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DATA COLLECTION, SITE SELECTION AND FARMER PARTICIPATION IN ON-FARM EXPERIMENTATION*

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* The views expressed in this paper are not necessarily those of CIMMYT

** CIMMYT Economics Program

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PREFACE

In cooperation with researchers in many national agricultural research programs, CIMMYT has sought to develop procedures which help to focus agricultural research squarely on the needs of farmers. The process involves collaboration of biological scientists and economists to identify the groups of farmers for whom technologies are to be developed, determining their circumstances and problems, screening this information for research opportunities, and then implementing the resulting research program on experiment stations and on the fields of representative farmers.

CIMMYT's Economics Program has emphasized developing procedures for the first stage of this process, through to establishing research opportunities. The evolution of the procedures, now synthesized in a manual "Planning Technologies Appropriate to Farmers: Concepts and Procedures" has been strongly influenced by collaborative research with many national programs and with CIMMYT's wheat and maize training programs. Our efforts with national programs began in 1974 with Zaire's national maize program, then moved to work in Tunisia, Pakistan, and Egypt. The pace of work accelerated notably in 1976 with assignment of regional economists stimulating similar work in Kenya, Tanzania, Zambia, Ecuador, Peru, Bolivia, Panama, El Salvador, and India. Cooperation with still other national programs is now underway. We believe that the resulting procedures offer cost effective and robust guidelines to national programs.

We are now preparing reports that illustrate the implementation of these procedures in various national programs. While not all such work can be reported, we take this opportunity to thank all of those who have collaborated with us.

This paper describes work undertaken with the Production Research Program of INIAP, Ecuador's national agricultural research institute. It reports some of the experiences of researchers -- Ecuadorian and CIMMYT professionals -- in on-farm experimentation. It focuses on the collection and organization of data during this phase of on-farm research and as such contributes to CIMMYT's concern for developing and refining research procedures that are useful to national programs.

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1. INTRODUCTION

1.1 On-Farm Research Methods

This paper attempts to contribute to the development of methods for the conduct of on-farm research. Its focus is the activities associated with on-farm experimentation. It presents some guidelines for site selection, communicating with farmers and data collection during experimentation. These guidelines were developed and used in an on-farm research program in Ecuador.

When considering the organization of on-farm research which leads to the promotion of improved technologies it is convenient to think of four separate phases:

1) the planning phase, in which target groups of farmers are identified and information is collected about their circumstances;

2) the experimentation phase, in which trials designed to develop and test new technologies are planted with representative farmers;

3) the analysis phase, in which data from the planning and experimentation phases are combined in order to derive recommendations for farmers; and

4) the assessment phase, in which data obtained on farmers' experiences with the new technologies are used to make judgements on the promotion of recommendations.

Good guides are now available for planning experiments[1/] and for

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1/ Byerlee, D., M. Collinson, et.al."Planning Technologies Appropriate to Farmers - Concepts and Procedures". CIMMYT, Mexico, 1980

the economic analysis of trial results[2/], but little has been written about the experimentation phase. This is unfortunate, because it is the phase of on-farm research that accounts for the majority of researchers' time and effort. The following pages offer some suggestions for research activities during on-farm experimentation.

1.2 On-Farm Experimentation

On-farm experimentation places the researcher in direct contact with a farming system that is often quite complex. It is the researcher's responsibility to learn as much as possible about this system and the ways it affects the crops with which he is working. This requires research methods much different from those utilized in traditional experiment station research.

Information about the farming system is collected during the planning phase of on-farm research, but this is only the beginning. During the experimentation phase the researcher has access to the farmers and their crops, and the opportunities for collecting information during the course of the season are considerable. Through observations and conversations the researcher picks up small pieces of information which are gradually woven together with data obtained from the trials themselves and from the earlier surveys. The results of this process are sometimes firm recommendations, but are often hypotheses that must be tested by further trials and data collection. There are ways of planning experiments, organizing research activities and recording information that make on-farm experimentation more effective.

Although this paper concerns the experimentation phase, its purpose is not to suggest what kinds of experiments should be planted or what types of agronomic data should be collected. Instead, the paper has two

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2/ Perrin, R.K. et.al. "From Agronomic Data to Farmer Recommendations: An Economics Training Manual". CIMMYT, Mexico, 1976

main goals:

1) Discuss ways of organizing the experimentation process through improved site selection to increase the availability and reliability of the data, both agronomic and socio-economic.

2) Propose that the collection of information about farmers' circumstances not end with the initial survey, but rather that it continue into the experimentation phase. In this regard, the paper discusses:
   a) Communicating with farmer collaborators.
   b) Collecting a broad range of data during experimentation.
   c) Recording and preserving this data.

The experiences that form the basis of the following discussion are those of the Production Research Program of Ecuador's National Agricultural Research Institute, INIAP[1/]. Researchers of the Production Research Program are stationed in various areas of the country with basic responsibility for collecting data on farmers' circumstances, planning and conducting on-farm experiments to evaluate technological alternatives for the most important crop or crop association in that area, and formulating tentative recommendations for farmers. Procedures described here are those utilized by one or two researchers with one vehicle who have responsibility for all program activities in the research area. Data collection methods are designed taking account of these limitations of personnel and resources.

[1/] For a more complete description of this program, see Moscardi, E. "The Establishment of a National On-Farm Research Entity in Ecuador", CIMMYT, Mexico, 1982.

