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The Design and Management of Call System Training in On-Farm Research

Robert Tripp, Ponniah Anandajayasekeram, and Gustavo Sain*
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Abstract

This paper, intended for those engaged in training national research and extension personnel in on-farm research (OFR) methods, summarizes the experiences of the CIMMYT Economics Program, in collaboration with members of the Maize and Wheat Programs, in developing call system training courses in OFR during the past decade. Call system courses consist of multiple meetings (calls) throughout one or more agricultural seasons in which members of national research and extension institutions are introduced to the methods of location-specific adaptive research. After briefly reviewing the methods and concepts of OFR, this paper describes the objectives, organization, and procedures of each call that constitutes the course. Suggestions for teaching materials and followup activities are also included.

Acknowledgements

We are grateful for help and advice on an earlier draft of this paper from Stephen Waddington and Patrick Wall.

We have learned a great deal about the management of call system courses in the past decade. Much of that knowledge is based on the experience of others in the Economics Program, especially Larry Harrington, Alberic Hibon, Allan Low, and Juan Carlos Martínez. We are indebted to them for their contributions as teachers and colleagues.
# Contents

Abstract .......................................................................................................................... ii
Acknowledgements ........................................................................................................... ii
Tables and Figures ........................................................................................................... v

1 On-Farm Research and Call System Courses .............................................................. 1
   On-Farm Research: An Overview .................................................................................. 1
   Call System Courses ..................................................................................................... 2
   Advantages and Disadvantages of Call System Training ............................................. 3

2 The Organization of Call System Courses .................................................................. 6
   Institutional Prerequisites ............................................................................................. 6
   Participants ...................................................................................................................... 6
   Site Selection .................................................................................................................. 6
   Teaching Responsibilities ............................................................................................... 7

3 First Call: Secondary Data Review and Informal Survey ............................................ 8
   Objectives ....................................................................................................................... 8
   Organization ................................................................................................................... 8
   Alternatives to a Single Call ......................................................................................... 8
   Outline ............................................................................................................................. 9
      Teaching Materials ...................................................................................................... 20
      Publications for Reference or Distribution .............................................................. 21

4 Second Call: Formal Survey .......................................................................................... 22
   Objectives ....................................................................................................................... 22
   Organization ................................................................................................................... 22
   Outline ............................................................................................................................. 23
      Teaching Materials ...................................................................................................... 27
      Publications for Reference or Distribution .............................................................. 27

5 Third Call: Planning An Experimental Program .......................................................... 29
   Objectives ....................................................................................................................... 29
   Organization ................................................................................................................... 29
   Outline ............................................................................................................................. 31
   Final Preparations for Planting the Experiments ......................................................... 35
      Teaching Materials ...................................................................................................... 35
      Publications for Reference or Distribution .............................................................. 36
6 Fourth Call: Visit to Experiments ........................................ 37
   Objectives ......................................................... 37
   Organization ...................................................... 37
   Outline ............................................................. 37
   Teaching Materials .............................................. 38

7 Fifth Call: Analysis of Experimental Results ......................... 39
   Objective ......................................................... 39
   Organization ...................................................... 39
   Outline ............................................................. 39
   Teaching Materials .............................................. 41
   Publications for Reference or Distribution ........................ 42

8 Activities Between Calls ............................................... 43
   Using Research Skills Between Calls ............................. 43
   Study Assignments Between Calls ................................ 46

9 Conclusion .......................................................... 47
Tables and Figures

Table 1. Call system training courses presented by CIMMYT ................. 4
Table 2. Evaluate possible solutions .............................................. 34
Figure 1. Call system training and the agricultural cycle .......................... 3
Figure 2. Various circumstances affecting farmers' choice of a crop technology .............................................. 10
Figure 3. Problems, causes, and solutions:
Maize in Celica, Ecuador ......................................................... 13
Figure 4. Guidelines for an exploratory survey
(CIMMYT training, Mexico) ...................................................... 15
Figure 5. Steps in the planning process .............................................. 30
Figure 6. Analysis of causes of priority problems ................................. 32
Figure 7. Example of a formal assignment in a call system course ............ 45
On-Farm Research and Call System Courses

The purpose of this paper is to summarize the experiences of the CIMMYT Economics Program in the development of call system training courses for teaching the methods of on-farm research. These courses consist of multiple meetings, throughout one or more agricultural seasons, in which members of national research and extension institutions are introduced to the methods of location-specific adaptive research. CIMMYT has 10 years of experience in this kind of training; the Maize, Wheat, and Economics Programs have all organized call system courses. This paper focuses on the call system courses organized by the Economics Program, in collaboration with members of the crop programs.

This paper does not discuss methods of on-farm research (OFR) in detail and assumes that the reader is familiar with the basic ideas and concepts of OFR. Neither does the paper provide specific information on particular courses that have been offered. Instead, it tries to summarize what has been learned about the organization of "hands-on" training in OFR methods. We believe that some of our observations will be useful to those who are engaged in training national research and extension personnel in the methods of OFR. The experiences of call system courses should provide helpful suggestions regarding the methods and organization of a training program in OFR, whether it is long-term training or focuses on particular aspects of OFR.

On-Farm Research: An Overview

On-farm research is a set of methods that allows researchers and extension agents to 1) assess the problems and conditions of well-defined groups of farmers, 2) to set research priorities on the basis of this diagnosis, 3) to design a research program that includes experimentation on farmers' fields, 4) to assess the results of that research in terms that are compatible with farmers' interests, and 5) to develop recommendations accordingly. The methods of OFR have been widely discussed and are being adopted by a growing number of national agricultural research programs.

The first step in a location-specific OFR program is to do some sort of diagnosis. Two diagnostic techniques are particularly important. The first is the informal survey, in which small groups of researchers take observations in farmers' fields and speak with farmers about their practices and problems. As the term "informal" implies, no questionnaire is used in the survey, which is managed like an informal conversation. A second diagnostic technique is the formal survey, which features a short, well-focused questionnaire developed after carefully analyzing the results of the informal survey.

The diagnostic information is then used for planning an experimental program. The information is reviewed and key production problems and their causes are identified.
This analysis is used to develop priorities for a research program that includes both experiment station and on-farm experimentation. Experimental factors that either explore production problems or test possible solutions are included in experiments that are planted on farmers’ fields, under their conditions. After the results of the on-farm experiments are analyzed, the information is used to further refine the experimental program and to develop recommendations useful for farmers.

This very brief outline of OFR ignores its links with other research and extension activities. Information developed by location-specific OFR is compared with, and contributes to, the priorities of national commodity and disciplinary research programs and departments. The extension service must also participate fully in OFR, which should in turn contribute to local extension programs.

Call System Courses

Although the basic ideas of OFR are not new to many national research programs, the introduction of a consistent set of methods for conducting location-specific adaptive research usually requires a considerable period of testing, discussion, and debate by national program personnel. Because OFR methods are logically linked one to another, and because the research requires detailed attention to a specific location, training is most effective if it can both emphasize the continuity of the methods and take advantage of "real life" data. These considerations led to the development of call system training, which tries to take participants through the major steps in OFR by conducting an actual research program in one area of the participants’ own country.

Figure 1 illustrates one arrangement for call system training. The first call takes place during the major agricultural season in the area and involves a two-week introduction to diagnosis using informal surveys. The second call, also two weeks long, is held after harvest and is based on a formal survey. The third call is a one-week exercise on priority setting and experimental design, taking place before the next season begins. The fourth call is devoted to visiting and assessing the on-farm experiments that were proposed in the previous call and planted by the local team of researchers and extension agents. The fifth call analyzes the results of those experiments after harvest. Thus the participants are introduced to the major methods in OFR during seven weeks of course work over approximately one and a half years. A sixth call may be presented to plan the next season’s experiments.

This paper describes the management of call system courses similar to the one depicted in Figure 1, but it is important to emphasize that the call system formats used by CIMMYT have varied widely. Courses directed by the Economics Program, with the participation of agronomists from the Maize and Wheat Programs, have usually included calls for diagnosis, planning, experimentation, and analysis. Several courses have offered an introductory call focusing on OFR concepts, analysis of secondary data, and initial field diagnosis. Many of the call system courses in Africa have not included a formal
survey. Call system courses led by the Maize and Wheat Programs (with Economics staff participating) have often emphasized the OFR stages of planning, experimentation, and analysis, sometimes beginning with a summary of previous diagnostic work in the research area instead of having participants do a full diagnosis. Table 1 presents CIMMYT’s experience with call system training, summarizing 20 courses in 15 countries.

