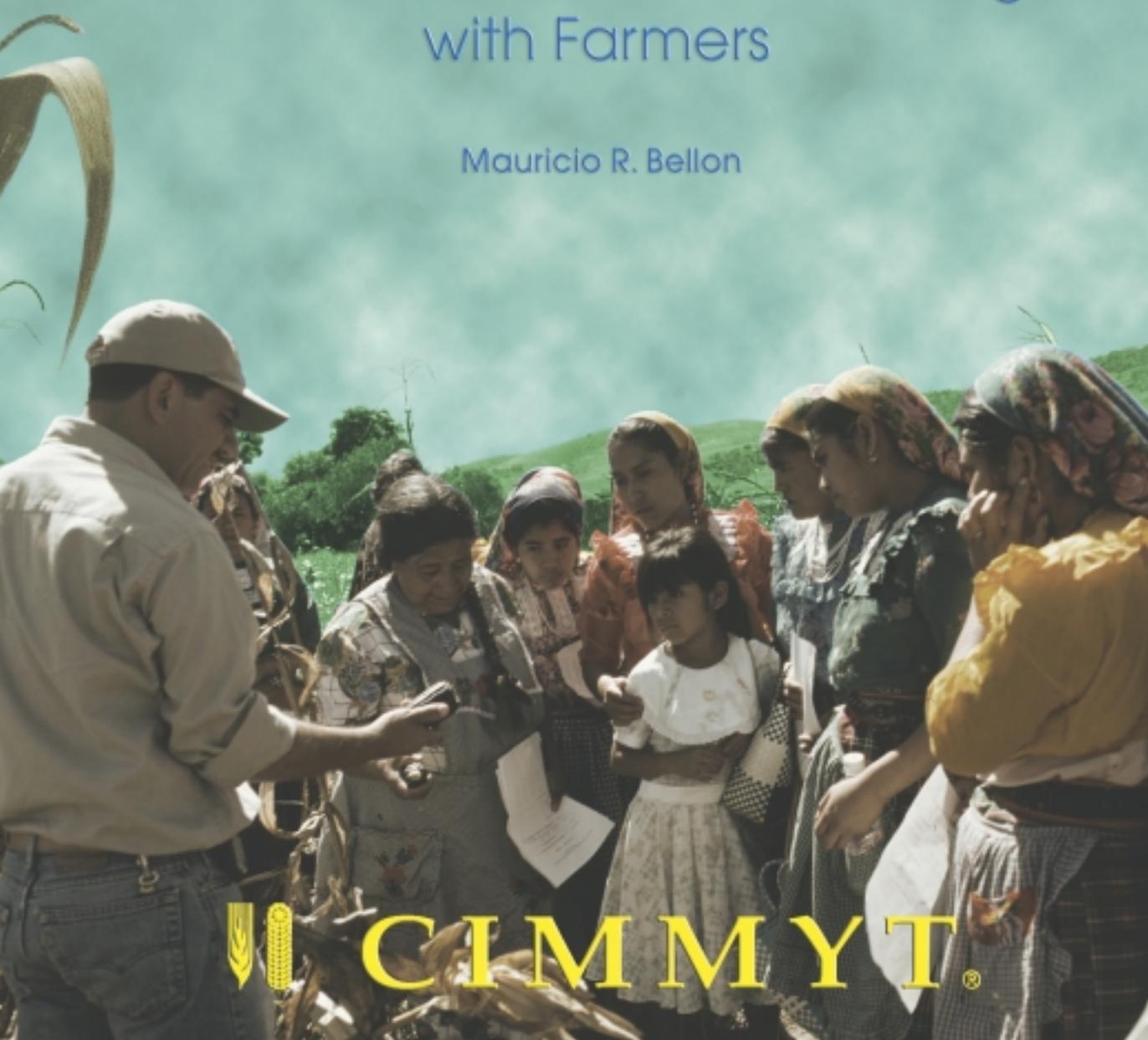


Participatory Research Methods for Technology Evaluation:

A Manual for Scientists Working
with Farmers

Mauricio R. Bellon



CIMMYT[®]

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Abstract: This manual presents methods that enable agricultural scientist and farmers to evaluate technologies/practices jointly. The methods are specifically designed for participatory research on germplasm and soil fertility technologies, and they are illustrated with actual examples from three research projects. The manual begins by reviewing conceptual issues that are important in participatory research and presents information to assist researchers in selecting research sites and fieldwork participants. Next, the manual describes the rationale and associated methods for each major activity in farmer participatory research: diagnosing farmers' conditions, evaluating current and new technologies/practices, and assessing their impact. Goals, procedures, advantages, and limitations of each method are outlined. The manual also presents detailed information on analyzing data gathered through participatory methods, discusses differences between gathering data through participatory methods and more traditional structured farm surveys, and offers examples, based on field experience, of the choices and strategies involved in applying these methods.

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Foreword

This manual on farmer participatory research continues a tradition in the CIMMYT Economics Program of developing practical, instructive guides that are based on direct experience in field research. The methods presented here have been tested and revised in rural communities over the course of many years, and they lend themselves to fieldwork in a wide range of settings.

I am pleased that the Economics Program's evolving experience in working with farmers can be made available to a wider audience through this manual. Although these methods may not be suited to every situation that researchers are likely to encounter—after all, each rural community, household, farmer, and researcher is different—I believe that readers will certainly benefit from the advice and experience distilled here, just as we shall benefit from their recommendations after they have used this manual in their own fieldwork.

It is important for readers to understand that this publication does not pretend to offer the final word in farmer participatory experimentation. Participatory research methods will continue to develop as researchers and farmers continue to learn from each other. For the present, however, Mauricio Bellon has given us a valuable guide to the insights as well as the uncertainties that agricultural scientists often experience as they seek to make the research process more inclusive—and ultimately more rewarding—for all who participate.

PRABHU L. PINGALI

Director, CIMMYT Economics Program

Preface

This manual presents a set of methods for agricultural scientists and farmers to evaluate technologies/practices jointly. It is intended for agricultural scientists who work on the development, adaptation, or diffusion of agricultural technology and want to incorporate a participatory approach in their work. It focuses specifically on methods that can be applied to germplasm and soil fertility technologies.

The manual describes how to collect, analyze, and use information for participatory research. The user of this manual should pick and choose the relevant methodologies for his/her work rather than launching into some pre-determined scheme. The methods are presented under three main activities in farmer participatory research: diagnosing farmers' conditions, evaluating current and new technologies and practices, and assessing the impact of new technologies and practices. Ideally these activities should fit into a coherent plan for developing technology, rather than being one-off exercises.

The methods presented here are illustrated with examples from three research projects. The first project involves participatory conservation and improvement of maize landraces in the Central Valleys of Oaxaca, Mexico. The second concerns participatory evaluation of soil fertility improvement technologies in Chihota, Zimbabwe. The third project is a more conventional study in a community of central Chiapas, Mexico, where participatory methodologies were used to understand the relationship between farmers' local knowledge of maize diversity and soils and their crop management decisions.

The manual begins with an introduction to participatory research, especially to some of the conceptual issues that are important in this kind of research. This introductory section is followed by an overview of the three projects used as examples throughout the manual so that the reader understands the context of the examples. Next, three central concerns of participatory research are explored: Where should this kind of research be undertaken? Who should participate? How should the participants work together?

The next sections of the manual describe the participatory methods associated with the three main activities mentioned above: diagnosing farmers' conditions, evaluating current and new technologies/practices, and assessing their impact. First, the rationale behind each participatory research activity is given. (For example, why do researchers need to conduct a participatory diagnosis of farmers' conditions?) Afterward, the methods corresponding to each activity are explained. The goal of each method is outlined and the procedures are described. Methods are illustrated with examples from the projects mentioned earlier. Occasionally the examples present the

work of other researchers and, very occasionally, consist of hypothetical situations. Comments on each method, such as a discussion of its limitations and advice for its application, are presented as well.

This manual is not a comprehensive exposition of all methods available for farmer participatory research. It deals with the methods that I and my colleagues have experience in using. The strength of this approach is that the manual can provide sound examples of how the methods were applied, including their advantages and limitations in a variety of situations.

I wish to acknowledge the participants and funding agencies that supported the three projects used as examples in this manual. The project in Oaxaca, formally named “CG Maize Diversity Conservation: A Farmer-Scientist Collaborative Approach,” has been implemented jointly by the International Maize and Wheat Improvement Center (CIMMYT) and Mexico’s National Institute of Forestry, Agriculture, and Livestock Research (INIFAP), under a grant from the International Development Research Centre (IDRC), Ottawa, Canada. The author gratefully acknowledges the work of the project team (Melinda Smale, José Alfonso Aguirre Gómez, Julien Berthaud, Suketoshi Taba, Flavio Aragón, Irma Manuel Rosas, and Jorge Mendoza). The project in Chihota, formally named “Chihota Soil Fertility Project,” has been implemented jointly by CIMMYT and by Zimbabwe’s Department of Agricultural, Technical and Extension Services (Agritex) and Department of Research and Specialist Services (DR&SS). The project in Chihota is one activity of the Soil Fertility Management and Policy Network for Maize-Based Farming Systems (Soil Fert Net), funded by the Rockefeller Foundation. The list of participants is too long for all to be acknowledged, but I wish to recognize the work of Stephen R. Waddington, Peter Gambará, Tendai Gatsi, Timothy E. Machedemze, Christine Kuwaza, Johannes Karigwindi, Philip Tawuyandago, and Obert Maminimini. Finally, the project in Chiapas was funded by a grant from CIMMYT and implemented jointly by the author and Jean Risopoulos.

I hope that researchers who are interested in using a participatory approach in their work find this manual useful, and I would appreciate any suggestions on how to improve it. Finally, I would like to express my appreciation to the farmers and researchers who, over the years, have contributed to the teaching and learning experiences distilled in the pages that follow. I particularly wish to thank José Alfonso Aguirre Gómez for sharing his ideas on farmer experimentation, Angel Pita and Xóchitl Juárez for providing one of the examples used, Stephen R. Waddington, Malcolm Blackie, Robert Tripp, Jeffrey B. Bentley, Michael Morris, and Janet Lauderdale for comments on earlier drafts, Prabhu Pingali for his encouragement to write this document, Kelly Cassaday for editorial assistance, Miguel Mellado for design, and Marcelo Ortiz for production.

MAURICIO R. BELLON
CIMMYT, December 2000

An Introduction to Farmer Participatory Research

Farmer participation in agricultural research is more than talking to six farmers or putting ten experiments in their fields. Above all, it is a systematic dialogue between farmers and scientists to solve problems related to agriculture and ultimately increase the impact of agricultural research. By responding closely to farmers' concerns and conditions, researchers can develop technologies that are adopted more widely and that respond to important social issues such as equity and sustainability.

Developing this dialogue between farmers and scientists is not as simple as one might think, because farmers and scientists have different needs, world views, knowledge systems, methods, and tools. When it is successful, dialogue between farmers and scientists can lead to more productive, stable, equitable, and sustainable agricultural systems. Achieving this goal should be good for farmers, because it enhances their welfare; for scientists, because it increases their job efficiency; and for society in general, because it adds to the food supply and encourages the conservation of natural resources for future generations.

Farmer participatory research has been defined as "the collaboration of farmers and scientists in agricultural research and development" (Bentley 1994:140). The need to improve our understanding of farmers' conditions and incorporate their perspectives into the development and testing of new agricultural technology is not new. The current interest in farmer participation is related in large part to farming systems research (FSR) (Tripp 1989). The FSR perspective recognizes that most small farms are an integration of multiple enterprises that require the management of diverse household resources to meet a range of subsistence, income, and community goals. A farming systems perspective also implies a commitment to include farmers' criteria and goals when setting research priorities (Tripp and Woolley 1990).

What, then, is new about farmer participatory research (FPR) methodologies? How do they differ from the FSR approach? It is useful at this point to consider the four approaches to farmer participation described by Biggs (1989:3):

- *Contractual*: Scientists contract with farmers to provide land or services.
- *Consultative*: Scientists consult farmers about their problems and then develop solutions.

- *Collaborative*: Scientists and farmers collaborate as partners in the research process.
- *Collegiate*: Scientists work to strengthen farmers' informal research and development systems in rural areas.

Farming systems research has focused mainly on the first two approaches, whereas FPR stresses the third and, to a lesser extent, the fourth. Furthermore, FPR emphasizes three aspects of farmer participation, which are recognized by FSR but not given such importance:

- 1) Most farmers have extensive, well-developed knowledge of their environment, crops, and cropping practices.
- 2) Many farmers carry out experiments on their own and generate innovations.
- 3) Farmers actively exchange information and technologies.

A short review of each of these aspects of FPR follows.

Farmers' Local Knowledge

As anyone who has worked closely with farmers knows, they possess knowledge about their crops, their farming environment, and their socioeconomic conditions. In many instances they can clearly articulate the rationale behind their management practices and their decisions. This knowledge, which has been documented formally by numerous social and biological scientists, includes their soils and productive environments (Bellon and Taylor 1993; Kamangira 1997; Edwards 1987), their crops and crop varieties (Richards 1986; Sperling et al. 1993), insects and pests (Bentley 1992; Bentley and Rodriguez 2001), and soil and water management practices (Wilken 1987; Lamers and Feil 1995).

Understanding this knowledge is a fundamental step towards generating a dialogue between farmers and scientists. It is a key reference point that farmers use to make decisions and to communicate among themselves. Scientists need to understand farmers' knowledge if they want to contribute to farmers' welfare by providing new information to them, by developing appropriate technologies with them, or communicating effectively with them. To understand farmers' knowledge, scientists must first elicit and analyze it.

Farmers' knowledge can be classified into three categories: perceptions, taxonomies, and rules of thumb. Distinct methods are required to elicit and analyze these different kinds of knowledge.

Perceptions are mental images obtained through the senses. Perceptions may or may not be shared widely among a group of farmers. In some cases, they can be idiosyncratic, be particular to an individual, and bear little or no relation to the perceptions of other members of a group. In other cases, they may be widely shared and agreed upon.

For our purposes, farmers' perceptions about alternative technologies are very important, particularly the characteristics they identify to assess whether technologies are appropriate for them. This assessment of whether a technology is appropriate does not necessarily consist of an absolute "yes" or "no" answer. It usually consists of a ranking of technologies from more to less appropriate. Knowing how to elicit these perceptions, translate them into criteria for evaluating a technology, and use them to rank alternative technologies is important for working with farmers to develop and assess agricultural technologies.

Taxonomies are the abstraction of perceptions into categories with names and defined properties. Taxonomies are organized in a hierarchical fashion. They are usually widely shared, and a given population will show a high degree of agreement about them. Among farmers, the most widely studied taxonomies are associated with soils. For example, Kamangira (1997:43) reports that farmers in the Songani catchment area of Malawi have ten local soil classes, mainly referring to soil texture and color. Kamangira also demonstrates how farmers' soil knowledge can be combined with scientific views about soil classes. Sandor and Furbee (1996) show how soil classes are organized in a taxonomic tree, and they compare farmers' local knowledge with soil physiochemical properties and their scientific classification.

Rules of thumb are logical propositions that relate two events in a cause-and-effect relationship: "If *this* occurs (or if I do *this*), then *that* happens." These rules may or may not be widely shared or agreed upon within a group of farmers.

In many cases, rules of thumb relate taxonomies to specific behaviors. A farmer may think that if a modern maize variety is not weeded early in the season, its yield will decrease significantly, but he or she may not believe this to be the case for a traditional variety (e.g., Bellon 1991). The farmer may therefore have the rule of thumb that if he/she can ensure access to sufficient labor early on, he/she should plant a modern variety; otherwise, a traditional one should be planted.

The elicitation of rules of thumb and their organization into behavioral decision models for the adoption of

specific technologies has been developed by social scientists; see, for example, Gladwin (1979) for timing of fertilizer application and Franzel (1984) for the adoption of an improved maize variety. These methods are particularly complex, however, and they can be time consuming.

Farmers' knowledge should not be dismissed or, conversely, idealized. As mentioned previously, farmers know many things about farming and their conditions, but there are many other aspects of farming that they do not know or misunderstand. Farmers' knowledge is well developed for phenomena that can be observed readily and for relatively straightforward cause-and-effect relationships. Their knowledge of soils and potential productivity is usually well developed, as is their knowledge of weeds and their impact on crop development. For phenomena that are difficult to observe or that have multiple and sometimes interacting causal factors, farmers' knowledge is often less precise, or incorrect, or non-existent. For example, farmers' knowledge of pests and diseases is usually deficient or non-existent. Smallholders lack the microscopes or sophisticated equipment that would allow them to make finer or deeper observations beyond the capacity of the naked eye, and they also lack the basic scientific concepts, such as knowledge of microorganisms or genetics, that would allow them to interpret many of their observations (Bentley 1994). Furthermore, farmers' knowledge may be inadequate in the presence of extremely rapid technical change, since farmers may not have enough experience with a technology to have understood all its dimensions.

One should not assume that farmers' knowledge leads to specific behaviors or vice versa, just as knowing that smoking is harmful certainly does not deter many people from smoking. As anthropologists frequently find, actual behavior deviates from and often contradicts the cultural rules of appropriate behavior (Johnson 1974). People often make unarticulated decisions that, though subconscious, have a definite impact on their behavior (Gladwin and Murtaugh 1980). In participatory research, we are particularly interested in how knowledge affects behavior and how behavior affects knowledge. For this reason, it is not enough simply to elicit and appreciate farmers' knowledge; we also need to link that knowledge to specific behaviors and vice versa. When interacting with farmers, scientists should always ask themselves, "If what they are telling us is true, what should we expect to see in their behavior?" and, if possible, probe for it. This attitude of scientists towards farmers should not be interpreted as arrogant and distrustful but rather should be seen as a desire to understand farmers better. Understanding evolves from testing perceptions and expectations against reality. Scientists should also keep in mind that many farmers may have a similar attitude towards scientists.

Finally, it should be pointed out that farmers' knowledge is dynamic. Farmers incorporate new information and concepts from extension, schools, input suppliers, the media, and others into their knowledge base and abandon other knowledge. They are particularly likely to create new categories or terms that reflect changes springing from newly adopted technologies. The response of varieties to new inputs such as fertilizers or herbicides may generate local concepts such as "sturdy" and "delicate" varieties: sturdy varieties can withstand delays in

weeding and/or fertilizer application without a substantial decrease in yield, whereas delicate ones cannot (Bellon 1991). In some cases, knowledge that proved correct under earlier circumstances may now lead to poor decisions. For example, fire is a common means of managing crop residues in the tropics. Fire is essential in swidden agriculture, and it may not be harmful provided that fallow periods are long enough to allow natural vegetation to regenerate and restore lost nutrients. Nevertheless, in an intensive tropical agricultural system its use is questionable at best and disastrous at worst. In these systems, using fire to recycle nutrients often results in their depletion; although nutrients become readily available, the efficiency of nutrient release is low (Lal 1987). It is important to identify such knowledge and try to modify it, although this may be difficult.

Farmers' Experiments

The fact that small-scale farmers in the developing world conduct experiments on their own is well documented (Johnson 1972; Richards 1986) and has become a pillar of farmer participatory research (e.g., Ashby et al. 1995; Buckles 1993). Farmers' experiments are important because they promote knowledge and evaluation of new and unproven technologies without jeopardizing farmers' livelihoods or scarce resources. These experiments may be farmers' basis for generating and adapting new technological options that fit their specific needs and conditions.

Farmers conduct different types of experiments (Rhodes and Bebbington 1988; Scoones et al. 1996):

- curiosity experiments—just to see what happens;

- problem-solving experiments—to address a specific problem they face;
- adaptation experiments—to adapt new technologies to known environments or known technologies to new environments; and
- fortuitous experiments—chance events that lead to changes in practices, which in turn lead to a new learning experience.

In the farmer-scientist interaction, the adaptation and problem-solving experiments are, respectively, the most relevant. The most common experiments involve comparing a new variety with a familiar one by planting a few rows of the former next to the latter (adaptation experiment). Scoones et al. (1996) report an example of a problem-solving experiment in which a farmer tested various planting strategies to improve sunflower germination.

Farmers' and scientists' experiments often differ (Bentley 1994; Perales 1993). Three key differences are:

1. Farmers' experiments commonly lack a control treatment.¹ Scoones et al. (1996:135) say that the farmer may carry the control "in the head."
2. In the fields where farmers' experiments are located, many factors may be modified simultaneously, or extraneous factors may not be controlled for.

3. Farmers usually do not replicate an experiment, although it is often said that they do so over time. For example, they may compare the current season's results with those of previous seasons.

From a scientist's point of view, these characteristics make farmers' experiments hard to analyze and interpret. As mentioned previously, the main source of data and evidence for farmers is their own observations; they usually lack instruments to observe such phenomena as nematodes or lack conceptual tools such as statistics to isolate one event from another. This difference serves to emphasize the point that many of scientists' experiments may not make sense to farmers, who probably lack the instruments and conceptual background to employ the scientific method.

Farmers and scientists can have different degrees of interaction or involvement in the design, management, and analysis of experiments. Different degrees of involvement are appropriate for accomplishing different objectives (Table 1). On one end of the continuum, the experiment is located in the farmer's field, but the scientist designs, manages, and analyzes it. This strategy may be effective for developing a basic

Table 1. Levels of interaction between farmers and scientists and possible outputs

Degree of interaction		
Scientist	Farmer	Possible output for which interaction is appropriate
Designs, manages, analyzes	Provides the field	An understanding of processes, components of new technology under farmers' biophysical conditions
Designs, analyzes	Manages, provides input into the analysis	An understanding of processes, components of new technology under farmers' biophysical conditions and their management
Designs, manages, analyzes	Designs, manages, analyzes	Joint evaluation and modification of a new technology
Training, guidelines, technical support	Designs, manages, analyzes	Capacity building, empowerment

¹ In many cases farmers conduct simple experiments, however, varying one factor at a time and comparing the results with their normal practice. These experiments are easier to interpret and comparable to those made by scientists.

understanding of processes or of the components of a new technology in the biophysical conditions where farmers operate. Further along the continuum, the experiment is located in the farmer's field; the scientist designs it and analyzes the results, but the farmer manages it and provides the scientist with some input to interpret the results. This form of experimentation brings the farmer's actual management into consideration.

Even further along the continuum, the farmer and scientist jointly design, manage, and analyze the experiment. This approach may be particularly useful for jointly evaluating a new technology and modifying it. Finally, at the other end of the continuum, the farmer designs, manages, and analyzes the experiment, which is located in one of his or her own fields. The scientist helps to improve the farmer's experimental methodology through training, provides some basic guidelines, and, in the early stages, offers technical support. Eventually, however, the farmer performs these tasks completely independently. This approach is appropriate for building capacity, empowering farmers, and fostering a process that perhaps can continue without the scientist's long-term involvement. We will return to these themes later in the discussion of guidelines for farmer-scientist experiments.

Farmers' Exchange of Information and Technologies

Farmers constantly share information about things that are important to them. These exchanges have been particularly well documented for seeds of different

crops and varieties (Cromwell 1990; Sperling and Loevinsohn 1993). Many innovations have spread from farmer to farmer without the intervention of any formal agricultural extension services, such as the diffusion of the moldboard plow in many parts of Africa (M. Blackie, personal communication) or the diffusion of velvetbean (*Mucuna* spp.) in Mesoamerica (Buckles 1995). Farmers exchange information as well. For example, farmers in Portugal exchanged a great deal of information through their laborers, who worked for different farmers and shared ideas such as using silage cutting machines (Bentley, personal communication).

Information and technology commonly are diffused through a social network, which can be defined as a group of people who share certain bonds, usually as a result of family or traditional social obligations. Social networks may play a fundamental role in the adoption of new technologies, particularly if they require collective action, such as constructing contour dikes for soil erosion and water control, which cannot be accomplished by a single individual (Smale and Ruttan 1997). Social networks also affect the flow of farmers' own experimental information. For example, the propensity of rice farmers in Sierra Leone to discuss new rice varieties (Richards 1986) contrasts with the concern of many Ghanaian farmers that excessive interest in a neighbor's farming activities may be linked to witchcraft (Tripp 2000).

Exchanges of information and technology may extend beyond these networks to include casual contacts made through travel, migration, and off-farm labor. Social barriers to these exchanges also exist, however; social networks may include only members of

one village, ethnic group, or social class. Diffusion of information and innovations outside the network may be difficult, and the network itself in some cases may act as a barrier rather than a conduit. For example, seed flows may take place mainly within a village, with few flows occurring between villages (Smale et al. 1999). Another interesting case is reported by Scoones et al. (1996), who point out that fear of witchcraft or of

generating envy from others may prompt farmers to conceal their knowledge and innovations.

It is important to keep in mind that farmers are not isolated individuals but members of social networks, and that these networks can play an important role in the diffusion, or lack thereof, of information and technology.

An Overview of the Projects Used as Examples in This Manual

Throughout this manual, experiences drawn from three participatory research projects provide examples of how the methods presented here have been applied in the field. The projects have involved smallholder farming communities in transition and concentrated on issues related to maize germplasm management and/or soil fertility. As of the writing of this manual, all of the projects are at different stages of completion. An overview of each project is presented here to give the reader an understanding of the various contexts from which the examples are taken. The specific methods used in each project and described in this manual are italicized.

The Oaxaca Project: Conserving Maize Diversity

In the Central Valleys of Oaxaca, Mexico, a project has been undertaken to determine whether it is possible to improve maize productivity while maintaining or enhancing genetic diversity. (“Maize productivity” is defined broadly in terms of yield, yield stability, and other characteristics that interest farmers.) The project develops and compares participatory interventions

with small-scale farmers in six communities in the Central Valleys. Through the project, farmers gain access to the diversity of maize landraces in the region, are trained in seed selection and management techniques, and learn principles to assist them in maintaining the characteristics of landraces they value.

Researchers selected the Central Valleys for this project for a number of reasons. One of the most important reasons is that farmers in the region have a long tradition of cultivating maize and have maintained the diversity of their landraces to the present. These landraces have considerable value for agriculture beyond the Central Valleys, because they have contributed to the development of improved, drought-tolerant maize cultivars that are popular elsewhere in Mexico. Modern maize varieties bred by researchers have had an almost negligible impact in the Central Valleys, and while their virtual absence may or may not have helped to conserve maize diversity in the region, it is a signal that scientific research has not provided farmers with new agricultural options.

The region is also ethnically diverse and agroecologically heterogeneous, and despite economic changes in recent years, Central Valley communities continue to place a recognizable

emphasis on their indigenous culture, including culinary practices for maize. There is no guarantee that farmers will remain interested in maintaining the diversity of their maize cultivars, however, so it is important to start exploring options for supporting this interest, including scientific research that responds closely to farmers' interests, needs, and constraints.