2. SELECTION OF SITES AND COLLABORATORS

2.1 Recommendation Domains

The most important concept in helping the researcher select sites for on-farm trials is that of the recommendation domain. A recommendation domain is a set of farmers who work land with similar features and who have access to similar resources. The farmers of one recommendation domain are thus tentatively eligible for the same recommendations with respect to the target crop. Information gathered during the planning phase of on-farm research is used to identify target crops and to delineate recommendation domains.

Recommendation domains are defined by two sets of circumstances: natural features such as soil, climate and topography; and agro-economic features such as access to resources and marketing opportunities. The researcher wants to make sure that the sites selected conform to the definition of the recommendation domain. Site selection may also be concerned with certain subsets of the recommendation domain, such as fields at a particular stage in a rotation pattern.

There are a number of possible sources of data to aid the researcher in site selection. One important tool for finding representative farmers is the survey that is carried out before beginning on-farm experimentation. A question can be included in the survey on the farmer's willingness to have a trial planted on his farm and a selection of appropriate farmers who have expressed interest in a trial can be made. As the researcher gains more experience in the area he will come to know many other farmers, and from the beginning of his work he will want to dedicate time to familiarizing himself with the zone and thinking about where and with whom he might plant the following cycle. In many cases it may be possible to plant trials with the same collaborators for a second year, but the necessity of providing wide coverage of the area, and the dangers inherent in developing "prof-

fesional collaborators", would indicate that two or three years should be the maximum time with one farmer, except in special cases such as experiments which study crop rotations, certain types of management, or long-term effects of herbicides or fertilizers. Finally, the local extension service is a possible source of ideas for experimental sites (See 2.2).

As he looks for farmers with whom to plant trials, the researcher has firmly in mind the characteristics of the various recommendation domains of his area. It is usually fairly easy to determine if a farmer fulfills these basic requirements and might be eligible for a trial. But recommendation domians are dynamic, and although the goal is to define them by as few characteristics as possible, the researcher is usually in the process of refining and revising the domains, and this often adds additional criteria to the selection process. In one area in Ecuador a particular recommendation domain was defined as being those farmers with less than five hectares, whose fields were between 2,500 and 2,900 meters above sea level, and whose maize was harvested principally for home consumption. An early-maturing maize achieved equally good results within this domain for farmers who had access to complementary irrigation and for those who did not. Thus access to irrigation was not a defining characteristic of the domain. In a subsequent cycle, however, experiments were conducted with a rotation of early-maturing maize and peas. In this case, the variety and planting method for the peas varied, depending on access to irrigation, and the researcher had to select his sites accordingly. In other cases, experiments within one domain may demand fields with specific fertility features or rotation histories, as the researcher works to see if these might serve to further disaggregate the current recommendation domain.

The idea of a recommendation domain is that a few key characteristics identify a group of farmers whose total constellation of practices and resources is relatively homogeneous. But within any such group of farmers there is always considerable variation, and it is well to take this into account in selecting sites. In the example above, neither the survey carried out beforehand nor the first year's trials gave any indication that there

were differences in maize practices or results between plots with and without complementary irrigation. But as it was obvious that irrigation might be an important factor in future work, and as the information at hand was not sufficient to be absolutely certain that there were no differences, it was thought advisable to try to select sites for trials by taking account of this factor, choosing some sites with access to irrigation and others without. It will thus be possible to analyze the results of several years' maize trials on irrigated and non-irrigated land to see if irrigation might indeed serve as a distinguishing feature in delineating new recommendation domains.

It is also advisable to be aware of possible biases in site selection. The information from the survey, and other sources of data, give the researcher an idea of the occurrence of many secondary characteristics among the farming population. Although it is assumed that most of these will be randomly distributed among the collaborators, it is best to watch for any significant concentration. For instance, if the survey indicates that less than 10% of farmers in the recommendation domain prepare their fields with a tractor, but the majority of the trials are planted in fields plowed with a tractor, it may be an indication that trial collaborators have access to a greater than average quantity of resources. Even though there might be no evidence to indicate any differences in results between maize planted in fields prepared with a tractor or with an ox plow, it would be wise to search for more collaborators who use ox plows. Similarly, if a disproportionate number of trials are found with farmers who sell much of their maize, belong to a particular ethnic group, or are community leaders, it may be an indication that trials are weighted towards farmers with particular resources or preferences. It is impossible to balance all of these factors in the selection process, but the researcher should keep an eye open for obvious biases.

2.2 Planning trials with extension agents

As the purpose of on-farm trials is to arrive at recommendations

that extension agents can use with confidence, maximum coordination with local extension services is essential. The idea is to develop shared responsibility for the design and management of the trials between researcher and extension agent, even though several years of work may be necessary to develop recommendations that the extension agent can utilize.

Collaboration between on-farm researcher and extension agent is most effective when their respective institutions share the same agricultural development goals and strategies. Although extension agents may be able to provide suggestions for areas in which to work and contacts with local farmers, the researcher often must acquaint the extension agent with the concept of a target group of farmers. On-farm researchers in Ecuador have learned to cooperate closely with those extension agents whose work involves them with representative small farmers, and to avoid extension programs whose approach brings them in contact with only a handful of so-called "progressive" farmers, or special "pilot projects" which require a high investment per participant, reach few farmers, and are not replicable over a wide area.

There are also sites which are legitimate for extension activities but are not necessarily appropriate for on-farm research. Ministry of Agriculture extension agents often provide advice to villages on the use of communal land to raise crops for sale for the benefit of the community, or use these plots themselves for demonstrations. If a considerable proportion of crop land in a given zone is communally managed, then some trials should be planted on this type of land. In one area, for instance, large cooperatives which grow wheat form one recommendation domain, while the individual small farmers that are found in the same area constitute a separate domain with different resources and management practices. But if communally managed land makes an insignificant contribution to local farming then trials on that land may be subjected to unrepresentative or uncertain management.