![Figure 1. Call system training and the agricultural cycle.](image)

Advantages and Disadvantages of Call System Training

Call system training offers a number of advantages. Because the training occurs within the participants’ country, it is immediately relevant to them. The area chosen for the course is selected by the national research and extension organizations as a priority area for establishing OFR. All OFR methods and techniques are discussed and chosen in relation to their applicability in that particular national setting. In addition, important questions regarding the implementation of OFR methods in research and extension organizations can be directly addressed through the choice of participants for the course. Researchers who are assigned to do OFR, whether full time or part time, are the primary candidates for the course. Supervisory personnel and members of commodity programs may also be included. The course can help these researchers learn how to assign responsibilities for adaptive research. Most call system courses also include extension agents who are assigned OFR responsibilities. The range of research and extension personnel who usually participate in a call system course contributes to the development of an appreciation for the value of interdisciplinary work and the challenges that it entails.
Table 1. Call system training courses presented by CIMMYT

<table>
<thead>
<tr>
<th>Country</th>
<th>Institution</th>
<th>Year</th>
<th>Topic</th>
<th>Number of calls</th>
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<td>D</td>
<td>P</td>
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<tr>
<td>Venezuela</td>
<td>Fondo Nacional de Investigaciones Agropecuarias (PONAIAP)</td>
<td>1980/81</td>
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<td>Honduras</td>
<td>Programa Nacional de Investigación Agropecuaria (PNIA)</td>
<td>1982/83</td>
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<tr>
<td>Peru</td>
<td>Programa Nacional de Cereales, Instituto Nacional de Investigaciones y Promoción Agropecuaria (INIPA)</td>
<td>1983/84</td>
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<tr>
<td>Zambia</td>
<td>Adaptive Research Planning Teams, Research Branch, Ministry of Agriculture</td>
<td>1983/84</td>
<td>. . .</td>
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<tr>
<td>Malawi</td>
<td>Adaptive Research Division, Department of Agricultural Research</td>
<td>1983/84</td>
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<tr>
<td>Kenya</td>
<td>Kenya Agricultural Research Institute (KARI)</td>
<td>1984-86</td>
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<td></td>
<td></td>
<td>(Eastern Kenya)</td>
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<tr>
<td></td>
<td></td>
<td>(Western Kenya)</td>
<td>. . .</td>
<td></td>
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<tr>
<td>Panama</td>
<td>Instituto de Investigación Agropecuaria de Panamá (IDIAP), Ministerio de Desarrollo Agrícola (MIDA)</td>
<td>1985/86</td>
<td>. . .</td>
<td></td>
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<tr>
<td>Mexico</td>
<td>Instituto Nacional de Investigación Agrícola (INIA)</td>
<td>1985/86</td>
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<tr>
<td>Ethiopia</td>
<td>Institute of Agricultural Research (IAR)</td>
<td>1985-87</td>
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<tr>
<td>Haiti</td>
<td>Ministère de l'Agriculture des Ressources Naturelles et du Développement Rural (MARNDR)</td>
<td>1986</td>
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<tr>
<td>Colombia</td>
<td>Federación Nacional de Cultivadores de Cereales (FENALCE)</td>
<td>1986 (wheat)</td>
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<tr>
<td></td>
<td></td>
<td>1986/87 (maize)</td>
<td>. . .</td>
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<tr>
<td>Lesotho</td>
<td>Ministry of Agriculture</td>
<td>1989/90</td>
<td>. . .</td>
<td></td>
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<tr>
<td>Costa Rica</td>
<td>Ministerio de Agricultura y Ganadería (MAG) (and representatives of other Central American research and extension organizations)</td>
<td>1989/90</td>
<td>. . .</td>
<td></td>
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<tr>
<td>Tanzania</td>
<td>Tanzanian Agricultural Research Organization (TARO)/Ministry of Agriculture</td>
<td>1989/90</td>
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</tbody>
</table>

a D = diagnosis, P = planning, E = experimentation, and A = analysis.
The opportunity to plan a research program and then take responsibility for its consequences is an important experience for the participants. The course provides a chance to develop information, set priorities for research, and modify those priorities based on the outcome of an experimental program. It also provides participants a format and a framework for approaching their own work in a more orderly fashion.

Call system courses are not without disadvantages, however, and they are only appropriate for training in certain skills and techniques. Call system courses should be seen as a means to help institutionalize OFR methods. They provide a hands-on example of a research program for participants to learn from and contribute to. The teaching emphasizes the management of diagnostic, planning, and analytical tasks rather than the introduction of advanced research methods. In the diagnostic calls, for instance, the management of an informal survey is stressed, and all participants are expected to be able to do such surveys after the course. Advanced techniques in survey design or agronomic field observation, on the other hand, are not highly stressed, which often presents a dilemma, because those techniques may be needed to do a good diagnosis. A balance must be struck among 1) taking time during the call system course to teach the technique; 2) having the course instructors or other specialists take the leadership in certain aspects of the work; or 3) providing follow-up training in particular research techniques. The exact balance will depend on the situation.

This dilemma illustrates the fact that call system training is a useful, but not sufficient, means of supporting the development of a national program's capacity in OFR. Similar dilemmas arise in the analytical and planning activities of the course, in which participants are expected to have a certain level of familiarity with subjects such as experimental design or statistical analysis but may require more training to be most effective in their work.
The Organization of Call System Courses

Institutional Prerequisites
Call system courses require a very large investment of time and resources by the sponsoring institution. A significant commitment is thus required of the research and/or extension institutions for whom the training is provided. In the first place, call system training is not suitable as an introduction to OFR, although the course may offer the first in-depth exposure to OFR for some participants. Research and extension must already have a strong commitment to this type of work, a familiarity with its advantages and limitations, and a clear idea of how to assign personnel to conduct the work. In the vast majority of cases, call system training has been offered in countries where national research and/or extension institutions already have an OFR effort in which a substantial number of staff are involved. In the rest of the cases, the institutions were ready to assign personnel to do OFR.

A further requirement for successful call system training is an assured source of resources to support course activities. Funding is needed for participants' travel, board, and lodging, as well as for instructional materials. Vehicles need to be provided for the fieldwork. In addition, an adequate budget must be secured for the activities of the researchers and extension agents working in the area where the course is held.

Participants
As noted earlier, the participants selected for the course should be researchers and extension agents whose job descriptions include significant responsibility for OFR. Those researchers are usually agronomists and social scientists, although other disciplines may be represented. The extension agents who participate in the course are those that are assigned to collaborate in OFR projects in their areas. Teaming researchers and extension agents who have responsibility for the same area is the logical strategy. Participants should be selected with great care. A basic rule in call system courses, adhered to in all but extreme cases, is "no substitution," although sometimes new participants may be admitted in later calls. Once a participant starts the call system course, he or she is expected to finish it, and participants' institutions should be informed that they will not be allowed to send different people to different calls.

Site Selection
The site for the course should also be carefully selected. Course instructors need to spend considerable time surveying possible sites with national program colleagues. The site should represent a priority for the national program and should offer some possibilities for the development of improved technology. A local team of researchers and extension agents should already be assigned to the area and they should have at their disposal resources representative of those of their colleagues in other parts of the country.
The call course may be designated to focus on particular commodities (or commodity-based production systems), or that decision may await the results of the initial diagnosis, but in either case the course should deal with commodities and problems with which the instructors have considerable experience. The area should not be seen as a "showcase" or pilot project, but rather as one of several areas in which adaptive research is being done. In many cases the call system course initiates OFR in an area, but this is not a requirement and courses may be given in areas where OFR has been done for several years. In a few cases, courses were organized so that successive calls were held in different locations where the national program conducts OFR.

The area should also offer adequate accommodations and facilities for "classroom" activities. These facilities may be a hotel, an experiment station with a dormitory, or some type of teaching institution. The facilities need not be luxurious, but they should offer a standard that is not considered a hardship by the participants. The call system course is a demanding one, requiring considerable field work, and if participants are unhappy with their food or lodging, or hampered by inadequate classrooms, the course objectives may be compromised.

Teaching Responsibilities
The call system course also imposes significant responsibilities on the instructors. Just as the participants are committed to the duration of the course, so are the instructors. The course puts an extra burden on trainers, as standard classroom exercises and examples are largely replaced by the uncertainties of actual research. Trainers learn along with participants, and must be willing to devote considerable time to reviewing the results of the previous call and preparing for the next one. As the management of interdisciplinary research is one of the focal points of the course, the instructors themselves must be comfortable working with each other and be able to communicate and compromise as they follow the research through one or more agricultural seasons.
Objectives
The first call of the course has several objectives. One of these is to assure that all participants understand the rationale for a farming systems perspective in agricultural research. In addition, the first call provides an opportunity to present an overview of the procedures and concepts of OFR. Most of the call, however, is dedicated to diagnostic techniques: analysis of secondary data and informal surveying. The call gives participants the opportunity to become familiar with selected techniques for analyzing secondary data, to see how these techniques are applied to local data sources, and to learn how to obtain these data sources for their own research areas. The principal focus of the call is an informal survey, and the call attempts to give participants enough experience to carry out future surveys. The course teaches how to conduct interviews and take field observations, how to plan guidelines for survey activities, and how to synthesize survey results in a report.

Organization
The first call requires a great deal of preparation. Course instructors need to visit the area where the course will be held and make sure that it is adequate. The area's farming systems should be broadly representative—in terms of the technical level of farming practices and the complexity of the systems—of the systems where most course participants work. The area should have roads that are good enough to allow participants to move about fairly easily during field work. The farming system should be assessed for the optimum time (agronomically) to do the informal survey.

Instructors also need to identify all relevant sources of secondary data for the research area, and prepare them for the first call. Introductory materials regarding on-farm research and the farming systems perspective should be prepared for initial classroom activities. In addition, if the instructors are from institutions outside the host country, they should be thoroughly familiar with the organization of research and extension institutions in the host country.

The call is usually divided among a few days of introductory classroom activities, a period of 4-6 days of field work, and a final 2-3 days in the classroom drafting a survey report.

Alternatives to a Single Call
It should be pointed out that although this discussion is based on our experience of using the first call to introduce OFR, analyze secondary data, and conduct an informal survey, there are alternatives. In a few cases the first call has been used more as a national OFR
orientation meeting, with broad attendance. The latter part of the first call then covered informal surveying with the participants who were to follow the rest of the course.

In other cases, an introductory call of one week's duration has been used to discuss OFR, analyze secondary data, and take initial field observations such as soil tests and plant stand counts. This call is held shortly after planting and followed later in the growing season by a two-week call dedicated to an informal survey. This arrangement offers two opportunities to take data in the research area, including the possibility of following a sample of fields over the growing season.