The Oaxaca Project is divided into three components: 1) diagnosis, 2) the development and evaluation of interventions, and 3) impact assessment.

The diagnosis comprised several activities that made use of participatory research methodologies. As a starting point, researchers collected samples of maize landraces that were thought to represent the spectrum of maize diversity in the Central Valleys. Landraces were collected in 15 communities that scientists chose for their range of agroecological and socioeconomic conditions and ethnic and cultural multiplicity. The researchers were also guided by some prior knowledge of the distribution of maize diversity. In each community, the scientists relied on eliciting the *local crop taxonomy* from a set of *key informants* to identify the diversity of landraces present and locate farmers who were willing to donate samples. Although a lack of funding prevented in-depth participatory research from being conducted in these 15 communities, a *site selection* exercise was done to choose a subset of six communities where most of the research would take place.

To assess the heterogeneity of farming households in the six communities and gain a clearer understanding of their goals, resources, and constraints, as well as the spatial and temporal variability

that affected their agriculture, a set of participatory methodologies was employed, mainly based on focus *group* discussions and *key informants*. These methodologies included the elicitation of the *local soil taxonomy*, *local crop taxonomy*, *local classification of farmers*, *local classification of climate*, and *wealth ranking*.

Additionally, a *baseline survey* with a *random sample* of 40 households per community was done to obtain a representative sample of households in the communities. This sample would serve as a control group for checking or comparing information obtained through participatory methods; it would also make it possible to perform the *impact assessment* when the project ended. The *baseline survey* included a systematic evaluation of the characteristics farmers considered important (derived from the *local crop taxonomy*) in maize landraces and how those characteristics were distributed among the landraces they grew (*demand and supply of characteristics*).

To evaluate the agronomic performance and morphological diversity of the collected landraces (information that was particularly important to the scientists), trials including all of the landraces were established in the 15 communities where they were collected. The trials were planted in farmers' fields but managed by scientists (*contractual approach*). Six field days were organized so farmers could view three of the trials: three field days were held when the maize plants reached physiological maturity, and three at harvest. At each field day, farmers were invited to see the landraces and to "vote" for the ones they liked. The farmers walked through the trial and recorded the numbers of all of the plots containing the landraces they liked. Researchers viewed the participants'

choices as “votes” and assumed that the higher the percentage of farmers voting for a maize landrace, the more potentially valuable it was to them. The purpose of this exercise was to obtain a “quick and dirty” sorting of the maize samples into a gradient of farmers’ interest. A *minimum set of socioeconomic indicators* was collected from participants so that researchers would have some idea of who participated in the field days. Based on the data from the agronomic evaluation and farmers’ votes, 16 landraces and one improved variety were chosen for the second component of the project—the “interventions” component.

An important issue in this kind of research is how to move from the diagnosis to the selection of specific interventions. In the Central Valleys, the diagnosis showed that farmers valued many characteristics in their maize landraces, especially traits related to consumption. The field days, which showed the diversity of maize collected in the region, drew much attention and participation from farmers, and the voting exercise suggested that there was no “best” or “ideal” variety. Instead, farmers appeared to want a range of varieties (i.e., a range of diversity). Although the collection of local landraces encompassed many different maize types, farmers actually planted only a mean of 1.6 varieties per household, and researchers concluded that farmers wanted *access* to diversity. They learned which specific traits farmers valued most in a maize variety: it tolerated drought, resisted insects in storage, and produced “something” even in bad years. Given the resources available to the project, none of these traits were easily amenable for breeding interventions, but they could be addressed through practices,

such as improved storage and seed selection practices. The diagnosis showed that current storage and seed selection practices were not meeting farmers’ needs and that training could play an important role in modifying farmers’ current practices. The training was based on understanding farmers’ knowledge about these issues and trying to provide general principles that farmers themselves could use, following Bentley’s ideas about the interaction between local and scientific knowledge (Bentley 1994).

The interventions consisted of giving farmers in the six communities access to the diversity of maize landraces present in the region (the 17 materials selected in the field days), training them in seed selection and management techniques, and teaching principles to help them maintain the characteristics of landraces they valued. These interventions were available to anybody who wanted to participate, and open invitations and publicity encouraged farmers to participate. Researchers used this approach because they were interested in understanding who participates, the incentives for participation, who benefits from participation, and how they benefit.

To give participants access to the diversity of maize landraces, *demonstration plots* were established in the six communities and more *field days* were organized. During the field days, participants saw the plants and ears of the maize landraces being offered and received information on their performance in the field. After visiting the demonstration plots, farmers could purchase seed of any material they wanted. The idea of giving access to this diversity was to facilitate farmer experimentation with the landraces. With

a subset of farmers who were skeptical but also highly motivated, researchers established a set of *farmers' experiments*.

To train and teach farmers, five training sessions were offered in their communities, starting with a discussion of their knowledge about maize reproduction and perceptions of maize improvement. Additional sessions taught basic principles of maize reproduction, principles of seed selection in the field and in the household (including hands-on exercises in the field), and principles and techniques for storing seed and grain.

The third component of the project, impact assessment, includes the *baseline survey* (described earlier) and the *monitoring* of a sample of farmers who participated in each intervention. Monitoring consists of systematic, yearly interviews with this sample of farmers; the interviews cover their participation and their perceptions of the advantages and disadvantages of their participation. A set of *impact indicators* was also established by scientists and participating farmers. To assess the distribution of participants and impacts by socioeconomic status, a *wealth ranking* was done for all participants.

To date, results of the project indicate that participating farmers in the study area demand access to diversity, particularly to relatively scarce maize types. Farmers value many different characteristics in their maize landraces, especially traits related to consumption. Among women, colored maize types and rarer types are in particular demand, and diversity is enhanced when these preferences are taken into account. The subset of maize types jointly selected by farmers and scientists for distribution was a success. In the project's first year

(1999), 804 kg of seed were sold in 197 purchase events (a farmer purchasing seed of a landrace), with a total of 123 farmers purchasing seed (the same farmer could purchase seed of more than one landrace). The training activities showed that participating farmers often did not understand certain aspects of maize reproduction, but once this knowledge was provided, at least some of them were keen to try new management techniques. Farmers who participated in the joint experiments verified that the "experimental" maize types worked well under their circumstances, and some of the types were considered to be even better than their own landraces, used as controls in the experiments.

The Chihota Project: Improving Soil Fertility

In Zimbabwe, the Chihota Soil Fertility Project seeks to expose farmers to a set of technologies for improving soil fertility and to gain farmers' assessment of those technologies in their own terms. Based on this assessment, project participants are identifying the potential for farmers to adopt each technology and the constraints that could impede adoption. Participants are also identifying any modifications required in the technologies or in institutional conditions (i.e., market circumstances, policies) that could diminish or eliminate those constraints. The soil fertility technologies being assessed in Chihota were developed by a network of agricultural scientists in Zimbabwe and Malawi (the Soil Fertility Management and Policy Network for Maize-Based Farming Systems, also known as Soil Fert Net).

Infertile soils are a major constraint to food production in Southern Africa, particularly in the communal areas of Zimbabwe, where smallholders with few resources rely on agriculture to survive. For these farm households, the development and adoption of new technologies to enhance soil fertility are an important means of improving food security.

Chihota, a communal area in subhumid northeastern Zimbabwe, was selected as the site of this pilot project because it has very infertile soils, maize is the most important crop, and the government agricultural extension service (the Department of Agricultural, Technical, and Extension Services, known as Agritex) has an active presence in the area. Chihota is located in Marondera District, Mashonaland East Province, and has nine wards, each with five or six villages. *Contrasting conditions* prevail in Chihota with regard to farmers' experience with soil fertility technologies: farmers in some of the wards have been exposed to soil fertility research, but farmers in other wards have not.

Like the Oaxaca Project, the Chihota Project has three components:

- 1) diagnosis, 2) interventions, and
- 3) impact assessment.

The diagnosis component comprised several activities in which participatory research methodologies were used. To assess the heterogeneity of farming households in Chihota and gain a clearer understanding of their goals, resources, and constraints, as well as the spatial and temporal variability that affected their agriculture, a set of participatory methodologies was employed. Four wards were selected for the diagnosis; soil fertility research had been conducted

only in two of them. In each ward, focus group discussions were organized with farmers working closely with Agritex (altogether, ten focus groups participated). The group discussions were used to elicit the *local soil taxonomy*, *local classification of farmers*, and *local classification of climate*. These classifications were used as a framework for discussing and identifying the technological options available to improve soil conditions and the constraints to their use (*eliciting constraints on using a technology*). Research collected a *minimum set of socioeconomic indicators* from all participants to gain an idea of who the participants were.

Additionally, a *baseline survey* with a *random sample* of 258 households was done to obtain a representative sample of all nine wards in Chihota. The survey was designed specifically to address many of the issues identified in the participatory diagnosis, particularly the type and amount of knowledge that farmers have about soil improvement practices. The survey helped researchers enhance their understanding of farmers' problems and perceptions. The sample serves as a control group for checking or comparing information obtained through participatory methods; it also makes it possible to perform the *impact assessment* when the project ends. The baseline survey included a systematic evaluation of farmers' knowledge of different soil improvement technologies.

As noted, an important issue in this kind of research is how to move from the diagnosis to the selection of specific interventions. The Chihota diagnosis revealed that farmers were concerned about many issues related to soil improvement technologies and

suggested that knowledge of such technologies was a particularly important issue for farmers. Farmers needed to be exposed to the technologies and learn more about them, so the interventions focused on enabling farmers to try soil improvement technologies under their own circumstances, using their own criteria.

The implementation component of the Chihota Project consisted of organizing many *demonstration plots* with farmers in their fields and of organizing *field days* to generate discussion and feedback among farmers and scientists.

The demonstration plots were set up and managed by groups of farmers in their communities in association with an Agritex extension worker. The plots were not only a demonstration but played the role of *farmer experiments* so that participating farmers could assess the technologies, which were:

- lime in combination with fertilizer;
- velvet bean (*Mucuna pruriens*) and sunnhemp (*Crotalaria* sp.), used as a green manure sole crop or intercrop with maize; and
- cereal legume rotations.

These technologies were chosen from a larger set of potential interventions by matching probable solutions from previous on-farm soil fertility research to the problems that Chihota farmers identified.

During the middle and end of the maize growing season, *field days* were organized. At the field days, farmers from the communities where the demonstrations were established visited them and discussed the pros and cons of the technologies with the farmers in charge of the demonstration plots. Agritex officers and scientists also

participated in the discussions. The discussions were documented to provide feedback to scientists. An important focus of the discussions was to identify the criteria (in other words, the characteristics) that farmers used to judge the technologies and to understand how farmers assessed the technologies (*eliciting farmers' perceptions of technologies*). A small, individual survey was done to quantify the perceptions of 85 farmers who belonged to the groups that helped conduct the demonstrations.

The impact assessment component of the Chihota Project remains to be implemented, except for the *baseline survey*. The impact assessment will entail *monitoring* a sample of farmers who participated in demonstration plots, who attended field days, and who did not participate at all. These farmers will be systematically interviewed about their participation, their perceptions of the advantages and disadvantages of their participation, and their perceptions of the advantages and disadvantages of the technologies. (The feedback exercise held during the field days was also a form of monitoring.) A set of *impact indicators* will also be established by scientists and participating farmers.

To date, results of the Chihota Project indicate that farmers who have evaluated the soil fertility improvement technologies regard them very positively. However, farmers perceive that poor access to inputs and a lack of specialized knowledge are the most binding constraints to adopting the technologies. This finding suggests that a fundamental step toward promoting adoption of the technologies would be to develop mechanisms for providing knowledge and inputs. As knowledge and input constraints loosen, labor and land

constraints may become more important. Given farmers' limited ability to generate surpluses (and cash) from farming, and given the alternative uses of those surpluses, there is a need to understand how farmers can finance the adoption of the technologies. Poor availability and accessibility of implements may also be a constraining factor that establishes the upper ceiling to adoption.

The Chiapas Project: Linking Farmers' Local Knowledge and Crop Management Decisions

In central Chiapas, Mexico, the Chiapas Project aimed to understand the relationship between farmers' local knowledge of maize varieties and soil types and their crop management decisions, including decisions about which varieties to plant, where to plant them, and how to manage them in terms of soil preparation, fertilizer use, and weeding. This project, unlike the two projects discussed previously, included no intervention and therefore no impact assessment *per se*. Many participatory diagnostic methodologies were employed, however, and the project had an important emphasis on eliciting and understanding farmers' local knowledge.

This fieldwork for the project was conducted during two periods, 1988-89 and 1998. *Key informants* were interviewed to elicit the *local crop (maize)* and *soil taxonomies*. Focus groups also discussed the taxonomies and how they were related (*advantages and disadvantages of different soil types and maize varieties, what variety to plant in which type of soil, and so on*). A questionnaire was applied to a *random sample* of farmers in both periods. In the second period, the

questionnaire included a systematic evaluation of the characteristics that farmers considered important (derived from the *local crop taxonomy*) in their maize and sought information on how those characteristics were distributed among the maize varieties they planted (*demand and supply of characteristics*). All farmers in the sample were classified using a *wealth ranking* methodology. Soil samples were collected (based on the local soil taxonomy), and samples of ears for each maize variety (based on the local maize taxonomy) were collected as well.

The Chiapas Project had several important results related to the use of participatory methodologies:

- the *local soil taxonomy* reflected objective soil properties;
- the *wealth ranking* reflected statistically significant differences in the possession of assets and sources of income among the wealth classes;
- the *local soil taxonomy* and the *wealth ranking* helped explain which specific maize varieties were planted and where they were planted; and
- farmers modified improved maize varieties to suit their needs better.

Many of these findings and methods will be discussed in later sections of this manual.

A Structure for a Participatory Research Project and Some Caveats

The projects in Oaxaca and Chihota share a similar structure based on three components. First, in the diagnostic component, scientists identify the conditions in which farmers operate, particularly from the farmers' own point

of view and relative to their own knowledge system. Second, based on the diagnosis, farmers and scientists identify a set of interventions and put them into practice. Third, through the diagnosis and interventions, an impact assessment component is built into the project to assess any changes that farming households perceive to have resulted from the interventions. This description of the three-component structure should not lead readers to construe that the implementation of a participatory research project is a linear process, however. It is just described in a linear manner here for clarity of exposition. During the intervention, or even during the impact assessment component of a project, new understanding can be generated and interventions can be modified or changed. For example, in the Oaxaca Project, joint experiments with farmers were not originally planned, but they were incorporated as researchers perceived farmers' skepticism and tried to address it. In the Chihota Project, the layout of demonstrations with farmers was modified as researchers learned that the original layouts were too complex and lacked some controls for simple interpretation, a lesson that is incorporated in this manual.

It is important to point out that in the three projects described earlier, the objectives were established by scientists based on their own assessments of the need to conduct research on particular issues, such as the improvement and conservation of maize genetic diversity or the development of new soil fertility improvement technologies. Those specific objectives were set because they were important to strategic research and

not necessarily because they met important needs expressed by participating farmers. Through the choice of location and dialogue with farmers, however, it became clear that the objectives of the projects were also of great interest to farmers. Aside from the specific benefits they held for participating farmers, the projects had a common interest in drawing lessons that would be widely applicable to other places and other farmers. In some instances, the issues addressed in the project may not appear to be of direct importance to farmers (for example, the assessment of different strategies for conserving genetic resources in Oaxaca). These issues and their related interventions did have to be explored in a real context, however, and the challenge for scientists is to find commonalities with farmers and make these issues important and interesting to them as well.

There are other approaches and ways of doing participatory research. The approach presented here is not the only one and not necessarily the best one for all situations, which is why this manual explicitly outlines the context (exemplified by the three projects) in which researchers and farmers have used the methods described in this manual. Some purists of participatory work may consider this approach too "top down" because it does not start from a specific assessment of the needs of specific farmers or households. Although most of the methods described here can be used in other contexts, many users of this manual will be operating under circumstances similar to those of the projects in Oaxaca, Chihota, and Chiapas.

Participation: Identifying the Places, People, and Procedures for Research

Three key decisions for a scientist using a participatory approach are deciding *where* to work (in other words, selecting a site), *who* to work with (who participates?), and *how* to work with them. These decisions depend fundamentally on what researchers, in conjunction with farmers, are trying to achieve (i.e., the research objectives). These decisions are critical because the scientists will rely on the selected persons to provide information about problems, resources, and constraints; to elicit local knowledge effectively; and to collaborate in conducting experiments. The selection of the site for fieldwork will to a great extent define the comparisons and lessons that can be drawn, and it will influence whether they are local comparisons and lessons or may be generalized to other regions or conditions. The method of interaction between scientists and farmers will delineate the types of analysis that can be performed, because the interaction will define the degree of aggregation of the data.

Farmers and their households, even when they are part of the same community, are not homogeneous. By failing to recognize the differences among farmers, scientists may end up working with a small subset of farmers,

unaware of how they relate to the rest of the farming population in the study area. Working with a subset of farmers is not necessarily incorrect, but ignoring their relationship to the rest of the community can lead to erroneous generalizations and limit the scope of research and its results. For example, working only with farmers who own cattle, who can apply manure to their fields, and who can use ox-drawn implements may result in the development of technologies that are irrelevant for farmers who do not own cattle.

Where to Work: Site Selection

The first step in deciding which farmers to work with is deciding *where* to work. In many cases this decision is pre-ordained for administrative, political, or logistical reasons. It may be possible, however, to choose villages or communities within a given region and thus select sites with particular characteristics that can enable the researcher to make generalizations from the results. The key is to select sites to maximize the possibility of meaningful comparisons based on a few key exogenous factors that are hypothesized to influence farmers' conditions and/or

decisions. The choice of these factors may vary according to the specifics of the country, the region, the farmers, the technologies of interest, and other variables, but the choice is usually based on researchers' prior understanding of the specific situation.

There are limits, however, to the number of factors that can be considered explicitly (usually no more than three). Within a region, for example, villages with contrasting infrastructures (access to markets) and population sizes can be selected. These two variables are important because they influence access to information, access to inputs, and the availability of land, labor, and capital. For example, population size with respect to available agricultural land plays a key role in the intensification of agricultural production. The agroecological environment, such as areas with contrasting soils or rainfall patterns, is another major variable.

All of these important exogenous conditions influence farmers' decisions, and scientists may want to know their relative importance while maintaining other factors constant. Scientists may think, for example, that the adoption of green manures is more attractive to farmers located in isolated areas (with less access to purchased inputs and fewer opportunities for off-farm labor) where population density is increasing (in other words, fallows are becoming shorter and more labor is available). By locating research sites in areas with these characteristics, researchers can test these hypotheses. Furthermore, discussions with farmers in such areas can confirm or dispute the hypotheses.

Villages in the region to be studied can be classified into a matrix² (Figure 1) through consultation with local experts (local officials, scientists, or extension workers). Another option for site selection is to use secondary information if it is available, including previous studies, older diagnostic reports, or a census. If the number of villages is not too large, yet another option is to conduct a short survey with the local authorities, focusing on village characteristics such as population, infrastructure (schools, electricity, roads, stores), sources of income, animals, and crops.

By locating research in villages with contrasting conditions, it may be possible to assess the impact of different factors while maintaining the others constant. For example, it may be possible to assess the importance of the availability of family labor and land versus the availability of purchased inputs and paid labor in the adoption of green manures. The village selection process can be thought of as a quasi-experimental

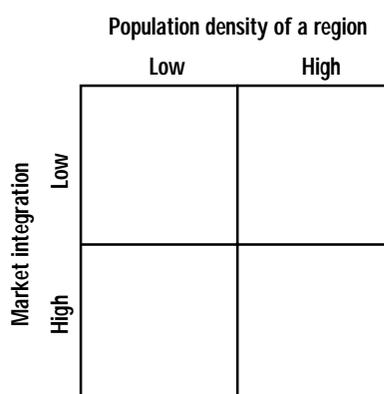


Figure 1. Hypothetical matrix to classify villages.

² Obviously, the specific matrix may vary from one situation to another according to the specific exogenous factors selected. A matrix such as this was used by Pingali et al. (1987) to locate the sites for their study of mechanization in Africa.

design that ensures enough variation in the sample to make meaningful comparisons. Often cells in the matrix may be void, which indicates that exogenous factors are correlated (e.g., villages with high population densities have good infrastructure and vice versa). In this case, although the effect of population density cannot be disentangled from that of infrastructure, at least we know that this is the case.

Example: For the Oaxaca Project, researchers had to decide where to work in the Central Valleys. The region encompassed many villages and thousands of people. Though maize landraces were collected from 15 communities, a smaller subset of communities had to be selected because the project lacked resources to cover even this limited number. Researchers consulted local authorities in each community to gain an idea of its general socioeconomic characteristics. These authorities estimated the number of households in each community, the major sources of income, supplies of infrastructure and transportation, and types of markets.

Little variation was apparent between communities in distance to markets or basic physical infrastructure. Local authorities were then asked to classify a set of different sources of income (i.e., crop production, animal husbandry, off-farm labor—agricultural and non-agricultural—and remittances from within and outside Mexico) into three categories according to their importance to the village economy (i.e., very important, moderately important, and not important). An analysis of this classification showed pronounced

differences in the extent to which the villages relied on non-farm income and remittance income from migrants. This information was combined with data on ethnicity, derived from census data, and on maize yield potential, derived from previous work by the national agricultural research organization. The 15 communities were located in a matrix of these variables, and six communities representing contrasting circumstances were selected (Figure 2). The horizontal axis in Figure 2 represents increasing dependence on local sources of income (local agricultural and off-farm labor) versus non-local sources of income (remittances from within and outside Mexico). The vertical axis represents location in zones of increasing maize yield potential, which also correspond to a gradient of rainfall (from low to high).

Who to Work With: The Selection of Participants (Informants/Experimenters)

In participatory research we always work with *informants* and *experimenters*. The informants are farmers, understood in the broadest sense as all members of a

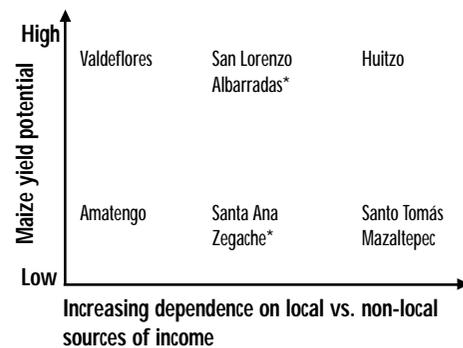


Figure 2. Classification of survey sites by source of income, ethnicity, and maize yield potential.

Source: Smale et al. (1999).

Note: * > 30% indigenous population.

farming household, whom scientists query about their knowledge, practices, needs, priorities, and resources. The experimenters are the farmers with whom scientists perform experiments and evaluations. The central question is how to select these informants and/or experimenters. (Note that usually an experimenter is first an informant but that not all informants become experimenters.) The content and quality of the information gathered, and the experimental results obtained by scientists and farmers together, depend fundamentally on the people scientists work with and therefore on how they select informants and experimenters.

Participants can be categorized into at least four types:

- 1) *Incidental*: Persons that researchers encounter who are willing to talk to them, without any *a priori* effort on the researchers' part to identify them.
- 2) *Key*: Persons researchers select based on well-defined, pre-established criteria. Key participants are usually selected with the help of local contacts who know the communities of interest well. These contacts include local authorities, extension workers, health workers, teachers, and secular and/or religious leaders.
- 3) *Randomly selected*: Persons who are chosen following statistical sampling procedures.
- 4) *Self-selected*: Persons who volunteer to participate.

Incidental participants are usually easy to find; an incidental participant can be a farmer who gets a lift from a scientist or the owner of a store where researchers buy supplies. The information collected from such people should be treated with caution, since researchers do not know who these people are in the context of the community (which socioeconomic,

political, or religious group they belong to), what interests they represent, or what biases they may have. Incidental participants can provide a starting point for scientists' interactions within a community, however, and they may give scientists an initial set of hypotheses about the local farmers and community.

Key participants are selected systematically. They should have certain well-defined characteristics that provide either an idea of the variation within a community or information about a particular group. Selection criteria could include:

- farmers who plant many crop varieties,
- farmers who have a reputation for good workmanship or for having an inquisitive turn of mind,
- young or old farmers,
- male or female farmers, or
- farmers with large or small land holdings.

These criteria are defined by the type of information scientists seek. Criteria may be established to avoid or at least diminish biases (that is, to avoid focusing on one group and ignoring others), or, when different communities are being compared, to ensure that informants are as similar as possible and therefore comparable. To focus on one group is not necessarily wrong, but to generalize from one group to others may be. Clearly, the process of selecting key informants depends on other informants (researchers' contacts in the community), but by establishing criteria researchers minimize their contacts' ability to choose whoever they want, without researchers' knowledge.

Each time scientists arrive in a community or contact a group of farmers, the scientists must notify and possibly obtain authorization from local authorities, such as the chief/headman or leaders of farmer groups. Frequently researchers already know useful people who are familiar with the community and its members, although they themselves may be outsiders, including extension workers, health workers, or teachers. These contacts are a primary source of information for identifying key informants.

Randomly selected participants provide the best perspective on a community of farmers in terms of their representativeness. The probability of including all the subgroups that may exist depends on how common they are, not necessarily on the views of particular informants, and random selection can help minimize biases. The information collected from these informants can be analyzed statistically, allowing us to make inferences with a defined level of probabilistic confidence about the farmers with whom we work. However, when a research project is directed at a particular group of people with specific characteristics, this selection method may not be the best or most cost-effective, because many people of no interest to the research objectives may be included.

Statistical sampling procedures also have problems, however. Before the sample can be drawn, ideally a census of the target community or communities must be conducted, but a census may not always be feasible. The census can be done using lists of farmers or households, compiled for other purposes, or by mapping all of a community's dwellings. If lists of farmers

or households exist, it is important to note that they may be biased. They may focus exclusively on a specific group within the community, such as farmers with irrigation, or farmers who grow cash crops, or farmers who participate in government programs. By combining different independently compiled lists, however, scientists can produce a comprehensive list. If the community is mapped, it is still possible to miss people, particularly in sparsely populated areas. Even though generating lists or maps may require a lot of time and money, it can produce accurate and comprehensive information. It is also possible that the randomly selected case sometimes turns into the self-selected case (especially in methods that require more than a brief meeting or interview) because of drop-outs and refusals.

Self-selected participants are usually highly motivated and may perceive advantages in participating, such as learning new techniques and getting access to new technologies. Their motivation may make them easier to work with, but researchers should be careful not to assume that they know their motivations. These people may choose to participate because they expect a political favor, whereas researchers think they are interested in acquiring new information. As usual, scientists should ensure that participants' expectations are explicit and that false impressions are not created. It is essential to know who these farmers are in the context of the community (i.e., which socioeconomic, political, or religious group they belong to and therefore which interests they represent or which biases they may have).