Apart from these reservations, the extension agent and on-farm re-

searcher should work in partnership to identify areas for trials and to develop research problems. Although it must always be made clear that on-farm research trials are primarily experiments, certain types of trials may be quite appropriate for demonstrations. The extension agent may of course have a separate set of criteria for planning his own demonstration plots.

2.3 Logistics

Another consideration in choosing sites is a logistic one. The ideal distribution of sites would have on-farm trials scattered throughout the recommendation domain. Questions of transportation and time often make this impossible in practice. If trials are placed too far from one another it may be impossible to get to all of them frequently enough. One compromise is to choose several areas within a domain to concentrate on during a given cycle, and cluster trials in these areas. A three-hour one-way trip to visit one site is probably not indicative of an efficient placement of trials, but if that same trip can be made to an area that contains three or four trials, then it is much more worthwhile (and much more likely to be made on a regular basis). Areas of trial clusters can of course be shifted from year to year.

It is sometimes worth considering placing several trials in the same community, especially if a number of different types of trials are being planted. There is a multiplier effect by putting more than one trial in a limited area because non-participating farmers are more likely to be aware of the researcher's work and the researcher has an increased opportunity to become acquainted with these farmers, to learn from their observations and their problems, and to get a more in-depth look at the farming system practiced in a particular area.

It is not usually worthwhile, however, to consider planting several trials with the same farmer. As a general rule it can be said that

two is the maximum number of trials that should be planted with one farmer, and that all things being equal, one trial with each of two neighboring farmers is better than two trials with the same farmer.

When considering the total number of trials to be planted it must be remembered that the establishment, management and analysis of an on-farm trial, including the necessity of spending a good deal of time with the farmer, make considerable demands on the researcher's schedule. It is possible to over-extend oneself and this usually detracts from the quality of the work. The exact number of trials for a given program depends on the type of trials planted, the size of the research area, the number of researchers and the type of transportation available, and the optimum number can only be established with experience. In Ecuador, the number of trials planted in one year in each research area generally varies from 15 to 25, managed by one or two researchers.

2.4 Contacting the farmer

Once areas are selected for the year's research and recommendation domains are defined, farmers who meet the requirements must be approached to see if they are willing to participate in a trial. There is no doubt that small farmers are themselves experimenters, and that the concept of trying a different variety or a new technique is quite acceptable to them. Nevertheless, in many places farmers have had little experience in working with government agencies and none at all in on-farm research, so that careful explanation of the farmer's duties and expectations for an on-farm trial must be made.

In the first few years of on-farm research in an area it is not always easy to reach a wide range of farmers. There are a number of factors that may affect the researcher's ability to make completely unbiased choices for collaborators. One common experience is that community leaders suggest that trials be planted in their own fields. It is often a worthwhile strategy, especially when working in a new area where making contact

with farmers is difficult, to plant the first trials with local leaders, for it serves to increase the visibility of the experimental work and add legitimacy to it. The sacrifice made is that such local leaders may be atypical in certain respects, having perhaps access to more resources than the average farmer.

This is only one instance of cases where the farmer chooses the researcher rather than the other way around. Although there is an obvious advantage to working with farmers who are articulate and aggressive, one must constantly be aware of possible biases in the selection process; male researchers ignoring female farmers, local elites monopolizing the researcher's attention, and researchers who do not speak the same language as the farmers, are only a few examples of possible problems.

2.5 Summary

The selection of trial sites is an activity which requires a great deal of thought and effort and is not something to be left until the last minute. The researcher should have definite goals for the sites that he requires. Some of the more important criteria are listed below, and for each site where a trial is planted the researcher should be able to make explicit the rationale for its choice.

1. Make sure that the site conforms to the basic characteristics of the recommendation domain.

2. Check the distribution of other characteristics which may be used to redefine recommendation domains.

3. Assure that the trial site fulfills the requirements for the type of experiment to be planted (rotation history, planting associations, etc.)

4. Arrange trial sites so they can be visited and managed during the sea-

son and so they provide opportunities for farmer participation.

Strive to extend work to new areas and new collaborators. Two or three years should be the maximum with one farmer, except for special circumstances.

6. If some trials may be used as demonstrations, solicit suggestions from extension agents regarding site selection.

7. Identify and correct biases in farmer selection from previous years.

3. COMMUNICATING WITH FARMER COLLABORATORS

3.1 Preparations for planting

The importance of explaining the nature of the on-farm experiment to the farmer cannot be overemphasized. If at all possible the exact measurements of the plot should be marked off well before planting, so the farmer knows the area where the trial will be located. Some types of trials require that data on the plot be obtained beforehand --soil analysis, cropping history, the exact crop association that the farmer will plant, etc.

Trial sites are selected taking account of the requirements for the year's experiments. Plots of a particular size, slope, fertility, etc. may be needed for certain types of trials. Although it is necessary to take account of individual farmer's interests and experience in placing the different types of trials, it is usually not advisable to ask the farmer which type of trial he would like, for often other considerations make it necessary to overrule his choice.

Most trials examine a small number of variables and all other factors are left at the farmer's level of management. This is sometimes more difficult than it sounds, however. It is not uncommon to find that

the farmer is planning a different type of crop association or density than the researcher is expecting, and a decision must be made as to whether to include these "unrepresentative" practices in the trial, or to ask that the plot be planted under practices more nearly equal to those of other trials. This of course argues for the desirability of learning the farmer's plans, early on, so that decisions can be made and discussed with the farmer.