**Outline**

**Introductory activities**--If the informal survey call is the first meeting of the course, sufficient time must be devoted to introducing and explaining the course, which will usually take a full day. The exact content of the introduction will vary depending on the situation. One important task is to review how the skills to be taught in the course fit into the job descriptions and responsibilities of the participants and how their work should be seen in the context of the research and extension institutions. There is often an opening ceremony of some sort for the course, and the officials of the respective institutions can be asked to include these themes in their remarks. The course participants should introduce themselves, saying something about their work and responsibilities.

Both the rationale and methodology of OFR should be presented in the introductory day. One suitable entry point is to discuss why farmers sometimes reject recommendations. Participants often have their own experiences, and we have also found it useful to provide examples of various farming situations (intercropping, evidence of crop-livestock interactions, practices that derive from labor shortages, adaptations to particular physical or biotic conditions) and ask participants to explain the rationale for these practices and analyze their potential compatibility with new technologies. The diagram on farmers' circumstances in Byerlee, Collinson, et al. (1980) (Figure 2) is a good reference for this discussion.

It is best to illustrate the methods of OFR in the context of the call system, explaining which methods will be used in each call (a handout with a diagram illustrating the stages of OFR is useful). A few slides may be shown to demonstrate the various techniques, but detailed methodological discussion should obviously wait until the appropriate call. It is, however, important to emphasize and discuss the compatibility of these methods with the job descriptions and objectives of the researchers and extension agents. Finally, a few words should be said about the logistics of this first call, and to make sure that there are no questions regarding participants' responsibilities, accommodations, or timetables.
Figure 2. Various circumstances affecting farmers' choice of a crop technology.

**Internal**
- Farmers' goals:
  - Income, food preferences, risk
- Resource constraints:
  - Land, labor, capital

**External**
- Markets
  - Product
  - Input
- Institutions
  - Land tenure
  - Credit
  - Extension
- National policy

**Farmers' decisions**
- Overall farming system
  - Cropping pattern, rotations, food supply, labor hiring, etc.

**Technology for the target crop**
- Time, method, amount for various practices

**Climatic**
- Rainfall
- Frosts

**Biological**
- Pests
- Diseases
- Weeds

**Soils/topography**
- Soil type
- Slope

**Natural circumstances**
- - - Circumstances which are often major sources of uncertainty for decision making.

Source: Byerlee, Collinson et al. (1980).
Review of secondary data—A review of secondary data should precede the informal survey. Depending on the types of data and their relevance, this activity may take one or two days. The data should be kept together and should be available throughout the course.

To be successful, this exercise requires some preparation on the part of the instructors or the participants from the training site. The idea is to introduce participants to the type of secondary data available (e.g., what does the agricultural census for 1980 look like, and where can you get access to it) and to get some practice in interpretation. All of this data must be assembled well before the call, examined, and prepared for classroom exercises. In the example of the agricultural census, it is useful to have the relevant volumes on hand for demonstration, and to prepare photocopies of particular pages that can be used for classroom exercises. The preparation of these materials also serves to help organize the participating institutions' access to data (e.g., making sure the economists have easy access to the census office, or understanding how the local meteorological service stores and reports its data). If large amounts of data must be examined, the data can be allocated among several groups of participants who then report the results of their analysis in a plenary session.

The types of secondary data that are available and relevant to the course will vary greatly from country to country. Some sort of census data are usually available and should be examined and used to characterize the population of the research area. Maps are invaluable throughout the course, and it is worth investing in large numbers of high-quality photocopies of the best maps of the region. The best soil maps and agroclimatic maps available should be assembled and used as part of classroom exercises in characterizing the research area.

Meteorological data are often of great importance, especially if factors such as rainfall or temperature are suspected to be key constraints to productivity. If local meteorological data are published at all they are often presented in too aggregated a form to be immediately useful, so some effort should be made to obtain the raw data. The data can then be used in classroom exercises illustrating various analytical techniques such as the derivation and interpretation of rainfall pentads. When this sort of analysis is done, it should be carried out with an eye towards providing particular individuals in the research organization with the experience and contacts necessary to do this analysis regularly and not simply for the purposes of a course. This organization of, and access to, secondary data is an example of how call system courses can contribute to strengthening the research institution beyond providing training to the immediate participants.

The reports of any previous research, extension, or rural development projects in the area should also be reviewed. The task of arranging the data gleaned from the files of various local agencies can be a significant contribution of the course, and participants can appreciate the value of data that are already available.
Classroom preparation for the informal survey—Several classroom activities are necessary before the group goes to the field. These activities can take anywhere from a half day to a day. The first task is to introduce participants to the nature of a diagnosis. There are two principal goals of a diagnosis: description and analysis. The descriptive part of the diagnosis includes an understanding of farmers’ circumstances. The review of secondary data will have contributed to this understanding, and remaining gaps should be discussed (soil analysis, location of markets, etc.). The other part of the description includes details on management practices for principal crops and a cropping calendar.

The analytical part of the diagnosis can be taught in terms of the "problem-cause-solution" model that is used throughout the course and is the basis for the planning call (Tripp and Woolley 1989) (Chapter 5). In this model, participants are urged to identify the principal production problems in the area, to understand the causes of those problems, and to begin to think about possible solutions, especially the compatibility of new technologies with the current farming system. One exercise used to introduce these concepts is shown in Figure 3.

In both the descriptive and analytical parts of the diagnosis, participants are also urged to think about differences in the research area. Do all farmers have the same practices and the same problems, or is it possible to identify distinct "recommendation domains" (Harrington and Tripp 1984)? This theme of targeting research to well-defined sets of farmers will be carried through the entire course.

A second part of the classroom work involves discussions and exercises on the conduct of an informal survey. In the informal survey, teams of two participants are responsible for 1) finding farmers to talk to, preferably in their fields; 2) carrying out an informal conversation; and 3) developing a set of observations based on guidelines designed by the group. Before going to the field, it is necessary to discuss how one locates farmers to talk to, whether it is possible simply to wander through the fields looking for farmers or if some sort of formal introduction through village leadership is necessary. If the latter is the case, it is important to make arrangements so that, once the initial formalities are carried out, the teams have access to a random selection of representative farmers, not a hand-picked group provided by local political leaders or extension agents. In addition, the group should discuss how to make sure they interview all members of the farming household who know about farming practices, particularly women, who are often responsible for many farming operations.

It is also useful to discuss interviewing techniques in light of local customs. What kind of an introduction is appropriate, what are the polite forms of address, how much note taking is permissible? Practice interviews are essential, in which some participants engage in role playing while others evaluate their efforts. An alternative is to have the instructors themselves present an interview (two interviewers and one farmer) following
Celica, in southern Ecuador, is an isolated region where cattle are the principal source of income and maize is an important crop. The maize is usually grown on hillside plots. The fields are prepared by cutting and burning the residues of the previous year’s crop. No tillage is practiced. The maize is planted with a stick, just before the rains begin. Farmers generally plant three seeds in a hole, and the holes are a meter or more apart.

One of the principal problems in maize production in the area is weed competition. Most of the maize fields are weeded in an unusual way: farmers weed only immediately around the maize plants, leaving the rest of the weeds. To decide what can be done about this problem of weed competition, we must first try to understand the cause of the problem.

1. In the first column below, list at least three reasons why farmers might be weeding in this way.

2. For each of the possible causes listed in the first column, suggest one or more possible solutions, and list them in the second column.

<table>
<thead>
<tr>
<th>Possible causes of the weed competition in the maize fields</th>
<th>Possible solutions</th>
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a script that illustrates many of the common errors that are made (skipping from subject to subject, putting words in the farmer’s mouth, asking overly technical questions, etc.). The interview is broken frequently and participants are asked to improve upon the performance. A separate discussion on note taking is also helpful, and the necessity of sitting down, in private, for 10-15 minutes after each interview to review and amplify the notes should be emphasized.

Agronomic observations—An important part of the informal survey is agronomic observations in farmers’ fields. In general, these observations tend to be more qualitative in the early days of the informal survey and to become more quantitative as the survey progresses. Thus on the first day, the objective may be to merely look for evidence of fertility or weed problems, or symptoms of disease or insect damage. Later on, plant counts, weed counts, or insect damage assessment for a sample of fields may be part of the day’s assignment.

As most of these observations require at least some review of field techniques, time should be allowed for this in the preparation period for each day’s survey. Instructors who are familiar with the area where the course is being carried out will have some idea of what types of observations will be most useful, and will prepare materials and handouts beforehand describing standardized measurement techniques.

Guidelines—A key to the management of the informal survey is the use of guidelines to structure the conversations with farmers and the field observations. The guidelines are developed by the group each evening, before the next day’s survey. The guidelines are modified on the basis of each day’s survey results, and tend to progress from the general to the specific. The guidelines for the first day usually deal with the basic cropping patterns and production practices in the area. They should aim to confirm impressions gained from the review of secondary data and fill in gaps in that information. The development of the first day’s guidelines is thus fairly straightforward, and may be based on the modification of a standard checklist of cropping practices and farmer circumstances (Figure 4). Guidelines for subsequent days require more work and are one of the principal products of the discussions that are held after each day’s fieldwork.

The guidelines can be presented in outline form, and should be structured in such a way that the basic points can be memorized, so that participants do not have the temptation to treat them as a questionnaire. It is most efficient if the guidelines can be photocopied (on a maximum of two or three pages) and distributed each evening. In the absence of photocopying facilities, participants will have to copy the guidelines into their notebooks.