How to Interact: Types of Interviews/ Interactions

Once the informants/participants have been identified, two forms of interviews or interactions can take place: *individual* or *group* exchanges. The individual interaction consists of a one-to-one interaction between the interviewer and the informant, while the group interaction brings together a group of informants, and the interviewer provides a series of questions or topics of discussion. In an individual interaction, the person with whom scientists interact is well defined and his/her characteristics (age, education, household resources, and so forth) can easily be established. The outcomes of the interaction can be related to these characteristics in a relatively straightforward manner. If many individual interactions take place, researchers can relate the variability of outcomes more specifically to the diversity of individuals participating and their conditions. In a group setting this is much more difficult to do, because it is harder to disaggregate the specific relationships between outputs and participants. A group setting provides a broader and more comprehensive perspective on the issues, however, and allows agreements and disagreements among individuals to be identified relatively rapidly. Individual interactions are relatively more suitable for generating an analysis, whereas group interactions are relatively more suitable for generating a synthesis, although results of each type of interaction can be used for analysis as well synthesis.

With respect to practical guidelines for the individual interaction, researchers should be sure that the informant understands the questions being asked. Researchers should be careful to use phrases, words, and examples that the informant readily understands. (Providing examples also enhances understanding.) The questions should be pre-tested for vocabulary and content and modified accordingly.

Some common problems with these interviews should be avoided. Friends and family members are frequently present during an interview, volunteering information or answering instead of the informant. In this situation, researchers have no control over—or background information on—the people providing the information, which later complicates its interpretation. It is the informant's information that researchers want. In many cultures, when a woman is interviewed in the presence of her husband, son, or father, she may be inhibited to answer questions freely, or the men may answer for her. Again, this situation should be avoided, because the information of interest is hers, and it should be as truthful and open as possible. It is particularly important to get women's unhampered point of view, since researchers will want to avoid gender biases in the information they collect.

In group interviews, it is important to limit the number of questions. This type of interview is excellent for generating inventories of things or issues (e.g., soil or crop types, problems, activities, and technologies) or for generating discussions among participants. In the latter case, however, scientists should

be careful not to impose a false consensus by forcing participants to agree on something when they find it difficult to do so. It may be unrealistic to expect consensus on many issues if the group is truly heterogeneous. Instead, the interviewer should aim to identify the points of agreement and disagreement among informants, especially the disagreements, which are of great value because they allow the interviewer to probe into the informants' differences. It is very important to try to establish the basis for the disagreements and to relate them to specific characteristics of the informants (e.g., poor versus wealthy, young versus old, men versus women). Background information on the informants can therefore be extremely useful; recall that such information should have been collected when the informants were selected. Another point to bear in mind with group interviews is that sometimes they provide information on what participants think "should be" rather than on what "actually is." Researchers should be careful in interpreting the results and should probe to establish whether the group is referring to an ideal rather than an actual situation.

Like individual interviews, group interviews have some problems that should be avoided. Often a few informants tend to dominate the discussions. They may be of higher social status or belong to a certain ethnic or politically dominant group, and they can give a biased view of the issues, while the perspectives of other group members are completely ignored. To avoid this situation, ask the quieter members of the group for their opinions. In many cases, they will not respond freely, since they may feel intimidated by

the dominant members. If necessary, the interviewer should talk to them individually or separately. The interviewer can also split the group into dominant and quieter members and repeat the group interview separately. Distinguishing among informants in a group is particularly important when one is trying to rank problems or solutions. Different groups within a community may have different problems and solutions or attach distinct levels of importance to them.

Gender

Any participatory research methodology should consider the importance of gender. From a practical point of view, this means that researchers should be sure to include participants who play different roles within households, such as women, children, spouses, parents, and female heads of households. This also means paying special attention to interactions among household members. Depending on where the research is being done, it may be necessary to form same-sex groups (i.e., groups of only men or only women), since in mixed groups women may not participate at all. In other contexts, however, mixed groups may provide an excellent opportunity to elicit gender differences and concerns. Even in individual interactions it may be necessary for men to interview or interact only with men, and for women to interact only with women.

In the past, agricultural research focused mainly on male farmers and assumed that all household members shared the same goals, had the same access to resources and outputs, and faced similar constraints. Now it is clear that in most cases this view is incorrect. Just as

differences between farmers and households may be attributed to differences in access to resources, knowledge, and information, differences within households also exist and may be attributed to different factors. Household members may have diverse responsibilities, perform different activities, and have varying work loads and access to resources. They may also have conflicting interests. These differences can be particularly striking in Africa,³ where household organization can be extremely complex (for example, with polygamy or with members of the

same sex in a household there may be hierarchies—the first wife, second wife, the mother in-law, and so on). Regardless of where the research is being undertaken, however, gender considerations are always important and relevant. Researchers must also be careful to go beyond a simple concern with females or female-headed households and to look carefully at the way household members are organized and interact.

³ Doss (1999) presents an excellent review and discussion of gender and agricultural technology issues for Africa.

Diagnosis of Farmers' Conditions

Farmer participatory research involves more than identifying research participants, of course. It also involves identifying “users” or “clients.” These are the farmers whom researchers wish to reach with technologies and practices, and they are not necessarily participants in the research (either informants or experimenters).

Scientists may think that “all farmers are the same” or that they are working with “typical” or “representative” farmers, but unless researchers systematically address this issue from the start, they may be making a critical mistake. As discussed earlier, farmers and their households often are not homogeneous, even within a community. Farming households in a community have access to different resources. Some have more land, labor, or capital than others. Knowledge and information are not shared equally, either. Therefore, goals, resources, and constraints differ between farming households. Variability—spatial and temporal—is another fact of life for every farmer and his/her household. Soils and topography vary and seasons change. Because this variability influences what farmers can and wish to do, it is fundamental that researchers understand how resources and constraints are distributed in time and space.

In failing to recognize differences between farmers and households, researchers may overestimate the

potential impact of technologies or practices, because researchers may end up working with a smaller and possibly unrepresentative subset of the farmers they hope to serve, or they may have a very static view of farmers' resources and/or constraints. In other words, researchers run the risk of developing technologies that are adopted by a more restricted number of farmers than expected or desired, resulting in a lower impact than anticipated. It is crucial to identify and characterize groups of farmers who share similar goals, resources, and constraints in their socioeconomic and the biophysical environment, because these farmers will share similar problems and require comparable solutions (technologies/practices).

Many methods have been developed to describe and analyze socioeconomic and biophysical variability, but in a participatory approach our goal is to discover how the farmer and his/her household view this variability. Methods for achieving this goal for the socioeconomic environment include farmers' own classification of farmers, wealth ranking, a minimum set of socioeconomic indicators, and a calendar of activities. Methods for understanding farmers' view of variability in the biophysical environment include local classifications of soils and climate. Each of these methods is described in the sections that follow.

Local Classification of Farmers

Goal: Identify the socioeconomic categories and characteristics that farmers find relevant.

Rationale: Farmers have their own categories for classifying themselves. By eliciting these categories and their strengths and weaknesses, researchers should be able understand what is important about these farmers in an open but systematic way, without imposing their own views on the farmers. This information can be used to generate hypotheses about how farmers' conditions and technologies interact, identify factors that affect technology adoption, and define groups facing similar conditions regarding technological needs or constraints (e.g., recommendation domains).

Method: Researchers assemble a group of informants from a community, ideally a mixture of people of different ages, resources, and genders. The interviewer explains the objective of the exercise to the participants: researchers want to gain a better understanding of which types of farmer exist in their community, including the strengths and weaknesses of each type. The interviewer should also explain that this information will help researchers to understand farmers' problems, develop possible solutions, and guide them, as scientists, to interact better with farmers.

The interviewer poses the question: *What types of farmers are present in your community?*

The group makes a list of each of the types.

For each type, the interviewer asks the following questions:

What are the characteristics of this type of farmer? (In some cases these are obvious from the name of the category, but in others they may have to be described in greater detail.)

What are the strengths of this type of farmer? (In many cases, strengths can be interpreted as the resources available.)

What are the weaknesses of this type of farmer? (In many cases, weaknesses can be interpreted as the constraints faced.)

Table 2 shows the types of data that can be gathered using this method. It is important to identify responses that refer to the same concept, since people may express their ideas in different forms. This requires some judgement on the part of the scientist, but usually it is not difficult. The farmer types usually refer to the presence, absence, or extent of an attribute, such as the ownership or lack of an asset (e.g., owns cattle, does not own cattle, owns a few cattle but not a lot). The number of types can be very large, and some of them are likely to be correlated. For example, one type may be "farmers with cattle" and another "farmers with manure." Clearly, farmers who have cattle are also likely to have manure.

Implicit in the farmer types are "themes" or wider categories, which make it possible to group different types within a larger theme or category. These themes or categories become the basis for analyzing the classification. They tell researchers which factors farmers consider important and in many cases how the factors are related. These factors and their relationships can be used to group farmers in homogeneous groups and/or to generate hypotheses about how these factors influence farmers' decision-making (see example).

Table 2. Data collected in an exercise to elicit farmers' classification of themselves, Chihota, Zimbabwe

Farmer type	Strengths	Weaknesses
Farmers who plan	Farm operations done on time Good crop stands	Crops can be eaten by livestock Crops wilt if rains come late
Farmers who do not plan	–	Extensive farmers No rotations Lack resources
Farmers with cattle	Have manure Have resources	Do not have grazing areas
Farmers without cattle	Borrow in time Provide labor for others	Delayed farming operations Lack resources, lazy at times
Farmers with manure	Crop stands are good and yields high	–
Farmers without manure	–	Crops are of poor quality and therefore yields are low
Field farmers	Plan well ahead of time High volume of output for storage	Seasonal farmer Take risks because production is seasonal
Garden farmers	Stable income because production is perennial	Do not help the needy
Resource-rich farmers	Sell produce to others Stable income Farm operations done on time	Do not give implements for free

Source: Gambara et al. (1998).

Example: This method was used in the diagnosis component of the Chihota Project to assess and understand the heterogeneity of farming households and to identify some of the socioeconomic variables underlying this heterogeneity. Agritex extension officers organized focus group discussions with farmers working closely with them. There were three types of groups: male, female, and mixed, for a total of ten groups.

The groups identified 29 farmer types. This number may seem excessive and the types *ad hoc*, but analysis of the types revealed that they could be grouped into eight themes or categories. (The data in Table 2 came out of that exercise.) Table 3 shows the types grouped by category. Some of the types refer to personal characteristics such as age and sex. Most involve the ownership or lack of an asset

such as cattle, or access to income or knowledge. The themes or categories refer to common socioeconomic variables such as age, gender, wealth, and access to inputs and knowledge. Although many of the results presented below may seem obvious, the reader should bear in mind that there was no *a priori* reason why this should have been so, and that this information was collected in only four days of fieldwork. For somebody not familiar with the system, this information may be very valuable to provide a first set of hypotheses about the socioeconomic factors that are important. At least it can serve as a check that farmers also attach importance to factors that scientists believe are important.

Based on the strengths and weaknesses⁴ associated with each farmer type, the following picture emerged from Chihota

⁴ Presented at length in Appendix 1. This appendix provides a good sense of the "raw" data collected in this type of exercise.

farmers: Age is a category associated with the ownership of assets, access to family labor, and knowledge. In general, younger farmers are considered worse off than older farmers. Gender is associated with control over labor, assets, and income. Male farmers are in control. Not surprisingly, there seems to be tension between male and female farmers. For example, females consider that they are not rewarded for their labor and that their fields are prepared last.

Table 3. Farmers' classification of themselves and their characteristics, Chihota, Zimbabwe

Socioeconomic category	Farmer type	Number of groups mentioning type
Age	Young	3
	Old	3
Gender	Male	3
	Female	3
Ownership of, access to inputs	Draft animals	3
	Cattle	3
	Manure	1
	Implements	4
	Garden	6
	Dry lands	6
	Large fields	1
	Small fields	1
	Own fields	1
Fenced fields	1	
Labor allocation	Works outside the area	1
	Works in groups	2
	Works individually	2
	Industrious	4
	Lazy	4
Access to cash, wealth	Adequate cash for farming	3
	Rich	2
	Poor	2
Knowledge	Has knowledge	5
	Has Master Farmer Certificate	1
Linkage to market	Sells produce	1
	Farms for subsistence	1
Synthetic (combines different categories)	Performs operations on time	2
	Attains high yields	1
	Plans operations	1

Source: Bellon et al. (1999).

The ownership of assets in general is linked with the timing of farming operations, the ease of performing them, and the crop yield achieved. Owners are considered to perform operations on time and easily, and therefore to get higher yields than non-owners. A particularly important asset is the ownership of gardens. Gardens were mentioned in very positive terms. They provide a stable income and are less subject to drought compared to dry lands, where income is more seasonal, less stable, and production is more exposed to drought. The size of landholding is another interesting case. Farmers consider that farmers owning larger fields tend to spread inputs thinly, while those with smaller fields concentrate inputs. Cultivating as large an area as possible is a practice that has been observed in marginal environments in Africa, and it may be a risk management strategy or a means to establish or maintain property rights over the land.

Labor allocation refers to a process by which farmers with skills to work elsewhere substitute hired local labor for their own labor, which highlights the increased integration of these farmers into the market economy. Another aspect of labor is organized labor; farmers working in a group cooperate by sharing labor as well as knowledge, and they can buy inputs together. Working in a group may be more common among farmers who work closely with extension, since extension staff often favor group arrangements.

A puzzling classification is the one that identifies farmers as "lazy" or "industrious." It is not clear whether "lazy" farmers are truly lazy or if they are classified this way because they are

poor or sick. For example, participants recognized that “lazy” farmers were a good source of labor for others, which raises the question of why these farmers are working for others, if they are so lazy. Puzzling results such as this may be the product of rapid research, and a longer stay and interaction with farmers may reveal the factors that explain the puzzle. At least two hypotheses about these types of farmers can be considered. One is that there are lazy people in any society, and these farmers are indeed lazy; the second is that the farmers participating in the group classification exercise are of a higher social status and consider people of lower status to be lazy, even if clearly they are not, since they work for them.

Access to cash is linked with the timing of farm operations and with the ability to purchase inputs and hire labor. Those with access to cash were considered to be in a better position than those without it.

Farmers who possess knowledge are viewed very positively. The groups provided a long list of strengths for those who have knowledge and a long list of weaknesses for those who do not. Knowledge is associated with timely operations, high yields, and crop rotations. The emphasis on knowledge may also be related to the fact that almost all participants work with the extension service. Therefore they value access to knowledge and have been exposed to the message that knowledge is important.

Linkage to the market captures the differences between those who sell their produce and those who are subsistence farmers. This distinction may not be absolute, since it is most likely that many farmers produce crops for sale as well as subsistence.

Finally, three types appear again and again, frequently together, as attributes throughout the farmer classification: timely performance of farming operations, high yield of crops, and planning of operations. These attributes are highly correlated. As farmers see it, the ownership of assets, access to cash, and possession of knowledge lead to good planning and timely operations, which in turn lead to high yields.

The classification provides researchers with a set of variables that can be used to group farmers in homogeneous groups: by age, gender, ownership of assets, labor allocation strategy, and access to knowledge. For example, the most contrasting groups can be seen as 1) young females with few assets, who do not work off of the farm and have poor access to knowledge, and 2) older males with many assets, who work off of the farm and have good access to knowledge. Obviously these groups may have different goals and resources, face distinct constraints, and require different technologies.

The classification also provides researchers with a set of hypotheses about the problems that these farmers face and their possible causes. It should be pointed out, however, that in many cases these classifications provide researchers with *associations* between factors and not necessarily with *relations of causality*, which researchers have to deduce. For example, the following hypotheses derived from the example can be postulated:

- Female farmers get low yields because their fields are plowed late by male farmers who control the oxen and the implements.
- Male farmers who own oxen get higher yields because they perform operations on time.

- Farmers who own cattle get higher yields because they have access to manure to apply to their crops.
- Farmers working in groups get higher yields because they gain better access to inputs by pooling their resources.

These hypotheses can be expressed in a causal diagram that provides a model of how different factors interact (Figure 3). This figure illustrates the relationship between factors identified in the classification, particularly in relationship with the timing of the performance of agricultural operations and yields.

Comments: The types elicited from farmers may, in some cases, be self-serving and value-laden. For example, it is not clear whether the qualities of laziness and industriousness refer to truly personal characteristics, describe a position within a social hierarchy, or represent a value judgment by one group of people regarding others. In interpreting the data, researchers should

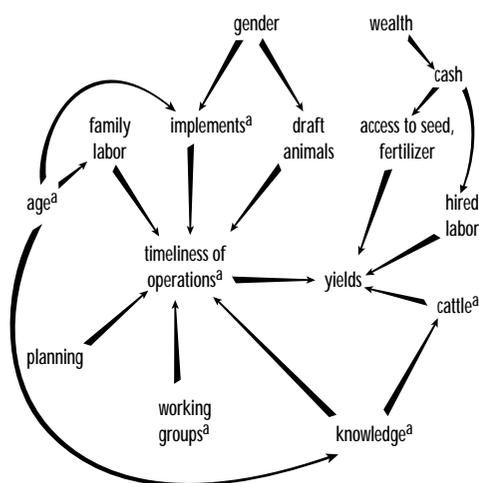


Figure 3. Causal diagram of the factors that affect yields based on those identified by farmers' classification of themselves in Chihota, Zimbabwe.

^a Indicates a factor associated with a farmer type; the rest indicate factors identified as strengths or weaknesses associated with a farmer type.

always be careful to recognize the implicit value judgments and the social relations present in these types.

Another example of how informants' judgments can be value-laden or self-serving comes from the list of strengths associated with farmers who have no cattle (Appendix 1). According to informants, those farmers have the following strengths: they borrow money, provide labor for others, are cattle herders, and buy cattle from others. Clearly, these qualities are viewed as strengths by those who benefit from farmers without cattle: people who lend them money, hire their labor, or sell animals to them (e.g., cattle owners). Furthermore, an examination of the weaknesses listed for farmers who have no cattle (such as cruelty to cattle or gaining when crops are unintentionally destroyed by livestock) confirms that these views come from people who have cattle.

Wealth Ranking

Goal: Classify farmers in a community into wealth categories.

Rationale: Wealth is an important social category in most societies, although its specific definition will vary not only from one culture to another but sometimes from one village to the next. Wealth is a relative category that depends on the very particular circumstances of farmers. Unlike the local classification of farmers discussed previously, wealth ranking establishes certain predetermined concepts and categories (e.g., "wealth," "rich," "poor"). The specific definitions of "wealth" and of what constitutes a "rich" or a "poor" farmer depend on the local conceptions of these terms. Members of a community usually are keenly aware of their positions and those of others in the community. This method is based on that knowledge. The

wealth ranking provides a way to group farmers and analyze their preferences. Clearly what is appropriate or desirable for one wealth group may not be so for another. Furthermore, the constraints to adopting a new technology or practice may be completely different among wealth categories, since each may control different sets and amounts of resources. A wealth ranking is also a tool to analyze the potential and actual distribution of benefits and costs of a technology (see "Comparing Different Technological Options," p. 54, for an example of how wealth ranking can be used).

Method:⁵ This method assumes that researchers have compiled a list of households in a well-defined community/village, which they want to rank. The researchers will need to define what constitutes a household in the particular place where they are working. Although a household is often defined as a group of people who live together and eat from the same pot, this definition may not be useful in certain societies with extended families, and researchers should establish what constitutes a household through discussions with local informants. A few (one to four) reliable informants with good knowledge of the people in their community should be identified. It may be a good idea to include male and female informants. Informants can be interviewed either together or separately. The former strategy provides a consensus ranking, while the latter makes it possible to test the consistency of the rankings. In the case of multiple individual rankings, the rankings of

several informants should be highly correlated. If they are not, the lack of correlation indicates that there is a problem. Perhaps the informants do not know the households well, have access to different information, have used different criteria to do the ranking, or have simply not provided accurate information.

First, the interviewer asks the informant(s) to define what "wealth" is in the community. After identifying the local word(s) for wealth, the interviewer and informant(s) can discuss what a "wealthy" or rich household/farmer is, focusing particularly on its characteristics. Then the characteristics of poor farmers can be discussed; following that, the characteristics of the group that falls in between (not rich or poor) can be identified. After the distinctive characteristics of each group are defined, the interviewer writes the characteristics corresponding to each group on a large, easily visible piece of paper. The interviewer checks with the informants to see that everyone agrees with the characteristics. Next, the interviewer reads the names of the farmers from the list of households and asks the informants to indicate the group to which they belong. Alternatively, researchers can prepare cards, each one with the name of a household, and ask the informants to put them into one of three piles, each representing a wealth rank.

When this exercise is done with a group of informants rather than an individual,

⁵ Some of the ideas described here are based on Grandin's (1988) work on wealth ranking, although the method presented here differs somewhat from her approach. In Grandin's method, informants make as many groups as they wish by creating piles of cards containing the names of households that in their view belong in the same wealth rank. Then each household is given a score based on the pile where it was classified, and the scores of several informants are averaged out. This average is used to do the final ranking. For the specifics of the method consult Grandin (1988).

the group may discuss the classification. If there is disagreement about the classification, the interviewer should ask about the reasons for the disagreement and note the contrasting rankings that informants provide for farmers who classification was disputed. When the exercise is done with several individual informants, the researcher should compare the characteristics associated with the rich, intermediate, and poor, as well as the rankings, once the exercise has finished. If discrepancies are identified, ideally the researcher should go back to the informants for clarification, and this information should be noted as well.

If in addition to (and independently of) the wealth ranking the researcher has collected other qualitative and/or quantitative socioeconomic data on the households that have been ranked, the researcher can test for an association between those variables and the wealth ranking. Ideally this association should be significant, as indicated by statistical analyses of the quantitative and qualitative data, using the wealth classes as a grouping factor by village. A significant association provides independent evidence of the validity⁶ of the wealth ranking. In most cases, however, such data are not available, which is one reason why a wealth ranking may be done. It should be stressed that a wealth ranking is faster, cheaper, and easier to implement than a full-scale survey.

Even if socioeconomic data are available, it may still be desirable to perform a wealth ranking. The wealth ranking is

based on the knowledge of local people who may be aware of assets and relationships that may not even have been captured by survey data. These include initiative, entrepreneurial ability, experience, and social or political relationships.

Example: This methodology was used in the Chiapas Project to rank all the participating households and test the extent to which different types of farmers adopted various maize varieties. The informants defined wealth based on certain characteristics such as ownership of a pair of bullocks, cattle, a motor vehicle, or appliances; the type of house; and total landholdings. Poor households had houses made of wattle and daub or adobe, without cement floors and plastered walls, and possessed almost no appliances. Fewer households owned a pair of bullocks and some cattle. None had privately held land or a motor vehicle. Households that were intermediate between rich and poor had adobe houses with cement floors and plastered, painted walls. Ownership of a television set, gas stove, and even a refrigerator was common. Many households owned a pair of bullocks and cattle, and a few had privately held land. Rich households owned brick or adobe houses with cement floors and plastered, painted walls. These households had television sets, refrigerators, gas stoves, and even videocassette recorders. Some owned a pair of bullocks but others did not, since they had a tractor or could pay to rent one. Many had privately held land and some had motor vehicles.⁷

⁶ Validity denotes the extent to which a measurement tool is measuring what it was designed to measure (Adams et al. 1997).

⁷ Contrast this ranking in Chiapas with one in Malawi (Smale and Phiri 1998), where well-to-do households produced enough maize to last from harvest to harvest; owned some livestock, an oxcart or other farm machinery, and several changes of clothing; and had a house with an iron roof and brick walls.

Independently of the wealth ranking, a household survey was done for all households. The survey included questions on socioeconomic variables such as landholding, ownership of livestock and other assets, performance of off-farm labor, and reception of remittances. Therefore the validity of the wealth ranking could be tested. To do so, an analysis of variance (ANOVA) was done to compare the means of each of the wealth classes (rich, intermediate, and poor) for key quantitative socioeconomic variables, and a Chi-square test of association was done to assess the relationship between wealth rank and each qualitative variable. Table 4 presents the results.

The wealth ranking was consistent with objective, independently measured characteristics of the households. In general the trends in ownership among

wealth ranks were what one would expect: the rich had more assets than the intermediate class, and the intermediate class had more assets than the poor. These results corroborate the validity of the wealth ranking. Furthermore, the wealth ranking was included in a regression analysis that showed that those classified as poor planted on average a smaller area to improved varieties and a larger one to landraces than the rest (Bellon and Risopoulos 2001). These results show how combining participatory methodologies with more conventional analytical tools can enhance the analysis.

Comments: This method is most appropriate for a single village or community since it relies on the knowledge that the informants have of fellow community members, and the definition of wealth classes is relative to

Table 4. Comparison of farmer characteristics by wealth rank, Chiapas, Mexico

Variable	Wealth rank				P-value ^a
	Poor	Medium	Rich	Overall	
Number of farmers	50	32	16	98	–
Ownership of assets					
Total land holdings (ha/farmer)	6.2	10.6	14.5	9.0	.000
Cattle (% farmers own)	18.0	37.5	68.8	32.7	.001
Cattle (head/farmer)	1	3	11.2	2.9	.000
Pair of oxen (% farmers own)	44.0	50.0	56.3	48.0	.668
Horses (% farmers own)	58.0	75.0	87.5	68.4	.054
Pigs (% farmers own)	64.0	84.4	75.00	72.5	.127
Pick-up truck (% farmers own)	0.0	3.1	68.8	12.2	na
Tractor (% farmers own)	0.0	0.0	6.3	1.0	na
Sources of income					
Off-farm labor by farmer (% performing)	68.0	43.8	37.5	55.1	.030
Type of labor (% performing)					.009
Agriculture	50.0	42.9	16.7	44.4	–
Construction	29.4	57.1	16.7	35.2	–
Commerce	0.0	0.0	16.7	1.9	–
Other	20.6	0.0	50.0	18.5	–
Off-farm labor by other family members (% performing)	40.0	75.0	37.5	51.0	.004
Remittances (% receiving)	10.0	28.1	18.8	17.4	.106
Use of hired labor (% hiring)	58.0	68.8	93.8	67.4	.029

^a P-value associated with a Chi-square test of association for qualitative variables and one-way ANOVA for quantitative variables; na = not applicable (too many blank cells).

the members of the community. Comparisons across communities may be more difficult, because the definition of “rich” or “poor” in one place may be different in another. There is good evidence, however, that at least in certain circumstances wealth rankings are valid across regions (Adams et al. 1997). Even if this is not the case, the characteristics that informants use for the classification may provide a rough basis for comparisons across villages. If additional quantitative and/or qualitative socioeconomic information is available, then researchers can compare the wealth classes among villages.

