting research for all farmers in the target area, heterogeneity in circumstances not withstanding) are clearly unfeasible.

There was less consensus, however, on the appropriate criteria for delineation of recommendation domains. Some argued that major agro-climatic differences be used to identify "land-types" and that research be conducted in the context of the known characteristics of a given "land-type". Others argued that the current farming system itself be used to distinguish between recommendation domains, that is, that farmers currently operating similar farming

systems be included in the same recommendation domain. This is because the current farming system has evolved via a series of decisions made by farmers as they weigh and balance all circumstances -- agro-climatic, socio-economic and institutional -- that impinge on production decisions. Furthermore, the current farming system provides the basis upon which new technology will be added by farmers (Collinson, 1980 B).

The appropriate size of a recommendation domain was also posed as an issue. Workshop participants agreed that the number of farmers to be grouped into a single recommendation domain varies inversely with the size of the research budget and with the heterogeneity found in farming practice in the target area. Size, then, may vary from only a few thousand farmers to tens or even hundreds of thousands of farmers per domain.

3.2 Focus on the Whole System Versus on a Pre-Determined Enterprise

The phrase "farming systems research" carries with it a connotation of wholeness, a feeling that everything in the farming system must be considered simultaneously. As was pointed out in section 2.1, however, "farming-systems-research-in-the-small", in which the ratio of variables to parameters is low, may be considered valid FSR because planning and evaluation of research on a limited number of variables is conducted in the context of the whole system.

The question was raised regarding the extent to which the ratio of variables to parameters should be minimized. Specifically, when is it wise to focus research on a pre-determined commodity rather than on the whole farming system, or on the crop sub-system?

Two conditions favorable to concentration on a pre-determined enterprise were noted in the workshop. First, when research is planned in a region

where the pre-determined enterprise in question is a major absorber of farmer resources, that enterprise will frequently offer the best leverage on such system problems as deficient income, excessive risk, and seasonal variability in the use of farmer-owned resources. Second, agricultural research in developing countries is frequently organized by crop. The use of the pre-determined enterprise focus allows an easier introduction of FSR concepts into on-going research programs, especially (as is often the case) when there exist poor linkages among agricultural research institutes, and between them and policy-making and farmer-contact agencies (Collinson, 1980 B and Norman, 1980).

From the above, it should be clear that a focus on the broader cropping system may be advisable when there is little scope for improvement in the farmer's major crop activity and when the organization of research administration allows this more ambitious approach.

3.3 Technological "Pieces" versus "Packages"

The wisdom of recommending complete packages for LDC farmers has been considered an issue for some time. Five years ago, the "package of practices" approach was criticized in the Indian context (Ryan and Subrahmanyam, 1975). More recently, a sequence of adoption of practices was favorably compared to the traditional package approach (Mann,).

Surprisingly, Workshop participants found the "package" versus "pieces of technology" question to be a non-issue. It was felt that the focus should more properly be placed on the scale and complexity of new inputs or practices. A package of scale-neutral and simple innovations should be more usable by farmers than a single but complex technological "component" which is furthermore unusable on small farms. In addition, insofar as a "package" is recommended (say, due to strong complementarity between package components),

each component should be individually tested for acceptability in terms of scale and complexity. Otherwise, the rejection of one component will likely lead to the rejection of the whole package.

In light of the above, workshop participants largely felt that individual components or "small packages" were more likely to pass the scale/complexity test than large packages and that, therefore, research should generally avoid the formulation of large "packages" of practices.

4.0 Acquisition of Information on Farmer Problems and Circumstances

A broad consensus was soon reached on the need for information on farmers: An intimate acquaintance with the natural and socio-economic circumstances and problems of target farmers was seen as necessary to the proper design and evaluation of technology. Discussion focused on the advantages and disadvantages of alternative data sources and data collection instruments in achieving the desired degree of understanding.

4.1 Secondary Data

Such secondary data on soils maps, land use maps, rainfall records and the agricultural census were generally felt to be useful in distinguishing parameters from variables, or "the environment vector" from "the management vector", at least in a preliminary way. Such data may lead to a tentative delineation of target groups of farmers or "recommendation domains" for the target area in question. Furthermore, some participants felt that extensions of these recommendation domains into locations outside of the current target area may be hypothesized, based on a careful description of environmental characteristics.

However, it was felt that secondary data will rarely provide the insight into farmer problems and circumstances needed to design new technology. Such data is generally inadequate to list production problems facing farmers, "pre-screen" possible solutions to these problems in light of current farming systems, or even describe current farmer practices. It is almost always, then, necessary to gather some information directly from the target farmers themselves.