As the informal survey progresses, the questions on the guidelines become more specific, until they may resemble a formal questionnaire. The degree to which this trend predominates will depend on the situation. One of the great advantages of an informal survey is that it allows the group to explore a wide range of issues and avoids the danger
Figure 4. Guidelines for an exploratory survey (CIMMYT training, Mexico).

This abbreviated set of guidelines is useful for the initial period of an exploratory survey. It is helpful for diagnosing the farming system and identifying key enterprises that can be studied in more detail as the exploratory survey progresses. These guidelines are based on those found in M. Collinson (1982), Farming Systems Research in Eastern Africa.

A. Enterprise pattern, output use, system trends

1. List the crops grown and livestock kept by local farmers. Note whether most or just a few farmers engage in each crop enterprise you have listed.

2. Obtain rough estimates of the number of fields and area devoted to each major crop.

3. For each major crop, list the varieties grown.

4. List the end uses for the major crops, crop varieties, and animals.

5. a. Note crops, varieties, or livestock that used to be widespread but are now disappearing. Assess why this is happening.
   b. Note crops, varieties, or livestock that are becoming more widespread. Assess why this is happening.

B. Enterprise calendar, food preferences

1. For each major crop or crop variety, establish:
   a. The usual time of first cultivation.
   b. The usual time of planting.
   c. The latest possible time for a viable planting.
   d. Reasons for varying the planting time.

2. Assess the reasons why local farmers use different varieties.

3. Detail the main dishes eaten by farm families in the area. What are the preferred constituents?
C. Causse of output variations, main production methods

1. For the major crops:
   a. What was the lowest output you remember?
   b. What year was this?
   c. What factors caused the low output?
   d. Can other factors strongly influence output?

2. For the major crops, does the area you plant stay constant, or does it change from year to year? If it changes, why?

3. What methods do you use for growing your major crops?
   a. Cultivation
      i. How many? Method?
      ii. Do you always use the same methods?
   b. Weeding
      i. How many weedings are done? Method?
      ii. Does the number or method vary?
   c. What items do you usually buy for this enterprise (seed, fertilizer, herbicide, insecticide, fungicide, hired labor, machinery, etc.)?
      i. What was the source of each purchase (or credit)?
      ii. What year did you start to purchase this product?

D. Land, labor, and cash availability

1. Will all the crops you grow do well on all your fields?

2. Do you grow the same crops in the same places year after year? If not, what rules do you have about moving crops to different places?

3. How many members of your family work on the farm?

4. a. What is the busiest month of the year for farming in this area?
   b. What work, on which enterprises, is going on at this time?
   c. Is there a second busy period?
   d. What main work goes on then?

5. Do you and other local farmers hire any labor during the year?
   a. What months?
   b. What enterprises?
   c. What operations?

6. Do you and other farmers hire machinery during the year?
   a. What months?
   b. What enterprises?
   c. What operations?

7. What are the main sources of cash income for local farmers?

8. Do many families have members working off the farm?

9. What is the most difficult period of the year for cash for local families?
of having research priorities determined by preconceived ideas. The early guideline themes are thus kept as broad as possible, and people are encouraged to pursue other topics that do not appear on the guidelines. On the other hand, with as many as 10-15 teams of researchers visiting three or four farms in a day, there is obviously the opportunity for collecting at least some quantitative information. In general, the temptation to quantify simple frequencies should be avoided. Efforts at reporting the exact percentage of farmers that apply fertilizer to their maize tend to distract attention from the more important task of finding the approximate proportion of farmers who use fertilizer and understanding the rationale behind their decisions. Thus in the latter stages of the informal survey a particular hypothesis about fertilizer use may be proposed and tested (e.g., the relationship between crop sales and fertilizer use) and participants may be asked to collect the requisite information from each farmer interviewed.

A second instance of quantification is the collection of field observation data. As the survey progresses, it may be found that having relatively precise measures of parameters such as plant stands or insect damage may be more useful than qualitative impressions of the severity or incidence of particular conditions. Because the informal survey is carried out during the cropping season, there may be field observations that need to be taken at that time. The danger is that the final days of the informal survey are converted into a mechanical data-gathering exercise, cutting short the opportunity to explore the research area with an open mind. The exact balance that is struck will depend on the nature of the research area and the possibilities for further data collection. In some instances, short formal field observation surveys have been designed to be carried out by the local staff in the area before the next call of the course.

Discussion of each day's survey results—It is very important that the results of each day's fieldwork are thoroughly discussed before setting out the following day. Discussions are usually more productive if participants have time to eat and rest awhile after returning from the field in the early afternoon. A minimum of three hours of discussion is necessary, preferably in the late afternoon to early evening.

The guidelines for the day provide a logical organization for the discussions. As new points or questions are raised, these can be noted down as potential contributions for the following day's guidelines. Teams that went to the same area can be grouped together and can be asked to discuss among themselves their conclusions and then provide a summary report. The discussion is best carried out point by point, exhausting the observations on a particular theme from all the areas before moving on to the next theme. Considerable effort is often needed to move participants away from reporting only those observations that confirm their particular viewpoints, or from dwelling on the unusual or the idiosyncratic. Emphasis should be placed on the evidence available to support conclusions and the representativeness of the data. On the other hand, the small number of observations after the first day or two of surveying, combined with the great variation that is often found in a particular area, will mean that there will be many honest
differences of opinion and interpretation, and an effort should not be made to achieve a consensus prematurely. Such uncertainties are best referred to the following day’s guidelines.

Because these discussions are often wide-ranging and potentially confusing, it is important that a summary be provided after the discussion of each point and that a rapporteur be assigned to note the conclusions. Otherwise it is very easy to find that the fifth day’s discussion repeats a dispute aired on the first day. The general notes of the rapporteur (which can be organized easily by topic in a loose-leaf binder) are an important resource for the final write-up as well. Despite a thorough discussion that reveals widely varying observations, one’s own field experience will color the writing of a final report unless more objective summary notes are available.

Field logistics for survey—The number of days spent in the field for the informal survey will depend on the nature of the research area and the time available for the course, but four to six days are usually adequate. Maps should be studied carefully to assure that the survey will cover as much of the research area as possible. In the first days of the survey it is particularly important to achieve wide coverage of the area, sampling the variability that has been indicated by the analysis of secondary data. Later on in the survey the decision may be taken to concentrate on certain parts of the area.

The availability of vehicles must be certain well before the course starts. For a group of 25 participants, as many as 6 vehicles can be profitably used. If fewer vehicles are available, routes have to be planned with care so that different groups can be dropped off and picked up. As considerable walking is also usually necessary, groups and vehicles must be dispersed so that participants have the maximum time possible in the field. In general, it is best to start to the field very early in the day, usually around dawn, to provide enough time to reach the destination and do survey work while farmers are still in the field. A return time should be agreed upon that provides people enough time and energy for a useful discussion before the next day’s fieldwork.

The survey should be carried out without any prior preparation of farmers, if possible. It is worthwhile, however, to confirm the availability of farmers in the area, making sure that the timing of the visit does not coincide with a public function that farmers are expected to attend, for instance. If it is necessary to ask that farmers await the arrival of the groups, either because local custom requires this formality or it is easier to have farmers guide the participants to their fields, then these arrangements should be made ahead of time.

Except in unusual circumstances, such as the need for translation in a multiethnic area, the survey should be carried out by teams of two or three people. A single interviewer would have trouble managing and recording all the information, and more than two or three become intimidating to the farmer and tend to get in each other’s way. It may be
useful, however, to use larger groups on the first day of the survey if participants have little experience. Each group can be assigned an experienced resource person.

More than one group may go to the same village or area in one vehicle, but should try to divide up upon arrival. The composition of the groups should not be left to chance. Instructors should have a good idea of the skills and capacities of the participants, and teams should represent a mixture of disciplines and a balance of capabilities.

Participants should be provided with good quality, locally available field notebooks, preferably with hard covers. It is necessary to check each morning that everyone has the day’s guidelines, the relevant maps, and, when necessary, food and water.

A decision has to be taken regarding whether to maintain the composition of the teams over the survey period, or to switch people around. Changing composition provides an opportunity for people to get experience working with various colleagues, but the course offers other opportunities for this, and as it usually takes a bit of experience before people can work together efficiently as interviewers it is probably better to maintain team composition throughout the survey.

A more difficult decision involves whether teams should be sent to the same part of the research area each day or be able to move around. The obvious advantage of moving around is that participants get a good idea of the diversity of the research area. The disadvantage is that if the area is at all diverse it means that teams are continually introducing themselves to new environments, rather than pursuing particular issues in more and more depth. Even in the absence of diversity, teams that move around run the risk of visiting exactly the same places and even attempting to interview the same farmers as a team that visited the previous day. A possible compromise is to maintain some stability from day to day, but allow certain teams to shift around. If two or three teams share one vehicle, then one team may shift each day. One good source of stability may be the drivers of the vehicles, who can be assigned particular areas throughout the survey period. Even if the drivers are not participants in the course they can serve as guides for teams who have not visited the area previously.