Minimum Set of Socioeconomic Indicators

Goal: Identify key characteristics of participants (informants/experimenters). If possible, compare them to the population of users/clients, and thus establish whether they are representative (or at least make any bias explicit).

Rationale: One problem with participatory work is that usually it involves a self-selected group of people (i.e., the people who choose to participate). This group does not necessarily reflect the conditions and interests of all farmers in a region, so it is important to know the participants. The content and quality of the information elicited and the joint outputs obtained depend on the people with whom researchers work. To assess the degree to which participants are representative of all farmers in the region of interest, the researcher should compare the participants’ characteristics with characteristics of the population of households in the region.

Method: Develop a short questionnaire that includes a few, mostly qualitative questions. The questionnaire should be filled in 5 to 10 minutes with all participants in an activity or (if the number is too large) with a sample of them (e.g., one out of four). The questions should be simple and easy to answer. Usually they will deal with characteristics that reflect the participants’ resources, constraints, and goals. Ideally, the information gathered should be comparable to other information that is representative of the households in the region of interest, such as a census or a representative survey. The questionnaire may request information on:

- gender;
- age;
- ability to read and/or write;
- number of years of formal education completed;
- number of years of independent farming (farming experience);
- size of land holdings by tenurial arrangement (this requires previous knowledge of the land tenure regime);
- crops grown;
- types and number of animals owned;
- agricultural off-farm labor;
- non-agricultural off-farm labor; and
- remittances from family members working elsewhere.

The researcher may decide to include other key characteristics identified from farmers’ own classification. It is important to clarify whether the questions refer to the respondent *as an individual* or to *the household in which he or she lives*. For example, the enumerator should carefully specify whether the question refers to land owned or controlled by the respondent as an individual or to land that is owned or controlled by the respondent’s household.

The same specificity is needed when asking about animals and sources of income.

Example: In the Oaxaca Project, field days were organized for farmers to vote on the landraces collected so that they could be sorted into a gradient of interest. During these field days a questionnaire was used to obtain a minimum set of socioeconomic indicators. The purpose of the questionnaire was to get an idea of participants' characteristics and to separate farmers' votes from the votes of the other field day participants. The purpose of the voting exercise was to gauge farmers' interest in the landraces, so researchers were not concerned with the votes of other participants. The questionnaire showed that of 306 persons who attended the field days, only 213 individuals were involved in maize

farming, and 54% of these were women. Only the votes of those 213 individuals were taken into account.

The questionnaire also revealed important differences between male and female farmers who participated in the field days (Table 5). Compared to the men, the women were younger, had less farming experience and more formal education, and planted a much smaller area to maize on average. More women received remittances, and fewer worked off of the farm. Not surprisingly—given that women planted a smaller area to maize than men—a higher proportion of women purchased maize and a lower proportion sold it. Almost all of the women said that they grew maize to be self-sufficient in that commodity, compared to a still important, but smaller, percentage of men. The percentages of male and female participants who said that they grew maize

Table 5. Field day participants in Oaxaca, Mexico, characterized by agricultural activity, gender, and other variables

Characteristic	All	Male	Female
Number of participants	213	97	116
Age (yr)	43.6	49.7	38.4
Mother tongue (% speaking)			
Spanish	88.0	87.9	88.0
Zapotec	11.6	12.1	11.1
Other	0.4	0.0	0.9
Education (mode)	Elementary, not completed	No education	Elementary, not completed
Experience in farming (yr)	19.7	24.1	15.9
Area planted to maize (ha)	2.7	4.3	1.3
Remittances (% receiving)	44.0	40.4	47.0
Off-farm labor (% performing)	47.2	57.6	38.5
Purchase maize (%)	55.1	39.4	68.4
Sell maize (%)	28.7	38.4	20.5
Goals of maize production (%)			
Home consumption	94.0	88.9	98.3
Sale	24.1	33.3	16.2
Livestock ownership (%)			
Bullocks	31.5	49.5	16.2
Cattle	31.0	39.4	23.9
Pigs	59.3	48.5	68.4
Poultry	71.8	70.7	72.7
Goats, sheep	38.6	36.7	40.2

Source: Bellon et al. (1998).

for sale differed dramatically. Twice as many men as women engaged in commercial maize production. Another difference between female and male participants was that a higher percentage of men tended to own bullocks and cattle, whereas women tended to own pigs. These data suggest that while self-sufficiency was a fundamental goal of all farmers, men tended to be more commercially oriented, to produce more maize because they planted a larger area, to depend more on off-farm labor and less on remittances, and to raise different types of livestock. These findings, in turn, suggest that men and women may value the characteristics of maize varieties differently.

Aside from the questionnaire for field day participants, researchers surveyed a sample of farmers in the Oaxaca study sites (baseline survey). The random, representative sample of the farming population in the region enabled researchers to determine the extent to which field day participants were representative of the farming population in the area. A few questions asked of field day participants were not included in the sample survey, although the sample survey retained the questions related to personal characteristics, sources of income, and agricultural assets. Table 6 compares some of the personal and household characteristics of participants in field days with

Table 6. Selected personal and household characteristics of participants in field days and sample survey, Oaxaca, Mexico

Characteristic	Females		Males		Households	
	Field days	Sample survey	Field days	Sample survey	Field days	Sample survey
Participants (no.)	116	240	97	240	213	240
Age (yr)	38.3	48.1 ⁺⁺⁺	50.1	54.2 ⁺⁺		
Education (% reporting)						
No formal education	8.6	31.3 ^{***}	5.2	16.7 ^{***}	–	–
Elementary, not completed	36.2	40.0	38.1	53.8	–	–
Elementary, completed	38.8	22.5	33.0	22.9	–	–
Junior high school	9.5	3.8	10.3	3.8	–	–
High school or technical school	5.2	1.7	3.1	2.1	–	–
College	1.7	0.8	10.3	0.8	–	–
Literacy (%)	92.2	67.9 ^{***}	94.8	82.1 ^{***}	–	–
Mother tongue Spanish (%)	87.9	74.6 ^{***}	87.6	68.3 ^{***}	–	–
Non-farm sources of income (%)						
No off-farm labor or remittances	–	–	–	–	25.4	26.3 ^{ns}
Off-farm labor only	–	–	–	–	30.5	37.5
Remittances only	–	–	–	–	28.2	24.2
Off-farm labor and remittances	–	–	–	–	16.0	12.1
Maize area (ha)	–	–	–	–	1.8	3.0 ⁺⁺⁺
Ownership (%)						
Pair of bullocks	–	–	–	–	31.5	59.6 ^{***}
Cattle	–	–	–	–	30.5	37.9 [*]
Pigs	–	–	–	–	59.2	50.0 [*]
Horses, mules	–	–	–	–	45.1	76.7 ^{***}
Goats, sheep	–	–	–	–	38.0	40.4

Source: Bellon et al. (2000).

Note: ++ (+++) indicate t-test, significant at the .05 (.01) level; * (**) *** indicate chi-square test of homogeneity, significant at the 0.1 (.05) .01 level; ns = not significant. In the case of education and sources of income, the statistical test applies to all categories.

information from the random sample of farmers in the study sites. These data make it possible to test whether there was a bias between field day participants and a representative sample of the population of farmers in the area.

The results show that men and women who participated in the field days were younger and better educated than the average for the region. A higher percentage of field day participants had Spanish as their mother tongue compared to the respondents in the sample survey. In terms of non-farm sources of income, there was no difference between field day participants and respondents in the sample survey, although the survey respondents farmed a larger maize area and a higher percentage of them owned bullocks, cattle, horses, and mules. These data do not necessarily mean that field day participants are poorer than the survey respondents. Since field day participants generally have more years of formal education, farming may have contributed less to their livelihoods than it did for farmers in the region as a whole. Field day participants seem to be a biased sample of the overall farming population of the region, but regardless of the reason for the bias, maize farming is clearly still important for field day participants, as demonstrated by their attendance at the field days.

Ideally the researcher would like a representative sample of farmers to participate in the research activity, but participation is a voluntary endeavor, and farmers cannot be forced to participate purely for “representation.”

Comments: One problem with the minimum set of indicators is that if they change from one group to another or from one situation to another, it may be

difficult to compare results. As more information becomes available, for example, a researcher may wish to change the indicators to fit the new knowledge, but this should be avoided to the extent possible. If changes are unavoidable, the researcher should at least retain as many common indicators as possible. Ideally, researchers should include questions that elicit information that is comparable to information from other sources, such as census or other survey data, so that results can be compared and if possible extrapolated across different groups or settings.

Calendar of Activities

Goal: Identify how productive and leisure activities are organized and interact during the year in a community.

Rationale: Households in a community, and individuals within them, carry out different activities during the year. These activities may be complementary, may compete with one another, or may not interact at all. Competition in the allocation of time among activities is an important consideration for any household because it has implications for the household economy. It is particularly important to identify any labor bottlenecks and when they occur. Researchers should be especially careful to develop separate calendars for males and females within the same household, because their activities may differ substantially.

Method: The method presented here is to develop a generic calendar of activities for a community. The method focuses on all of the activities carried out by all households within a community, rather than on the activities of one specific household, because an

individual household may pursue only a subset of the activities carried out across a community. Identifying specific combinations of activities for specific households will provide an idea of the different livelihood strategies present in the community.

A group of key informants is assembled and asked to list all activities in which males and females engage. First the group is asked about productive activities, which in the case of agriculture would include crops grown and types of livestock kept. Informants are also asked about the kinds of off-farm labor in which they engage, such as day labor in agriculture, construction work, and working as a mechanic or carpenter. Second, the group is asked to list activities necessary for the household to function, including food preparation, going to the market to purchase food, repairing the house, cleaning the house, and studying with children. Third, the group is asked to list activities conducted for the community, such as repairing the roads or irrigation system or organizing and participating in religious celebrations. Finally, informants are questioned about their leisure activities, including time spent resting.

Once the list has been compiled for each type of activity, informants are asked to point out the months during the year when they take place and to specify which household members participate.

Activities of particular interest may be disaggregated by subactivities. For example, maize production can be disaggregated by land preparation, number of weeding, number of fertilizer applications, harvest, storage, and sale, and informants can identify the month of the year in which each subactivity takes place.

Example: Figure 4 is a one-year calendar of activities for Santa Ana Zegache, a community in the Oaxaca Project.

Activities related to crops and animals are listed first, followed by off-farm labor, community work, and religious celebrations. This calendar shows the conflicts between tending one's own crops of maize and beans and performing agricultural labor off of the household farm. Taking care of sheep and goats is a year-long activity, while caring for cattle has a better defined period. To analyze the potential impact (timing conflicts and opportunity cost) of a new activity, such as growing a new crop or building contours for erosion control, the labor demand for the new activity should be overlaid on this calendar.

Comments: One common mistake with this method is that researchers develop a calendar only for agricultural activities, ignoring off-farm labor, community work, and religious celebrations. Such a calendar may omit activities that are as important—or even more important—than the agricultural ones.

One limitation of this method is that it provides information only on the timing of activities and not on the intensity of labor use. The researcher knows when an activity takes place but not how much time and labor it requires (information that can be difficult and time consuming to obtain).

Local Taxonomies of Soils

Goal: Identify the soil types farmers recognize and the characteristics they find relevant for each type.

Rationale: Farmers have their own categories for classifying soils. They may recognize different problems in each

	J	F	M	A	M	J	J	A	S	O	N	D
Maize / squash <small>Males/Females</small>	Post-harvest					Seeding period			Growing period			Harvest period
Beans <small>Males/Females</small>						Seeding period			Harvest period			
Alfalfa (irrigated) <small>Males</small>	Grown and harvested throughout the year											
Castor beans <small>Females</small>				Harvest period		Seeding period			Growing period			
Vegetable production <small>Males</small>					Growing period				Growing period			
Peanuts <small>Males/Females</small>						Growing period						
Chickpeas <small>Males</small>						Growing period						
Backyard garden <small>Females</small>	Grown and harvested throughout the year											
Oxen <small>Males</small>	Sell / buy					Buy			Sell			
Cattle <small>Males</small>	Sell								Fatten			
Pigs <small>Females</small>	Sell / buy		Fatten		Buy							
Sheep / goats <small>Children/Females</small>	An ongoing process of buying, selling, and growing											
Poultry <small>Females</small>	Sell / buy		Fatten		Buy							
Fieldhand <small>Males</small>												
Construction work <small>Males</small>												
Other off-farm work <small>Males/Females</small>	Primarily police and army (males), house help, hand crafts, sell tortillas in the market (females)											
Community work <small>Males/Females</small>												
Temporary migration <small>Males</small>												
Religious festivities <small>Males/Females</small>				Holy Week				Patron saint festivity			Day of the Dead	

Figure 4. An example of a calendar of activities, Santa Ana Zegache, Oaxaca, Mexico.

type, such as waterlogging. They may tailor their crops, varieties, or management practices to the specific soil types, perhaps by applying different amounts or types of inputs or planting particular varieties. Therefore, explicitly taking into account the variability farmers recognize in their soils may be an important factor for the development and/or adoption of agricultural technologies. These taxonomies may be useful in defining where certain technologies may or may not be appropriate (i.e., recommendation domains). Furthermore, for scientists it may be also important to know this taxonomy to communicate more effectively with farmers.

Method: A group of informants from a community is assembled, ideally a mixture of people of different ages, resources, and genders. Researchers explain that they want to learn about the types of soils that exist in the community, including their positive and negative characteristics. Researchers explain that this knowledge is vital for understanding and developing solutions for soil problems faced by farmers.

The interviewer poses the question: *What types of soils are present in your community?*

The group lists each soil type. For each type, the interviewer should check whether there are subtypes by asking whether all soils of that type are the same, or whether there are different classes for that type. Once subtypes are identified, the interviewer asks the following questions for each type:

How do you identify this soil type?

What are its positive characteristics (advantages)?

What are its negative characteristics (disadvantages)?

It is important to identify responses that refer to the same concept, since people may express their ideas in different forms. This requires some judgment on the part of the scientist, but usually it is not difficult. As with the farmer classification, the responses may refer to some underlying property of the soil, which should be identified. Researchers then use this information to generate a table that synthesizes all of the data.

Example: This method was used in the Chihota Project to identify the soil types farmers recognized. Afterwards, their soil taxonomy was the basis for identifying and discussing the technological options they used to cope with soil infertility and whether these options were targeted to specific soil types or not. Farmers listed ten types of soil for agricultural use. Table 7 describes the four most important types. The descriptions are based on texture (i.e., particle size), fertility status, and color (the latter is used to distinguish subclasses). The advantages and disadvantages listed for each soil type refer particularly to its water-holding capacity, ease of work, inherent fertility, response to fertilizers and manure, tendency to become waterlogged; to its particular uses, such as use in gardens; and its appropriateness as a building material.

The two most common soil classes for maize production were the lighter textured soils, Jecha and Shapa. Jecha is a sandy soil of low fertility and poor water-holding capacity, which can easily become waterlogged, is easy to work, and is good for building. Shapa is a sandy loam soil of low to average fertility. Yields of crops grown on this type of soil may be low unless additional inputs are applied, but Shapa soils have better water-holding capacity than Jecha soils. Although they can also become waterlogged, Shapa soils

Table 7. Farmers' soil taxonomy, Chihota, Zimbabwe

Soil class	Subclasses	Description	Advantages	Disadvantages
Jecha	White Blackish Grayish	Sandy soil, coarse-grained, low fertility, used for building	Responds to manure application Can get good yields, even with inadequate rains Easy to work Good for building	Low fertility Low water-holding capacity Erodes easily Becomes waterlogged easily Can get very hot Difficult to farm, because of need to apply more inputs
Shapa	Black (dema) White (nhuke)	Sandy-loam soil, easy to cultivate, low fertility	Produces good yield, even with inadequate rains Average water-holding capacity Can hold water for long periods One can grow any crop Responds well to manure and fertilizer Easy to work Can be worked by hand	Low to average fertility No yield unless inputs added Gets waterlogged under heavy rain Crops fail if little rain Maize wilts easily when hot Not good for growing groundnuts
Rukangarahwe	Reddish Whitish	Gravel, mixture of fine and coarse- grained sands	Resists erosion Good yields if rains are good Does not get waterlogged Good for road construction Good for fruit tree production	Infertile Blunts farming implements Difficult to work (to plow, weed) Poor water-holding capacity Crops wilt with reduced moisture Difficult to plow deeply Needs too much water Many plants are cut during cultivation Harbors termites
Churu/Rechuru	Makura (upland soil, type of termite mound) Bani (fley soil, type of termite mound)	Termite mound soil, heavy texture, sticks when wet and cracks when dry	Can be used to improved soil High fertility Good yields if rains are good Used for molding and plastering Used as graveyards	Hard to dig Crops wilt with slight moisture stress Requires a lot of water to support plant growth Difficult to plow

Source: Bellon et al. (1999).

are easy to work but are not good for growing groundnut. The subclasses of Shapa soils depend on the position of the soil in the toposequence. The darker subclass, which is considered more fertile, is located lower in the toposequence; the whitish subclass is in the intermediate parts of the toposequence; and the grayish and least fertile subclass is found at the top. Although agronomists and soil scientists working in the area knew many of these characteristics, they did not know how farmers referred specifically to these

soils. Therefore at a minimum this exercise enhanced the communication between scientists and farmers at a low cost to both.

The underlying soil properties of the taxonomy are texture, color, water-holding capacity, ease of work, inherent fertility, response to fertilizers and manure, and proneness to waterlogging. Aside from actual soil properties, particular uses (e.g., in gardens and as building material) were important in the taxonomy.

It is possible to study the relationship between the local taxonomy and objective soil properties. Researchers can sample each of the soil types that farmers identify and conduct physical and chemical laboratory analyses. For example, in the Chiapas Project, farmers identified five soil types: Tierra Negra, Tierra Baya, Tierra Colorada, Tierra Colorada Arenosa, and Tierra Cascajosa. Researchers sampled 104 fields that included the five soil types and analyzed the samples' chemical and physical properties. An analysis of variance using the soil classes as the grouping factor (Table 8) indicated that farmers' soil taxonomy discriminated among objective properties in their soils and that objective properties were consistent with farmers' perceptions.

Comments: In working with farmers' soil taxonomies, as with any other type of local knowledge, researchers must be cautious about making generalizations to other people or areas. Specific soil classes may change from one community to the next. Even within a community, researchers should check with farmers who did not participate in the taxonomy exercise to see whether they hold the same ideas about the soil classes and properties and to probe for additional classes. When researchers work in more than one community and similar soil names recur, they should always check to see whether the names refer to the same

underlying soil or soil property or to something different.

Local Classifications of Climate

Goal: Identify factors relevant to farmers that define the climate during the growing season.

Rationale: Farmers recognize favorable and unfavorable climatic conditions for crop production. These conditions are associated with particular climatic events and conditions. Many of farmers' risk management strategies are ways of coping with these events and conditions, so identifying farmers' views of these events and conditions and their interaction is fundamental to understanding those strategies and designing technologies that are compatible with farmers' current practices. To a great extent, these factors reflect a value judgment, not a value-free description of a phenomenon. Farmers often refer to a "good" or a "bad" season for the crop of interest, and there are many different ways in which a bad season occurs.

Method: A group of informants from a community is assembled, ideally a mixture of people of different ages, resources, and genders. Researchers explain that they want a better

Table 8. Soil chemical properties by farmer soil class, Chiapas, Mexico

Property	Mean	Tierra Negra	Tierra Baya, Tierra Colorada	Tierra Colorada-Arenosa	Tierra Cascajosa	F-statistic	P-value
Organic matter (%)	6.1	8.7	5.9	3.3	1.7	9.7	.0000
pH	6.6	6.7	6.4	6.1	7.3	8.1	.0001
Sand (%)	49.0	38.4	48.9	65.0	68.1	9.7	.0000
Clay (%)	28.0	36.2	26.2	22.0	14.0	6.7	.0004
Observations (no.)	97	33	44	10	10	-	-

Source: Bellon and Taylor (1993).

understanding of which climatic characteristics constitute a “good” and a “bad” cropping season.

The interviewer poses the questions:

What are the characteristics of a “good” season?

What are the characteristics of a “bad” season?

Usually these characteristics refer to underlying climatic factors or events. These factors can be combined to create different “types” of seasons, some “good” and some “bad.” Not all theoretical combinations are real or appear frequently. Researchers may need to relate the factors identified by farmers to actual rainfall data to identify relevant “types” of seasons in terms that are meaningful to farmers.

Example: This method was used in the Chihota Project as a framework for a later discussion of risk management strategies. Farmers were asked about the characteristics of “good” seasons and of “bad” seasons. Their answers reflected five underlying factors (Table 9): the onset of the rains, the end of the rains, drought in the middle of the cropping season, distribution of rainfall, and quantity of rainfall. By combining these factors, types of seasons can be identified. For example, one season begins in November, finishes in March,

and has a mid-season drought. Another starts in mid-October, finishes in April, and has no break in rainfall in the middle of the season. These types of seasons can be used to discuss different management options to cope with climate-related cropping problems or to explore how climatic factors might affect a new technology (for example, how the late onset of the rains might affect the application of lime or the choice of a new variety).

Comments: Local classifications are more complex for climate than for soils, because climate is much more dynamic, changing from one year to the next, whereas soils change very slowly. Developing a classification of climate also requires a higher level of abstraction, because participants are trying to identify common aspects in climate patterns that occur throughout relatively long periods. People are notoriously bad at judging long-term trends. A classification of climate clearly entails more limitations than other classifications, but it can still be useful to systematize and discuss key aspects of climate and their impact on agriculture and other elements of farmers’ livelihoods. It should be noted that the method presented here is not concerned with eliciting farmers’ perception of climate data (see, for example, Gill 1991) but with identifying

Table 9. Underlying factors defining “good” and “bad” seasons according to farmers, Chihota, Zimbabwe

Underlying factor	Good season	Bad season
Onset of rains	Mid-October	After October
End of rains	April	December, March
Mid-season drought	–	Rains break for three weeks in mid-season
Distribution of rains	Even throughout season; allows periods of sunlight	High rainfall in April, low rainfall during grain filling stage
Quantity of rain	Rains give time to work in field	Excessive rains cause waterlogging, very long rainy season

conditions and events that farmers use to classify a season with regard to its impact on crop production.

Local Crop Taxonomies

Goal: Identify the different types (or farmer varieties⁸) that farmers recognize in one crop species, and identify the traits farmers find relevant for each type. (This method may also be used for different crop species rather than for varieties of a single crop species.)

Rationale: Small-scale farmers usually plant more than one variety of a crop, particularly if it is one of their most important crops, and they have their own categories for the different varieties or types. Each of these varieties has specific characteristics, some positive and some negative. By identifying the different varieties and their advantages and disadvantages, it is possible to recognize the crop characteristics that farmers value and how these are distributed across the varieties they plant. This information is valuable for improving breeding strategies (for example, by pinpointing which traits to improve) or for identifying new varieties that may interest farmers. Additionally, this information may be valuable for understanding farmers' incentives to maintain crop diversity on the farm, an approach to conserving genetic resources and biodiversity that is becoming more important.

Method: A group of informants from a community is assembled, ideally male and female farmers with a reputation for planting many different varieties. Researchers explain that they want a

better understanding of the various types of a particular crop that exist in the community, including the positive and negative characteristics of each type. Researchers explain that this information is important for understanding the problems that farmers have with this particular crop and their possible solutions.

The interviewer poses the question: *What types or varieties of crop X (e.g., maize) does your community plant?*

Each of the types is listed. The interviewer checks whether each type is subdivided into finer categories and asks whether these categories are subdivided as well. *The interviewer continues until there are no finer categories.* Once all categories have been elicited, the interviewer asks the following questions for each one:

How do you tell this variety apart from other ones?

What are its positive characteristics (advantages)?

What are its negative characteristics (disadvantages)?

It is important to identify responses that refer to the same concept, since people may express their ideas in different forms. This requires some judgment on the part of the scientist, but usually it is not difficult. As with the other farmer classifications, the responses may refer to some underlying characteristic or property, and therefore it is important to identify them. Researchers can use this information to generate a table that synthesizes all the data.

⁸ *Farmer varieties* (referred to as "varieties" in this manuscript) are the crop populations that a group of farmers recognize as distinct units. Each of these varieties combines a particular set of characteristics that farmers recognize, such as a certain yield potential, growing cycle, particular performance under biotic and abiotic stresses, response to management, or culinary and storage properties.

Example: This method was used in the Oaxaca Project to identify the diversity of maize types grown by farmers, and the results formed the basis for an analysis of the supply and demand of characteristics (a method presented in the next section of this manual). For simplicity, this example will focus only on the exercise carried out in one of the communities in the project, Santa Ana Zegache. This exercise was conducted with a group of eight farmers (two women, six men). They identified four types of maize, based on grain color: Blanco (white), Amarillo (yellow), Negro (black), and Belatove (red). They did not recognize divisions within these classes. The advantages and disadvantages of each type are presented in Table 10. The underlying characteristics of the variety taxonomy are yield, duration, ease of sale, consumption quality, and suitability as animal feed.

During the discussion, it emerged that planting date—and therefore the uncertainty of the duration of the growing season—was very important. Although in the earlier part of this exercise farmers did not identify any disadvantage associated with white maize, a key disadvantage became clear: white maize had a high yield, multiple

uses, and was easy to sell, but it had the longest growing cycle. Its longer duration was a negative characteristic if the rains were delayed and it had to be planted late, because then the crop risked being exposed to drought and to frost. The other maize types had shorter growing cycles (white > yellow > black > red) and provided farmers with the flexibility to respond to the uncertain onset of the rains. If the rains arrived late, farmers could plant a shorter duration maize type. Farmers recognized the trade-off between duration and yield, and grain color was an indicator of this relationship.

Although women particularly appreciated the colored maize types, they were difficult if not impossible to sell, which was not a great problem in their subsistence-oriented farming system. These insights emphasize that there is no “best” or “ideal” variety; farmers need and want diversity. Even the very desirable white type had problems. The results from Santa Ana Zegache confirm the idea that planting different maize types is, at least in part, a risk management strategy. They also show that grain color is an important “marker” that farmers use to make planting decisions.