In some cases it is best to leave the planting of the trial to the farmer. This is the case when farmers have very special planting practices which the researcher would have a difficult time duplicating. In one very dry area where maize trials were planted, farmers had developed special procedures to assure germination. They planted only very early in the morning, placing the seed immediately after plowing the furrows and then covering it so as not to lose any moisture. In this case it was found best to have the farmer himself do the planting, although the researcher was present to supervise. As a second example, it is widely known that farmers are better able to broadcast seed than are researchers.

It is best to plant trials with the farmer at the same time as he is planting the rest of his crop. Even if the trial requires planting at a different time (experiments on planting dates, for instance), the farmer should be present. It will often be necessary to make several visits to the farmer to arrange the planting date.

Finally, once the trial is planted the researcher must be sure that the farmer understands his responsibilities. If the trial is to be left completely under farmer management then it must be explained that the farmer is to treat the experimental plot in exactly the same way he treats the rest of his field.

3.2 Farmer-Researcher Interactions

It is very easy to plant a trial, make observations on it, har-

vest it and take yield data, all without ever talking to the farmer. This is a great loss, for the observations and opinions of the farmer are one of the most valuable types of data provided by on-farm research. It should be remembered that recommendation domains are defined as groups of farmers, thus collecting information from fields fulfills only a part of the researcher's obligations.

Farmers who have volunteered to have a trial planted in their field are usually eager to talk about it, but in order for the researcher to take maximum advantage of this opportunity it will be useful to consider the farmer-researcher interaction from the outside. In doing so, he will probably be able to recognize that the farmer will be looking upon this activity in a different way than the researcher does. For the researcher, on-farm research is part of government service in agricultural development; it also offers him the added incentive of an intellectually challenging type of experimentation under unique conditions. The farmer represents one of a series of points on a map that make up his research strategy. For the farmer, on the other hand, the on-farm trial is the work of a government agency he may not have even heard of. His principal motivation in planting the trial may be to see if he can get some of the new seed or other inputs for his farm, or to avail himself of the advice or other services he perceives the researcher may have to offer.

As the season progresses, as the researcher and the farmer participate in the planting together, as they exchange views and engage in casual conversation during the cycle, as the researcher offers the farmer simple favors (a ride to town, advice on his crops) and the farmer reciprocates with hospitality during the researcher's visit, they come to look at each other differently. But the establishment of this type of partnership takes time.

In the meantime, the researcher must set about trying to get the farmer to give his frank opinions of what he sees in his field. One of the

principal problems is that the farmer may treat the researcher with exaggerated deference. His only experience with government agricultural personnel may have been in contacts with an extension agent, where something has been "demonstrated" to him. He has learned that his best strategy in such cases is not to question what is told to him and to adopt a humble posture. The researcher would only contribute to this charade by talking down to the farmer (for Spanish speakers, by addressing him as "tu" rather than "Usted", for instance). The likelihood of accomplishing any worthwhile transfer of information in this situation is very low. Part of the on-farm research strategy is the assumption that, with respect to the trial in the ground, both the farmer and the researcher have important contributions to make, and any behavior that will facilitate the honest interchange of their viewpoints is to be encouraged.

The researcher should try to remain as open as possible in collecting information, and refrain from giving the farmer the impression that he already knows the answers. The question, "You weed this field twice, don't you?" will likely be answered in the affirmative, no matter what the farmer's practices may actually be. An attitude of honest curiosity on the part of the researcher is more likely to give the farmer the confidence to fully express his opinions and experiences.

Visits to trials should be organized so that there is a good probability of finding the farmer. If, for instance, the researcher is accustomed to visiting in the morning, when the farmer is usually away working in distant fields, he will want to plan visits for late in the afternoon. The more often the researcher takes the farmer with him to visit the trial the more likely it is that the farmer will realize that he, as well as the researcher, has responsibility for observing the trial's development, and the more likely he will be to carry out his duty.

Farmers appreciate visits from the researcher (this is one of

their greatest complaints against extension agents) and the information gained from a few minutes of casual conversation may at times be as valuable as the results of the trial itself. It is a good idea to make visits to farmers with specific questions in mind, although the farmer should be encouraged to talk about whatever concerns him. Farmers' opinions and comments should be noted in the field book (4.1)

3.3. Summary

The farmer is the researcher's partner in on-farm experimentation, and there are a number of rules that should be observed in order to facilitate communication between them:

1. Before planting, make sure the farmer understands the nature of the trial, and ensure that the specific planting practices to be used are agreed upon.

2. Ensure that the exact site for the trial is agreed upon and that communications are established with regard to planting date, so that the farmer will be present.

3. After the trial is planted, arrange visits so that the farmer is encountered, and always take the farmer to observe the trial.

4. Address the farmer in the locally accepted polite manner; do not talk down to him.

5. Develop the habit of including a wide range of topics in conversations with the farmer as a way of learning as much about the total farming system as possible.

6. Encourage the farmer to express his opinions rather than simply affirming what the researcher says.

7. Try to have in mind topics or questions to discuss with the farmer on each visit.

4. RECORDING DATA

4.1 The field book

The data collected during visits to trials must all be recorded in such a way that they can be used in analyzing trial results and forming hypotheses to be tested in following cycles. The data may be used not only by the researcher in charge of the trials, but by others as well, even in subsequent years.