Although the majority of the informal survey should focus on individual interviews and field observations, interviews with groups of farmers are often useful as well. Where group interviews can be arranged, it is usually best to hold them later on in the survey, when participants have some familiarity with the area and are able to ask specific questions regarding what they have seen or heard during the previous days. Another set of interviews that is often very useful is to survey key informants such as local input suppliers, traders, or millers. A day can often be usefully devoted to this type of interview, and it may provide a welcome break from the fieldwork if it is scheduled on the fourth or fifth day of surveying.
Preparing a report--Two to three days are needed to produce a draft document summarizing the results of the survey and the review of secondary data. The report should be organized to describe farmers' circumstances, the major crops they grow, and their production practices and to identify principal problems, their causes, and the implications for further work. The report should be written by assigning sections to groups. The groups should not be the same as the fieldwork teams but should rather represent a mix of participants with experience from different parts of the research area and different disciplines. Individual field notes and the rapporteur's notes from the general discussions should both be used.

Outlines of individual sections should be produced and presented by the working groups before they write drafts of their sections. The report should be detailed enough to represent the work that was invested in the survey, but short enough to be readable and to provide a model for national program reports produced outside of the context of a course. It is unlikely that the final version can be prepared before participants leave, but it is the course instructors' responsibility to ensure that the final version is prepared, photocopied, and distributed to participants well before the next call.

**Teaching materials**

- Originals of secondary data and photocopies of relevant pages.
- Maps of the region and photocopies.
- Pencils, erasers, pencil sharpeners.
- Photocopier, paper, stapler.
- Blackboard and/or flip charts.
- Field notebooks for each participant.
- Tape measures (for field observations).
- Soil sampling equipment.
- Other equipment for agronomic field observations.
Publications for reference or distribution


Handouts on informal survey guidelines and techniques for agronomic field observations.
Objectives
It would be fair to say that formal survey techniques have been somewhat neglected in both the practice and teaching of OFR. As the ideas and concepts of OFR were being developed, a great deal of emphasis was placed on replacing formal survey techniques by informal methods. There is a good rationale for this, as OFR demands a much broader understanding of farmers’ conditions than could be offered by most standard farm surveys. But once a good informal survey has been carried out, a short, well-focused formal survey may be very helpful. From a teaching standpoint, the formal survey call offers an excellent opportunity to explore the conclusions of the informal survey, to rigorously test some of the hypotheses that have been developed by the group, and to try to resolve any differences of opinion that remain.

The teaching goals of this call are a bit different from those of the informal survey call, which introduces techniques that all researchers and extension agents should be familiar with and can be expected to use fairly frequently during their careers. Formal surveying, on the other hand, is a more specialized technique, usually carried out, or at least directed by, social scientists. It is unrealistic to believe that competence in formal surveying can be developed in a two-week course or that most participants will have occasion to take responsibility for formal surveys in the course of their work. The objectives of the call are thus 1) to familiarize participants with the procedures and rationale of formal surveying so that they can understand and interpret survey results, and 2) to get experience in characterizing a research area and testing hypotheses about production practices and problems.

It should be pointed out that the formal survey call has not always been offered in call system courses organized by the CIMMYT Economics Program. This was especially true of several courses in Africa. In those cases it was felt that the initial (informal) diagnosis provided sufficient information to plan a research program. In addition, there was little immediate possibility that course participants could carry out formal surveys in their own areas, because budgets and personnel were limited.

Organization
The formal survey call is usually held after the harvest at the end of the season that was analyzed during the informal survey. Instructors need to choose a time of the year when there is a good chance of finding farmers at home, with some leisure to respond to a questionnaire. If there is more than one agricultural season in the year this may require some thought.
The formal survey is carried out in the same area that was the focus of the informal survey. If possible, the same course facilities and accommodations should be used. The same number of vehicles used for the informal survey will be necessary, and because questionnaires need to be produced quickly, good typing and photocopying services are required.

The informal survey report from the previous call needs to have been completed by this time and, if possible, distributed to participants before they arrive at the formal survey call.

The course begins with several days of classroom work during which the survey is designed. Once the questionnaire is in final form, 3 or 4 days are usually necessary to carry out the interviews. The remaining 3 or 4 days are spent back in the classroom, analyzing the survey and preparing a report.

Outline

Classroom activities--The first day of the call is devoted to a thorough review of the informal survey report, a listing of topics to include in the formal survey, and a brief introduction to questionnaire design. It is very helpful if the informal survey report can be distributed to participants well before the call. Even so, it is worth allowing a couple of hours at the beginning of the call for the participants to read the report before beginning the discussion. The review of the report is carried out with a view towards identifying any points of contention or differences of interpretation that can be resolved by the formal survey, formulating testable hypotheses, and deciding which variables require quantification.

Emphasis is placed on justifying each question that is proposed for the questionnaire, and participants are asked to explain how they see each piece of information being used in the design of a research program. Much of the questionnaire will be devoted to characterizing farming practices in one particular cropping system, with emphasis on possible differences among various categories of farmers (recommendation domains). Such quantification should not be carried to excess, but good estimates of the proportion of farmers with particular circumstances or practices is useful for justifying research plans and for defining what constitutes a representative farmer. In addition, the formal survey presents an opportunity to test hypotheses about the occurrence or causes of production problems. It may be hypothesized that it is principally farmers practicing a certain rotation that are affected by a particular problem, for instance, and this can be tested through the survey. Blank contingency tables should be constructed during survey design to make sure that the necessary information is being captured. Finally, the survey provides a chance to test some tentative ideas about possible solutions to production problems. If a proposed innovation requires more labor at a certain time in the crop season, the survey can be used to investigate whether labor is available at that time.
Most of the time should be spent discussing the implications of the formal survey, but it is very helpful to do some simple exercises on the design of questions as well. These exercises should illustrate some of the key factors in making a questionnaire clear and unambiguous (Byerlee, Collinson et al. 1980; Bernsten 1980).

**Questionnaire design**—After discussing a format and organization for the questionnaire (Byerlee, Collinson et al. 1980) participants can be divided into groups and assigned parts of the questionnaire to design. Their draft questions should be presented and discussed before the entire group. The questions should be edited and reformulated for clarity and relevance, but if there is strong sentiment from the group for a particular question it should be included in the first draft.

The first draft of the questionnaire can be compiled from the handwritten group work, or if there is time it can be typed. Enough photocopies should be made so that every participant has one, with several additional copies to be filled in during the interviews. Some preparation before the interviews is advisable, but the purpose of the first draft is to place participants face to face with farmers with the objective of filling out a questionnaire. Participants can be sent in groups of 4 or 5 to interview one or two farmers. The farmers should have practices and conditions similar to those of the majority of farmers in the area, and should be willing to spend a considerable amount of time (often more than an hour) with the group.

In some countries the questionnaire will have to be translated into the local language(s). In this case the first draft should be translated for testing so that participants can begin to think more carefully about the wording of their questions.

The testing of the first draft of the questionnaire is a valuable learning experience. As one member of the group attempts to question the farmer, the others can observe the inadequacies in presenting the questions, the misunderstandings that arise, and the lack of clarity in many of the questions. The first draft is almost always much too long, and participants come to appreciate the value of shorter, more well-focused questions. The experience of field testing the draft is worth much more than a day’s lectures on questionnaire design. The groups return with a much clearer idea of what a good questionnaire should look like.

After the field experience and subsequent class discussion, the groups can design a second draft. Once it is tested in the field, the second draft may serve, with minor modifications, as the final questionnaire, or at times one more round of testing (perhaps just with particularly difficult questions or issues) is necessary. The production of the final questionnaire requires a good typewriter or word processor and good quality photocopying. Questionnaires that are poorly prepared, cramped, or difficult to read are a disaster, and will lead to much confusion and poor data collection. Production of the questionnaire may take place in the evening or night after the final discussions.
Enough questionnaires should be prepared to accommodate the proposed sample size, with some extras, and to provide at least one copy for each participant to review. The review is important (often a bit tedious) and may take a half a day. This involves going over the questionnaire, question by question. Some role playing is helpful here, with participants taking turns asking the questions and someone, perhaps an instructor, providing answers that represent the ambiguity and variability that is likely to occur in farmers’ responses. Although these issues will have been discussed during the design of the questionnaire, it is important to review the entire questionnaire very thoroughly before going to the field.

**Sampling frame**—The other issue that needs to be discussed before going to the field is sampling. A sampling frame needs to be selected before the beginning of the call. This can be done in consultation with local researchers, and the necessary data and materials (maps, census data, village lists, etc.) should be collected before the call, or developed in the first few days while the questionnaire is being designed.

In many areas where call system courses are held, the possibility of developing a rigorous sampling frame is remote. More rough-and-ready techniques need to be resorted to. Cluster sampling is often useful, in which a set of villages or settlements is selected at random and then an attempt is made to list or map their entire populations. A random selection of farmers is then made from these lists. Whatever technique is selected, it should be applicable throughout the country so that participants can use it in their own areas. In Honduras, it was found that the malaria control service kept records and maps of all households and that a random sample could be drawn from them. In a multiethnic area of Zambia, an anthropologist provided advice on how to set up a sampling procedure.

A short lecture on various sampling techniques and their advantages and disadvantages is usually helpful. Participants should play an active role in the random selection of the sample, so that they appreciate the process. A sample size of between 50 and 80 farmers is usually adequate for this type of survey.

**Logistics**—The group is divided into teams of two persons for administering the questionnaire. Each group is provided with the necessary information (names, maps, house numbers, etc.) in order to locate the sample farmers. Additional farmers are also selected as replacements if it is impossible to locate the original ones, but rules must be agreed upon for the use of the substitute sample. In general, there should be at least two attempts to locate the sample farmer before a substitute is chosen. Each group is given a clipboard (preferably with a cover), pencils, eraser, and pencil sharpener. The groups should be chosen so that members work well together. They may alternate as interviewer and recorder, or they may find that each prefers to take responsibility for a single task.
Vehicles and routes need to be arranged so that the teams can be dropped off and picked up in an efficient manner. As with the informal survey, the earlier in the morning the teams start out, the better, unless farmers are inaccessible during the early part of the day. After each interview the team must sit down and review the questionnaire form to be sure that all information is recorded and legible. The questionnaires are turned over to a supervisor (either participant or instructor) at the end of the day for further checking. A safe place should be designated for storing the completed questionnaires.