Table 10. Maize types and their characteristics in Santa Ana Zegache, Oaxaca, Mexico

Maize type	Characteristic	Advantages	Disadvantages
Belatove	Red grain	Grows very fast	Low yield Not a lot of animal feed
Amarillo	Yellow grain	Good yield Faster growing	Not widely consumed Difficult to sell
Negro	Black grain	Fast growing	Very difficult to sell Lower yield
Blanco	White grain	Good for consumption (tortilla, atole) Used for everything Easy to sell	No disadvantage

In the case of Santa Ana Zegache, the classification and number of maize types was simple, but this is not always so. Figure 5 shows the complexity of the maize taxonomy produced by farmers in the Chiapas Project, which stands in sharp contrast to the simplicity of the Oaxacan taxonomy. Farmers in Chiapas grouped their maize varieties into three major classes: landrace (*criolla*), improved, and “creolized”⁹ (*acriollada*) varieties. Each class comprised several maize types. Some landraces were further divided by grain color. The differences between the taxonomies from Oaxaca and Chiapas are partly explained by the fact that farmers in Chiapas are much more commercially oriented, even though subsistence production is also important. Although they had landraces with desirable characteristics, the farmers in the Chiapas Project had also been exposed to improved varieties that were well adapted to their conditions, and in fact they had modified some of the improved varieties to suit their needs (the creolized varieties).

Comments: Even within one community, the information elicited just

from one group may be incomplete. It is necessary to probe further with other farmers or groups. Ideally, researchers should ask farmers to bring samples of the different crop varieties they recognize to the group discussion and ask them to classify the varieties together.

Farmers’ classification of varieties may not necessarily coincide with researchers’ classification. In Santa Ana Zegache in Oaxaca, genetic resource specialists collected samples of ten types of maize, including all four grain colors. Based on agromorphological characteristics, these types were classified into three classes (one class could include more than one grain color).

As with other types of local taxonomies, a local crop taxonomy may be valid just for the community where it was elicited. The same name may refer to different biological entities from one community to the next. It may be misleading to compare varieties from different communities using local taxonomies. “Maíz Blanco” from community A may not be the same as “Maíz Blanco” from community B.

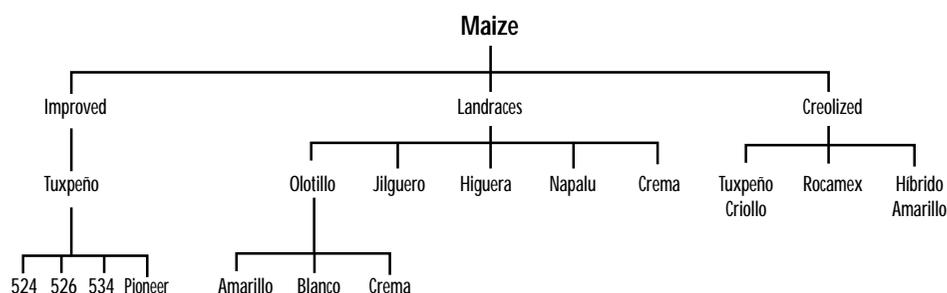


Figure 5. Classification of maize types in Vicente Guerrero, Chiapas, Mexico.

⁹ Creolized maize varieties are scientifically improved varieties that have been in the hands of farmers for several growing seasons and have been modified by them. These varieties usually are appreciated because they combine desirable traits of improved varieties with those of landraces.

Identifying Points of Intervention

Goal: Identify the technologies/practices to be developed and/or tested with farmers.

Rationale: The diagnosis of farmers' conditions usually reveals a large set of problems or constraints that farmers confront. The classification of farmers may show socioeconomic constraints, soil taxonomies may indicate problems with soils, and so on. Many of these problems cannot be resolved by research. If patterns of land inheritance discriminate against women, for example, there is little that an agronomist or a soil scientist can do, aside from noting the problem and considering how it may affect the technical solutions that can be offered to farmers to improve soil fertility.

Among the spectrum of problems uncovered in the diagnosis, it is fundamental to identify the areas of intervention where interaction between scientists and farmers can provide appropriate solutions through new technologies or practices. Obviously the particular expertise of the scientists working with the farmers will influence which problems can be addressed. Even so, the specific problems that should be addressed (and therefore the specific areas of intervention) are not necessarily easy to identify.

Method: A group of informants from a community is assembled, ideally a mixture of people of different ages, resources, and genders. Researchers explain that they want a better understanding of the informants' problems.

The interviewer poses the question: *What are your problems?*

The interviewer lists the responses. Since the informants' answers may refer to the same problem in different ways, once all problems have been identified, they should be grouped by similarity. For example, someone may say, "The crop does not produce," and someone else may say, "We get bad production." Both responses refer to low yields. Responses should be grouped in consultation with the informants, by saying, for example, "Do you agree that the statements 'The crop does not produce' and 'We get bad production' refer to the same problem? If so, let's agree on a common way of expressing it."

Once the problems have been consolidated, the interviewer asks the informants to rank them by asking informants which problem they consider to be the most important, which is second most important, and so on. There may not be consensus; different informants may rank problems differently. The interviewer notes the different rankings for each problem. Alternatively, the interviewer can ask each informant to rank the problems, and then use the average ranking or the most frequent ranking to order the problems by importance. Another strategy is to ask informants to vote on the importance of each problem.

This exercise helps researchers identify the general areas of intervention where they can make a contribution. It also helps researchers to gauge the potential importance of each intervention, because they can see the entire range of problems that farmers face and the importance of each. *The farmers' answers may range over a very broad range of topics, including all sorts of things that agricultural research can do nothing about, and they may raise people's expectations. Therefore, researchers should be*

*extremely careful to be clear to farmers about what the researchers can and cannot do. The understanding that researchers may have gained with the use of farmers' classification of themselves may be helpful in guiding and focusing the discussion.*¹⁰

Once the general areas of intervention have been identified, researchers should repeat the exercise to identify and rank the specific problems that are suitable for research. *At this stage, it is fundamental that researchers keep the discussion focused on areas where they can make a contribution. Keep the discussion as specific as possible.* For example, the general concern of "low yields" may consist of more specific problems, including late planting, insect attack, lack of irrigation, and difficulty in purchasing fertilizers.

After problems have been identified and ranked, the group of informants and researchers should discuss possible options for addressing them.

The interviewer asks the informants: *What do you think can be done to improve/ solve this problem?*

The pros and cons of the different options identified can be discussed and the group can agree how to proceed. It is important that the responsibilities of farmers and scientists regarding future action are defined very clearly in terms of what each will and will not do.

Example: A maize agronomist and a rural sociologist used the method described above to query a group of very poor, subsistence-oriented, indigenous farmers in a small community in the state of Puebla, Mexico, about their

problems.¹¹ The group comprised 100 farmers, 40 of them female, ranging in age from 20 to 60. This number of participants is unusually high and reflects a high degree of social organization within the community. After a long discussion in which researchers used their knowledge of the area and the communities to encourage farmers to focus on specific issues, the group mentioned the following problems:

- low prices for coffee and pepper;
- lack of labor for harvesting coffee;
- lack of infrastructure to dry and process coffee, which led to marketing problems because farmers could sell coffee only as berries, not beans;
- poor transportation infrastructure;
- insufficient maize production to cover their needs;
- difficulty selling other agricultural products, such as tropical fruit (prices were so low that was not worth harvesting the fruit);
- lack of sufficient drinking water during the dry season; and
- lack of doctors and medicines, although the community had a health center.

The group was asked to rank the problems in order of importance. Problems associated with coffee and maize were equally important, followed by the lack of services (water and health), the lack of transportation infrastructure, and the difficulty of marketing tropical fruit. The scientists participating in the exercise explained to the group that their expertise was in maize, and unfortunately they could give little assistance with problems related to

¹⁰ Other methodologies can be used to address these issues in a very focused manner, such as causal analysis with farmers (Tripp and Woolley 1989).

¹¹ This example was kindly supplied by Angel Pita and Xóchitl Juárez from the Universidad Autónoma de Chapingo, Mexico.

coffee, pepper trees, services, or infrastructure. The remainder of the exercise focused on insufficient maize production.

Participants were asked about their specific problems in maize production. They mentioned that while their local maize varieties were good, the varieties nevertheless had some problems. The main problem was that the varieties were tall and vulnerable to lodging, and the participants wished to test new maize varieties. The group mentioned high storage losses as another problem, as well as losses to pests in the field (white grubs and fall armyworm). They also wanted to know about other types of fertilizer. The fertilizer formulations they used for maize were originally provided for coffee production and had low nutrient concentrations (e.g., 18-12-6 N-P-K). The ranking of these problems in order of importance was: 1) maize varieties, 2) fertilizers, 3) storage losses, and 4) field pests.

Based on this exercise, several specific areas of intervention were defined:

- 1) evaluating new maize varieties, both local and external, with farmers;
- 2) conducting simple experiments with different fertilizer types and rates; and
- 3) evaluating the use of metal silos for storing maize. Although farmers wanted to evaluate the use of pesticides, they decided against it when they learned of the expense and of the need for special handling to avoid health risks.

Comments: An important role for scientists participating in this type of exercise is to provide their analytical skills to identify the causes behind the problems and propose solutions that may not be apparent to farmers. Farmers know their environment and circumstances better than anyone, but in many instances the causes of many of their problems may not be evident to them, and scientists can explain those causes. For example, farmers may not understand the workings of supply and demand. When they see that the price of a crop increases, they may all plant it the next season, perhaps increasing supply so greatly relative to demand that the price falls substantially. Nor may farmers understand decreasing marginal returns to an input. They may believe that applying double the amount of fertilizer will increase production twofold, which may lead them to waste the input without obtaining the expected results.

In summary, researchers can propose new options that may be unknown to farmers, such as conservation tillage for areas with erosion or where soil preparation is a constraint. Researchers can also provide new knowledge to help farmers understand problems better; with pest control, for instance, researchers can provide knowledge about pests' reproductive cycles or the role of beneficial insects.

Evaluation of Current and New Technological Options

Any technology or practice used by farmers represents a particular way to solve one or several problems. Each technology or practice responds to farmers' concerns in specific ways, which may be regarded as the *traits* or *characteristics* that define the technology or practice. Farmers can view some characteristics as positive or advantageous (i.e., as benefits) and others as negative or disadvantageous (i.e., as costs).

Any practice or technology entails trade-offs between its positive and negative traits. As a farmer from Chiapas once said when discussing maize varieties, "With each variety you gain in certain things but lose in others." He explained that with a modern variety, farmers gained higher yields, shorter duration, and less lodging, but they also lost something, because the variety required more inputs and more careful management. The choice of one technology/practice over others is greatly influenced by the balance between its positive and negative characteristics. Depending on the preferences, resources, and constraints that individual farmers face, a beneficial characteristic for one farmer may be a negative one for another, or the balance between positive and negative traits may be acceptable for one farmer but not for another.

Any new technology presented to farmers will either improve or substitute for the technological options they currently have. It is fundamental to identify these options and understand perceptions about the advantages and disadvantages of each one. Only then will researchers be able to assess the appropriateness of potential new technologies or practices, evaluate the likelihood that they will be adopted, and if necessary modify them to suit farmers' needs better. To identify gaps in knowledge and perceptions among those involved in the process of technological change, it is vital to understand not only farmers' perceptions but also those of other stakeholders in the research process, mainly the scientists and technicians proposing these new technologies.

This section presents several methods for identifying technologies that farmers presently use, eliciting and analyzing farmers' perceptions of their costs and benefits, and enabling farmers and researchers to evaluate new technologies together.

Eliciting Farmers' Perceptions of Technological Options

Goal: Identify the criteria used by farmers to assess available technological options.

Rationale: Farmers have several technological options at their disposal. They have perceptions of their advantages and disadvantages and therefore their trade-offs. Inherent in these perceptions are the criteria that farmers use to judge these technologies and most likely any new ones. It is important to know and understand these criteria if researchers are to identify new technological options of interest to farmers, including improvements to current ones.

Method: Define the problem to be addressed, such as inappropriate germplasm, infertile soil, or problems with pest management or crop storage. A group of informants from a community is assembled, ideally a mixture of people of different ages, resources, and genders. The first step is to identify the technological options that farmers recognize to deal with the problem of interest. For germplasm, this is relatively easy because the local crop taxonomy provides this information. For other problems—soil infertility, a pest, storage, and so on—it may be necessary to ask, for example:

What can you do to deal with this problem?

Or ask specifically: *What can you do to improve your soils? What do you do to control a particular pest? What do you do to protect your stored maize?*

The answers to this question are the options recognized by farmers. Researchers should try to be as inclusive

as possible, and to elicit as many answers (options) as possible. At this stage it is not important to establish how important these are, but to have the most comprehensive list.

Then for each option identified, the interviewer asks:

What are its advantages?

What are its disadvantages?

The interviewer records all answers. It is important to identify responses that refer to the same concept, since people may express their ideas in different forms. This requires some judgement on the part of the scientist, but usually it is not difficult. (This is similar to what has been done for the local soil and crop taxonomies). Once this has been done, researchers should identify the underlying properties, characteristics, or concerns implied in farmers' responses. This last activity is a fundamental part of this method, since these characteristics, properties, or concerns are the basis for the criteria. It is important to express the criteria in terms that make sense to farmers. The following examples show how this method is applied for germplasm and soil fertility management.

Example for germplasm: The Oaxaca Project included a collection of landraces representing the maize diversity present in the region. As indicated earlier, the collection was based on the local crop taxonomy elicited from key informants in all communities sampled. Farmers donating the maize samples were asked about the advantages and disadvantages of each landrace they donated. Table 11 presents the local maize taxonomy and the advantages and disadvantages for the six communities that are the focus of the project. Note for example how farmers refer to an advantage with different terms:

Table 11. Perceived advantages and disadvantages of maize types, Oaxaca, Mexico

Type	Blanco (white kernel)				Amarillo (yellow kernel)		Negro (black kernel)	Belatove (red kernel)	Pinto
Subtypes	Tempranero (early)	Delatoba	Olote delgado (thin cob)	Blanco (generic)	Amarillo (generic)	Tepecente	None	None	None
Advantages	Early Good tortillas Thin cob Yields by volume White tortilla	Heavy Yields by volume Good storage Soft pasture	Yields by volume Easy to shell	Good tortillas Good production Not too delicate Heavy Yields by volume Low ear rot Good pasture Good for sale Withstand drought Easy to shell Good for consumption	Weight Good tortilla Tasty tortilla Withstands drought Yields by volume Withstands weeds Early Good yield Good storage Tasty atole Good yield Grows fast	Withstands pests A lot of grain	Good tortillas Early Tasty tortillas Color Tasty tlayuda Sweet atole Withstands cold	Good tostadas Very early Grows very fast	Good adaptation
Disadvantages	Low yield Small ear			Low yield High ear rot Poor storage	Poor storage Not widely consumed Difficult to sell		Attacked by pests Low yield Very difficult to sell	Low yield Little pasture	

“early” and “grows fast.” The taxonomy has five maize types, based on grain color: Blanco (white), Amarillo (yellow), Negro (black), Belatove (red), and Pinto (multicolored). The white and yellow types were subdivided further into four and two subtypes, respectively. All answers can be grouped as characteristics related to a set of concerns: consumption, yield, sale, duration, adaptation, and response to biotic and abiotic stresses. These advantages and disadvantages were used to identify the criteria that farmers use to judge their maize. Table 12 presents these characteristics grouped by concern and then expressed as the criteria. The data show how important consumption characteristics are for these farmers. These criteria will be used later for comparing different varieties/ technological options.

Example for soil fertility management:

The Chihota Project included feedback from farmers who had been evaluating three soil fertility improvement technologies: lime in combination with fertilizer; green manuring (velvetbean and sunnhemp), sole or intercropped with maize; and cereal legume rotations.

During these feedback sessions, farmers were asked about the advantages and disadvantages they perceived in these technologies (Table 13). All answers can be grouped as characteristics related to a set of concerns: impacts on soil fertility, fertilizer use efficiency, productivity, costs, labor and inputs, alternative uses for the crops, rainfall, and biotic stresses. These advantages and disadvantages were used to identify the criteria that farmers use to judge the technologies. Table 14 presents these characteristics grouped by concern and then expressed as the criteria.

Table 12. Characteristics and criteria used to judge maize types, Oaxaca, Mexico

Concern	Advantages	Disadvantages	Criteria
Consumption	Tasty tortillas Tasty/sweet atole Tasty tlayuda Tasty tostada Easy to shell Good storage Good pasture Soft husk (totomoxtle)	Poor storage Little pasture	Taste of tortillas Taste of atole Taste of tlayudas Taste of tostadas Ease of shelling Storage properties Production of pasture Husk quality
Yield	Good yield–weight Good yield–volume Good yield (generic)	Small ear Low yield	Yield by weight Yield by volume
Duration	Early/ fast growing		Duration
Sale	Easy to sale	Difficult to sell	Ease of sale
Adaptation	Good adaptation		Adaptation
Abiotic stress	Withstands drought Withstands cold		Withstands drought Withstands cold
Biotic stress	Withstands weeds Withstands pests Low ear rot	Attacked by pests High ear rot	Withstands weeds Withstands pests Susceptibility to ear rot

Table 13. Perceived advantages and disadvantages of soil fertility improvement technologies, Chihota, Zimbabwe

	Lime with fertilizers	Cereal/legume rotations	Green manures
Advantages	Improves yields Crops grows well Improves soil structure Improves soil fertility Corrects pH Increases fertilizer efficiency Not expensive Cut costs of fertilizers Suppresses weeds Early to assess	Residual fertility Reduced fertilizer use High yields Increased crop diversity Multipurpose use of legumes Disease control Early to assess	Improves soil fertility Cheaper than fertilizers Increase yields Can be used to feed cattle None
Disadvantages	Needs adequate rains Crops suffers if rains are late Damage soil if over-used Can be washed away by wind Still assessing None	Legumes affected by disease Poor germination Still assessing None	Not for human consumption Seed unavailable Labor intensive None

Table 14. Characteristics and criteria used to judge soil fertility improvement technologies, Chihota, Zimbabwe

Concern	Advantages	Disadvantages	Criteria
Soil fertility	Improves soil fertility Corrects pH Residual fertility Improves soil structure	Damage soil if over-used	Impact on soil fertility Impact on pH Impact on residual fertility Impact on soil structure Impact on soil if over-used
Fertilizer efficiency	Increases fertilizer efficiency Reduced fertilizer use		Impact on fertilizer efficiency
Costs	Not expensive Cut costs of fertilizers Cheaper than fertilizers		Cost vis-à-vis inorganic fertilizers
Inputs		Seed unavailable Can be washed away by wind	Ease of accessing inputs Chances of input loss
Labor demands		Labor intensive	Impact on available labor
Productivity	Improves yields Crops grows well High yields Increases yields		Impact on yield
Alternative uses for crops	Increased crop diversity Multipurpose use of legumes Can be used to feed cattle	Not for human consumption	Alternative uses
Rainfall		Needs adequate rains Crops suffer if rains are late	Interaction with rainfall
Weeds	Suppresses weeds		Impact on weeds
Germination		Poor germination	Impact on germination
Diseases	Disease control	Legumes affected by disease	Impact on/from disease

Comments: This method—whether it is applied to germplasm or another kind of technology—only provides an inventory of characteristics that farmers use to assess the technological options they know, although it is likely that they would use the same criteria to judge new options. This method is only descriptive. Researchers cannot assess which characteristics are more important for the farmer. Nor can they assess the importance of the characteristics in relation to the technological options available, particularly for those characteristics that can be delivered by several technologies (in other words, researchers cannot tell how much of a characteristic of interest, such as yield, is supplied by a particular variety or input). This information is important for determining which characteristics should be improved or to evaluate new technological options compared to current ones.

Comparing Different Technological Options

Goal: Systematically compare and analyze farmers' perceptions of technological options.¹²

Rationale: The previous method helps to elicit information on the advantages and disadvantages of technologies, on the implicit characteristics that farmers value in those technologies, and therefore on farmers' criteria for judging technological options. To compare and evaluate technological options in a systematic manner, however, it is necessary to assess the importance of each of these characteristics relative to

each other (i.e., farmers' demand for these characteristics) and the extent to which each technology provides these characteristics (i.e., the technology supply of characteristics). A technological option that is better at supplying characteristics that farmers consider more important is more valuable than one that is inferior. Furthermore, even when a technological option is good at supplying certain characteristics, if these are not very important, its value is diminished.

Method: The previous method provided a list of characteristics that farmers valued, but it could not clarify how much the individual characteristics were valued relative to each other or how specific technological options provided each characteristic. In many cases, scientists add characteristics to the list of characteristics identified previously, based on their experience, even though farmers may not have identified them. In some instances, certain issues are not mentioned because they are obvious to informants, or informants simply fail to articulate or mention them. Clearly, the scientists' experience and common sense should complement the farmers'.

The exercise described here can be done with a group of farmers or individual farmers, a choice that has implications for the analysis (see comments below). It assumes that the relevant technological options have already been identified (e.g., maize varieties, soil improvement technologies, and so on).

First, researchers explain the objective of the exercise to the participants. The researchers make it clear that, in

¹² The emphasis here is on the evaluation of technologies based on their characteristics. This method is particularly suited for crop varieties, which is the focus of the work described here. The reader is referred to CIMMYT (1988) for methods using other factors in technology evaluation.

discussions with them or with other farmers, they have identified a set of characteristics or issues that farmers find important in their technological options. Now they wish to know *how important* those characteristics are to farmers, since some are likely to be more important than others. Researchers can provide an example to make this point. Then they should note that not all of farmers' technological options perform equally well with respect to each of those characteristics (here another example may be useful). Therefore, researchers also want to know *how good or bad* farmers consider each of these options to be with respect to each characteristic.

Second, the interviewer asks farmers to rate the importance of each of the identified characteristics (in other words, to assess the demand of characteristics) by asking:

How do you consider this characteristic (e.g., yield, drought resistance) to be: very important, somewhat important, or not important?

This question is repeated for all characteristics identified as important. It is highly desirable to make cards, each illustrating one of the characteristics, and ask farmers to place each card in a pile corresponding to the rating they consider appropriate (very important, somewhat important, not important). Figure 6 presents a hypothetical example with cards. (Appendix 2 shows examples of cards used in the Oaxaca Project).

Third, farmers are asked to rate the performance of each technological option with respect to each characteristic as: very

good, intermediate/acceptable, or poor¹³ (assess the supply of characteristics). To do this, the interviewer asks:

How do you consider this option (e.g., variety A, velvet bean, lime) to be in terms of its performance with respect to this characteristic (e.g., drought resistance, increasing soil fertility): very good, intermediate, or poor?

This question is repeated for all options and a given characteristic. Then the process is repeated for the next characteristic, and so on until no more characteristics remain to be discussed. It is desirable, since it simplifies the process, to use the cards from the second step in this method. Put them in a row (Figure 7). Above them, place three cards depicting the rating of performance (poor, intermediate, very good), perhaps shown as a frowning, straight, or smiling face, or thumbs up/thumbs down, or some other image adapted to the place where the research is being done. As shown in Figure 7, this card placement creates a matrix in which the first row displays the characteristics and the columns display the possible performance ratings.

Using cards that name or depict the options (with varieties you can use actual ears or panicles of specific varieties), researchers ask the farmers to place the card with the option (or the ear) in the row with the card with the characteristic and under the column for the appropriate performance rating. The results are noted.

The results from these ratings can be compared across different types or

¹³ The rating has to be adapted to the characteristic. In some cases, "very good," "intermediate," or "poor" may not be the most appropriate way to rate a characteristic. If the characteristic of interest is the labor required for the technology to work properly, a more suitable rating may be "high," "intermediate," or "low."

 Not important	 Somewhat important	 Very important
 Withstands cold	 Withstands wind	 Withstands drought
 Easy to shell	 Invest labor	 Cash investment
 Good for tejte	 Taste of tortilla	 Good for nixtamal

Figure 6. Hypothetical example of cards rating the importance of maize characteristics.

Note: No order of importance is implied within a column. Each column represents a pile of cards associated with the importance rating.

	 Poor	 Intermediate	 Very good
 Good for nixtamal			
 Invest labor			
 Withstands drought			

Figure 7. Example of a card layout to rate characteristics.

groups of farmers and/or varieties/ technological options using the average ratings. These average ratings can be used to compare and rank the importance of different characteristics to farmers (demand of characteristics) or to compare and rank the performance of different options with respect to each characteristic (supply of characteristics).

As mentioned previously, this rating exercise can be done with a group of farmers or individual farmers. The group strategy may produce a consensus on the ratings. There is no guarantee, however, that a consensus may be reached. If the group is heterogeneous, it is very likely that farmers may not agree on the importance of many characteristics, because each farmer faces different problems, may have different priorities, and therefore may value characteristics differently. In fact, identifying the disagreements and discussing them may provide important information on farmers' diverse priorities. Furthermore, in a group setting it may be difficult to analyze variation among individuals with different goals, resources, and constraints, and researchers will be more limited in their ability to generalize the results to other farmers. One strategy for gaining this information is to ask for a show of hands (voting) and record how each member of the group rates the importance of a characteristic and the performance of a technological option with respect to a characteristic. It may be useful to record the votes disaggregated by gender. This procedure provides a better idea of the variability in ratings across group members.

A second strategy allows statistical tests and inferences to be made if researchers have a random, representative sample from a population of farmers. The ratings can be combined with a typology of farmers, such as the wealth ranking, to

analyze how different types or groups of farmers rate the characteristics (for example, which characteristics are important for poor or rich farmers, male or female farmers, farmers with and without machinery). The performance of different technologies with respect to each characteristic can be assessed statistically, which offers a better idea of the trade-offs involved (see example below).

A third strategy can be used if many groups are interviewed. Each group can be treated as an "individual" and the average ratings can be calculated across groups. Alternatively, if a show of hands is asked for each group and the results are recorded, individual votes within a group could be used for the analysis. Since there are many groups, this would lead to a large number of ratings. Researchers should be careful in applying statistical inferences to these techniques, however. If the sample of informants is not randomly chosen, researchers may violate the assumptions of the tests they want to apply, invalidating their results. However, these approaches provide a better idea of the variability present and still permit some basic parameters to be calculated, such as the average rating or percentage for each rating, at least for the participants and without claiming wider representation.

Example: This method was used in the Oaxaca Project to compare different maize landraces, based on the categories identified by eliciting the local crop taxonomy (presented earlier). The results for only one community, Santa Ana Zegache, are presented here for simplicity and because the results differed across communities.

The rating exercise was done as part of the baseline survey with a random sample of 40 farming households in the

community. Male and female members of each household were interviewed separately. The list of characteristics included all the ones identified across the region. The reader should note that this list of 25 characteristics included characteristics that were not identified explicitly by farmers using the method to elicit their criteria. The additional characteristics were included because researchers thought that they would be important (in fact they were). The additional characteristics included yield stability (“produces something even in a

bad season”), yield of tortillas by kilogram of dough, and suitability for all uses identified in the region (special dishes and preparations).