4.2 Farm Surveys: Informal versus Formal

Three major alternatives for obtaining information from farmers were discussed by Workshop participants: informal surveys (at times referred to as "sondeos"), one-contact formal surveys, and multiple-visit formal surveys or farmer panels. Farmer record-keeping was grouped with multiple-visit surveys. Each of the three alternatives was strongly advocated by at least one participant. The advantages and disadvantages of each data collection instrument were discussed and a surprising degree of consensus was reached with regard to the conditions under which a given instrument may best be used.

Informal surveys (informal conversations with farmers without the use of enumerators, questionnaires, or a random sample) were felt to be useful and even necessary under a wide variety of conditions. They provide a rapid and inexpensive means of obtaining a qualitative understanding of the farming systems of target farmers (Hildebrand, 1979). They represent the minimum in data collection that is required for planning downstream FSR. That is, when time is short and resources (especially skilled personnel and transport) are very scarce, informal surveys are a usable method for identifying the most important production problems facing farmers, and for describing the salient features of the natural and socio-economic environment in which farmers make decisions.

Furthermore, informal surveys were felt to be essential for the planning and execution of subsequent formal surveys, if such are desired. They guide researchers in hypothesis formation, questionnaire development and choice of sampling technique.

If the advantages of informal surveys (speed, low expense) were recognized by workshop participants, their disadvantages were similarly noted. The lack of random sampling combined with a focus on qualitative data may easily lead to credibility problems: It may be difficult to convince decision-makers not involved in the informal survey process that the data are valid. Furthermore, when representativeness is an issue ("Just what are the characteristics of a representative farmer?"), a careful answer is not to be had without data based on random sampling. Finally, even proponents of informal surveys admit that they are not good sources of data for the analysis of experimental data: This is due to the lack of quantification inherent in the method. In short, it was felt that occasions will frequently arise when it is wise to follow an informal survey with a formal survey. When time and resources allow, and when researchers are faced with the issues of "credibility", "representativeness" or "quantification" noted above, some kind of formal survey is advisable.

In this correction, some participants proceeded to advocate the use of farmer panels, or multiple-visit surveys. It was argued that multiple-visit surveys provide superior time series data, especially with regard to such variables as labor flow, cash flow and non-cash income, that farmers find difficult to remember. They build more rapport with farmer-respondents, facilitating the acquisition of reliable data on sensitive questions. (Binswanger and Ryan, 1979). In general, they provide a "depth" of understanding at the expense of "breadth". That is, repeated visits to the same farmers may lead to a superior

understanding of the complex details of a local farming system ("depth") but it will prove relatively difficult to generalize and extrapolate the understanding that is achieved ("breadth") due to the necessarily small number of farmers visited.

A number of questions were raised with regard to the use of multiple-visit surveys in planning and evaluating downstream FSR. Some participants felt that the precision in measuring flow variables that is achievable with farmer panels is excessive for the purpose at hand. That is, the increase in precision may not be worth the increase in expense. Indeed, the expense of multiple-visit surveys was a source of concern to many. Participants noted the high staff-time requirements, enumerator and travel expense, the time lag between survey initiation and its termination, and the expense and difficulty in analyzing and reporting survey results. Some participants questioned whether the widespread use of farmer panels by national FSR programs is at all practical in light of the above difficulties. Farmer panels, they felt, may be more appropriate to international centers that conduct upstream FSR.

But multiple visit may have some validity when testing stage

A final alternative was discussed: the single-contact formal survey. Proponents of this data collection instrument noted that a small-sample, random-sample, single-contact formal survey can be used to quantify and "verify" the results of a preceding informal survey. This formal survey is focused on topics of importance, as determined by the informal survey. This combination of informal survey plus small-sample formal survey overcomes many of the problems associated with exclusive reliance on informal surveys ("credibility", "representativeness", and "quantification") while avoiding the cost-related problems associated with farmer panels (CIMMYT, 1980). Subsequent discussion brought out several difficulties in using this approach. In the context of a complex farming system, it

is difficult to obtain precise estimates of flow variable with a single-contact survey. (There was little discussion, however, on how precise the measurement of these variables must be in order to plan and evaluate research on new technology.) Furthermore, it is difficult to gather information on sensitive questions because a single-visit does not allow much development of rapport with the respondent. The use of random sampling may be burdensome if suitable sampling frames are lacking. Finally, data processing and analysis, while far less onerous than that associated with farmer panels, may still lead to unexpected costs and delays.