If 10-12 teams are in the field, three days is usually sufficient to complete the survey. If some areas are particularly difficult or some farmers are hard to reach, a few teams can be sent out for an additional day to finish the survey.

Analysis--A few classroom lectures generally precede the analysis of the survey data. One set of lectures presents or reviews simple statistical parameters and ways of presenting survey data. Generally in a call system course the analysis of this type of formal survey requires no more than frequencies, measures of central tendency, chi-square tests, and t-tests. Some simple examples can be presented and discussed.

In addition, a bit of classroom discussion is necessary to introduce the idea of survey coding (unless it has been decided to precode the survey, in which case the discussion will have already taken place). A codebook is then developed with the group, and enough copies are made so that each working group has access to one. Assignments are then made for coding questionnaires. The codes are recorded on large sheets of paper that need to be acquired beforehand. Either paper specifically designed for this purpose or various types of accounting forms, with many rows and columns, can be used. Coding sheets should be checked for legibility, combined in a convenient manner, and photocopied (often photoreductions provide a more manageable product).

Working groups of three or four people can be designated and assigned analytical tasks for particular parts of the survey. Reference should be made to earlier discussions about the frequencies and contingency tables that seem important. Groups can report on the results of their work and can return to a second round of analysis after class discussion.

Although it is tempting to carry out the analysis by computer, this should not be attempted unless computers are available and a significant number of the participants have experience in using them. Otherwise the call will turn into a course on computers. At the end of the call, those who are interested can enter the data into a computer and carry out further analyses, but in an introductory exercise such as the one in this call, the experience of "counting up" and using pencil, paper, and calculator is valuable and should precede any more sophisticated analysis.
We have usually entered the survey data on a computer after the call and have used the computer to check the results of the group work and to do additional analysis before producing the final report.

Writing the survey report--When the analyses are completed, each group is asked to write a draft portion of the survey report. The drafts are discussed and then collected, collated, and edited into either a separate report or an amplification of the report produced at the end of the first call. This report is made available to the participants before the next call.

Teaching materials

- Copies of informal survey report from previous call.
- Set of secondary data (from previous call).
- Copies of maps.
- Pencils, erasers, pencil sharpeners, rulers.
- Blackboard and/or flip charts.
- Photocopier (if possible with reduction capacity), paper, stapler.
- Clipboards.
- Calculators.
- Graph paper, large sheets of paper for coding survey.
- Tables of random numbers.
- Statistical tables for survey analysis (chi-square, t-test, etc.).

Publications for distribution or reference


CIMMYT Eastern African Economics Programme. 1985. Teaching notes on the
diagnostic phase of OFR/FSP. Concepts, principles and procedures. Nairobi:
CIMMYT Eastern Africa Economics Programme.

Exercises and handouts on sampling and statistical tests (e.g., L. Harrington. 1981.
Simple statistics for manual analysis of farm survey data. CIMMYT Economics
Training Note. Mexico, DF: CIMMYT)
Objectives
The planning call seeks to provide participants with experience in planning an experimental program. Although the purpose of the call is to use the data that have been developed in previous calls to identify priorities for research, both on the experiment station and on farms, the emphasis is on the design of on-farm experiments. Thus the planning call focuses on a method for identifying priority factors for on-farm experimentation and the design of an experimental program to address those factors.

The most important goal for the planning call is to make sure that the rationale for each planning decision is made clear and that the assumptions behind each decision are explicit. The first half of the call, in which experimental factors are identified, follows the format described in Tripp and Woolley (1989), which provides considerable detail on selecting experimental factors and identifying other priority research activities; the discussion below will only outline the procedure (Figure 5). This format relies on the problem-cause-solution model introduced in the first call. Participants are asked to identify important production problems, analyze their causes and interactions, and propose feasible solutions. The second half of the call is devoted to experimental design and usually includes some formal review of relevant theory, decisions on the number and types of on-farm experiments to be planted, and discussion of the logistics of the experimental cycle.

Organization
The planning call lasts a week and should be held in a facility that can accommodate both classroom discussion and small group work. This facility might be the same one used in the previous two calls, or it might be in a location closer to an experiment station or in a city or town convenient to the majority of participants. Often researchers who are not part of the course will be called upon to lend their expertise to certain parts of the planning call, and this might influence the choice of location for the call as well.

Setting priorities and designing experiments with a group of research and extension personnel who have little experience in these activities is a challenge. This call provides a format for performing those tasks, and group discussions and activities are aimed at providing democratic means for making decisions. But majority rule is not feasible in all cases, and instructors will have to decide when to challenge group opinion or call in additional expertise. The instructors themselves will have to be prepared to spend long hours discussing the results of each day’s session, planning activities for the following day, and being able to come to compromises themselves on the difficult issues of priority setting and experimental design.
Figure 5. Steps in the planning process.

1. Identify problems
2. Rank problems
3. Identify causes
4. Analyze interrelations among problems and causes
5. Identify solutions
6. Evaluate solutions

Further evidence required to identify or evaluate problems
Further evidence required to determine causes of problems

List A: Factors for experimentation
List B: Other diagnostic activities
List C: Longer term research
List D: Institutional support

The report of the formal survey should be prepared and distributed to participants before the call. Instructors should spend time reviewing the data that have been developed in previous calls and discussing their impressions regarding research priorities before beginning the planning call.

Outline

Review of problems--The first step in the planning call is to review the reports that have been produced in previous calls and any other information that has been developed by the local team. Some difficult questions of interpreting data may have been referred to specialists in the research service, and it is helpful if they can be on hand in this case.

The purpose of the review is to identify important production problems that can be addressed by on-farm research. Problems should be defined clearly as biological limiting factors, such as a nutrient deficiency or weed competition, or inefficiencies in resource use, such as high production costs or the availability of underutilized land or labor. Participants can be divided into groups to develop their own lists of problems. The lists should include the evidence for each problem and, in cases of uncertainty, suggestions for collecting further evidence. These suggestions should be noted, as they may either have implications for selecting experimental variables or finding time for the local team to pursue other data collection activities.

Once the groups have presented and compared their lists of problems, a general list should be agreed upon and submitted for group work on setting priorities. The group work should be done on the basis of criteria discussed and agreed upon by all participants. Criteria may include the seriousness of the problem (in terms of yield or income loss), the distribution of the problem, and the importance of the crop(s) affected. Group assessments can then be compared and agreement reached on a rough ordering of priorities for the problems.

Final decisions regarding which problems can be addressed by the research program may be postponed until later in the planning process, but if possible, problems of low priority should be eliminated from further consideration after this initial ranking. It is difficult to continue with more than 10-12 problems for consideration.

Identification of causes--For each remaining priority problem, a cause or causes should be identified. These causes will have been discussed in the earlier diagnostic calls of the course. Some examples should be presented and discussed, and it is often helpful to introduce the idea of diagrams, with arrows leading from causes to problems (Figure 6).

The problems can be assigned among groups who can then present their analyses of causes and discuss any further evidence that is required to understand causality. Additional evidence may come in the form of exploratory experimentation or other types of diagnostic studies. These suggestions should be noted down for future reference.
It is also helpful to try to interrelate all of the major problems and causes that have been identified. One way of doing this is with a summary diagram that collates the individual causal diagrams. This is a difficult task for the group to do quickly, and it may be best for the instructors to prepare such a diagram and devote the majority of class time to a discussion of the implications of the relations among various problems and causes.

**Solutions**--Once the causes for the problems are delineated, problems can be assigned to individual groups in order to consider possible solutions. The groups should be encouraged to brainstorm at this stage and to consider as wide a range of solutions as possible for the problems assigned to them. Groups can then present and discuss their ideas.
The possible solutions are then evaluated for inclusion in an experimental program. Evaluation criteria should be thoroughly discussed, and a format can be provided for assessing the proposed solutions. Criteria for assessing solutions may include: the probability that the proposed solution will function under farmers' conditions; the solution’s profitability; its compatibility with the rest of the farming system; its riskiness; the need for institutional support for the solution; the ease with which the solution can be tested by farmers; and the ease of carrying out the experimental program. A suggested format appears in Table 2. Again, groups may be assigned particular problems for which they assess the proposed solutions. Group conclusions are discussed and final decisions are made.

This process will result in a list of experimental factors that includes proposed solutions that have been judged acceptable and a list of exploratory factors that is used to develop more information about the existence or causality of certain problems. In addition, there will be a list of possible further diagnostic activities that have emerged in the discussion, as well as suggestions for longer term research and institutional support. These can be discussed later in the call.

Designing experiments—Before beginning to actually design on-farm experiments it is often helpful to review certain aspects of the theory and practice of experimental design. Course leaders can decide which topics are most relevant to the particular situation and make short presentations. It is assumed that the majority of the participants have some understanding of experimental design, and this brief presentation should in no way be seen as an introduction to the topic or a comprehensive review.

This presentation should emphasize aspects of experimental design that are specific to on-farm experimentation, such as the tendency to have fewer treatments and therefore fewer plots and replicates but more sites. If the national research program uses a typology of on-farm experiments (exploratory trials, verification trials, etc.) this should be reviewed and discussed. In addition, a brief review of the special requirements of managing on-farm experiments and selecting nonexperimental variables should be presented.