Analyzing the demand of characteristics

Table 15 compares the ratings for the importance of maize characteristics by men and women in farming households. The table reports the average rating, based on the following scale: 1 = very important, 2 = somewhat important, and 3 = not important.¹⁴ A Wilcoxon matched-pairs

Table 15. Average ratings of importance of maize characteristics by males and females, Santa Ana Zegache, Oaxaca, Mexico

Concern	Characteristic	Average rating			Top 5 characteristics	
		Males	Females	P-value ^a	Males	Females
Consumption	Taste of tortillas	1.78	1.38	0.01	–	–
	Good for atole	1.80	1.55	ns	–	–
	Good for tlayudas	2.23	1.63	0.00	–	–
	Ease of shelling	2.08	2.68	0.00	–	–
	Good for storage	1.08	1.50	0.00	2	–
	Good pasture	1.90	1.70	ns	–	–
	Good feed	1.20	1.53	0.02	5	–
	Nixtamal quality	2.05	1.33	0.00	–	5
	Good for tamales	2.25	2.23	ns	–	–
	Good for tejate	2.73	2.38	0.01	–	–
	Good for pozole	2.95	2.80	0.03	–	–
	Good for nicoatole	2.90	2.70	0.02	–	–
Yield	Yield by weight	1.25	1.05	0.03	–	2
	Yield by volume	1.28	2.03	0.00	–	–
	Yield of tortillas	1.98	1.45	0.00	–	–
	Yield stability	1.13	1.03	0.10	4	1
Duration	Duration	1.40	1.55	ns	–	–
Sale	Ease of sale	1.85	1.53	0.03	–	–
Abiotic stress	Withstands drought	1.03	1.08	ns	1	3
	Withstands wind	2.55	1.88	0.00	–	–
	Withstands cold	2.75	2.30	0.00	–	–
Biotic stress	Withstands weeds	2.45	2.35	ns	–	–
	Withstands pests	2.40	1.60	0.00	–	–
Management	Produced with little labor	1.40	1.85	0.01	–	–
	Produced with little money	1.10	1.18	ns	3	4

Note: ns = not significant.

^a P-value associated with a Wilcoxon signed ranks test for two related samples.

¹⁴ Appendix 3 shows what data for the demand and supply of characteristics look like.

signed ranks test (a non-parametric statistical procedure) was used to test for statistically significant differences between males' and females' ratings for a characteristic.¹⁵

A comparison of men's and women's ratings shows highly significant differences for most characteristics. Of the 25 characteristics, only seven had no statistically different ratings. Of the five top-rated characteristics, however, men and women coincided in three: tolerance to drought, yield stability, and low cash investment. Men also included storage properties and suitability as feed in the top five characteristics, and women included yield by weight and *nixtamal*¹⁶ quality. These results also show that men and women value many characteristics: the average ratings for 14 and 17 characteristics for men and women, respectively, were between "very" and "somewhat important."

These results show important gender differences in the demand for maize characteristics. Failure to recognize these differences would lead to biased interventions. In the Oaxaca Project, if males alone had participated in the voting exercise that identified landraces to be distributed, it is very likely that the choices would have been of interest to them but less so for women. These results also have implications for breeding. Improvements in yield stability or tolerance to drought would be beneficial for both men and women, but

any improvements that come at the cost of decreasing nixtamal quality could negatively affect women more than men, since women value nixtamal quality much more than men do.

The large number of characteristics rated as "very" or "somewhat important" also suggests that both men and women demand *diversity*, since it is unlikely that *one* maize type will be good at supplying all of the characteristics they value. Therefore there may not be a "best" or "ideal" maize type. These farmers require a range of maize types, and this fact motivates the intervention of providing farmers with access to diversity in the Oaxaca Project.

Similar analyses can be done using any grouping or classification of farmers, such as a wealth ranking. Table 16 groups men and women separately by wealth rank and reports the average rating for each wealth rank (i.e., rich, medium, poor), based on the following scale: 1 = very important, 2 = somewhat important, and 3 = not important. A Kruskal Wallis one-way analysis of variance by ranks (a non-parametric statistical procedure) was used to test whether there were differences in the ratings—in other words, whether each rating for a characteristic was statistically equal or not among the three wealth groups.¹⁷

The ratings of characteristics among the wealth groups were not statistically

¹⁵ The table reports the mean or average rating, from which it is easier to identify differences and trends, but the test is based on the null hypothesis that the median (not the mean) of the population of differences is zero (Daniel 1978:135-9). A non-parametric test, such as the one used here, is more appropriate because the ratings are ordinal and their underlying distribution is unknown and is not likely to be normal. In this case, this test is used because males and females were not selected independently of each other but were members of the same household (they were related).

¹⁶ Nixtamal is the dough used to make tortillas, which requires that the milled maize be soaked in water with lime.

¹⁷ The table reports the mean or average rating, from which it is easier to identify differences and trends, but the test is based on the null hypothesis that the three population distribution functions are identical against the alternative hypothesis that they do not all have the same median (Daniel 1978:200-5).

Table 16. Average ratings of importance of maize characteristics by wealth rank for males and females, Santa Ana Zegache, Oaxaca, Mexico

Concern	Characteristic	Males by wealth rank					Females by wealth rank				
		Rich	Medium	Poor	Total	P-value ^a	Rich	Medium	Poor	Total	P-value ^a
Consumption	Taste of tortillas	1.79	1.83	1.83	1.81	ns	1.38	1.54	1.00	1.38	ns
	Good for atole	1.64	1.92	1.67	1.75	ns	1.38	1.69	1.33	1.50	ns
	Good for tlaxudas	2.21	2.42	2.17	2.28	ns	1.62	1.54	1.67	1.59	ns
	Ease of shelling	2.21	2.00	2.00	2.09	ns	2.54	2.77	2.67	2.66	ns
	Storage properties	1.14	1.08	1.00	1.09	ns	1.31	1.62	1.50	1.47	ns
	Good pasture	1.93	2.00	1.50	1.88	ns	1.46	1.92	2.00	1.75	ns
	Good feed	1.29	1.17	1.00	1.19	ns	1.46	1.54	1.67	1.53	ns
	Nixtamal quality	2.07	2.08	2.17	2.09	ns	1.46	1.31	1.00	1.31	ns
	Good for tamales	2.50	2.25	1.83	2.28	0.06	2.46	2.08	2.17	2.25	ns
	Good for tejate	2.86	2.75	2.67	2.78	ns	2.54	2.23	2.33	2.38	ns
Good for pozole	3.00	2.92	2.83	2.94	ns	2.85	2.85	2.67	2.81	ns	
Good for nicoatole	2.86	3.00	2.83	2.91	ns	2.69	2.69	2.50	2.66	ns	
Yield	Yield by weight	1.36	1.08	1.33	1.25	ns	1.15	1.00	1.00	1.06	ns
	Yield by volume	1.29	1.50	1.17	1.34	ns	2.15	1.85	2.00	2.00	ns
	Yield of tortillas	1.93	2.00	2.00	1.97	ns	1.62	1.54	1.17	1.50	ns
	Yield stability	1.14	1.00	1.00	1.06	ns	1.08	1.00	1.00	1.03	ns
Duration	Duration	1.29	1.58	1.50	1.44	ns	1.46	1.54	1.50	1.50	ns
Sale	Ease of sale	1.71	2.00	1.83	1.84	ns	1.31	1.85	1.83	1.63	ns
Abiotic stress	Withstands drought	1.00	1.00	1.00	1.00	ns	1.00	1.15	1.17	1.09	ns
	Withstands wind	2.43	2.58	3.00	2.59	ns	2.08	1.69	2.00	1.91	ns
	Withstands cold	2.71	2.50	3.00	2.69	ns	2.31	2.38	2.17	2.31	ns
Biotic stress	Withstands weeds	2.14	2.67	2.50	2.41	ns	2.15	2.31	2.67	2.31	ns
	Withstands pests	2.36	2.33	2.67	2.41	ns	1.31	1.85	1.50	1.56	ns
Management	Produce with little labor	1.36	1.42	1.50	1.41	ns	1.92	1.77	1.67	1.81	ns
	Produce with little money	1.07	1.08	1.00	1.06	ns	1.15	1.23	1.17	1.19	ns

Note: ns = not significant.

^a P-value associated with a Kruskal Wallis one-way analysis of variance by ranks for males and females separately.

different.¹⁸ Not surprisingly, for the top five characteristics all wealth ranks among men and among women coincided on the following: yield stability, tolerance to drought, and low cash investment. Men across all wealth categories coincided on storage properties. Women across wealth categories agreed on yield by weight; for poor women, taste of tortillas and nixtamal quality were also particularly important.

These results suggest that improvements in any of the traits may benefit all farmers equally. If differences between wealth groups had emerged for certain characteristics, however, the improvement of those characteristics would have benefited some groups more than others. It is also important to note that losses in some characteristics may be more negative for some groups than for others. For example, if resistance to lodging is rated significantly higher by the “rich” group, the introduction of a new variety more resistant to lodging may benefit them more than the other groups. On the other hand, if the “poor” group rates resistance to storage pests significantly higher, and a new variety has substantially lower resistance to these pests, the cost of adopting the new variety will be higher for the poor group than for the other groups.

By analyzing the ratings of these characteristics as shown here, researchers gain a method to predict how the costs and benefits of introducing a new technology are likely to be distributed among different groups of farmers and/or members of farming households.

Analyzing the supply of characteristics

Table 17 compares farmers’ ratings of the performance of Blanco (white), Amarillo (yellow), Negro (black), and Belatove (red) maize types by gender group. For each characteristic identified earlier, each maize type was rated based on the following scale: 1 = very good, 2 = intermediate, or 3 = poor. For the characteristics related to labor and cash investments, the rating scale was: 1 = little, 2 = intermediate, 3 = a lot. The table reports the average rating per maize type,¹⁹ except for yield by weight, yield by volume, yield of tortillas, anthesis (days to male flowering), and days to be ready for harvest (an indicator of duration), for which the means of estimates provided by farmers in the appropriate units are used. A non-parametric Kruskal Wallis one-way analysis of variance by ranks for the ratings and a parametric one-way analysis of variance for the continuous variables were used to test for statistical differences across the different maize types for each characteristic.

Men’s assessments of the four types showed statistically significant differences for most characteristics. The Blanco type is superior to the other types for all characteristics, except for having the longest duration. On the other end of the spectrum, the Belatove type is inferior to all other types, except for having the shortest duration. Amarillo and Negro are intermediate. The assessment shows a gradient of performance from Blanco to Amarillo, Negro, and Belatove. These results

¹⁸ Except for the case of “good for tamales” among men, where the poor rated it higher than the rest.

¹⁹ As with the demand of characteristics (Table 16), Table 17 for supply of characteristics reports the mean or average rating, which makes it easier to identify differences and trends, but the test used in each table is based on the null hypothesis that the three population distribution functions are identical against the alternative hypothesis that they do not all have the same median (Daniel 1978:200-5).

Table 17. Average rating of the performance of different maize types for several characteristics of importance to male and female farmers, Santa Ana Zegache, Oaxaca, Mexico

Concern	Characteristic	Males						Females					P-value ^a
		Blanco	Amarillo	Negro	Belatove	Total	Signif. ^a	Blanco	Amarillo	Negro	Belatove	Total	
Consumption	Taste of tortillas	1.00	1.11	1.00	1.33	1.04	0.01	1.03	1.07	1.00	1.00	1.03	ns
	Good for atole	1.00	1.47	2.46	2.33	1.42	0.00	1.00	1.33	2.40	3.00	1.32	0.00
	Food for tlayudas	1.00	1.17	1.00	1.00	1.04	0.09	1.00	1.00	1.00	1.00	1.00	ns
	Nixtamal quality	1.00	1.22	1.29	1.67	1.13	0.00	1.00	1.07	1.00	1.00	1.02	ns
	Good for tamales	1.00	1.06	1.93	2.33	1.24	0.00	1.00	1.07	1.10	1.00	1.03	ns
	Good for tejate	1.00	2.00	2.36	2.33	1.55	0.00	1.03	1.80	2.20	2.00	1.39	0.00
	Good for pozole	1.00	1.83	2.43	2.33	1.52	0.00	1.03	1.20	1.80	1.00	1.18	0.00
	Good for nicoatole	1.00	2.11	1.50	3.00	1.44	0.00	1.00	1.87	2.50	3.00	1.46	0.00
	Ease of shelling	1.05	1.11	1.36	1.00	1.12	ns	1.45	1.07	1.00	1.00	1.29	0.01
	Storage properties	1.75	2.06	2.71	3.00	2.05	0.00	1.85	2.20	2.90	3.00	2.11	0.00
	Good pasture	1.00	1.00	1.93	2.33	1.23	0.00	1.08	1.07	1.90	3.00	1.23	0.00
	Good feed	1.00	1.00	1.07	1.00	1.01	ns	1.00	1.00	1.00	1.00	1.00	ns
Yield	Yield by weight ^b	653.8	544.9	520.4	461.3	595.1	0.01	395.8	296.0	230.0	156.7	346.9	0.01
	Yield by volume ^c	4.00	3.99	3.99	4.00	3.99	ns	3.97	3.97	3.98	4.00	3.97	ns
	Yield of tortillas ^d	38.37	38.78	39.14	39.00	38.64	ns	36.05	36.80	38.00	40.00	36.58	ns
	Yield stability	1.08	1.56	1.86	2.00	1.37	0.00	1.63	1.33	1.20	1.00	1.48	0.04
Duration	Anthesis ^e	79.9	74.6	62.9	60.0	74.6	0.00	74.0	65.9	53.5	45.0	68.9	0.00
	Harvest ^f	121.9	116.2	97.4	95.0	114.9	0.00	127.5	118.3	97.1	96.0	120.5	0.00
Sale	Ease of sale	1.00	1.28	2.00	2.00	1.29	0.00	1.00	1.20	1.80	2.00	1.18	0.00
Abiotic stress	Withstands drought	1.35	1.89	2.64	2.33	1.76	0.00	1.54	1.47	1.60	2.00	1.54	ns
	Withstands wind	1.25	1.33	1.21	1.33	1.27	ns	1.48	1.60	1.20	2.00	1.47	ns
	Withstands cold	1.13	1.11	1.14	1.00	1.12	ns	1.25	1.47	1.40	1.00	1.32	ns
Biotic stress	Withstands weeds	1.63	2.06	2.00	1.67	1.80	0.01	1.80	1.93	1.60	1.00	1.79	ns
	Withstands pests	1.45	1.56	1.71	1.33	1.52	ns	1.58	2.07	2.11	3.00	1.78	0.00
Management	Produced with little labor	2.50	2.33	2.50	2.00	2.44	ns	2.30	2.33	2.40	2.00	2.32	ns
	Produced with few purchased inputs	2.58	2.56	2.57	2.00	2.55	ns	2.33	2.40	2.40	2.00	2.35	ns

Note: ns = not significant.

^a P-value associated with a Kruskal-Wallis ANOVA test for the ratings, except for yield by weight, yield by volume, yield of tortillas, anthesis, and harvest, which are associated with a parametric ANOVA.

^b Expected yield (kg/ha) calculated from the best, worst, and more frequent yield declared by farmers for each maize type, following the method of the triangular distribution (Hardaker et al. 1997).

^c In kg/local unit of volume (almud).

^d Number of tortillas/almud

^e Number of days to anthesis (male flowering)

^f Number of days for the crop to be ready for harvest

suggest a trade-off between duration and good performance for other traits. All types, however, are considered particularly inferior for storage properties. These results are consistent with those obtained from the folk maize taxonomy exercise, in which farmers expressed that planting date—and therefore the uncertainty of the duration of the growing season—was very important. While Blanco maize had a high yield, multiple uses, and was easy to sell, it also had the longest growing cycle. Its longer duration was a negative characteristic if the rains were delayed and it had to be planted late, because then the crop risked being exposed to drought and to frost. As noted, the other maize types had shorter growing cycles (white > yellow > black > red) and provided farmers with the flexibility to respond to the uncertain onset of the rains, even though they were inferior for other characteristics.

Women's assessments of the four maize types showed statistically significant differences for a lower number of characteristics than men's assessments. For example, unlike men, women did not consider differences for consumption qualities such as taste of tortillas, nixtamal quality, tlayudas, and tamales, but they did for ease of shelling. All of these characteristics have to do with aspects of maize preparations they are responsible for making. Women provided much lower estimates for yield by weight and duration, but their ordering of these characteristics was similar to men's. An important difference is that they considered that Amarillo, Negro, and Belatove had higher stability than Blanco. In general they rated

colored maize types much better than men did. In particular, women perceived colored maize types to perform better compared to Blanco than men did, so the trade-off between good performance and duration was not as strong among women as among men. Colored maize types may be more important for females than for males, and women may be playing an important role in their conservation.

The performance of any new variety introduced into this area of Oaxaca could be rated with respect to these characteristics by a panel of farmers to predict how the variety might fit into the production system, which varieties it might displace, and how it would complement other varieties. For example, a shorter duration white maize type equal in other respects to the white type currently in use could displace the colored maize types since it would decrease the trade-off between desirability and duration. On the other hand, improving the storage quality of colored maize types may encourage their conservation.

Attainment index

Ideally these two types of ratings (demand and supply of characteristics) could be combined into a single measure to indicate how well a particular variety or technological option meets all of the interests and needs of a farmer or group of farmers. This attainment index²⁰ would aggregate the performance of a variety or technological option over all characteristics that are important to a farmer, while taking into consideration that the importance of the characteristics is not equal. Having very good performance for a characteristic that is very important for a farmer—in other

²⁰ This concept and term have been used in the economics literature to describe the extent to which a service-provider meets customer expectations (Reed et al. 1991). The concept has also been used to explain the adoption of rice varieties (Sall et al. 1997).

words, it meets his/her interests or needs—is not the same as having very good performance for a characteristic that is only somewhat or not at all important. Generating an attainment index is a complex procedure that is rooted in economic theory and requires researchers to make assumptions about preferences. Although methods for producing an attainment index are beyond the scope of this manual, interested readers are referred to Reed et al. (1991), and Appendix 4 provides some of the author's personal reflections on this very important subject.

Comments: This method is particularly well suited for assessing crop varieties (as shown in Tables 16 and 17). In theory it should also be useful for other types of technologies, although experiences of its application to other technologies such as soil fertility improvement or pest management options are scant. Therefore the application of this method to those areas is still an open area of research.

The method described here used a scale with three levels. A scale with more levels (five, for example) could be used for the supply of characteristics. Such a scale could range from “very good” to “good,” “intermediate,” “poor,” and “very poor.” Going beyond five levels may be impractical, however. The more levels used, the more precise the results, but the exercise may become more difficult for farmers. Using a scale with more levels becomes particularly important when the technological options are very similar; it helps to distinguish among them.

This method is analogous to the matrix ranking method commonly used in participatory research. *Ranking* is more

intuitive and easier to do with farmers than *rating* (ordering items from more to less important or from better to worse). However, if the number of options to be ranked is only one or is not the same for all informants, problems may arise. If there is only one option (for example, a farmer plants or knows only one variety), how can it be ranked? How can researchers compare the rankings of two farmers, one who grows two varieties and another who grows five?²¹ Obviously this is not a problem if informants are presented with a similar number of options. Another potential difficulty is that several options can be ranked, but the best may still be considered inferior or vice versa (i.e., all options are inferior, but this is the least bad, or all options are very good, but this is the best). These issues cannot be addressed by ranking alternatives, so it may be preferable to rate them. The method presented here also ranks technological options, but it does so indirectly, based on the ratings.

Eliciting the Constraints on Using a Technology

Goal: Identify the factors that farmers perceive as constraining the use of a technology or practice.

Rationale: Even a well-known and appreciated technology may not be used by all of the farmers who want to use it. Factors beyond the specific characteristics of the technology may constrain its use. Although comparisons of different technologies provide some important information about these factors, it is useful to have a specific method to identify them.

²¹ There are methods to standardize the rankings from different numbers of options; see, for example, Smith et al. (2000).

Method: Researchers identify which technologies or practices will be evaluated (see “Eliciting Farmers’ Perceptions of Technological options,” p. 50, for how to do this). An interviewer asks a set of key informants or focus groups:

What do you do, or what could you do, if anything, to solve a particular problem (for example, to improve a soil, cope with drought, and store the harvest in a way that protects it better from insects)?

The answers to this question provide a set of available technological options. For each of these options, the interviewer asks:

Has anyone among the group used the option?

What factors have limited your ability to apply the option?

If you did not apply that option, what were the reasons?

The answers should be compiled and tabulated for analysis.

Example: This method was used in the Chihota Project to understand the constraints to technologies that farmers recognize and could use to improve soil fertility. The technologies and their constraints were identified in the context of farmers’ own soil taxonomy (presented earlier). Table 18 shows the results of this exercise.

Table 18. Technological options available to farmers in Chihota, Zimbabwe to improve their soils, and the constraints they face, by local soil type

Technological option and constraint	Local soil type							
	Jecha	Shapa	Rukangarahwe	Rebani/ Doro	Mhukutu/ Bukutu	Churu/ Rechuru	Chinamwe	Rondo/ Chidaka
Apply termite mound soil								
Shortage of termite mounds		x		x		x		x
Shortage of labor to dig and move mound	x	x	x			x	x	
Labor intensive	x			x				x
No cart to move termite mound		x	x					
Low priority for the soil class			x					
Digging mound causes erosion		x						
Apply manure								
No cattle	x			x		x	x	
Shortage of draft power	x	x						
Garden has priority for manure applications	x	x	x					x
Apply fertilizer								
No cash to purchase	x	x	x		x	x		x
Lack of knowledge	x	x	x		x			
No cash to hire labor	x	x	x					x
Apply lime								
No cash to purchase	x	x	x		x	x		x
Lack of knowledge	x	x	x		x			
Early planting								
No cash to hire labor	x	x	x					x
Deep plowing								
Shortage of draft power	x	x						
Early plowing								
Shortage of draft power	x	x						
Fallow the land								
Shortage of arable land	x							
Raised beds								
Labor intensive to raise beds				x				

Source: Adapted from Bellon et al. (1999).

The constraints reflect a number of underlying themes. The two most common themes were 1) scarcity of inputs and lack of access to them (including local inputs, such as manure and termite mound soil, and purchased inputs, such as fertilizers and lime) and 2) scarcity of labor to apply inputs, caused by the labor-intensive nature of the operations, by the lack of labor, or by the lack of cash to hire labor. Other themes that emerged were the high priority given to alternative uses for inputs (farmers preferred to apply manure to gardens rather than field plots) and the low priority given to improving some soil classes (e.g., Rukangarahwe). The lack of implements and power were also cited as limitations, although these constraints related specifically to the practices of deep plowing and application of soil from termite mounds. Farmers also noted that the lack of land limited the frequency and duration of fallows. Several farmer groups mentioned that the lack of knowledge about application rates for fertilizer and the use of lime was a constraint.

Demonstration Fields and Field Days

Goal: Expose farmers to new technologies, such as varieties, practices, and inputs, and get farmers' feedback on the new technologies.

Rationale: If scientists, extension agents, or some other external agent would like farmers to evaluate or adopt new technologies, farmers need to get acquainted with these technologies in a way that costs them little money, time, and risk. Even before farmers can decide whether they want to experiment with a

new technology or practice, they need to see it. Demonstration fields and field days are organized to accomplish this goal. The field days can also give scientists and extension workers information in a systematic way about farmers' perceptions of new technologies.

Method: Researchers, extension agents, or other interested groups (e.g., staff of non-governmental organizations) establish one or several demonstration fields, which may be located on farmers' fields or on experiment stations. The demonstrations may be established and managed exclusively by the researcher/extension worker or together with farmers.

The demonstration field is divided into plots containing the set of technologies to be shown to farmers. The technologies should be presented in a way that distinguishes them from one another as clearly as possible (for example, by partitioning the plots so that each technology is obvious to observers). The technologies should be laid out as simply as possible. Avoid complex designs that obscure the characteristics of each technology. *A demonstration field is not a complex multifactorial experiment.*

Good and sufficient information about each technology should be presented next to the plot it occupies.

Demonstration fields showing crop varieties are straightforward. Each variety is planted in plots of a few short rows (e.g., four rows, each 6 m in length). The plot is labeled with a sign giving the name of the variety, its duration, yield, performance under drought, and any other information that may interest farmers. It is advisable to include commonly planted local varieties to facilitate farmers' comparisons between new and current varieties.

Showing the effects of inputs, rotations, and other agronomic practices in demonstration fields can be more difficult than displaying new varieties. For example, different levels of pest attack with different cultural control practices must be shown with numbers, even if there is a demonstration plot. The simplest and most recommended way is to plant adjacent plots with and without the input, rotation, or other practice, making it easier for farmers to judge the impact of each practice.

Often a goal of demonstrations is to show the impact of different rates of an input or of different inputs together. In this case, demonstration plots should be organized in an incremental way. To show the impact of different input rates, the first plot has the lowest input rate, the adjacent one the next rate, and so on. To help farmers compare the effects of several inputs together, the first plot includes just one input, the next includes two, and so on, until the last plot has the full package of inputs. The inputs should be ordered from the one with the highest return to investment to the one with the lowest return. It is important to remember that in some cases the input with the highest return may be the most expensive or difficult for farmers to obtain. In that case, the order of inputs should be adjusted from the one with the highest return to investment to the one with the lowest return, subject to the constraints faced by farmers.²²

Demonstrations with technologies that involve impacts over more than one season (e.g., rotations, applications of lime) are even more complex to present, because the benefits do not accrue during the growing season when the

demonstration is established. This means that the demonstration will need to be repeated the next season, which must be planned from the start.

Once the demonstration fields are established, field days can be organized for farmers to come and look at them. The number of participants is an important variable for the way these days are organized. If few farmers participate, a more in-depth discussion about each of the technologies can take place. With a large number of participants this usually is not possible.

Example for germplasm: An intervention of the Oaxaca Project was to provide farmers with access to the diversity of maize landraces present in the region. This diversity was represented by a set of 16 landraces and one improved variety chosen by farmers and scientists. Demonstration plots with these 17 materials were established in the participating communities. The aim of the demonstration was to enable farmers from each community to see the 17 materials, especially their plant and ear characteristics, and to purchase the ones they wished to experiment with. The varieties included ten with white grain, three with yellow grain, three with black grain, and one with red grain. They were planted in small plots, each with four rows, and grouped by color so farmers could compare them. Each plot had a sign giving the identification number for the variety and information on yield, plant height, and drought resistance. Figure 8 shows the layout of a demonstration field in the Oaxaca Project.

The demonstration plots were established under irrigation during the dry season. This schedule meant that the field day

²² This presupposes an economic analysis of the inputs under farmers' conditions.