In summary, all three data collection methods demonstrate advantages and disadvantages. With specific reference to downstream FSR conducted by national programs, however, the following may be concluded: 1) An informal survey represents the minimum data collection effort necessary for planning research. 2) Where time and resources allow, it is wise to follow the informal survey with a formal survey. 3) In many cases, a small-sample, single-contact formal survey will be sufficient to "verify" the results of the informal survey. 4) However, when time and resources allow, and when flow variables must be measured with some precision in the context of a complex farming system, researchers might wish to consider using a farmer panel in addition to a single-contact survey.

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4.3 Observations in Farmers' Fields

One further data collection method was discussed: observations in farmers' fields. This method has at times been combined with informal or formal survey activities and has been used to help identify high-priority problems for downstream FSR. Workshop participants agreed, however, that field observation by itself is insufficient for identifying and ordering in importance the production problems with which target farmers must cope. Field observations are

time and location specific, and are regarded as relatively costly. That is, to gain an idea of the variation in the incidence of problems in farmers' fields, quite a few sites must be inspected. Yet even this procedure will not deal with the variation in the incidence of problems over time. Nonetheless, observations in farmers' fields may prove useful when combined with data from farm interviews. For example, the combination of a physical weed count in a farmer's field and data on the farmer's weed control practices for that field may provide a clearer insight into the scope for improving weed control practices. More generally, field observation can lead to the identification of some production problems while data from farmers can help determine the frequency of incidence and severity of those problems, and what farmers are currently doing about them.

5.0 Design, Testing and Evaluation of New Technology

The social scientist's influence in applied FSR may be measured by his effect on the decisions taken in the design, testing and evaluation of new technology for a target group of farmers, or recommendation domain. Armed with his knowledge of farmer problems and circumstances, and the tools of economics, he is in a good position to aid agronomists and other biological scientists in pre-screening possible solutions to high-priority problems, choosing representative farmers for collaboration, analyzing experimental data, and much more. Nonetheless, the social scientist must address a series of procedural issues in order to fulfill his role.

5.1 Pre-Screening Alternative Technologies: Technology Design

Workshop participants tended to agree on the basic steps in technology design. First, factors that limit production of the target enterprise(s) must be listed. Those limiting factors about which nothing can be done are relegated to the status of parameter -- they cannot be used as experimental

variables. For each limiting factor that remains, a list of potential solutions or treatments drawn up.

Each potential solution is "pre-screened" for feasibility. That is, budgets are constructed to determine yield changes needed to pay treatment costs -- agronomists then can estimate the likelihood of achieving these yield changes. Apparently profitable treatments are then examined for consistency with the farming system of target farmers. Input and product markets, cash flow, labor flow, crop calendars, etc. are noted and the effects of alternative treatments on each are estimated. Those treatments that appear profitable and that mesh well with the current farming system (use under-employed resources, reduce resource use during peak demand periods, etc.) receive priority in technology testing.

Some participants used different terms to describe the above criteria for technology design: "biological feasibility", "resource feasibility" (resource availability), and "economic viability" or profitability (Zandstra, 1980). The net effect, however, is about the same.

Although there was widespread agreement on the basic steps of technology design and pre-screening, there was considerable variance among participants in the detailed steps which they tended to follow. Some advocated formal meetings a month before planting, attended by the entire research team, in which experimental treatments are defined in detail. Others suggested a more informal, flexible approach. These differences in detail were largely atributed to such factors as team size, scope of the experimental program (variable to parameter ratio) and class of experiment for which treatments are being designed.

One issue related to the identification of limiting factors was raised but, unfortunately, was not treated in the detail that it merits: Are problems in crop and livestock production best identified by researchers, through observations in farmers' fields and/or through inferences derived from farm survey data, or directly by farmers as they comment on their "felt needs"? There is undoubtedly a role for both approaches. The balance between them, however, is not well defined.

5.2 On-Farm Experimentation

Some of the broader issues related to on-farm experimentation have already been discussed (research on the whole system versus research on a predetermined commodity, complete "packages" versus technological "pieces", etc.). Other, narrower issues still remain regarding this topic, however.

One accepted role of the social scientist in applied FSR is in aiding other researchers in the choice of representative farmers as collaborators. In practical terms, this can become a difficult task because no single farmer ever precisely represents all other farmers in a given recommendation domain. Two feasible approaches were noted. In the first, farmers are asked (during a formal survey with a random sample) if they would be willing to collaborate in on-farm research. Terms and incentives are described. Of those farmers willing to collaborate (and experience shows that most farmers are willing if the incentive structure is adequate), a random sub-sample is drawn.