Participants can carry out group work to design the on-farm experiments. The first task is to decide which factors belong together in the same experiment and how many different types of experiments are required. If plans exceed 4-6 different types of experiments then some adjustments will have to be made in the number of experimental factors that are being addressed, because a large number of different types of experiments will be impossible for the local OFR team to manage. The decision on the exact composition and type of each experiment may take a considerable amount of discussion, and instructors should have a fair idea beforehand of what types of experiments are appropriate.
Table 2. Evaluate possible solutions

<table>
<thead>
<tr>
<th>Possible solution</th>
<th>1 Probability that technology will function</th>
<th>2 Profitability</th>
<th>3 Compatibility with system</th>
<th>4 Contribution to reducing risk</th>
<th>5 Institutional support</th>
<th>6 Ease of testing by farmers</th>
<th>7 Ease of carrying out experiments</th>
<th>Final decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a 80 kg N/ha for maize,</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>Low</td>
<td>x</td>
<td>x</td>
<td>Medium</td>
<td>High</td>
</tr>
<tr>
<td>half at planting and half at 30 days, in hole</td>
<td>(already tested)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1b Maize residues</td>
<td>Medium</td>
<td>(?)</td>
<td>Low</td>
<td>High</td>
<td>x</td>
<td></td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>1c Chicken manure</td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>High</td>
<td></td>
<td></td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td>1d Leucaena</td>
<td>Medium</td>
<td>(?)</td>
<td>Medium</td>
<td>High</td>
<td>x</td>
<td>x</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>3a Maize variety A</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td>High</td>
<td></td>
<td></td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>4a Pre-emergence herbicide C</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>x</td>
<td></td>
<td>Medium (need to postpone hand weeding)</td>
<td>High</td>
</tr>
<tr>
<td>(but requires postponing hand weeding)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4c Pre-emergence herbicide E</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
<td>Medium</td>
<td>x</td>
<td>x</td>
<td>Medium (need to postpone hand weeding)</td>
<td>High</td>
</tr>
</tbody>
</table>

Source: Adapted from Tripp and Woolley (1989).
The tentative plans regarding the number of experiments should be compared to the resources available to the local team before proceeding. It should be confirmed that the transport facilities, staff, and funding for the researchers and extension agents who will be managing the experimental program are sufficient.

Several additional rounds of group work are then necessary to complete the design of the individual experiments. Once the types of experiments have been decided, group work should turn to decisions regarding the exact number and levels of experimental variables. Each group can take responsibility for a particular experiment.

The next assignment is to discuss the number of repetitions and sites required for each experiment. Groups should develop guidelines for selecting sites for each experiment, including the types of farmer and the crop management practices to which the experiment is addressed.

In addition, group work needs to be devoted to the design of the fieldbook for each of the experiments. Participants need to discuss what types of data are required about the site and the farmers, as well as the observations that will be taken during the growing season. Draft fieldbook pages should be produced.

Final Preparations for Planting the Experiments

It is necessary to spend time after the call with the local team of researchers and extension agents who will take responsibility for planting and managing the on-farm experiments designed during this call. If there are still doubts regarding some of the details of the experimental designs that emerged from the call, there is an opportunity to consult the relevant researchers and make any necessary modifications before planting. A good deal of time is necessary to locate sites for the experiments, and this should be a priority activity. In many cases the instructors have participated in at least a part of the planting with the local team to make sure that all of the experiments are established. If the course is aimed at researchers or extension personnel with no experience in planting on-farm experiments, an additional call may be organized at planting time.

As well as making sure that the experiments are established, course organizers also need to work with the local team to be sure that any other suggested diagnostic activities can be carried out and that there is good communication between the local team and the members of other programs and departments in the research service who are interested in on-farm experiments.

**Teaching materials**

- Copies of informal and formal survey reports.
• Set of secondary data.

• Pencils, erasers, pencil sharpeners.

• Blackboard and/or flip charts; overhead projector.

• Photocopier, paper.

Publications for distribution or reference


Handouts on aspects of experimental design, data collection, site selection.
Objectives
The fourth call is concerned with visiting the on-farm experiments that have been planted as part of the course. One objective is to provide an opportunity for participants to interpret responses to treatments, taking account of the hypotheses that motivated each experiment. The call also offers participants experience in taking data from experiments and determining whether additional data will be needed to help interpret the responses observed.

Organization
The call involves a week devoted to visiting the on-farm experiments during the growing season. The call should be timed so that participants can see responses to experimental treatments and can assist the local team in taking measurements and notes. The instructors should visit all the trial sites with the local team before the call and decide which sites should be included in the visit. If possible, it is best to visit all the sites, but this may not be feasible. Sites for visits should be selected not only with a view towards logistics, but also to illustrate contrasts in response and particular successes or failures.

The visits should be arranged by the local team so that the farmer who is hosting the trial will be present. A visit by such a large group may be a bit overwhelming, but the local team should explain the purpose of the visit to the farmer and ask that she or he be prepared to discuss reactions to the experiment or any other themes of interest. The relevant pages from the fieldbook for each site should be photocopied and prepared for distribution to the participants.

Outline
Field visits--The purpose of each experiment should be reviewed with the group before leaving for the field, and the local team may want to report briefly on the highlights of the season to date, the number and locations of the trials that have been planted, and results of any diagnostic activities that have been carried out. If field data are to be taken at each site (such as plant counts or insect damage assessment), the techniques should be reviewed before going to the field.

The farmer should be present at the majority of site visits. As much of the visit may be devoted to taking data and reviewing fieldbook notes, it is usually best to designate a period of time, usually near the beginning of the visit, for discussions with the farmer. These discussions should include farmers' impressions of the experiments and especially any modifications that have been made by the farmers in either experimental or nonexperimental variables.
If the extension service is planning demonstrations or field days associated with any of the experiments then these should be included as part of the call activities.

It is generally better to arrange the field visits so that they do not take up the entire day. The usual situation is that the first visit of the morning is characterized by critical examination of the trial and lively discussion of observations and interpretations. As the day wears on, visits become shorter, observations more perfunctory, and discussion with farmers less animated. Visits carried out during the morning, then a break for lunch and classroom discussions in the afternoon, provide enough variety to keep participants interested.

Other activities--The field visit call is a good opportunity to take more agronomic observations in farmers' fields as well, perhaps following up on some themes that were left over from the earlier diagnostic calls. If it is decided that some formal surveying is appropriate, the survey should be designed, introduced to the participants, and then carried out at the same time that they visit the experiments. Observations may be taken on the fields of the farmers collaborating with the trials, but some sort of random sampling beyond trial collaborators should also be included. It also may be useful to do some preliminary analysis in the classroom of fieldbook data or data that have been collected during the call.

The call also provides an opportunity for some classroom teaching. Possible topics include selected agronomic themes, or an introduction to the techniques of economic or statistical analysis that the participants will use in the next call.

**Teaching materials**

- Copies of fieldbooks.
- Field notebooks.
- Pencils, erasers, pencil sharpeners.
- Tape measures and other equipment necessary for field observations and measurements.
Fifth Call: Analysis of Experimental Results

Objective
The objective of the call on analysis of experimental results is to teach participants techniques in the statistical and economic analysis of experimental data and to give them experience in the interpretation of such analyses. The basic techniques should be familiar to participants beforehand, but the call provides an opportunity to apply these methods to the data developed during the course. Another objective is to assess the planning of the research program in light of the experimental results. The assumptions and decisions made during the planning call should be reviewed during this call. Finally, the call gives participants an opportunity to at least begin discussing the planning of the second cycle of experimental work, although a complete planning exercise for the second cycle is often the subject of a further call.

Organization
This call probably requires more preparation than any other. The instructors should visit the experimental sites again before harvest and perhaps even assist in the harvest itself. All of the harvest data should then be analyzed so that the instructors have a good idea of the results and are able to think about how to arrange group work on various tasks in analysis to take best advantage of the five days allotted to the call. All data necessary for economic analysis should have been collected by the local team before the call. Enough copies of the fieldbook data should be available for the classwork, and pocket calculators or other computing facilities should be available for the call.

The fifth call may be held in the same place as the third (planning) call. The entire week is spent in group work, presentations, and report writing, so the facilities should allow this type of work to proceed smoothly.

Outline
Data analysis--The call can begin with a review of the past season’s experiments, concentrating on the major results and including the number of trials harvested, the number lost, the principal problems encountered, and any unusual conditions that affected the trials. This review should be in the hands of the local researchers and extension agents who were in charge of the experiments. Before starting the actual analysis of the course experiments, it has sometimes been found helpful to present a case study, showing all the steps in the analysis of one set of experiments.

The first step in the analysis is "data scrutiny," a qualitative review of the differences in response among sites and of the unusual responses within a site. The objective of this review is to see if any sites should be eliminated from further analysis because they do not conform to the definition of the recommendation domain for the experiment or if
particular treatments at a site should be eliminated or adjusted because of factors such as animal damage or management error. This scrutiny requires access to fieldbook data and a good knowledge of the experimental sites. It is often best to have the local team lead a general discussion on this topic, rather than rely on group work.

Once this initial scrutiny has defined the sites and treatments that are eligible for analysis, participants can begin the statistical analysis. Each group can be assigned an experiment. Groups of two to four are adequate for analytical tasks. If participants have access to computers, and if it is possible to have several computers available for the course, then the data can be entered and processed by the participants. If participants do not have experience with computer analysis, then instructors can provide computer printouts of analyses and request certain calculations by calculator as exercises. In any case, the emphasis is placed not on the mechanics of the statistical analysis but rather on the interpretation and implications of the results.