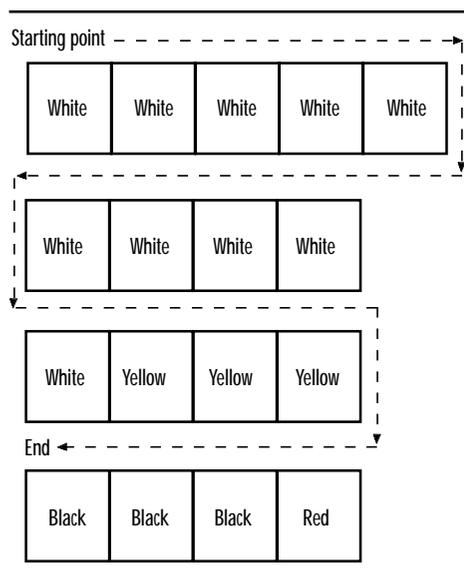


Figure 8. Layout of a demonstration field, Oaxaca Project.

Note: The color refers to the grain color of the maize planted in the plot.

could be held just before planting in the rainy season, so farmers who purchased a maize variety for experimentation could plant it soon after the field day.

For the field day, the two inner rows of each plot were harvested and the harvested ears were put next to the plot. Farmers were organized into small groups of five together with one guide (usually a student from the local agricultural school) to tour the demonstration. They were told beforehand that the purpose of the field day was to show them an array of maize varieties from the region and sell them any variety they found interesting. During the tour, the guide recorded farmers' opinions, positive and negative, regarding the varieties. Farmers were encouraged to note the identification numbers of the varieties they wanted to purchase. At the end of the tour they proceeded to a stand where the seed was offered for sale. The seed was sold at the price of local maize seed in the region. Sales were recorded along with

information on the purchaser (name and address) so that researchers could follow up on the impact of this process.

Example for soil fertility management:

An intervention of the Chihota Project was for farmers and researchers to establish a number of trials with new soil fertility improvement technologies developed by Soil Fert Net. Farmers managed the trials, and farmers and scientists designed them together. These trials were not typical scientists' trials but were simplified to fit farmers' interests and management. They had a dual role. On the one hand, they were a joint experiment between scientists and farmers to assess the technologies; on the other hand, they served as demonstration plots to expose other farmers to the technologies.

One of the technologies assessed was the use of lime together with nitrogenous (N) fertilizers, because low pH is an important problem in these soils. The trial/demonstration plot had a simple design in which a maize crop was planted in a field of 0.1 ha. Half of the plot was treated with lime and the other half was not. The management was exactly the same for both halves of the plot in all other respects—variety, number, and timing of weedings, and fertilizer application.

Just before harvest, farmers from the village where this trial/demonstration plot was established were invited to visit it. The criteria that farmers used to judge the demonstration were the growth of the plant stand and how green the maize plants looked. Farmers could readily see the difference between applying and not applying lime. During the field day an interesting discussion took place about how to finance the purchase of lime. Farmers in the village were applying 8 bags of N fertilizer per hectare (ammonium nitrate and Compound D), for

which they paid approximately Z\$ 450/bag. One bag of lime cost Z\$ 60 and 8 bags were recommended. By sacrificing one bag of N fertilizer, farmers could pay for almost all the lime required. If there is a synergistic interaction between N fertilizer and lime in these soils, it may be worthwhile for farmers to buy the lime. It was decided that the next demonstration experiment should test the substitution of some N fertilizer for lime.

Other demonstrations of the liming practice were not so straightforward. They compared the farmers' rate of N fertilizer and lime with the management practices recommended by the extension service, which included a higher application of N fertilizers, potash, phosphate, and lime. Although the differences between plant stands in the two treatments were striking, it was impossible to identify how each input contributed to the overall result. Furthermore, farmers thought it would be difficult to purchase all of the inputs. For farmers who had strong financial constraints on purchasing inputs, the second type of demonstration ultimately proved less useful than the first one. An alternative for this type of demonstration is a layout in which farmers' practice and the extension recommendation are separated from the addition or lack of lime. This design should allow farmers to identify the impact of lime independently of the impact of other fertilizers and different fertilizer rates. Figure 9 shows a layout for this type of demonstration. Note that there are paths to access the different treatments and a central place to see the four treatments at the same time (the circle in the figure).

Comments: In many cases, experimental plots designed to fulfill scientists' experimental needs are used as

demonstrations because research and extension systems lack the resources to mount special demonstrations. The problem with using experimental plots is that their randomized layout and testing of several factors often make it very difficult for farmers to draw lessons or conclusions about the technologies (treatments) displayed. To the extent possible this should be avoided.

It is important to keep a list of who attends a field day and to obtain at least some basic socioeconomic information on the participants (see the earlier section, "Minimum Set of Socioeconomic Indicators," p. 33). This information is useful for following up on the impact of field days on participants and for understanding the distribution of benefits among them.

Carrying Out Experiments with Farmers

Goal: Help farmers improve their own experiments by providing some basic training and guidelines (the experimental agenda and the process are completely in farmers' hands); or help farmers evaluate new technologies and practices selected jointly by farmers and researchers.

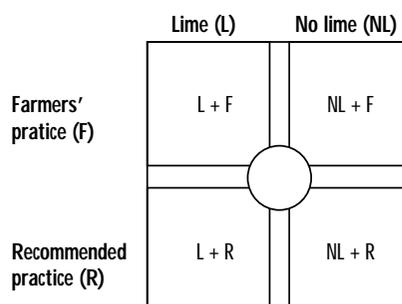


Figure 9. Layout of a demonstration field with two factors, Chihota project.

Rationale: Many farmers conduct experiments on their own, although their experiments usually differ from those of scientists in three ways: farmers usually do not include a control treatment, farmers may not keep all factors constant aside from the experimental factor, and farmers usually do not replicate experiments. An additional consideration is that farmers rely only on simple observation to judge the results of an experiment. These characteristics can make it difficult to interpret experimental results and derive clear conclusions. Scientists can help farmers improve their experiments.

Method: Rather than relying on a specific methodology, this process involves training farmers to conduct and interpret experiments, using the guidelines given in the following paragraphs.²³

Test only one factor at a time. Researchers should not use a multifactorial experiment if they want farmers to learn from it. Multifactorial experiments are for scientists, not farmers. If there are several factors, each one should be tested independently in a different field or section of the field. Although some farmers can work with multifactorial experiments, they may need to be trained to understand what these are and how to interpret them.

Emphasize to the farmer the need for a control treatment. The scientist should explain to the farmer that a control treatment is important for interpreting the results of an experiment. If there are several independent experiments in different fields, researchers should use the same control treatment to facilitate

comparisons and interpretation of the results. For example, if cattle manure applied at a specific rate is the common input used to maintain soil fertility, and researchers want to compare it to other inputs such as inorganic fertilizer, leaf litter, and termitaria, they should ensure that experiments with these alternative inputs include cattle manure as a control treatment.

Emphasize to the farmer that all conditions, except the experimental one, need to be kept equal in his/her field. The farmer can decide what those conditions should be, and they should be very clear in his/her mind. (Making a list of these factors together with the farmer is helpful.) An agronomist may object to having an experiment in which weeds are left to grow (if that is not its objective), but a farmer may consider that having a certain number of weeds reflects his/her normal conditions. What the farmer and the agronomist should understand is that having weeds is all right, as long as the experimental and control treatments have a similar number of weeds and weedy plots are a condition relevant to the farmer.

Establish which indicators and criteria will be used to judge the outcome of the experiment. Do not assume that farmers and scientists focus on the same indicators or have the same criteria to judge and interpret the outcome of an experiment. A farmer may focus only on how good or green a plant stand looks, while a researcher may want to look at the yield at harvest. One approach is to use the characteristics identified by eliciting farmers' perceptions of costs and benefits of a technology, described

²³ The author thanks José Alfonso Aguirre Gómez for sharing his ideas on farmer experimentation, which are the basis for these guidelines.

earlier. Another approach is for the scientist to discuss several questions with the farmer:

What do you expect from the experiment?

What elements would you focus on to judge it?

Under what circumstances would you judge one treatment to be better than the control?

The scientist may want to ask him/herself the same questions and compare the answers with those of the farmer. Ideally, farmer and scientist should reach consensus on these three issues, although differing perspectives are acceptable as long as both parties are aware of them.

Replicate an experiment among farms, not necessarily in the same field. As pointed out earlier, farmers usually do not replicate experiments across space. It is often assumed that farmers replicate experiments over time by comparing the present season's results with those of the previous season. From a researcher's perspective this may be a poor practice, because conditions change from one season to the next and the comparison may not be valid. From a farmer's perspective, it may not make sense to replicate an experiment across fields. Replications may appear to be a waste of resources, and in any event, farmers lack the statistical tools to identify relevant factors.

If it is considered important to replicate an experiment, however, it may be feasible to do so across farms. This strategy also entails problems, because experimental conditions vary across farms. One solution is for researchers to ask farmers with replicates of the same experiment to agree on the conditions that will be maintained constant. For example, with all farmers carrying out a particular experiment, reach an

agreement on the following factors: the soil type (according to their local taxonomy); the placement of experimental plots; and the number of weedings, the method used, and their timing. The use of farmers' local soil taxonomy may help ensure that farmers with replicates put them in similar soils.

An interesting way of combining farmers' and scientists' experiments is the approach of the "mother-baby" trial (Snapp 1999; CIMMYT 2000). A research-managed trial is established in a central location, usually a village, with all of the technological options to be tested and appropriate controls and replication according to scientific standards (the "mother" part of the trial). Nearby, within easy access to farmers in the village, a set of farmers' experiments is established (the "babies"). These experiments include a subset of the technological options of the mother trial, they follow a simple design based on the guidelines presented earlier, and they are established and managed by farmers. The conditions and management of the baby trials should reflect farmers' circumstances and interests. This experimental layout yields results that are of interest and have credibility for both scientists and farmers.

Example: During field days in the Oaxaca Project, researchers learned that many farmers were skeptical about how the varieties would perform under their own management conditions, so researchers proposed a set of joint experiments with the varieties. They furnished the seed and a simple experimental design, and farmers provided the fields and the management. Initially the idea was that four farmers from each community would participate, but certain communities had more

volunteers; eventually 29 farmers participated.²⁴ Each farmer agreed to plant three of the varieties included in the field day, plus one of his/her own varieties, and to manage them in exactly the same way. Each variety was planted in four rows of approximately 10 m. One of the varieties was a common check.

Researchers imposed no management conditions but systematically monitored and recorded what farmers did. During the growing season, researchers organized visits by one group of farmers to other groups in different communities so that they could assess the performance of the varieties under different environmental and management conditions and discuss the experiments with the other participating farmers.

At the end of the season, researchers and farmers harvested the plots together and measured the yield. The maize was harvested from two different 5 m sections taken at random from each of the two inner rows of each plot. Researchers measured the distance between rows, the distance between plants, and the number of plants planted per hole to determine planting density and extrapolate yield per hectare.²⁵ Farmers kept the harvested maize and rated the agronomic performance of the materials with respect to a set of traits (see "Analyzing the Demand of Characteristics" and "Analyzing the Supply of Characteristics," pp. 58-63). Farmers verified that the varieties worked well under their management and environmental conditions.

Comments: The main goal of experimenting with farmers is to address their information needs about new technologies and solutions to problems in a way that is relevant, cheap, systematic, and has low risk for them. Ideally, farmers' and scientists' interactions regarding experimentation will produce information that is credible but not too costly for all parties involved in the experimental process. This means simplifying the experimental design so that it does not take too much of farmers' time and labor, yet it produces results that are relevant to farmers and of interest to scientists. Although there is a compelling need for simplicity and ease of interpretation, these experiments can be useful for scientists and even subjected to certain statistical analyses. For example, the data collected in farmer experiments can be used to carry out a modified stability analysis (Hildebrand 1984; Kamara et al. 1996) (see Appendix 2 for an example).

Note, however, that some technologies do not lend themselves to this type of trial because they are very complex and interact with many different factors simultaneously, so by focusing on individual factors, one may not really get the "big picture."

Another approach for the interaction between farmers and scientists regarding farmers' experimentation is for scientists to provide new techniques and scientific concepts to fill key gaps in farmers' knowledge and not necessarily to change the farmers' own styles of experimentation.

²⁴ All 29 farmers received seed, but 3 did not plant the experiments and another 6 harvested nothing because of pests, early frost, excess water, and lodging.

²⁵ Researchers should be careful not to read too much into these extrapolated yields, because there is great variation within fields. The yields should be interpreted as indicative and compared only to others obtained through similar means.

Assessing the Impact of New Technologies

The adoption of a new technology or a practice changes the way that farming households operate, the costs they incur, and the benefits they generate and/or receive. As pointed out earlier (“Evaluation of Current and New Technological Options,” p. 49), any technology represents a particular way of solving one or several problems, and ideally it translates into an increase in the farming household’s well-being. In assessing the impact of a technology, researchers want to determine whether the new technology has really addressed the needs and/or desires of the intended beneficiaries and whether it in fact has contributed to increasing their well-being. A new technology may also have many unintended consequences, including positive and/or negative effects on people that were not targeted originally, and it is important to learn about these other impacts.

The Complexity of Assessing Impacts

The complex nature of impact assessment has several sources:

- It is often difficult to separate the changes brought about by the adoption of a new technology from the effects of other factors that are unrelated to the new technology.

- Impact ideally should involve measuring “objective” impacts (e.g., changes in nutritional status, labor allocation, productivity, and income) as well as determining “subjective” impacts (e.g., changes in perceptions of well-being with the adoption of the new technology).
- The same technology may have a completely different impact on the various members of a household.
- A new technology may have unintended impacts, both positive and negative.
- A new technology may affect people who were never considered in its development and implementation.

This manual presents methods for assessing the *perceived* impacts of a new technology on its intended beneficiaries, including different members of a farming household. While the manual also attempts to deal with unintended impacts, it does not consider impacts on people who are not members of the target group, such as urban food consumers or farmers located outside the study area.

The Impact Assessment Process

Goal: Assess the changes that the farming household *perceives* to have occurred as a result of adopting a new technology or practice. These changes

may be positive or negative and may be not be the same for different household members.

Rationale: Changes brought about by the adoption of a new technology or practice ideally should translate into increased well-being for all members of the farming household, but unfortunately this is not always the case. For this reason, it is important to establish which changes have been brought about by the new technology/practice and the extent to which these changes have increased or decreased the well-being of the members of the household. Obviously, such an assessment depends on household members' perceptions of well-being.

Method: Given the complexity of impact assessment, this manual presents a set of guidelines rather than a fixed methodology for assessing impact. Although the focus is on the perceptions of impacts rather than on the actual impacts, the guidelines presented here may be appropriate for both.

Establish a set of impact indicators. Impact indicators are a set of variables, conditions, and/or perceptions that both farmers and scientists expect to change with the adoption of a certain new technology or practice. These indicators may be different for farmers and scientists.

The first step is to identify indicators of well-being that are relevant for different members of the farming household. Many of these indicators should have been identified in the diagnostic phase described earlier, for example during the classification of farmers or the wealth ranking (see "Diagnosis of Farmers' Conditions," p. 24). It is also possible to have discussions with key informants or groups of different types of households and household members to identify

which conditions signal that they are doing well (e.g., they have no need to buy food during the year, or they have additional time for new activities or leisure).

The second step is to identify indicators of the changes that may result from using the new technology. To do this, scientists and key informants or groups of different types of households or household members discuss the following question:

If you adopt this technology, what do you expect to be different?

This question may seem vague, but the point is to be as open and broad as possible—in other words, to "cast the net widely." Besides identifying the indicators, the answers to this question allow farmers and scientists to discuss which indicators are reasonable and which are not, or, put another way, what is reasonable to expect from a technology. Far-fetched expectations may disappoint farmers and create a perception of failure, even when a technology may have had very positive impacts.

Once the indicators have been identified, the next step is to relate the two sets of indicators, since not all indicators of well-being may be relevant to the specific technology being adopted. Researchers should also ask themselves the same questions so that they develop one list of indicators for farmers and another for themselves, which may or may not coincide but will be explicit.

Establish a baseline. Since impact assessment is based on an analysis of changes, it is fundamental to generate a baseline to which changes can be compared. The baseline describes and, if possible, measures the impact indicators

that have been identified, and any associated relevant conditions, before a new technology/practice is adopted. The relevant conditions depend on the technology/practice to be adopted, particularly with respect to the current technologies or practices that may be modified or displaced by the new ones. Ideally, the baseline should be done among a random, representative set of farming households so that generalizations can be made. Alternatively, it can be done among key informants or focus groups that encompass the range of potential beneficiaries of a new technology or practice.

Establish a monitoring system. Once the indicators have been established and the baseline done, researchers should follow up systematically among a sample or subgroup of people who participated in the baseline. A follow-up consists of visiting the sample or subgroup and collecting information on the impact indicators from them. To identify unintended impacts, the follow-up visit should also feature an open-ended discussion of people's views, positive and negative, of the adopted technology/practice. Obviously, the follow up cannot be done immediately. Time (at least a year) has to pass between the introduction of a new technology/practice and the first follow-up, and several follow-up visits may be made at subsequent intervals. Unfortunately, lack of funding may constrain the ability to carry out these visits, but a system should be in place so that if they do take place, the information collected is valuable.

Carry out a final assessment. At some point after a new technology or practice has been introduced and (one hopes) adopted, a "final" assessment should be

done. The idea of a "final" assessment is slightly artificial, because the impacts of a technology will probably continue to unfold after the impacts study has been completed, but funding considerations or the closure of the research project make it important to choose a specific time to carry out this assessment. The final assessment consists of a dialogue that includes scientists, farmers who adopted the new technology/practice, and farmers who did not. Ideally the discussion will include farmers who participated in the baseline analysis, but it need not be restricted to them.

The dialogue is based on a discussion of farmers' and scientists' perceptions of the changes that occurred in the impact indicators as the result of adopting the technology. The discussion should include an open-ended consideration of positive as well as negative changes and should particularly try to identify the unintended impacts of the technology. For example, the discussion could be guided by the following questions.

Earlier you said that you expected changes in these things (refer to the indicators previously identified).

Do you think that those changes have occurred?

Have they been positive or negative for you, and why?

Have changes occurred with the adoption of this technology that you did not expect or foresee?

Or, in more general terms:

What do you do you consider has changed in your livelihood with the adoption of (name the technology/practice)?

Which of those changes do you consider to be positive, and why?

Which of those changes do you consider to be negative, and why?

This dialogue can be organized as a series of group discussions between scientists and farmers, including different members of the household. It may also include a more formal survey, particularly with those in the baseline study. A more formal survey may include techniques for evaluation of the new technological options, such as the rating methodologies explained above. It may also include specific questions based on the indicators identified by both farmers and scientists, such as the numbers and types of varieties now planted, adoption of the new soil fertility improvement technologies, knowledge of new concepts, application of new techniques, and so on. The results of this dialogue should be documented and used to reassess the new technology/practice.

Example: The Oaxaca Project includes an impact assessment component. To assess the impact of this project, farmers and scientists established a set of indicators (Table 19). Farmers' indicators referred mainly to enhanced food security and access to landraces with valuable traits, either by recuperating old materials or acquiring new ones. Scientists' indicators referred to an increase in the diversity of landraces grown at the household and community levels, as well as the genetic diversity present in those landraces.

The baseline study of a representative random sample of farming households in the six communities provides a control against which researchers and farmers can eventually compare the changes

resulting from the Oaxaca Project (which, as of this writing, has not yet concluded). The baseline study included questions on maize requirements, distribution of yields, storage practices, numbers and types of maize currently and no longer grown, and a rating of traits for each maize type grown. All information was collected for male and female members in the household involved in maize production, preparation, and consumption. The baseline also included a collection of the maize types grown by a subsample of these farmers.

During the different interventions (demonstrations and field days, training sessions, joint experiments), researchers recorded the names and addresses of participants and selected a random sample of participants for monitoring. At the end of the growing season after the demonstrations took place, these farmers were interviewed about their own socioeconomic characteristics, the maize types they grew, and their perceptions of the landraces they bought, including a systematic rating of their characteristics. Additionally researchers and farmers participated in open-ended discussions about gaining access to these "new" landraces. The discussions yielded information on unforeseen impacts. For example, the availability of a short duration, red-grained maize (Belatove) had two advantages. First, it offered some farmers the possibility of growing two crops a year. Second, it gave others the opportunity to plant and harvest an earlier maturing crop that provided

Table 19. Impact indicators identified by farmers and scientists in a participatory research project, Oaxaca, Mexico

Farmers' impact indicators	Scientists' impact indicators
Maize harvest does not get spoiled while stored	Farmers grow new maize types with desirable traits
Less need to purchase maize	Farmers grow more maize types
Recover desirable maize types that were lost	Genetic diversity increases at the household level
Identify new maize types with good consumption and/or sale characteristics	Genetic diversity increases at the community level

maize for home consumption when stores from the previous year were finished, thus decreasing the need to purchase maize. Another of the landraces offered was in great demand by women, who liked its purple husk for making tamales (a special maize preparation wrapped in the husk). Before the project, this maize type was very rare, but now it seems to be diffusing rapidly throughout the region.

It is too early to provide an accurate picture of the impacts of the Oaxaca Project, but to date, the monitoring shows that the project is having an impact on farmers' indicators and to some extent on scientists' indicators (although the impact on genetic diversity has not yet been established). Farmers have shown great enthusiasm for purchasing diverse sets of landraces. During the 1999 demonstrations, 804 kg of seed were sold in 197 purchase events (a farmer purchasing seed of a landrace), with a total of 123 farmers (27% female) purchasing seed (the same farmer could purchase seed of more than one landrace). As part of the follow-up, researchers also interviewed farmers who did not participate in demonstrations and experiments. These farmers explained that they had chosen not to participate because they thought that the landrace varieties offered would not work under their conditions, they lacked time to participate in project activities, and they did not want to take the risk of planting landraces that they did not know.

The example provided here is not typical of most new technologies offered to farmers, because the technologies in this instance are sets of landraces. More commonly new technologies consist of improved varieties, inputs, and improved crop management practices. However, the basic procedure illustrated above is applicable to other kinds of technology.

Comments: As pointed out, impact assessment is complex and ideally includes subjective as well as objective indicators. Because subjective perceptions may not coincide with objective conditions and vice versa, if researchers focus exclusively on one or the other kind of impact, they will develop an incomplete picture of the true impacts of a new technology and/or practice. It is also important to remember that *externalities*—unintended impacts that go beyond the target group—should also be taken into account in the impact assessment. There is no scope to discuss this subject in this manual, but it is covered extensively in the literature on impact assessment.

Conclusions

Farmer participatory research in agriculture is, above all, a systematic dialogue between farmers and scientists to solve agricultural problems. The methods presented in this book are tools for guiding and organizing that dialogue. As the reader has seen, this manual and the agricultural research projects it describes are structured to reflect a sequence of participatory research activities that can be summarized as follows:

- learn from farmers;
- identify technological options to test;
- design a method to test them; and
- evaluate their impact.

Participating farmers and scientists implement all these activities jointly. The section on diagnosis in this manual has dealt with the first two activities, the section on the evaluation of current and

new technologies has dealt with the third one, and the section on impact assessment has dealt with the final activity. Although this manual has explained participatory research activities in a fixed order, by now readers will understand that these activities are not steps in a strictly linear process. During research on the interventions, or even the impact assessment, new understanding can be generated and interventions can be modified or changed. Finally, readers should be reminded that they should pick and choose the methods that are relevant for their work rather than launching into some predetermined scheme. The specific methods selected should fit into a coherent plan for technology generation, rather than being one-off exercises.