In the second approach, farmer-collaborators are selected purposively. Any farmer in a given domain may be chosen as long as he fits into, say, the middle 50% of the frequency distributions for those variables considered to be especially important by researchers.

One issue that received considerable attention from workshop participants was that of the proper level for non-experimental variables (NEV's) or the "background matrix". Three alternatives were presented: the farmer's level, some high and non-limiting level, or some intermediate level (chosen for its expected profitability in a future technology package). The choice of NEV level was found to depend on the research client and the level of research ("upstream" or "downstream"). Selected NEV's may be set at high, non-limiting levels for some kinds of "upstream" research or for demonstrations for policymakers (e.g., on the yield effect of an unavailable input). The consensus of participants, however, was that NEV's should be set at the farmers' level in trials aimed at formulating near-term recommendations for farmers, that is, in "downstream" research. Some participants noted, however, that as research continues, some NEV's may be raised to an "expected future recommendation level".

One issue upon which there was little consensus is the proper number of experimental variables to be included in a research program for a given recommendation domain. Suggestions ranged from three to thirty. This is, of course, merely a re-statement of the issue of the proper scope of research -- that is, the question of the variable to parameter ratio, which has already been treated.

The question of farmer participation in on-farm experiments was discussed briefly. Farmers were seen as playing many roles in on-farm research: responding to surveys, loaning their fields, commenting on alternative experimental treatments, completely managing other treatments, and sharing their experiences with new technology. The extent of direct farmer involvement, however, is dependent on the kind of experiment being conducted. Farmer participation becomes increasingly crucial as one moves from small-plot, replicated

experiments to verification of recommendations for new technology. Farmer-managed experiments in which farmers operate the new technology themselves and are even responsible for input acquisition and risk management, were seen as useful in testing recommendations flowing from small-plot, researcher-managed trials.

A host of other issues related to on-farm experiments were raised but not discussed in the workshop. For the record, they are listed as follows: choice of experimental design, plot size, number of replications per site per experiment, number of sites per experiment, number of experiments per site, extension personnel involvement, highest C.V. acceptable, probability level for the rejection of the null hypothesis, and assembly of site-specific data during experimentation (Violić, 1980).

5.3 Economic Analysis of Experimental Data

The issues related to economic analysis of the results of on-farm experiments were divided into two classes: private effects and social effects of new technology.

The choice of analytical technique was the major issue regarding the measurement of the private effects of new technology (that is, costs and benefits that accrue only to farmers who adopt the new technology). Participants agreed that kind of experiment (researcher-managed versus farmer-managed), choice of target crop, level of research (upstream versus downstream), and location of research (national programs versus international centers) influence the choice of proper analytical techniques. Analysis of variance to determine the significance of differences between treatment means was advocated, but is clearly restricted to small-plot, replicated experiments. Partial budgets and, at times

enterprise or whole farm budgets, were proposed to examine the profitability of new technology. Finally, linear programming and formal risk analysis were advocated for use under special circumstances: when the target enterprise interacts strongly with other farm enterprises, when there are no markets for farmer-ow resources and when time and resources are available to correctly use these techniques. At times, some participants noted, international centers become directly responsible for downstream research because no national program is available to accept this responsibility. In such a case, more sophisticated techniques may be used to analyze experimental results. In general, however, it was felt that national FSR programs should develop the capacity to use budgets with imagination and flexibility rather than attempt the use of more complicated analytical tools.

A further issue in the measurement of private effects of new technology is that of the adjustment of experimental yields. Researchers normally obtain higher yields than farmers, even when they simulate the farmer's practice. When they occur, these yield differences are thought to be due to unconscious improvement in management (timeliness in weeding or insect control, better plant population) or earlier harvesting (by virtue of which researchers avoid field losses that farmers must face). Inflated yield estimates, however, are likely to lead to inflated expectations of returns and over-stated estimates of profitability. Workshop participants agreed that the problem is a common one, but reached no consensus on how to handle it. A proportional deflation of yields for all treatments was not found to be generally acceptable, as interactions between treatments and the causes of yield inflation are likely to exist.

In the workshop issues surrounding the use of survey and experimental data to predict the broader consequences of new technology for society were briefly discussed. As one participant noted, we would like to be able to

predict the effect of new technology on nutritional levels, employment, income distribution, long run versus short run effects, the balance of payments, etc. However, even ex-post explanations of the impacts of new technology have been generally unsatisfactory. Ex-ante prediction of these effects are likely to be even less satisfactory because of difficulties in predicting such factors as: farmer adaptation of new technology, adoption rates by farmer strata, yield and employment changes over time and space, performance of support institutions (e.g., input suppliers and product markets), and institutional change due to the effects of new technology (Flinn, 1980).