There are many ways of recording data from trials. Most involve the use of some sort of field book for noting biological data. The following is a description of a more comprehensive type of field book used in an on-farm research program working with maize and beans (see Appendix). It consists of a series of mimeographed pages for each trial, placed in permanent binders. There are nine different types of pages for recording data. The pages are mimeographed before planting, and their format can change from year to year. The idea is to decide what information is of importance for a particular season and then design forms to aid in its collection. Much of the information is most easily obtained if the researcher develops good rapport with the farmer. The pages of the field book should not be administered to the farmer in the form of a questionnaire; if they are they will assume the same limitations as any formal survey. The idea is to take advantage of informal conversations with the farmer and observations in the field to fill in the field book during the course of the season. It is often a good idea not to write too much in the farmer's presence, for this may inhibit him from being completely open.

1) Planting data

This includes the date of planting, a description of the type of

trial and its design, dimensions of plots, including factors under the farmer's control (such as width of furrows or planting density), the varieties and inputs employed, and soil moisture and other conditions at the time of planting. It is useful to note the sources of inputs used; at times experimental varieties for trials come from more than one source (experiment station supplies, seed multiplication institutions, etc) and agricultural chemicals may have varying histories as well (insecticide recently purchased or from old stocks, for instance).

2) Field plan

This is a careful map of the trial layout, completely labelled. It includes enough identifying landmarks so that anyone visiting the trial can orient himself at once and identify the various treatments. This page and the one on planting data are duplicated so that extra copies are available for other researchers who may want to visit the trials, such as the extension agents who collaborate with the program.

3) Characteristics of the plot

This describes the plot where the trial is planted, and much of this information is best collected before planting, in order to aid in deciding what sort of trial would best be planted at this site. Relevant data include the cropping and fertilization history of the plot, land preparation before planting, type of soil, results of soil analysis, altitude and slope.

4) Management of trial

This page is filled in during the course of the year and records two types of information. It is first a record of the work of the researcher on the trial, including any replanting, applications of fertilizer, insecticides and other inputs during the course of the year. Second, and of equal importance, it is a record of the work the farmer has done on the

trial, including all weeding, irrigation, etc.

In one maize program which studied the effects of various herbicide treatments against local weeding practices, an accurate record of the timing and labor involved in the farmer's weedings was essential. In another maize area, farmers had the custom of throwing household refuse and manure on their fields, and some estimate of the quantity and distribution of this extra fertilization was helpful in interpreting results.

5) Observations on the farmer's crop

In the case of the maize research program, a field of the farmer's own maize, usually close to the trial, is selected for observation, and data are taken throughout the year. These may include variety, associations, planting density, management practices, most common insect and weed problems, etc.

These data serve three purposes. First, they are valuable in comparing with the data on trial management. The researcher must conscientiously study the plot, and not assume that he will find the same practices as in the trial. In some cases farmers devote extra care to the trial, and this must be discovered and discouraged if data are to be obtained under truly representative conditions. On the other hand, cases have come to light where the trial has been weeded less than the farmer's own maize, either through misunderstanding or a feeling that the trial maize really didn't require that much attention.

A second use of data on farmers' practices is the chance to investigate in a semi-formal manner some questons that may have escaped the initial survey. The sample of collaborators is probably a non-random one, but is designed to be fairly representative. Questions can be addressed to this sample that may aid in understanding the farming system. In one case, use of information available in the field book was helpful in understanding differences among farmers in planting density, an issue that was difficult to study in a formal survey.

A third use of this page is to give the researcher an idea of just how representative his sample of farmers is. Data on farm management practices can be compared to those of the initial survey to see if there have been any outstanding biases in sample selection. It should not be assumed, however, that the original survey data is always valid. In one case the survey indicated that farmers used the weeds in their fields for animal feed, but closer questioning of the sample of collaborators showed that only weeds that appeared in the later part of the cycle were so utilized. This was important because it opened possibilities for herbicide trials.

6) Characteristics of the farmer

The purposes and nature of this page are very similar to those of the previous one. It asks questions about the farmer, his landowning, marketing practices and other economic activities. Like the page on farmer's management practices, it gives the researcher a chance to compare his sample characteristics to those reported for the farmers of the area in the survey.

This page also gives him the chance to study various matters in greater depth than would be possible in a survey. For this reason, the questions on this page (and on the previous one) are subject to change considerably from year to year, as new research interests appear. Work in one maize-growing area, for instance, indicated that there was considerable difference among farmers in the use they made of maize leaves for animal feeding, and in the time at which they were cut, so that several questions pursuing this matter could be included for the sample of collaborators to try to understand the reasons for these differences.[1/]

1/ It should be emphasized that neither the page on the farmer's crop nor the one on farmer characteristics pretend to be anything like a farm management record-keeping system. The present Ecuadorian program does not have the personnel to carry out such an exercise, and it is felt that a relatively few well-directed questions about collaborators and their practices constitute a manageable alternative.

7) Agronomic data from the trials

There is a wide range of agronomic data that may be collected.[2] The important thing is for biological scientists to decide beforehand which information is necessary for which trials and to plan the data collection process accordingly. Much of the data require frequent visits to trials and careful, time-consuming observation, so that it is essential to identify priority topics for each trial. If a new variety is being tested, for instance, station scientists may want to know days to flowering, but if the data are already established, then there may be no need to collect them. Similarly, if a variety of maize is being tested specifically for its stalk strength, then percentage lodging of this and other varieties in the trial should be carefully recorded. But if the research does not concern lodging resistance, then the researcher may not have to spend his time taking exact data from all the trials. Because the agronomic observations required may vary from trial to trial, and from year to year, it has been found that a relatively "open" form is best for recording this type of information.