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Appendix 1

Farmers' Classification of Themselves, Chihota, Zimbabwe

Farmer type	Strengths	Weaknesses
Young	<ul style="list-style-type: none"> • Energy to conduct operations • Grow modern types and varieties of crops • Opportunities to get new knowledge 	<ul style="list-style-type: none"> • Have no farming implements • Have no arable land • Have no children to help with farming
Old	<ul style="list-style-type: none"> • Have farming implements • Have arable land • Have children to help with farming • Grow traditional types and varieties of crops • Have old and new knowledge to impart to new generations 	<ul style="list-style-type: none"> • Have less energy to conduct operations
Male	<ul style="list-style-type: none"> • Have better opportunities • Own farming implements: their lands are worked earlier • Are in charge, get the bulk of proceeds from crop sales • Decision-makers • Good planners • Own fields • Prefer garden crops 	
Female	<ul style="list-style-type: none"> • Grow all types of crops • Better farmers than males • Do not go beer drinking • Do a lot of work in the fields • Plan operations in a timely fashion • Devoted to work 	<ul style="list-style-type: none"> • Do not own farming implements • Do not own fields • Their fields are prepared last • Fall under husbands, not rewarded for their labor • Not leaders in farming issues
Have draft animals	<ul style="list-style-type: none"> • Prepare lands on time • Have manure • Can use livestock for other purposes • Operations are easy and timely • Get good yields 	<ul style="list-style-type: none"> • Cattle destroy other people's crops • Some prepare fields of others before preparing their own
Have no draft animals		<ul style="list-style-type: none"> • Late land preparation • Carry out operations late • Field operations are difficult • Have no access to manure • Get low yields
Have cattle	<ul style="list-style-type: none"> • Have manure • Have resources • Timeliness of operations • Have milk, meat, and <i>lobola</i> (dowry) • Have access to cash 	<ul style="list-style-type: none"> • Cause soil erosion • Can destroy crops of other farmers • Do not have grazing areas
Have no cattle	<ul style="list-style-type: none"> • Borrow • Provide labor for others • Cattle herders • Buy cattle from others 	<ul style="list-style-type: none"> • Delay operations • Little manure, low yields • Lack of resources • Lazy at times • Cruel to livestock • Gain when their crops are unintentionally destroyed by livestock
Have manure	<ul style="list-style-type: none"> • Have good plant stands • Get high yields 	
Have no manure		<ul style="list-style-type: none"> • Have crops of poor quality, low yields
Have implements	<ul style="list-style-type: none"> • Able to perform timely operations • Get good yields • Have necessary implements • Operations are made easy 	
Have no implements		<ul style="list-style-type: none"> • Delayed operations • Get low yields • Do not have cattle and other implements
Have garden	<ul style="list-style-type: none"> • Stable income from year-round production • Sell produce • Provide enough to family • Well-paying enterprise • Help others • Produce several crops a year 	<ul style="list-style-type: none"> • Cause soil erosion • Some are encroaching into grazing areas • Use large quantities of water • Do not help the needy • Small arable lands • Workaholics

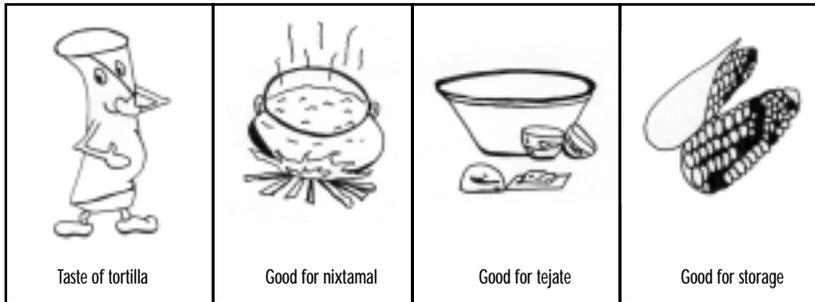
Farmer type	Strengths	Weaknesses
Have garden (cont'd.)	<ul style="list-style-type: none"> • Always busy (throughout year) • More income than dryland farmers • Not as affected by adverse weather (droughts) as dryland farmers • Diversity of crops • Mainly grow horticultural crops 	
Dryland farmers	<ul style="list-style-type: none"> • Plan ahead of time • High volume of output for storage • Market their crops • Maintain contours • Large landholding to be inherited • Big arable lands • Practice crop rotations • Have time to relax 	<ul style="list-style-type: none"> • Get only one crop per year • Receive income once a year • No stable income because of seasonality of production • No adequate financial resources to prepare/plan next season • Expose to negative effects of adverse weather (droughts)
Have large fields	<ul style="list-style-type: none"> • Attain high yields • Wide variety of crops 	<ul style="list-style-type: none"> • Spread inputs thinly over large area
Have small fields	<ul style="list-style-type: none"> • Low total harvest • Narrow variety of crops • Apply inputs to smaller piece of land, therefore sometimes attain high yields 	
Own fields	<ul style="list-style-type: none"> • Grow crops in both dryland and gardens 	
Do not own fields	<ul style="list-style-type: none"> • Borrow fields temporarily from other farmers 	
Have fenced fields	<ul style="list-style-type: none"> • Field protected from livestock 	
Have no fenced fields		
Work outside the area	<ul style="list-style-type: none"> • Can afford to hire labor 	
Do not work outside	<ul style="list-style-type: none"> • Conduct operations on their own, do not use hired labor 	
Work in groups	<ul style="list-style-type: none"> • Quick operations • Team spirit • Share knowledge and experiences • Team up to buy inputs • Share labor • Encourage each other 	<ul style="list-style-type: none"> • Operations can be delayed by some group members
Work individually	<ul style="list-style-type: none"> • No-one will delay operations • Little knowledge • Slow with operations 	<ul style="list-style-type: none"> • No-one to encourage/correct another • If sick, no-one will work in field
Industrious	<ul style="list-style-type: none"> • Work hard in their fields • Attain high yields • Feed visitors • Send children to school • Seek advice from other farmers • Healthy 	<ul style="list-style-type: none"> • Workaholics • Always thinking
Lazy	<ul style="list-style-type: none"> • Source of labor for others • Good messengers 	<ul style="list-style-type: none"> • Do not perform timely operations • Want to rest more than work • Beg for food • Feign sickness when rainy season starts • Always away from their farms • Do not feed their families • Do not send children to school • Do not care • Do not follow what others are doing
Adequate cash for farming	<ul style="list-style-type: none"> • Can hire labor • Can buy inputs early • Plan well • Timely operations • Attain high yields • Can afford to sell farm produce 	
Inadequate cash	<ul style="list-style-type: none"> • Buy from others 	<ul style="list-style-type: none"> • Operations always conducted late • Attain low yields • Cannot attain high yields • Cannot grow crops well • Not enough production for home consumption
Rich	<ul style="list-style-type: none"> • Stable income • Timely operations • Adequate farm implements 	<ul style="list-style-type: none"> • Do not give implements for free

Farmer type	Strengths	Weaknesses
Rich (cont'd.)	<ul style="list-style-type: none"> Care about farm activities Adequate food supply Adequate inputs (freezer) 	
Poor		<ul style="list-style-type: none"> Cannot afford seed, fertilizer Do not produce adequate amount of food Delay operations Lazy and sometimes cruel
Farmers with knowledge	<ul style="list-style-type: none"> Have resources Have enough food Sell to others Attend Agritex (extension) lessons Know how to plan for next season Have good homestead Know how to look after livestock Timely operations Good crops Attain high yields Practice crop rotations Know when to establish crops Use manure Not jealous 	
Farmers without knowledge		<ul style="list-style-type: none"> Operations not timely even if using own implements Delay operations Work hard but get poor yields Do not practice crop rotations Jealous Do not use manure Cause erosion Do not plan activities Do not attend Agritex (extension) lessons Do not know how to look after livestock Use outdated farming methods
Have Master Farmer certificate	<ul style="list-style-type: none"> Knowledgeable about farming operations 	
Do not have Master Farmer Certificate		<ul style="list-style-type: none"> Sometimes not sure of operations
Sell their produce	<ul style="list-style-type: none"> Feed society Have cash Good role model 	<ul style="list-style-type: none"> Little food for home consumption
Subsistence farmers	<ul style="list-style-type: none"> Produce enough for family Honest, do not steal from others 	<ul style="list-style-type: none"> Do not help others Hate those who sell Do not send children to school
Perform operations on time	<ul style="list-style-type: none"> Have knowledge Attain high yields Have enough implements Produce good crops 	
Do not perform operations on time		<ul style="list-style-type: none"> Give names to rains to explain their lateness Do not have implements Do not attain high yields
Attain high yields	<ul style="list-style-type: none"> Have high yields every year Sell to others Plant early 	<ul style="list-style-type: none"> Arrogant
Do not attain high yields		<ul style="list-style-type: none"> Lack resources Attain low yields Run out of food stocks before next harvest
Plan operations	<ul style="list-style-type: none"> Operation done on time Get good crop stands Crops wilt if rains arrive late 	<ul style="list-style-type: none"> Crops can be eaten by livestock
Do not plan operations		<ul style="list-style-type: none"> Extensive farmers No rotations Lack resources

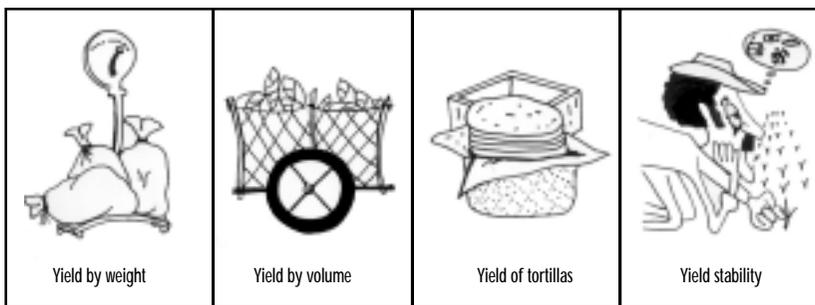
Appendix 2

Examples of the Cards Used to Depict Variety Characteristics, Oaxaca Project (demand and supply of characteristics)

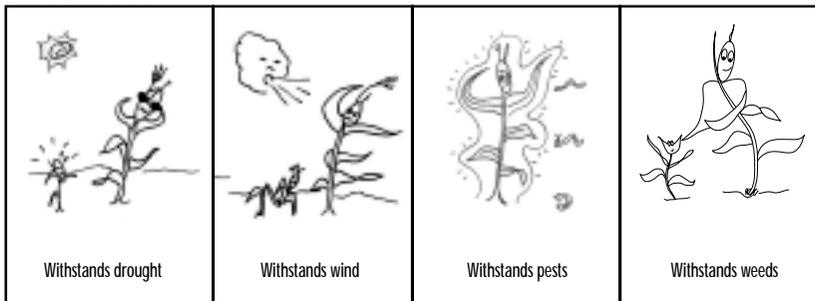
Consumption



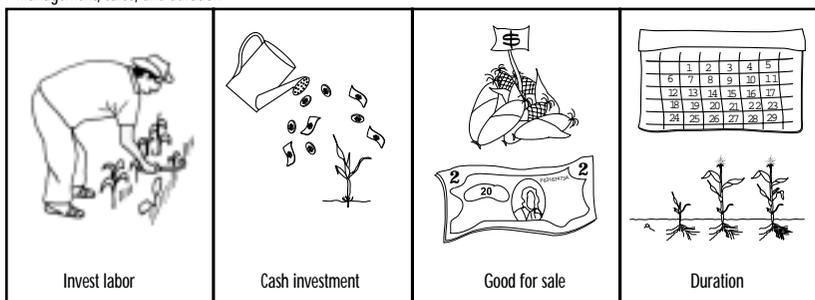
Yield



Abiotic and biotic stress



Management, sales, and duration



Appendix 3

Examples of the Data Used for Analyzing the Supply and Demand of Characteristics

Tables A3.1 and A3.2 (for men and women in the same household, respectively) show the data that can be obtained by using the method to elicit the importance of characteristics of a variety or other technology. Each row is a household and each column is a characteristic. This table came from a spreadsheet. To perform a statistical analysis like the one presented in the example, the data can be imported into a statistical package such as SPSS (release 7.5.3), which was used for this example. With SPSS, researchers used two nonparametric tests: the Kruskal-Wallis test for “K-independent samples” and the Wilcoxon matched-pairs signed ranks test for the “two related samples.” This second test was used for comparing the ratings of the importance of characteristics between men and women from the same household. Note that to do this test, the two tables should be put side by side with slightly different names for the characteristic, i.e. “withstands drought-men,” “withstands drought-women.”

Table A3.3 presents an example of the data that would be obtained by using the method to elicit the performance for each characteristic by each variety or technological option from men (a similar table should be generated for women, but unlike the previous case the analysis is independent). Each row is a combination of a household and a variety grown by a male farmer, while each column is a characteristic. This table came from a spreadsheet. Note that each farmer may have more than one row, since he may plant more than one variety. The names of the maize types are presented, but they have also been coded into numbers (1 to 4) in an adjacent column. For the statistical analysis, the data were imported into SPSS (release 7.5.3). Researchers used the routine statistics, nonparametric tests, and (for the Kruskal Wallis analysis of variance by ranks) the “K Independent Samples” option. This latter test is used for comparing the ratings of the performance for each characteristic across the four maize types.

Table A3.1. Ratings of importance for each characteristic for men (demand of characteristics), Santa Ana Zegache, Oaxaca, Mexico

Household ID, men	Yield-weight, men	Yield-volume, men	Nixtamal quality, men	Taste of tortilla, men	Yield stability, men	Ease of shelling, men	Withstands drought, men	Withstands wind, men	Withstands weeds, men	Cash investment, men ^a	Labor investment, men ^a
1	1	1	2	1	1	2	1	3	2	1	3
2	2	1	3	3	1	2	1	3	2	1	1
3	1	2	2	1	1	2	1	3	2	1	2
4	2	1	2	1	1	2	1	3	1	1	1
5	2	1	2	2	1	2	1	3	3	1	1
6	1	2	2	2	1	2	1	3	2	1	1
7	1	1	1	1	1	2	1	3	2	1	2
8	1	2	3	3	1	2	1	3	2	1	1
9	2	1	1	3	1	2	1	3	2	1	1
10	2	1	2	1	1	2	1	3	3	1	2
11	1	1	3	2	1	2	1	3	3	1	2
12	1	1	2	3	1	3	1	2	2	1	2
13	1	1	1	2	1	2	1	2	2	1	2
14	1	1	2	2	1	2	1	3	3	1	2
15	1	1	1	2	1	2	2	3	3	3	2

Note: 1 = very important, 2 = somewhat important, 3 = not important.

^a For cash and labor investment, 1= little, 2= regular, 3= a lot.

Table A3.2. Ratings of importance for each characteristic (demand of characteristics) for women, Santa Ana Zegache, Oaxaca, Mexico

Household ID, women	Yield-weight, women	Yield-volume, women	Nixtamal quality, women	Taste of tortilla, women	Yield stability, women	Ease of shelling, women	Withstands drought, women	Withstands wind, women	Withstands weeds, women	Cash investment, women ^a	Labor investment, women ^a
1	1	2	1	1	1	3	1	1	3	2	1
2	1	3	1	2	1	1	1	2	2	1	1
3	1	2	1	1	1	3	1	2	2	2	1
4	1	2	1	1	2	3	1	3	2	1	3
5	1	1	1	1	1	3	1	2	3	1	1
6	1	2	3	1	1	3	1	2	1	1	1
7	1	3	1	1	1	2	1	2	3	1	1
8	1	1	1	2	1	3	1	3	1	1	2
9	1	3	1	1	1	3	1	1	3	1	2
10	1	1	2	1	1	3	1	3	2	1	3
11	1	1	1	1	1	3	1	1	2	1	2
12	1	2	2	1	1	2	1	2	2	1	2
13	1	3	1	1	1	3	1	1	2	1	2
14	1	1	1	1	1	2	2	2	2	1	1
15	1	1	1	1	1	3	1	2	2	1	1

Note: 1 = very important, 2 =somewhat important, 3 = not important.

^a For cash and labor investment, 1= little, 2= regular, 3= a lot.

Table A3.3. Ratings of performance of each maize type for each farmer with respect to each characteristic (supply of characteristics), Santa Ana Zegache, Oaxaca, Mexico

Household ID	Number of maize types	Maize type	Type code	Nixtamal quality	Taste of tortilla	Yield stability	Ease of shelling	Withstands drought	Withstands wind	Withstands weeds	Cash investment	Labor investment
1	1	Blanco	1	1	1	1	2	1	1	2	2	2
2	1	Blanco	1	1	1	2	2	2	2	1	2	2
3	1	Blanco	1	1	1	1	1	2	1	1	2	2
3	2	Amarillo	2	1	1	1	1	1	1	1	2	2
4	1	Blanco	1	1	1	2	2	2	2	2	2	2
4	2	Amarillo	2	1	1	2	1	2	2	2	2	2
4	3	Negro	3	1	1	2	1	1	2	3	2	2
4	4	Belatove	4	1	1	2	1	1	2	3	2	2
5	1	Blanco	1	1	1	1	2	1	1	2	2	2
5	2	Amarillo	2	1	1	1	1	1	1	2	2	2
6	1	Blanco	1	1	1	2	1	1	2	2	2	2
7	1	Blanco	1	1	1	2	1	1	1	2	2	2
7	2	Amarillo	2	1	1	2	1	1	1	2	2	2
8	1	Blanco	1	1	1	2	2	2	2	2	2	2
8	2	Negro	3	1	1	1	1	1	1	1	2	2
9	1	Blanco	1	1	1	2	1	1	1	1	2	2
10	1	Blanco	1	1	1	1	1	1	1	2	2	2
10	2	Amarillo	2	1	1	1	1	1	2	2	2	2
10	3	Negro	3	1	1	1	1	2	2	1	2	2
10	4	Belatove	4	1	1	1	1	2	2	1	2	2
11	1	Blanco	1	1	1	2	2	2	2	2	3	3
12	1	Blanco	1	1	1	1	2	1	1	2	2	2
12	2	Amarillo	2	1	1	1	1	1	1	2	2	2
13	1	Blanco	1	1	1	2	2	1	2	1	2	2
13	2	Negro	3	1	1	2	1	2	2	2	2	2
14	1	Blanco	1	1	1	2	2	1	1	1	3	3
14	2	Negro	3	1	1	1	1	1	1	1	3	3
15	1	Blanco	1	1	1	2	2	2	1	2	3	3

Note: 1= very good, 2 = intermediate, 3= poor. Each farmer has a different number of maize types, e.g., Farmer 1 only has one type, while Farmer 4 has 4 types.

Appendix 4

Using an Attainment Index in Farmer Participatory Research

The following discussion is based on the author's intuition, and for that reason it is not included in the main text of this manual. Although the approach described here differs from the approach of Reed et al. (1991), which has been used in the published literature, it may stimulate further thinking on this important subject.

The attainment index is a measure of the extent to which the overall performance of a particular variety or technological option meets all of the interests and needs of a farmer or group of farmers. Therefore an attainment index combines the two types of ratings—the demand and supply of characteristics—discussed previously.

It would seem intuitively obvious that a variety or other technology that performs very well for many important characteristics should be more desirable overall than one that performs very well for characteristics that are only somewhat important. Conversely, a variety or technology that performs poorly for many important characteristics should be less desirable than one that performs poorly for less important characteristics. The question, however, is how to combine both types of rating to generate *an ordinal measure*

that makes it possible to rank the different varieties or technologies from more to less desirable.

The first possibility that comes to mind is simply to multiply the supply and demand ratings. The numbers associated with these ratings are in any case arbitrary, and what is important is their order, not their magnitude. Researchers could code the ratings by 1 = very important, 2 = somewhat important, 3 = not important, and 1 = very good, 2 = intermediate, and 3 = poor. Multiplying the ratings would give a scale between 1 and 9 (best to worst) for each trait, and it would be possible to sum across the characteristics. A drawback of this scale is that it would have many ambiguities. For example, it would imply that the combination “very important, poor” would be equal to “not important, very good.” Obviously a variety that performs poorly for a very important characteristic is the worse case, and if a characteristic is not important, it is irrelevant whether a variety performs very well or poorly, but with this method the two cases would be equivalent. Furthermore, if a farmer considers many traits to be unimportant, the attainment index would be very large, indicating that he/she is dissatisfied with the variety, when in fact the opposite may be true.

A second possibility is to assign arbitrary scores but with certain properties to both types of rating. For ratings of the importance of characteristics, the scores, could be between 1 and zero (1 for “very important” and zero for “not important”). “Somewhat important” can be assigned an intermediate score such as 0.4. These scores maintain the order of importance, and the zero takes into account that it does not matter how a variety performs for a characteristic that is irrelevant. (The reason for choosing 0.4 for the intermediate rating will be explained later.)

For ratings of the performance of a variety for a characteristic, the scores could be between 1 and -1 (1 for “very good” and -1 for “poor”). The “intermediate/acceptable” rating can be assigned an intermediate score, such as 0.5. These numbers maintain the order of performance, and the -1 takes into account that a poor performance has a negative impact on the well-being of a farmer.

Both ratings can be combined in a matrix that produces an ordinal scale that runs from more to less desirable (Figure A4.1). For each cell in the matrix, the scores in the column and row are multiplied,

generating an index that varies between 1 and -1. The ordinal scale is as follows:

Very important-very good (1) > very important-regular performance (0.5) > somewhat important-very good performance (0.4) > somewhat important-regular performance (0.20) > not important-any performance (0) > somewhat important-poor (-0.5) > very important-poor (-1).

The score 0.4 was assigned to “intermediate importance” to produce the ordering shown above, following the assumption that it is more important or desirable to have an intermediate performance for a very important characteristic than to have a very good performance for a characteristic that is “somewhat important.” Clearly it is more desirable to have (1) a variety that has an intermediate rather than a poor performance for a very important characteristic, rather than (2) a variety that has a very good rather than an intermediate performance for a somewhat important characteristic, or a variety that has an intermediate rather than a poor performance for a somewhat important characteristic.

Alternatively, one could assign an equal score to both intermediate ratings and

Supply weights \ Demand weights		Very important	Somewhat important	Not important
		1	.4	0
Very good	1	1	.4	0
Intermediate	0.5	.5	.2	0
Poor	-1	-1	-.4	0

Figure A4.1. Matrix of scores for an attainment index.

assume that a farmer is indifferent between the two cases presented above (i.e., it is equally desirable to have an intermediate performance for a very important characteristic, or a very good performance for a characteristic that is “somewhat important.”)

Then, for each particular variety, the scores for each characteristic can be added to generate an overall weighted score of performance—the attainment index. The index reflects the overall desirability of a variety to the farmer who rated it.

Some farmers may consider some characteristics to be unimportant (therefore they will have a zero score), whereas other farmers may not. To take these differences into account, it is necessary to normalize the index. Otherwise, when two scores are compared, one may be very large—not because one of the varieties was more satisfactory, but simply because the farmer who rated it considered many traits to be very or somewhat important, whereas another farmer rating the same

variety might consider fewer traits to be important (and may even have found the variety to be more satisfactory). It is important to divide the score by a “perfect” score (i.e., the score that would have been obtained if the variety had scored very well for all relevant characteristics, weighted by the importance of the characteristic). This means that the perfect score is simply the summation of all demand scores and that unimportant characteristics are not taken into account.

To get a measure of the desirability of a certain variety for a community as a whole, the attainment indices for the farmers in the community can be averaged. Researchers should be careful not to read too much into the actual scores, which are based on arbitrary numbers. As noted, the important point is the *ordering* of the varieties in terms of their desirability (ability to supply what farmers want).

An example of how to calculate this index using these scores follows. The data are taken from the man in

Table A4.1 Demand and supply ratings for several characteristics and two maize types grown by the man in household 4 used for calculating an attainment index, Santa Ana Zegache, Oaxaca, Mexico

Characteristic	Importance		Performance			
	Demand score		Blanco	Supply score	Negro	Supply score
nixtamal quality,	2	0.4	1	1.0	1	1.0
taste of tortilla,	1	1.0	1	1.0	1	1.0
yield stability,	1	1.0	2	0.5	2	0.5
ease of shelling	2	0.4	2	0.5	1	1.0
drought	1	1.0	2	0.5	1	1.0
wind	3	0.0	2	0.5	2	0.5
weeds	1	1.0	2	0.5	3	-1.0
cash	1	1.0	2	0.5	2	0.5
labor	1	1.0	2	0.5	2	0.5

Note: Demand and supply scores from Figure A4.1

household 4 of Tables A3.2 and A4.1 for the maize types Blanco and Negro. Table A4.1 presents the data.

For the variety Blanco:

$$(.4 \times 1) + (1 \times 1) + (1 \times .5) + (.4 \times .5) + (1 \times .5) + (0 \times .5) + (1 \times .5) + (1 \times .5) + (1 \times .5) = 4.1$$

The perfect score to be used for normalization would be:

$$(.4 \times 1) + (1 \times 1) + (1 \times 1) + (.4 \times 1) + (1 \times 1) + (0 \times 1) + (1 \times 1) + (1 \times 1) + (1 \times 1) = 6.8$$

Normalized score:

$$4.1 / 6.8 = 0.603$$

For the variety Negro:

$$(.4 \times 1) + (1 \times 1) + (1 \times .5) + (.4 \times 1) + (1 \times 1) + (0 \times .5) + (1 \times 1) + (1 \times .5) + (1 \times .5) = 3.3$$

The perfect score to be used for normalization would be:

$$(.4 \times 1) + (1 \times 1) + (1 \times 1) + (.4 \times 1) + (1 \times 1) + (0 \times 1) + (1 \times 1) + (1 \times 1) + (1 \times 1) = 6.8$$

Normalized score:

$$3.3 / 6.8 = 0.485$$

Hence, Blanco is superior to Negro overall. However, it should also be pointed out that for ease of shelling and particularly for drought tolerance Negro is better (although it is much worse at tolerating weeds).

The normalized attainment index is more important for comparing different farmers, who naturally will differ in their demand for certain characteristics.

Appendix 5

An Example of the Modified Stability Analysis

The kind of data generated from farmers' experiments in the Oaxaca project—yield data from several varieties grown on different farms in the region—can be analyzed with a modified stability analysis.

Each experiment located on a farm would be considered a trial. The average yield of all varieties included in a given trial, which is representative of the conditions of crop production at that location (i.e., the environmental index), is plotted against the yield of each variety in that trial. The relative height of the plotted line represents the general yield of the variety; the slope represents its adaptability to different environmental conditions. A flat slope represents a stable response, whereas a steep slope represents the opposite. Hildebrand (1984) recommends using a minimum of 14 farms (trials) to gain an accurate estimate of treatment differences over environments, when there is need for a wide range of environments. Clearly it is not appropriate for farmers to participate in this kind of analysis, although it is based on data generated by participatory experiments. Its results may be useful to scientists, however, and can be useful to farmers when presented in a simplified manner to discuss the appropriateness of planting the varieties tested in different environments.

The dataset from the farmer experiments in Oaxaca is small (3 to 6 farms, with two replicates per farm), but bearing this limitation in mind, they can still be used to provide an example of the possible interpretation of such an analysis. Yields of maize landraces were plotted against the environmental index for each farm where they were grown during the wet season of 1999 (Figure A5.1). As mentioned previously, the yield was the weight of the ears harvested in a 5 m strip chosen randomly in the inner two rows of the experimental plot. The six landraces included three with white grain, one with yellow grain, one with black grain, and one with red grain. Figure A5.1 shows that the red and yellow landraces (varieties 34 and 40, respectively) are the most stable (i.e., they have the flattest slope), whereas the white materials (118, 134, and 152) have a steeper slope. There is a crossover point where the white maize types start to perform better than the other maize types. This crossover indicates that in "poor" environments, the other maize types may be superior, whereas white maize may perform better in "good" environments. (Remember that for farmers in Oaxaca, grain color is an indicator of other traits, particularly duration.) Kamara et al. (1996) provide another example of this methodology for four maize varieties (three improved and one local) evaluated in three locations of Mali.

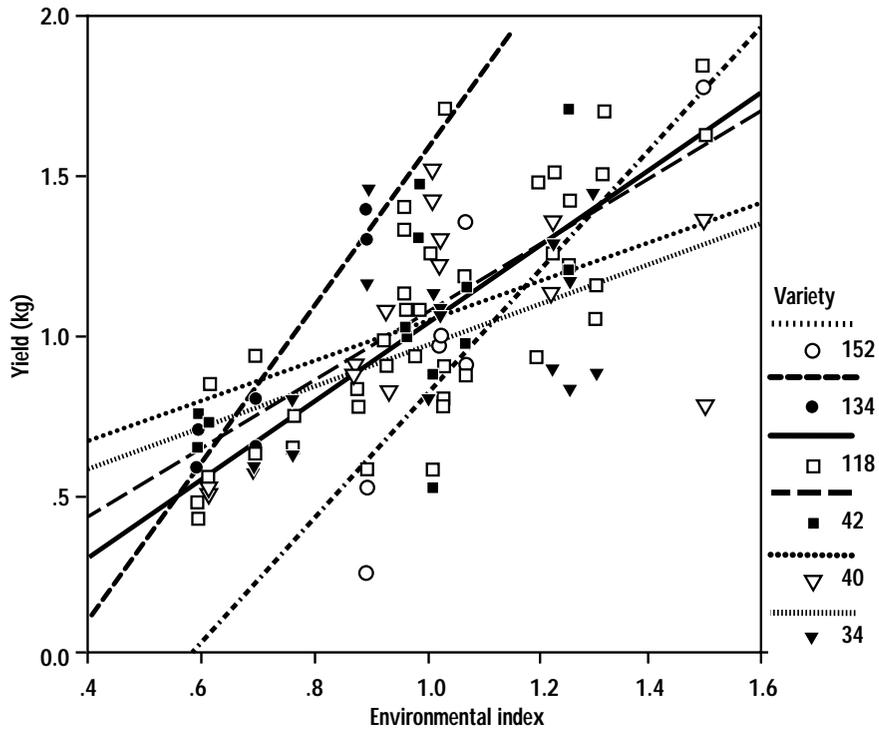


Figure A5.1 Yield response to the environmental index in six communities of the Central Valleys of Oaxaca, Mexico.