5.4 Farmer Assessment of New Technology

"Economic evaluation of experimental results", as discussed in the preceeding section, is one step in selecting new technology useful to, and usable by farmers. In conducting economic evaluation, researchers assume that they are familiar with the important costs and returns associated with new technology and that the decision criteria they use are similar to those used by farmers.

One further step in evaluation is possible, however, and was briefly discussed in the Workshop. This step may be termed "farmer assessment" of new technology or "monitoring farmer experience" with that technology. In farmer assessment, those farmers with sufficient experience with the new technology (such that they have made a decision for or against its use) explain how they employ it, list its advantages and disadvantages, and describe why they decided in favor or (or against) its use in commercial production. This normally implies that farmers must have used the technology, possibly upon the request of researchers, on their own fields on a substantial scale, incurring all costs, benefits, and risks. Farmer assessment is likely to be useful: 1) when farmers

had little previous experience with a component of the new technology (and therefore cannot be expected to provide useful information in an ex-ante survey), 2) when a knowledge of the recommended technology is needed to sharply focus questions regarding farmers' experiences (because there are many possible solutions to farmers' problems), 3) when the farming system is complex (and therefore costly to accurately represent in a formal model), and 4) when ex-ante survey work was not well conducted (Harrington, 1980).

Two issues related to farmer assessment were brought out: Which farmers should be chosen to assess a new technology, and which data collection instruments are best used in assessment?

With respect to choice of farmer, it was argued that only "knowledgeable" farmers should participate in assessment. It is unfair to include in assessment those farmers who have not made up their minds. This can restrict assessment to ex-collaborators and early adopters. Will they be representative of target farmers? In any event, how does one determine whether a given farmer is sufficiently "knowledgeable" that he may participate in assessment?

With respect to data collection instruments, it was pointed out that a wide range of tools may be appropriate, depending on the number of target farmers with previous experience with the new technology to be assessed. Purposive surveys, random surveys and formal farmer trials are all likely to play a role at one time or another.

6.0 Institutionalizing Social Scientists in Agricultural Research Systems

As a final theme, workshop participants discussed the issues that surround the establishment of social scientists in agricultural research institutions. The major issue was that of the organization of agricultural research

as such, and the place of the social scientist under varying organizational arrangements. Interwoven into this main issue were sub-issues of incentives, minimum qualifications, and training.

With regard to the organization of agricultural research, three alternatives were presented and discussed. The first alternative stemmed from experience in E. Africa, where both "upstream" and "downstream" research are coordinated through area-based experiment stations. Social scientists have recently been introduced directly onto these stations as staff members. This role is two-fold: Help agronomists design "downstream", on-farm research that is more relevant to the needs of target farmers, and provide feedback on farmer problems to help breeders re-orient "upstream", on-station research. The major problem faced to date is one of status: The junior-level economists find it difficult to deal with the relatively senior-level breeders and agronomists.

A second alternative stemmed from experience in Ecuador and Guatemala. In these cases, a clearer mandate is given to a research team to conduct "downstream" research for defined areas. The tie to the experiment station still exists, but is looser. The on-farm research team receives transportation facilities with which to conduct its work and, in one case, receives a salary premium. That is, their wage is above that of their "on-station" counterparts. The research team, which has a mandate to deal with all important crops, is largely composed of agronomists. A social science support unit is available to aid research teams in conducting and analyzing farm surveys, maintaining contact with collaborators during experimentation, and analyzing experimental data. But social scientists are not part of the research team as such.

This arrangement appears to ease many of the status-related problems noted under the first alternative. It seems to have been effective in making agronomists more sensitive to economic issues (and economists more sensitive to biological issues). However, insofar as social scientists do not share responsibility for research decisions, and insofar as they cannot become intimately acquainted with a research area by continuously working there, their input may be less effective and more easily ignored.

A third alternative for organizing agricultural research stemmed from experience in Asia. Under this alternative, a research team is responsible for "downstream" research for a defined area, with little formal contact with a given experiment station. A social scientist is directly assigned to the research team and is just as responsible as other team members for research decisions. Most research decisions are taken in a formal meeting of the whole team about a month before planting.

ANNEX I

April 1-3, 1980

Workshop on "Methodological Issues Facing Social Scientists in On-Farm/Farming Systems Research"

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