8) Harvest data

This form includes spaces for date of harvest, harvest weight, percent moisture, number of plants harvested, size of plots harvested, and other observations.

9) Observation forms

Unlike the other eight pages, this is a form that is filled out on each visit, so a large number of these forms are included for each trial. The form is divided into areas for general observations. Besides spaces for the date of visit and whether or not the farmer was contacted, there are spaces for observations on insects, diseases, weeds, climatic conditions, etc. If

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2/ As mentioned in the introduction to this paper, the purpose here is not to define what sorts of agronomic data are to be collected, but rather to present methods that aid in their collection and interpretation.

these observation pages are filed in the field book, at the end of the season the researcher has a record of the number of visits made to the trial and can quickly reference the behavior of the trial with respect to insects or any other particular concern.

Copies of these forms are distributed to extension agents and other researchers who may visit the trials so that their observations can be included as well. A number of blank pages are also included in the field book for each trial so that additional observations and data can be recorded.

The field book should be regarded as a tool which is to be used during the management of the year's trials and as a source of information in future years for reinterpretation and analysis of results. It is most effective if it is conscientiously redesigned each year to meet the needs of the research. It is only of value if it is used--if it is taken along on each visit to the trials and if the data are recorded in the field.

4.2 Summary

The amount of data available to the on-farm researcher during the experimentation phase is considerable, especially if care has been taken in selecting trial sites and establishing rapport with participating farmers. This information is useful not only in evaluating the technologies being tested, but for further understanding the farming system and developing new hypotheses to be examined. But the information is of little use if it is not collected according to a fixed plan and recorded so that researchers can use it. The data collection process should conform to the following guidelines:

1. All data should be recorded immediately, in some type of a permanent field book.

2. Agronomic data required from each trial should be carefully identified

beforehand and arrangements made for their timely recording.

3. The format of the field book is redesigned each year in order to correspond to increased knowledge of the farming system and changes in research emphasis.

4. There should be space in the field book for noting farmers' observations and opinions.

5. A brief record of each visit to the trial should be made.

6. Data recorded should not only come from the trial itself but from the farmer's field as well.

7. Data should be recorded so that other researchers can understand it and use it, even in future years, in interpreting trial results.

8. Most data can be recorded without administering questions to the farmer as in a formal survey; casual conversation with the farmer usually works best.

5. FURTHER DATA COLLECTION POSSIBILITIES

5.1. Other data from the area

Since the researcher has the responsibility of formulating recommendations, he must have at hand good data on crop prices and input markets. Every couple of months he will want to visit local markets and traders to obtain current prices for target crops, transportation costs, discounts for quality, etc. At the same time he will want to ascertain prices and availability of the various agricultural chemicals and other inputs appropriate for his crops. Such data should always be placed in a permanent record book, so seasonal and long-term patterns can be analyzed. Conversations in both the towns and countryside will also provide information about the characteristics of farm labor markets and sources and rates of credit for farmers.

Of equal importance to the quantitative economic data, and also deserving a place in the records, are the many qualitative observations that the researcher makes throughout the year. In formulating insecticide recommendations in one maize research program, for instance, observations on farmers' use of insect-damaged maize as animal feed were every bit as important as yield data and insecticide prices. The researcher should take every opportunity to talk with not only trial collaborators but also with their neighbors, to take a peek over the fence to see what other people's fields look like. Each season the researcher may have in mind a series of questions that he will want to ask farmers with whom he comes into contact. The questions may be asked in the course of informal conversations, but a simple record-keeping page may be designed to record the answers. Another important activity is to build a glossary of the local farming vocabulary which may be of a quite regional and specific nature.

Weather conditions should be noted during the growing season. Some programs put rain gauges with a few of the collaborating farmers and provide mimeographed pages with facsimiles of the gauge face on them, so the farmer only has to draw a line at the level of rainfall and mark the date. In some areas the national meteorological service has stations, and data can be obtained from them.

The on-farm experimentation is often not the first research that has been carried out in the area. The on-farm researcher should acquaint himself with the results of any past or present work done with his target crops. Equally important to obtaining this type of secondary data is the necessity of sharing trial data and conclusions with all interested parties working in the area.

At times in the course of the work a formal survey or other special study may be called for. In one program looking at maize, the initial survey provided sufficient information about maize practices to begin work. By the fourth year of research recommendations regarding new early-maturing varieties of maize were being produced, and work became more oriented to-

wards possible rotations and associations with this type of maize. The first survey had not provided much detail on other crops, so a small survey was designed and carried out in a series of sites known to be representative of the research area, and this served to orient work for the following year.

This illustrates the balance that exists in on-farm research between surveys and trials. Formal data collection should not run too far ahead of experimental capabilities. Initial surveys should provide enough data to begin trials on those technologies for which there exists research capacity. As work progresses, questions and hypotheses are formed. Some of these can be tested in trials, while others can be explored through informal questioning of collaborators and other farmers in the area. After several years of work, however, there may be a list of questions which are best answered through a carefully designed formal survey.

5.2 Observation trials

As an intermediate step between formal on-farm trials and simply following farmers' behavior with a new technology, informal observation trials are sometimes useful. In these, farmers are given the test variety or input and are asked to use it in a part of their fields. Although this type of trial may not require the researcher's presence for planting or even perhaps for harvesting, it still demands a good deal of his time, in carefully selecting farmers and in visits during the growing season. In few cases is the simple distribution of a new variety or input to farmers and the reliance solely on their evaluations a worthwhile strategy. The researcher must visit the field at least several times, see under what conditions the innovation is being used, and make his own evaluation of the results. Therefore observation trials should be undertaken only with the realization that they are also trials, and that they will require some amount of the investigator's attention.