The types of statistical analysis will depend on the objectives and designs of the experiments, but in general single-site analysis of variance followed by across-site analysis of variance are carried out. This exercise can be followed by a closer examination of the across-site analysis to look for significant site by treatment interactions. Finally, there should be a summary of main treatment effects and treatment interactions.

Each group may make several reports on its work during the analysis of the experiments it has been assigned. If there are four or five different experiments, this work may take up to two days, and instructors need to pace the presentations and make assignments so that there is enough time for other course activities.

Following a review of the statistical analyses and the agronomic interpretation of the results, a decision is made regarding which experiments should be submitted to economic analysis. The economic analysis is carried out on the combined yield data for a particular experiment. The techniques of economic analysis (CIMMYT 1988) should either be familiar to the participants or should have been presented as part of the previous call or as an assignment before this call. If the call lasts 5 days there is only a little time for reviewing the procedures.

The first step in the economic analysis is to develop a partial budget for the experiment. The economic data (input prices, labor costs, crop prices, etc.) need to be available for the research area. A sheet with this data should be prepared beforehand, and the local team can explain how the data were obtained. Groups can prepare partial budgets and have them checked by instructors before proceeding to do a marginal analysis. The results of the economic analysis should be presented and discussed. If it is appropriate to do so, instructors might lead a brief discussion on further economic analyses that might
be useful, such as an examination of the sensitivity of conclusions to possible price changes.

**Writing the final report**—Once the analytical work is completed, the groups should write draft sections of the final report. The antecedents and rationale for each experiment should be included in the report, as well as the analysis and interpretation. The report format should be discussed carefully beforehand, so that it conforms to the requirements of the local institutions.

**Follow-up and evaluation**—The implications of the experimental results for the next year's research can be included in the final report, but a one-week call is not sufficient to include planning for the next cycle. It is strongly recommended that the group be reconvened to plan the following cycle of experiments, either by adding a second week to this last call, or offering a sixth call. This additional meeting time gives participants a second experience with the procedures for planning and experimental design.

Even if the call system course does not proceed with a sixth call to plan the following experimental cycle, some follow-up activities should be contemplated. At a minimum, the final report of the analysis call should be produced and distributed to all participants. The report can serve as a model for reporting procedures for the participating institutions.

In addition, during the fifth call participants should thoroughly evaluate the course. A questionnaire can be designed to record participants' opinions regarding the strengths and weaknesses of the course, as well as to elicit suggestions for future activities.

**Teaching materials**

- Photocopies of fieldbook pages, harvest data, field plans.
- Previous reports; secondary data.
- Pencils, erasers, pencil sharpeners.
- Blackboard and/or flip charts; overhead projector.
- Photocopier, paper.
- Graph paper, rulers.
- Calculators and/or computers.
• Statistical tables.

• Data from research area for economic analysis.

Publications for distribution or reference


Call system courses attempt to offer a concentrated learning experience in on-farm research methods by scheduling a series of short calls at appropriate times in the research cycle. Nevertheless, there is an opportunity and a necessity for taking advantage of the time between calls to develop further training activities. There are two reasons to focus attention on the periods between calls. The first is that these periods should be used by participants to practice the research skills they have learned in the previous call. The second reason is that, because the call system attempts to teach a wide range of subjects in short time periods, reading or study assignments may be given before the next call so that less classroom time is needed to cover a subject.

Using Research Skills Between Calls
The ideal situation for a call system course is to have all participants return to their own areas after a call, carry out the methods they have just learned, and report back to the group during the next call. In a few courses, this has happened. The call system course has been used in certain countries to stimulate the simultaneous and parallel development of on-farm research projects in several areas of a country. But because of different stages of development of local research programs and different agricultural cycles in various parts of the country, the ideal is usually not attained. Nevertheless, some sort of assignment should be made after each call in order to reinforce the skills taught during the call.

Assignments dealing with the analysis of secondary data are fairly straightforward. After the call in which these techniques are discussed, participants should be asked to obtain as many data sources (maps, etc.) as possible that are relevant to the work in their areas. In addition, they should be asked to carry out at least one analysis (such as an examination of rainfall data) and be prepared to report on the results and their implications during the following call.

After the informal survey call it is reasonable to expect that participants will carry out some sort of similar work in their own areas, although not necessarily a full-scale survey. Participants might instead be asked to carry out a more limited set of activities, such as organizing a survey of a few days, with as many researchers and extension agents as can be involved, to look at a limited set of issues in a relatively small area. The activities should involve both farmer interviews and field observations. A brief report should be presented in the following call.

Activities to follow the formal survey call (if it is offered) are a bit more problematic, because it is difficult to do a "partial" formal survey. In addition, if the call has been participants' first experience with a formal survey, they will almost certainly need some
outside help in setting up their own surveys. A compromise assignment would involve a brief exercise in formal sampling and data recording. Each participant may be asked to choose a particular problem in his or her area, decide what sort of information (farmer interviews or field observations) is necessary to investigate it, devise a suitable sampling frame for a small area (such as a village), and conduct a brief study.

After the planning call, participants should be asked to follow a similar procedure in their own areas. If the period between calls corresponds to the time when participants would normally plan their research programs, then they can be asked to report on the results of that planning at the next call. If participants are not involved in planning during that period, then they should be asked to report on particular issues that are relevant to planning experimental work (past or future) in their areas.

Assignments after the field visit call and after the data analysis call will necessarily involve reporting on data from on-going experimental work in the participants’ own areas. Formal assignments may be given to participants, as shown in a handout used in Eastern Africa (Figure 7).

Another assignment that should be made after one of the calls is for participants to assemble a set of economic data that will be useful for analyzing trials from their own areas. These data would include costs of inputs and labor, selling prices of crops, the amount of labor estimated for particular tasks such as weeding, and perhaps an estimate of local interest rates, if relevant. If the instructors can collect these data early in the next call, an interesting sheet of comparative data across regions of the country can be prepared and presented.

Whatever assignments are made, they should be treated as part of the course, and time should be allocated during the next call so that participants can make short reports on their findings. If several groups of participants have carried out complete activities, such as surveys, or have an entire set of experimental data to present, then the presentations must necessarily be selective. Perhaps one group should be chosen to present a complete report and the others should give highlights of their work.

As the call system course progresses, these reports not only serve to reinforce the skills learned in the previous call but also help develop a sense of identity and communication among the participants. They become increasingly familiar with each other’s work, and increasingly confident in presenting their own ideas and offering critiques of their colleagues’ work. The logical outgrowth of this interaction is a group of researchers and extension agents who are able to carry on with these sorts of research planning and reporting meetings after the call system course has come to a close.
For each trial in your program:

1. Organize, standardize, and scrutinize the data.

2. Choose the appropriate statistical technique for evaluation.

3. Complete the statistical analysis--interpret your results.

4. Based on information from (3), perform an economic analysis of the trial (include risk in your analysis).

5. Interpret the results of your statistical and economic analyses with respect to the problem under investigation (consider system's compatibility).

6. What information did you obtain from farmers regarding the trial?

7. What additional information do you need to better interpret the above results?

8. How would you use the available information in future planning?
   a. Would you continue this experiment next season, or are additional experiments needed? If the latter is the case, what would the treatments be, where would the experiment(s) be located, and who would manage them?
   b. Would you change your design? If yes, how?
   c. What tentative recommendations, if any, can you make from this information?
Study Assignments Between Calls
The period between calls can also be used for study assignments so that classroom time does not have to be devoted to formal teaching. Because of the varied backgrounds of course participants and the wide range of subjects included in the call system course, some formal teaching is necessary to make sure that everyone is more or less at the same level. But an excellent way of dealing with much of this variability is to offer opportunities for individual study in between calls. Participants who are unfamiliar with a particular topic can devote more time to it.

Economic analysis is a good example. The manual used for teaching economic analysis (CIMMYT 1988) has an accompanying set of exercises that participants can work on at their own pace. Similarly, assignments can be made for problems in statistical analysis, to make sure that everyone is familiar with the basic concepts and procedures. Reading assignments can be offered on other research techniques. There is obviously a limit to these sorts of assignments, and instructors may find that they wish to organize complementary or follow-up training activities to treat particular subjects in more depth.

Finally, many of the calls have a report as their final product. In most cases a good first draft is all that can be expected at the end of the call. The instructors and the local researchers and extension agents are responsible for developing the final report as soon as possible. If it is at all possible, the report should be distributed to participants before the next call, with the request that they review it carefully and come prepared to discuss it at the beginning of the next call.
Conclusion

The full value of call system training will not be realized without follow-up activities with the participants. The experience of having worked together for more than a year on a common research project and the group dynamic that is engendered by this experience mean that subsequent meetings of the participants are often very fruitful. It is often useful, for instance, to have former participants meet every year to present and discuss the work from their own areas. In many cases the call system course has stimulated the establishment of regular planning meetings, using course participants as a nucleus. The meetings may involve persons working on location-specific projects in one region or persons whose research focuses on a particular commodity. These meetings have often served to establish institution-wide formats for planning and reporting.

Call system training can thus contribute to the institutionalization of OFR and the establishment of diagnostic, planning, and reporting procedures for location-specific adaptive research that scientists and extension agents are comfortable with. But this organizational framework must be complemented by high-quality research, efficient extension programs, and a clear commitment to developing agricultural technologies adequate for the needs of the nation’s farmers.