Contrasts between observation trial results and those of formal trials are sometimes striking, and may lead to new hypotheses. In one area, a new maize variety grown in trials did rather poorly, while in observation trials planted with local farmers it did quite well. Investigation showed that the primary difference in management between the two types of trials seemed to be manuring, which was not practiced in the fields offered for the formal trials. It is not unusual to find that poorer than average land is offered for a trial, while observations with small quantities of a new variety are planted by the farmer with special care. Attention to the results of both types of trials helps to establish a range of data and to identify critical variables which may limit the performance of the variety.

5.3 Follow-up on adoption of practices

In the second, and subsequent years of on-farm trials the researcher will want to do some follow-up on the activities of previous collaborators as an aid in assessing technologies that have been tested, whether or not they have yet become part of recommendations.[1/]

If a farmer has grown a new variety as part of an on-farm trial the previous year, it is most worthwhile checking to see whether he has planted the new variety again, on his own. In one maize area, many collaborators in one recommendation domain grew a new variety the following year, while few in another recommendation domain did so. The difference turned out to be the amount of insect attack that the variety suffered in storage in the latter domain. In another case, a number of farmers who had planted an early-maturing maize as part of a variety trial used it the following year in their own "experiments", in which they planted small quantities of the variety at various times of the year. Their experience provided valuable data on the range of planting dates possible for the new variety.

1/ Methods for formally assessing farmers' experiences with recommendations fall outside the scope of this paper. (See L. Harrington, "Farmer Assessment of Maize Recommendations in Northern Veracruz State, Mexico." Unpublished Ph.D dissertation, Michigan State University, 1980.)

Changes in management practices should also be noted. In one maize area, most farmers who had seen insecticide used to control ear worm in trials adopted insecticides the following year, on their own. This helped verify the importance of subsequent trials which concentrated on refining insecticide recommendations.

In the case of new varieties, it is necessary to follow their acceptance in the kitchen and in the market as well, to see if they are consumed by the farmer's family in the same way as local varieties, and if they can be sold as easily as local types. In a cassava program, neighboring farmers and merchants were invited to the harvest of variety trials. Their opinions as to the market potential of the various types proved valuable in selecting varieties for further testing. Samples of the varieties were also distributed so that they could be prepared in the farmer's homes and opinions on the palatability of the new varieties were then collected.

5.4 Other activities with farmers

The more contact the researcher has with collaborating farmers the better.[1/] It has been found valuable to take farmers to visit each other's trials, for they are particularly sensitive to small variations in farming practices within their own environment and often make valuable observations. One program has experimented with having several farmers from the same recommendation domain assist in the harvest of the various trials. The same program found it useful to call together the collaborators of a particular domain after harvest to discuss the results and propose experiments or improvements for the following year.

Taking account of what farmers believe to be important has led to experiments with other technologies or even with crops which had not been

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1/ For a detailed description of ways to involve farmers in an on-farm research program, see Kirkby, R., P. Gallegos, T. Cornick, "On-Farm Research Methods: A Comparative Approach. Experiences of the Quimiag-Penipe Project, Ecuador". Cornell International Agricultural Mimeograph Series, Cornell University, Ithaca, New York, 1981.

considered. In one case, although trials had focused on maize, the principal crop of the area, farmers expressed great interest in research that would deal with the diseases that were affecting their broad beans, and the following year new broad bean varieties were screened in the area. In another program, farmers' complaints about storage losses led to the development of a series of on-farm storage trials.

Throughout the year the researcher will also want to make sure he works closely with extension agents, not only in the management of the trials, but in other activities as well. Demonstrations or field days can be jointly organized. As the on-farm research progresses and recommendations begin to be produced, the researcher and the extension agent begin to share another common interest: they both will want to measure the adoption rates of recommended practices, to analyze the appropriateness of the recommendations and the effectiveness of their communication methods.

5.5 Summary

The management of on-farm trials requires the researcher's full time presence in the target area, and it is possible to take advantage of this to collect data which is useful in interpreting results and planning future work. Among the strategies that have been found useful are:

1. Decide what data (prices, meteorological, labor supply, etc.) are necessary and design forms to record and store this information.

2. Be alert for ways of increasing interchange with farmers; talk to farmers who are not trial collaborators and visit their fields.

3. Develop contacts with local merchants, traders and others who are good sources of information on markets.

4. Learn about other research that is, or has been, done in the area.

5. Follow the experiences of former collaborators with new technologies.

6. Maintain good contacts with local extension personnel and plan work with them.

7. Develop a list of research questions and decide whether trials, less formal experiments, informal enquiry or survey methods are required to answer them.

6. CONCLUSIONS

This paper has described various types of data that are available to researchers in the course of on-farm experimentation. Although agronomic data derived from the trials is the basic information sought in this phase of on-farm research, no attempt has been made to suggest exactly what type of biological information should be obtained, nor how it should be analyzed. The object has been instead to point out that the way in which the field research is organized can make an important contribution to the validity and completeness of this type of data, and that a wide variety of information is available to the researcher to help interpret the agronomic observations.

Most programs in on-farm research operate under severe budgetary constraints, and the one described in this paper is no exception. Thus data collection methods must take account of these limitations and take maximum advantage of the resources that are available. The basic organization of data collection requires: careful planning of the trials, including the accomodation of each site selected to the overall research strategy; attention to developing participating farmers as collaborators and valuable sources of information; the establishment of means of recording and storing all of the data so that they are available for analysis; a conscious effort to collect supplementary information from as wide a range of sources as possible; and the coordination of research efforts with extension services.

Although it is possible to develop guidelines for managing data collection during on-farm experimentation, the experience and imagination of the

researcher are equally important, for no set of fixed procedures can substitue for the ability to take a flexible, open-minded approach to problems in the field. Much of the information obtained in the course of the research is tentative, at times even contradictory. It comes in bits and pieces and requires much of the researcher's time in trying to fit it together into logical patterns. Careful recording and maintenance of relevant data is essential to the process. It becomes part of the dynamic of on-farm research, where this year's uncertainties are transformed into next year's experiments. The researcher is of course involved in data collection and analysis in order to produce recommendations as rapidly as possible, but an equally important product of the process is a set of hypotheses to be tested in subsequent cycles.

Finally, it should be noted that the data collection procedures of on-farm experimentation are complex and varied because the problems that they treat are so difficult. The concepts of on-farm research have been developed in response to the fact that many programs of technology transfer in rural development have failed because they have not taken account of the many factors that impinge on small farmer decision-making. The approach described here asks that the researcher collect a wide range of information through a variety of techniques, in order to understand the place of his target crops within the total farming system. His job is to use on-farm experiments as a basis for establishing a research partnership with farmers and extension agents which will improve the effectiveness of agricultural investigation.

APPENDIX

Field book used in an on-farm research program investigating new technologies for maize and beans in Imbabura Province, Ecuador.

(1) PLANTING DATA

Location _____ Farmer _____ Trial _____

Planting date _____

Type of trial _____ Design _____

Size of trial _____

Length of rows _____ Distance between rows _____

No. seeds per hole: Maize _____ Beans _____ _____ _____
(other)

Method of planting beans _____

Crop	Variety	Source of seed
Maize	_____	_____
	_____	_____
	_____	_____
Beans	_____	_____
	_____	_____
	_____	_____

Fertilization of plot (including that of the farmer) _____

_____

_____

Weed control _____

_____

Insect control _____

_____

Other operations at planting _____

_____

Soil moisture _____

(2) FIELD PLAN

Location_____ Farmer_____ Trial_____

KEY

(3) CHARACTERISTICS OF THE PLOT

Location_____ Farmer_____ Trial_____

Cropping History

Year	Crop(s)	Fertilization

Preparation of the plot

Activity	Method
Plow 1	
2	
Harrow 1	
2	
Furrow	

Slope_____

Irrigation? Yes / No Frequency of irrigation_____

Soil type_____

Soil analysis: N_____ P_____ K_____ Zn_____ Mn_____ _____ ____

Altitude_____

(4) MANAGEMENT OF THE TRIAL

Location _____ Farmer _____ Trial _____

ACTIVITY	DATE	METHOD
Replanting		
Weed control 1		
2		
3		
4		
5		
Fertilization 1		
2		
Other 1		
2		
3		
4		
Irrigation 1		
2		
3		
4		
5		
6		

Other observations _____

_____

_____

(5) OBSERVATIONS ON THE FARMER'S CROP

Location _____ Farmer _____ Trial _____

Crop _____

Location of the field under observation _____

Slope _____ Soil type _____

Cropping history

Year	Crop(s)	Fertilization

Planting Density

Crop	Variety	No. of seeds per hole:	Distance between	
			Plants	Rows

Management

Activity		Date	Method
Weed control	1		
	2		
	3		
	4		
Fertilization	1		
	2		
Other	1		
	2		

Irrigation during year _____

(5) OBSERVATIONS ON THE FARMER'S CROP (Cont.)

What are the principal insect problems in the field? _____

_____

_____

What are the principal disease problems in the crop? _____

_____

_____

What are the most common weeds? _____

_____

_____

Source of seed used in the field: _____

_____

_____

Other observations:

(6) CHARACTERISTICS OF THE FARMER

Number of hectares worked this year:

Own_____ Rented_____ Sharecropped_____

Principal crops: 1)_____ 3)_____

2)_____ 4)_____

In which crops does he hire labor?_____

_____

In which crops does he use fertilizer?_____

_____

Use of other agro-chemicals_____

_____

Which crops are sold? 1)_____

2)_____

3)_____

4)_____

Off-farm employment or activities:_____

_____

_____

Problems in storage of crops:_____

_____

_____

Other observations:

(7) AGRONOMIC DATA

Location _____ Farmer _____ Trial _____

Crop _____

Block	No.	% Germ.	Days to Flowering	Diseases				Damage				Other observations			
				Date	Classification	Date	Classification	Date	%	Date	%	Date		Date	

(8) HARVEST DATA

Location _____ Farmer _____ Trial _____

Each treatment harvested is _____ rows of _____ meters.

Area of each treatment harvested: _____ square meters.

Block	No.	Number of plants	Number of ears			Weight			% humidity	% shelling	Dry weight	Beans			
			Good	Rotten	Total	Good	Rotten	Total				Number of plants	Weight	% humidity	Dry weight

(9) OBSERVATIONS OF THE TRIAL

(To be filled in on each visit to the trial)

Location _____ Farmer _____ Trial _____

Date _____ Technician _____

Was farmer present? Yes / No

Work on the plot since last visit: _____

_____

Development of the crop _____

_____

Insects _____

_____

Diseases _____

_____

Weeds _____

_____

Weather conditions _____

_____

Other observations: