PARTICIPATORY TECHNOLOGY DEVELOPMENT : ISSUES, CONCEPTS AND POLICIES

A Reader

(Resource material for the Winter School
on PTD – Concept and Methodology from
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PREFACE

This reader has been compiled by me for those who are interested to broaden their conceptual understanding of PTD. In the selection of articles included in the reader, I have tried to be just and unbiased. The articles brought together reveal that concern, respect and positive attitude for indigenous knowledge and farmers' experimentation are vital for sustainable agriculture and farmer participatory research. The reader also tries to address the various dimensions of PTD at the micro as well as macro level, and tries to combine the various issues of PTD with a wider understanding of the social, economic, technological and organisational context one is working in.

It is hoped that those involved in the field of farmer participatory research and extension will get inspired by the articles in the reader and will be motivated to undertake PTD in a more scientific way. However, it is left to the readers to act and react.

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INTRODUCTION

A brief review of the articles included in this reader is presented.

Measuring sustainability: issues and alternatives

The concepts of sustainability and general issues related with sustainability are discussed in this article. The methods for measuring sustainable growth, in terms of quantitative approaches are presented in detail. The concept of total factor productivity (TFP) is reviewed, and as defined in this article, it is a residual after accounting for the effects of increased input levels on output.
A checklist of criteria for assessing agricultural technology is given after this article by Harrington, which the readers will find interesting and useful.

Farmers who experiment: An untapped resource for agricultural research and development

The literature on the topic is briefly presented followed by the detailed presentation of the farmer experiments in two Peruvian potato production zones- one in the traditional zone and another in the non-traditional zone. The three kinds of experiments by farmers, viz, curiosity experiments, problem solving experiments and adaptation experiments are discussed. A case study of agricultural change when farmers' experiments succeed is presented which places experimentation within the larger context of technological change. The conclusion of the paper is that 'experimenting is a part of a goal-oriented adaptation strategy'.

Peasant knowledge: who has rights to use it?

Prof .Anil Gupta puts the important question to the academics- what is knowledge and who has the right to use it? He poses some important reflections for himself and those of us working with farmers. He concludes, "If knowledge were truly a common property, the academic discussion about rights to it would be trivial. But if knowledge can be expropriated by free riders or rent seekers, rules of the game need to be evolved".

Farmers' experiments and Participatory Technology Development

The author argues that the farmers are the main actors in the process of technology development, with outsiders playing a supportive role. The concepts of participation, indigenous knowledge and farmers' experiments are introduced and discussed. The six steps in PTD are discussed in detail. According to the author, the activities related to PTD are still in a stage of development. Many questions still need to be ensured as we proceed. He puts forward some of the questions for the readers to think and act.

Farmers' experiments with a new crop

The article throws light on the participatory extension approach in the Thai Wheat Programme, which helped to identify a number of viable production technologies. Thailand is a major rice exporter, but has no history of wheat growing. The Government began promoting wheat in 1983, but farmers were having problems with the official wheat growing technology until some farmers began developing technologies of their own. The key process of farmer-developed technologies is discussed.

Indigenous communication and indigenous knowledge

The authors in this article try to define indigenous communication and analyse the need and purpose of studying the same. The indigenous and exogenous communication is compared. The indigenous communication channels and sources are discussed. A typology of the interface between knowledge and communication types (4 quadrants) is presented and discussed. An understanding of indigenous communication improves the chances of true collegial participation by local people and outsiders in the design of development efforts.

Indigenous knowledge as reflected in agriculture and rural development

The authors stress that the importance of indigenous knowledge should be developed from where people are, rather than from where the disqualified 'experts' would like them to be. The works of different authors on indigenous knowledge as reflected in rural development are reviewed. It is emphasized that in the field of agricultural extension, the seminal work of Paulo Freire has sensitized many extensionists to the top down nature of much extension activities and of the need to incorporate the different local and cultural perceptions of risk and acceptability into many extension schemes.

The problem census: farmer centred problem identification

Extension is both a farmer centred and a problem centred process. Hence it is important for the extension personnel to know how to draw upon information provided by farmers at the4 village level and to involve them in a process that will enable them to identify and solve the problems by themselves. Such a process forms an essential component of the problem census technique, a method in which farmers are fully involved as a viable human resource. The steps involved in organizing and conducting a problem census are discussed in detail. A case study is also presented which helps the readers to get good idea of the amount and quality of information that can be obtained from a problem census method.

Participatory Research with community based farmers

Based on the experience gained from the Project for the Validation of Technologies for Highland Communities in Peru, the author first discusses the roles of the researcher as four-fold. The process of designing participatory activities is well elaborated. The assessment of the viability of new techniques and their possible effects upon the system as a whole is clearly explained. The problems and implications of participatory research methods are elaborated. She concludes that the requirements discussed in the article put new challenges on the researcher as well as on the research methodology itself. But the end result will be an increase in the number of farmers who gain more control over the processes required for improving their own production system, and, consequently, in a reduction in their dependence on outside agencies to solve their problems.

On Farm research and household economics

The article focuses on the need to orient on-farm research methodologies towards household economic concepts. The concepts of on-farm research and household economics are defined. The need for consideration of intra-household processes is highlighted. Some of the on-farm research findings are discussed in relation to time constraints, household differentiation and women farmers. The need for application of a household economics perspective in the on-farm research is argued. The concept of the recommendation domain has become central to on-farm research methodology which is very well portrayed.

Farmers' network: key to sustainable agriculture

The author in this article advocates a development support policy in which farmers' networks are seen and respected as a way in which farmers can take control of the agricultural development process. New forms of farmer networks are arising out of a need to gain access to power, new technology and information relevant to the farming community. The potential benefits of farmer networks are discussed. It is important to understand how farmers' networks operate and the recent research has provided important insights in this area, which is one that is frequently overlooked by development organizations. The question of linking with indigenous knowledge, either as an opportunity or risk is discussed. The author opines that farmer networks may help to protect farmers' intellectual property rights somewhat better in future. To avoid expropriation, indigenous networks will need to guard their knowledge carefully.

Daring to share: Networking among NGOs

Networking is the process resulting from our conscious efforts to build relationships with each other to further the cause of sustainable development. Networking adds a fundamentally new quality to human co-operation. It enhances inclusive thinking, creativity and dialogue. The author discusses about the value added to NGO activities by networking. Networks span an enormous range of activities and generally concentrate their efforts in four clusters of activities- the provision of services, learning together, advocacy and management .A possible framework for evaluating NGO network performance is discussed.

Survival under stress: Socio-ecological perspectives on farmers' innovations and risk adjustment

The author makes his presentation in three parts. The first part presents the sociological paradigm in which household adjustment with risks can be studied in a multi-enterprise, multi-market context. In the second part, the institutional aspects of research on farmers' risk adjustment (RA) mechanisms are discussed. A framework in which how indigenous technical knowledge and experimental process of generating this knowledge could be linked with formal research process is analysed in the third part. Empirical examples from various studies are also presented.

Participatory plant breeding: emerging models and future development

Participatory plant breeding (PPB) is used to cover a wide range of activities including both farmer participation in testing stabilized varieties as well as farmer selection of materials that are still segregating. The fundamental rationale of PPB programme is that joint scientist- farmer effects can deliver more than if each side works alone. PPB approach enhances farmers' involvement and responsibility. PPB is truly participatory only when the clients have real decision making power- from the first stages of setting the agenda through to deciding what varieties should be moved forwards.
According to the authors, PPB is still in an inception stage. Many programmes are taking a step by step approach, testing one or two innovations at a time. ICRISAT's work on diagnostic methods for breeding pearl millets in India has been unusually rigorous in detailing the range of farmer preferences and selection practices.

Mainstreaming gender in Participatory Technology Development

The present case study reflects on the collaborative efforts of AME, a professional support organization, and a number of NGOs involved in sustainable agriculture. The collaborative effort is viewed in terms of two interdependent processes- one of participatory development and testing eco-friendly and potentially sustainable technology in agriculture, and the other, of comprehensive capacity building of farmers, NGO staff, AME and researchers involved in a joint learning process. This twin process is referred to as PTD. A discussion on this joint effort to bring on gender perspective into this process forms the core content of this article. The women and men farmers' perceptions of the PTD process are compared and analysed. The authors conclude that the process of mobilizing knowledge gives women more self- confidence, control and respect in the domain of agricultural decision making.

Participatory Technology Development- implications for research and extension

The authors based on review emphasise the benefits of farmer participation in research and call for greater participation of farmers in research activities. Implementation of PTD concept, in the existing research set up is not easy, considering the organizational inadequacies and lack of receptivity of scientists to such ideas. Scientists should have an open mind and right attitude to work with farmers. This may require some sort of 'delearning'. In PTD, it is not monitoring the performance of a technology developed elsewhere, but evolving sound and appropriate practices. Success of PTD approach would essentially depend on the strength of linkage between and among research, extension and farmer systems.

Participatory Technology Development- some policy issues

The paper approaches the concept of PTD with the three-fold objectives-(a) to rationalize the technology development process in the farm sector,(b) to identify and clarify the systems involved in technology development process and define the roles of each system, and (c) to analyse the misconceptions about PTD and identify the relative advantages. PTD is based on the simple assumption that farmers are and remain the main actors in the process of TD and the outsiders can at best take only a supportive role. A stand has been taken atleast by a few that research can be done only by scientists and not by farmers. Such misconceptions have to be cleared and a proper perspective developed for the proper implementation of PTD

Measuring Sustainability: Issues and Alternatives

Larry W. Harrington

Introduction

Sustainability has been defined and characterized in vastly different ways—from the resilience of individual agro-ecosystems to food security in the face of global climate change. Approaches to measuring sustainability are heavily conditioned by how the word sustainability itself is understood. Some general issues are nevertheless common across all possible approaches.

General Issues

Predicting the future

Measuring sustainability implies drawing conclusions, or at least stating probabilities, about future events. When an agro-ecologist warns of agro-ecosystem breakdown as a system becomes less diversified, he or she is making a forecast. Similarly, when farmers' cultural practices are portrayed as unsustainable, predictions are implicitly being made about future levels of soil depth and fertility and crop productivity. More obviously, when the proponents of low-input sustainable agriculture advocate a switch to wholly renewable resources, they are making tacit assumptions about the future availability and prices of agricultural inputs.

All forecasts contain uncertainty, but some are more uncertain than others. Forecasts about the future effects of soil erosion on crop yields are probably more reliable than those about regional changes in temperature and rainfall due to global warming. The degree to which sustainability can be measured depends greatly on the ability of analysts to predict the future accurately.

Time frame

The problems of measuring sustainability are exacerbated by the different time frames that apply to different sustainability issues. Some problems are best studied over the medium term, within a time frame of 5 to 20 years. These include problems such as soil nutrient depletion, the build-up of weeds, pests and diseases, rapid soil erosion, and so on.

Other problems are best studied over a longer time frame of 20 to 100 years. These include slower forms of land degradation, such as erosion, salinization or desertification, and some of the changes expected in the external environment, such as the initial effects of global warming. Still other problems are best 'studied' (if the word still makes sense in this context) over very long time frames of 100 to 1000 years and beyond. These include questions concerning the 'ultimate' sustainability of agriculture.

State versus control variables

In some approaches to measuring sustainability, only 'state variables' (descriptors of the quality of the environment or of specific resources) are quantified. In others, both state variables and 'control variables' (variables that directly influence the level of a state variable) are quantified. For example, the control variable 'tillage practice' influences the state variable 'soil depth remaining after erosion'. There is typically a cause-and-effect relationship between control and state variables.

When only state variables are measured, considerable doubt can remain regarding the causes of observed changes. For example, per capita food production (a state variable) may be declining. The causes, however, cannot be ascertained unless appropriate control variables are also measured. They might be rising human population, lower use of inputs, a switch to non-food cash crops, declining yields, or a combination of these and other factors. A satisfactory assessment of sustainability is likely to require the simultaneous measurement of several state and control variables, linking problems with their causes.

Continuous versus discrete measurement

There seems to be little discussion in the literature on the issue of whether variables should be measured continuously or discretely. If sustainability is thought of as discrete, then in theory at least an agro-ecosystem can be described as being either sustainable or not. Measuring sustainability comes down to ascertaining which of these two states prevails. If sustainability is seen as continuous, however, it is possible to entertain different degrees of sustainability, opening the way to comparisons between systems. Most proponents of increased quantification seem to assume that continuous measurement is possible.

Level of measurement and substitution options

It is frequently assumed that sustainability is best measured at the plot level. Sustainability is taken to mean indefinitely maintaining the productivity of a specific cropping pattern in a specific location, without incurring a deterioration in the quality and quantity of the resources devoted to its production. Yet other cropping patterns may come along that are more attractive to farmers. And it is not always necessary to insist on the sustainability of all system components: some resources may be used in excess of sustainable levels, and the overall productivity of the system maintained by substituting among resources over time (Graham-Tomasi 1990). A major issue, then, is deciding exactly what it is that we are trying to sustain.

Sustainability of What? Three Concepts

Sustainability and sustainable agriculture have been analysed and defined in numerous ways. Indeed, there are almost too many definitions. Most of them fall under one or more of three concepts of sustainability: the agro-ecological concept, the resource concept, and the growth concept.

Sustainable agro-ecologies

Some definitions focus on sustainability in terms of system resilience, or the ability of an agricultural system or ecology to 'maintain its productivity when subject to stress or perturbation' (Conway 1986). Sustainability in the agro-ecological sense is enhanced through system diversity. The diversity of enterprises over time and space fosters the recycling of nutrients, increased efficiency in the use of moisture, nutrients and sunlight, and the reduced incidence of weeds, pests and diseases (Altieri 1987). Modern monoculture, characterized by low levels of diversity, is viewed as highly fragile, its equilibrium being controled through the use of external inputs rather than through internal feedback mechanisms (Ingram and Swift 1989).

In this view, then, agriculture can be made more sustainable by increasing system diversity and by fostering nutrient and energy cycling (and thereby reducing the use of external inputs) through the development of suitable new farming systems (Francis 1986; Altieri 1987). Consequently, monitoring trends in system diversity and in the internal cycling of nutrients and energy is perceived as fundamental when measuring the sustainability of an agricultural system.

Sustainable resources

Other definitions of sustainability focus on the continuing availability of resources over time, especially with regard to future generations and the rights of non-human species (Batie 1989). The emphasis is on stewardship, or the proper care and protection of resources (Barker and Chapman 1988). This approach is founded on the belief that future generations have the right to an environment and a stock of renewable and non-renewable resources in no worse condition than that enjoyed by the current generation.

In theory, the efficient intertemporal use of resources can be assessed by means of cost-benefit analysis (Schmid 1989). However, intertemporal efficiency considerations can be used to rationalize the extinction of renewable resources and the exhaustion of non-renewable resources (Clark 1976). Discounting future costs and benefits involves making judgements concerning the value of current versus future consumption. Serious ethical questions arise when the current generation of human beings makes these judgements on the behalf of future generations (Batie 1989; IFPRI 1989). Moreover, it can be argued that agricultural and economic development are inherently unsustainable simply because geometric growth rates (for example, in the demand for food) are ultimately incompatible with absolute scarcities (for example, in resources, or in the capacity of the environment to absorb pollution) (Heilbroner 1980; Batie 1989).

According to this perspective, the sustainability of agriculture can best be enhanced by slowing down economic development, stabilizing human population levels, and discouraging the exploitation of natural resources (especially common property resources) (Barbier and McCracken 1988; Durning 1990). Proponents of the resource availability view, then, argue that assessments of sustainability must somehow capture the quantity and quality of natural resources expected to be available for future generations.

Sustainable growth

A third major view of sustainability focuses on the need for continued growth in agricultural productivity while maintaining the quality and quantity of the resources devoted to agriculture. It implies using renewable resources at rates lower than that at which they can be generated, emitting wastes at rates lower than those at which they can be absorbed by the environment, and optimizing the efficiency with which renewable resources are used (Barbier and McCracken 1988).

This view of sustainability takes into account predicted increases in the demand for food arising from continuing population and income growth. It is this view that has inspired the definition of sustainable agriculture proposed by the Technical Advisory Committee of the Consultative Group on International Agricultural Research (CGIAR), according to whom sustainable agriculture 'should involve the successful management of resources for agriculture to satisfy changing human needs while maintaining or enhancing the quality of the environment and conserving natural resources' (CIMMYT 1989).

Sustainable growth can be realized (and measured) at several different levels. Among them are the regional level, at which the sources of growth in agricultural productivity are compared with expected growth in the demand for agricultural products (Byerlee and Siddiq 1989; Rosegrant and Pingali 1991), and the plot level, at which changes in yields and total factor productivity are explained in terms of changes in the levels of inputs, technical change, and changes in resource quality (Lynam and Herdt 1988). Clearly, the two levels are related: the ability of food supply to keep up with growth in demand increasingly depends on solving plot-level constraints to increased yields. Here again, not all system components need be used sustainably, for one resource may be substituted for another over time. Plot-level issues can be further subdivided according to the importance of externalities or common property resources as causal factors.

Categories of Sustainability Issues

A plethora of issues are raised regularly in relation to the sustainability of agriculture. An incomplete listing of these issues might include soil erosion, global warming, salinization of irrigated areas, deforestation, deterioration of soil structure, reduction in biodiversity, exhaustion of soil nutrients, desertification, pest and disease build-up, pollution from agricultural chemicals, and reduced future availability of agricultural inputs (including fossil fuels). Many of these issues, especially those having to do with land degradation or the maintenance of soil quality, have been studied in some depth by disciplinary and subject matter specialists. Other issues, such as global warming, are relatively new fields of enquiry.

To facilitate analysis, sustainability issues can be grouped into categories. Different ways of assessing sustainability may be needed for each category.

External versus internal

External issues of sustainability are those associated with changes in farmers' external circumstances. Global warming and climate change, the availability and prices of fertilizers and other purchased inputs, and changes in global biodiversity are examples. These issues are beyond the individual farmer's control. In contrast, internal issues of sustainability are those associated directly with the farming system and the farmer's capacity to change matters.

Not all issues can be classified as either internal or external. Farm operations undoubtedly contribute (although in a relatively subordinate way) to global warming (Pretty and Conway 1989). Moreover, most internal issues are conditioned to some extent by external circumstances. Nonetheless, the distinction helps by highlighting the relative importance of farm-level decision making in addressing sustainability problems.

Reversible versus irreversible

Sustainability problems may be distinguished as reversible and irreversible. The permanent effects of irreversible problems cause special concern. When future demand for a resource is uncertain and the effects of irreversible change are not well known, the present generation may perceive a value ('option demand') in maintaining the option to use that resource in the future (Johnston 1988). Some of the problems commonly associated with the sustainability of agriculture are not wholly irreversible. For example, soil nutrient depletion, loss of soil structure, or build-up of pests and diseases. In contrast, severe soil erosion or massive deforestation can be considered reversible only under the most optimistic—and unlikely—assumptions about future land use over very long periods.

Public health versus agricultural productivity

Some of the issues often included under the rubric of sustainable agriculture have less to do with the long-term productivity of agriculture than with the effects of agricultural practices (such as pesticide application) on public health. There is no doubt that these questions are important and that agricultural technology can or should be adjusted to address them. However, they are different from other sustainability problems in that they do not deal with threats to future food security.

Implications for Measuring Sustainability

Measuring an abstract property such as sustainability is, to say the least, challenging. It is unlikely that a single approach—equally useful regardless of the concept of sustainability or the category of problem under consideration—will ever be found. To this extent, the idea of 'measuring sustainability' has little meaning.

Measurements of the sustainability of agricultural productivity when this is threatened by external problems are likely to depend greatly on the work of disciplinary specialists outside agriculture. Within resource economics, for example, there are those who specialize in assessing the future availability and prices of natural resources (such as Chapman 1983, US Department of the Interior 1989). Agricultural field scientists would do well to monitor (without feeling compelled to duplicate) the work of these specialists. Probable farmer adaptations to increases in the prices of external inputs (adjustments in input use, shifts in enterprise mix, adoption of low-input technologies) can then be assessed. The work of specialists on global climate change and its implications for agriculture will take on a similar importance. Some studies of this issue have already been conducted (Arthur 1988; Jodha 1989), but much remains to be done.

According to the agro-ecological concept of system resilience, the measurement of sustainability depends on the development of reliable indicators of resilience and diversity that can be easily quantified. To date there has been little progress in formulating such indicators (Tisdell 1988). In contrast, following the 'sustainable growth' concept, there has been considerable work on approaches to measuring the sustainability of agricultural productivity when this is threatened by internal problems. Several approaches have been proposed, typically relying in one way or another on trends in yields or total factor productivity (state variables), with or without complementary evidence on resource degradation. Discussion of some of these approaches constitutes the rest of this paper.

Methods for Measuring Sustainable Growth

Non-quantitative approaches

Rejecting quantification. Some scientists reject the very notion that sustainability can or should be measured. For example, MacRae et al. (1989) argue that quantification tends to distort the research process, inducing researchers to choose quantifiable (but less relevant) variables at the expense of other non-quantifiable (but conceptually more important) ones. They are especially sceptical of numerical modeling of biological systems, arguing that the internal consistency of these models does not compensate for their lack of realism.

This rejection of quantification is linked to a similar rejection of 'reductionism.' It is not usually possible, MacRae et al. (1988) maintain, to analyse complex systems by examining a few variables and then applying the results over a broad area. Nor is it realistic to assume direct, single cause-and-effect relationships between factors. Given that sustainable processes are location-specific, they are difficult or impossible to quantify.

There is undoubtedly some truth in these arguments. Yet it is never possible to deal with any problem (not just sustainability problems) in all its real-world complexity. Scientists 'have to simplify to survive' (McCall and Kaplan 1985). In addition, the experience of farming systems research suggests that it is often possible to quantify and model complex biological systems without unacceptable loss of realism.

In contrast, analyses conducted without attempting quantification can lead to circular reasoning, with the relative sustainability of systems being assessed in terms of the degree to which they use practices that have been defined *a priori* as 'sustainable'. This increases the probability of self-deception and virtually eliminates the ability to compare different systems rigorously, examine sustainability-productivity trade-offs, or gauge the progress made towards specific goals.

Directional measurements. Most proponents of sustainable agriculture would probably not agree that measuring sustainability is utterly impossible, and that trying to measure it is a bad idea. Many, however, would be content with 'directional' measurements. A directional measurement is one that measures only the direction of change in the sustainability of a system, not the magnitude of that change.

Directional measurements are most attractive when it is felt that a proportional relationship exists between control and state variables. The assumption is that the sustainability of an agro-ecosystem is changed in rough proportion to changes in those practices felt to most strongly influence the system's future productivity (and/or its ability to deal with stresses and perturbations). For example, an agro-ecosystem suffering from gradually declining levels of soil nutrients is thought to become more sustainable in rough proportion to the amount of nutrients that, through appropriate interventions, can be generated or recycled within the system or applied from external sources. Insofar as the levels of these nutrients are increased, the system is assumed to become more sustainable.

Note that, in this approach, current levels of sustainability need not be measured. In fact, cardinal units of measurement are unnecessary. It is assumed that sustainability is a continuous, not a discrete, variable, but that measuring levels of sustainability in cardinal terms is unnecessary. If the assumption of proportionality between control and state variables is incorrect, of course, this approach can be thoroughly misleading.

Quantitative approaches

Purpose. Suitable methods of quantification are necessary in order for researchers to answer questions such as the following:

- Is System A sustainable or not?
- Is System A becoming more or less sustainable over time?

- Is System A more or less sustainable than System B?
- By what percent is System A more sustainable than System B?
- Is the relative sustainability of System A with respect to System B increasing or decreasing over time?
- What are the trade-offs between longer term sustainability and current levels of productivity of System A?
- Is the current productivity of System A more or less sensitive than that of System B to technical changes aimed at enhancing sustainability?

All the quantitative approaches discussed below have trend analysis in common. In trend analysis, time series data from the recent past are used to forecast the near future. The trends for specific state variables, such as output, yields, total factor productivity or per capita production, are assessed. The main aim of the analysis is to measure the extent to which a system has already become less sustainable. The questions are: which variables best capture a change in sustainability? Do some variables confound trends in system sustainability with other factors? Which variables are easy and economical to use?

Aggregate trends in output and yields. There is an understandable temptation to measure system sustainability in terms of trends in production and/or yields. These trends can be assessed through published data at the aggregate level. For example, when maize yields show a decline over time, researchers become apprehensive about the possible degradation of the resources devoted to maize production.

The drawback of this approach is that problems of sustainability can be present—and worsening—even when published data indicate a rising trend in output and yields. Similarly, they may be entirely absent despite data showing declining trends. Changes in aggregate output or yields may be due to other factors, such as changes in the quantity or quality of inputs used, or in the mix of enterprises selected by farmers (Harrington et al. 1990). For example, yields of a crop may appear to be declining over time simply because more attractive crops have replaced it in the more favorable production environments. Researchers must be especially careful of these confounding effects. On the whole it is unwise to assume that the productivity of a particular crop or enterprise over time is an adequate proxy for trends in system productivity or sustainability.

Total factor productivity. Lynam and Herdt (1988) suggest that sustainability be measured in terms of trends in total factor productivity (TFP). Thus:

(1) $TFP = O / I$

where O is the total value of all outputs and I is the total value of all inputs. A sustainable system would feature a positive trend in TFP.

Monteith (n.d.) notes, however, that the 'total value of all inputs' can be a somewhat arbitrary quantity, having diverse components whose relative value may be hard to assess.

A declining trend in TFP (as defined above) might be due to resource degradation or to declining product prices and higher input prices caused by gradual shifts in government policy. This approach takes no account of changes in the quality of the agricultural resource base and does not separate the technical factors that may be causing an observed decline in TFP. Measuring the total value of the outputs and inputs used in a farming system is likely to be expensive, since measurement is needed several times during the year (to minimize recall error), for a reasonably large number of farmers (to minimize sampling error), over an indefinite number of years.

Finally, Monteith notes that this approach focuses on sustainability at the plot level, avoiding assessment at the regional level. Rising TFP may mean little if population is increasing faster. Similarly, past gains in TFP may be misleading if made at the expense of system resilience or in ways that ultimately degrade farmers' resources. 'Turning points' in trends have always been the bane of those who would predict the future on the basis of the past.

Trends in per capita production. Monteith (n.d.) argues that, to be sustainable, a system should maintain per capita benefit levels from year to year (and in principle from generation to generation) and should not itself deteriorate as a consequence of being used. He summarizes this in the following rule: A system is sustainable over a defined period if outputs do not decrease when inputs are not increased.'

This rule has much to recommend it. However, it can be tested only in systems in which farmers use the same cropping patterns and associated livestock enterprises year after year on the same fields without increasing input levels. These conditions are sometimes found in subsistence systems with few opportunities for enterprise diversification or the use of external inputs, to which the rule seems best to apply.

With input levels held constant, per capita production is a function of yields, harvested area, and population density, where yield changes are driven by 'sustainability' factors (resource quality), not by varying input levels or land use shifts. Thus:

$$(2)\ C = Y\,(A/P)$$

where C = per capita production, Y = yield per unit area, A = harvested area, and P = population density. By differentiating with respect to time, percentage changes become additive in the following manner:

$$(3)\ (dC/dt)/C = (dY/dt)/Y + (dA/dt)/A - (dP/dt)/P$$

where (dC/dt)/C is the percentage change in per capita production with a small increment in time. In other words, the percentage increase in per capita production is the sum of the percentage increase in harvested area and the percentage increase in yields, less the percentage increase in population density.

For example, if yields are growing at 3.1% per year, with harvested area declining at 0.2% per year, and population increasing at 2% per year, then per capita production is increasing by 3.1 + (– 0.2) – 2.0 = 0.9% per year. Note that this approach assumes that parameter values do not vary over time.

Because this approach defines sustainability as the maintenance of per capita net benefits from year to year (net benefits vary in direct proportion to gross benefits because inputs are held constant), declining trends in per capita production are used to identify sustainability issues. However, this approach, like the previous two approaches, provides little information on the technical dimensions of any decline in the quality of the agricultural resource base—the root causes of unsustainability.

This approach could be applied to whole systems. However, given the need to measure harvested area and yield, its use in enterprise-specific analyses seems virtually inevitable. Indeed, Monteith himself uses enterprise-specific examples in his paper. This increases the danger of confounding yield declines caused by resource degradation with those caused by other factors, such as movement of a commodity from one land type to another.

Finally, the feasiblity of this approach hinges on whether input levels are held constant. In controlled trials, they can be, but on the farm they are usually found to vary. An approach that cannot assess the sustainability of systems in which both outputs and inputs are increasing does not seem terribly helpful.

TFP revisited. An acceptable method of quantifying sustainability should be capable of distinguishing between: (1) yield changes due to changes in levels of purchased inputs (movements along a production function), (2) increases in total factor productivity due to technological change (for example, upward shifts in the production function due to the adoption of an improved variety, or to earlier planting), and (3) reductions in total factor productivity due to resource degradation (for example, downward shifts in the production function due to nutrient depletion). Case (3) might be reflected in stagnant yields despite continuously increasing input levels, or yield reductions given constant input levels.

The TFP approach, which has been widely used for measuring the effects of technological change, can be be made more useful by linking it to a production function. TFP has been defined in many different ways. Samuelson and Nordhaus (1985), for example, use the following:

(4) $TFP = Q - SL(L) - SK(K)$

where TFP = total factor productivity (percentage change per year), Q = output growth rate (percentage per year), L = labour input growth rate (percentage per year), K = capital input growth rate (percentage per year), SL = (constant) labour factor share, and SK = (constant) capital factor share.

As defined here, TFP is a residual after accounting for the effects of increased input levels on output. As noted above, it confounds the positive effects of technological change and the negative effects of resource degradation. If it were possible to identify shifts in the production function attributable to technological change, the new residual after subtracting these would reflect the effect of resource degradation on productivity.

A farmer monitoring program recently begun in Nepal by the National Agricultural Research Center, the International Maize and Wheat Improvement Center, and the International Rice Research Institute takes this approach to measuring sustainability. A farmer panel is monitored by local research and extension workers twice per year. Input and output data are obtained, along with information on field-level productivity problems and assessments of resource quality. Yields and TFP are then explained (through a set of recursive regressions) in terms of changes in input levels, technological change, and changes in resource quality (with weather information included to reduce unexplained variability). This project is still at an early stage of development. However, like the 'trends in per capita production' approach, this approach focuses on the plot level, not the regional level. It says nothing about the race between rising demand on the one hand and productivity growth on the other.

Yield trends in relation to inputs applied. Not everyone likes the idea of estimating TFP. Direct estimation of the contribution of different factors to yield increase might be a less complex approach.

Cardwell (1982), for example, estimated the relative contributions of a number of factors, both positive and negative, affecting Minnesota maize yields from the 1930s to the present. Each factor was assessed separately. First, the contribution of a particular factor in kg/ha or kg/ha/year was estimated synthetically. The area and numbers of years over which the factor had been effective were used to estimate its current year contribution to yield change, which was then expressed as a percentage of the current yield.

Cardwell found that the switch from open-pollinated varieties to hybrids, improved weed control through herbicide use, increased plant densities and earlier planting accounted for most of the increase in yields. An increase in nitrogen fertilizer use also accounted for part of the yield increase, but much of this was merely a substitute for lower levels of manure and reduced levels of N from mineralized organic matter. Soil erosion was found to have reduced yield potential by 8% over the 50-year time horizon studied.

Byerlee and Siddiq (1989) used a more elaborate variation on this approach in their assessment of sources of growth in wheat production and yields in the Pakistan Punjab. They identified three major sources of growth: increased irrigated area relative to rainfed area, adoption of high-yielding varieties (HYVs) in both irrigated and rainfed areas, and increased HYV yields in irrigated areas. They also identified factors tending to depress yields: earlier planting, declining groundwater quality and increased field salinization, an increase in problem weeds, and lower fertilizer efficiency. Secondary factors were also included and measured. For example, the increase in irrigated wheat area was found to be partly due to a shift in cropping patterns, with farmers moving the crop from rainfed to irrigated areas.

This approach is powerful. It measures trends in both state and control variables, takes into account both land type changes and cropping pattern changes, assesses changes in input use levels, and identifies both positive and negative factors affecting yields. The approach enables researchers to predict future events more confidently.

At this level of disaggregation, for example, it becomes clear that some of the past sources of yield increase (notably, the adoption of HYVs) have been fully used and can no longer support further growth. It may also be found that some of the negative factors (such as salinity) are increasing in importance, threatening future productive capacity. By integrating all these factors into a single model, a powerful tool is forged for assessing yield and production growth over the near future. The figures can then be compared with expected changes in demand, to develop regional-level assessments of sustainability.

A disadvantage of this approach is that it is extremely data-intensive. It requires a combination of time series data from secondary sources and micro-level data from farm surveys and from on-farm and on-station experiments. In many cases these data will not be available and the approach will be unusable without a substantial investment in data generation. Moreover, the approach is even more difficult to apply to complex farming systems, at the level of the system rather than the commodity. The example given, focusing on wheat in the context of a relatively simple system, is already somewhat elaborate.

Finally, this approach, like all the others, interprets sustainability in terms of efficiency, not resilience, and shows little sensitivity to the virtues of diversity as a solution to sustainability problems. That is, the principles of agro-ecology seem to have little place, either in the analysis or in the conclusions.

Linear programming. When trend analysis is used to forecast the near future on the basis of information about the recent past, linear programming can be used to simulate possible future events given parametric changes in farmers' access to land and other assets. If farmers can choose between several activities that have different effects on sustainability, the conditions determining their choice become interesting.

One recent study examined this very question (Hildebrand and Ashraf 1989). Several alternative cropping activities were assessed, with some of them assumed to have more beneficial carry-over effects than others. Farm size was parametrically reduced to reflect likely changes arising from population pressure. An estimate was made of the minimum farm size needed to meet family food requirements, while maintaining soil fertility through fallow, alley cropping or fertilizer application strategies. Not surprisingly, it was found that minimum allowable farm sizes were larger when soil fertility maintenance depended on traditional fallowing and alley cropping activities. Activities featuring the use of chemical fertilizer allowed farm sizes to decline much further without reducing soil fertility below critical levels. The results highlighted a trade-off between fertilizer application and bush fallow area. However, it was not possible to compare the sustainability of different strategies, due to a lack of time series data.

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Checklist of Criteria for Assessing Agricultural Technologies

Productivity

- Does the technology meet farmers' needs in kind?
    - Does it improve food availability, quality and security?
    - Does it sustain or improve the availability of secondary products (fuelwood, building materials, medicines, gifts, etc)?
- Does it meet farmer/household needs for cash (or exchangeable products)?
    - Is there a market for the products?
    - Are prices high enough?
- Is enough land available to produce sufficient for farmer/household needs?
    - Quantity
    - Quality
- Do labour requirements fit farmers' labour resources?
    - By gender
    - By season
- Do farmers have access to the necessary inputs?
    - Are inputs available?
    - Are inputs affordable?
- Do financial requirements fit farmers' cash resources and needs for cost-effectiveness?
    - By different cost components (nutrients, pesticides, hired labour, transport, etc)
    - By season

Security

- Does the technology minimize the risk of
    - Crop failure (pests, diseases, drought, waterlogging, etc)?
    - Financial failure?
    - Health hazards?
    - Non-availability of external inputs?
    - Inappropriateness of exotic species?
- Does it allow sufficient management flexibility?
- Is it based on the use of local resources (genetic resources, knowlege, skills, etc)
    - Are these resources under the control of farmers?
- Does it reduce dependence on information, subsidies, credit from outside the farming system?
- Does it avoid conflicts between interest groups?

Continuity

- Does the technology maintain/enhance soil quality?
    - Soil life
    - Soil fertility (macro- and micronutrients)
    - Nutrient balance (macro- and micronutrients)
    - Structure
    - Water-holding capacity
- Does it recycle nutrients?
- Does it prevent/reduce soil nutrient loss?
    - Soil cover
    - Complementary root structure
    - Water conservation
- Does it enhance/maintain perennial biomass (grasses, shrubs, trees, animals)
- Does it use water efficiently and safely?
    - Water use efficiency of crops
    - Overpumping
    - Drainage
- Does it enhance diversity?
- Does it reduce toxic effects on people and resources?
- Does it enhance human health?
- Are maintenance costs (ecological and economic) affordable?
- Does it recycle capital?
- Does it have neutral or positive effects on systems beyond the farm (watershed, village, downstream areas, nation, etc)?
    - Use of non-renewable resources
    - Pollution of air, water, soil
    - Production of greenhouse gases

Identity

- Does the technology integrate well within the existing farming system?
    - Agro-ecologically
    - Socio-economically
    - At household level
    - At gender level
    - From a developmental viewpoint
- Is it possible to introduce the technology given the existing infrastructure (credit, roads, transport, extension support, etc)?
- Does the technology fit/strengthen the culture of the farming population?
    - Social organization
    - Religion or values
    - Tastes and preferences

    - Perceptions of social justice
- Can it be easily understood by farmers?
- Is it consistent with government policy?
    - Does it generate employment opportunities (on-farm, off-farm)?
    - Does it contribute to regional/national food security?
    - Does it contribute to foreign currency reserves?
- Does it benefit poor/powerless groups (men, women)?

Adaptability
- Has the technology already been practised by small-scale farmers (if so, with what results)?
- Does it bring rapid, recognizable returns?
- Does it allow experimentation/adaptation by farmers?
- Can it be easily communicated to other farmers?
- Can knowlege/skills required be easily transferred to farmers through training?

Guidelines for use
This is a checklist, not a 'should' list. People working with this list should feel free to give high or low values to different criteria, or to add, delete or change criteria as they see fit.

This checklist of criteria was prepared during ILEIA workshops.
ILEIA, 1991/2. Assessing low-external-input farming techniques: Report of a Workshop. ILEIA Newsletter 1 and 2.

Farmers Who Experiment: An untapped resource for agricultural research and development

ROBERT RHOADES AND ANTHONY BEBBINGTON

Introduction

THROUGHOUT THE CHANCHAMAYO Valley of Peru's Eastern high jungle, he was known as 'El Loco,' the crazy one. He had migrated in 1978 to the Chanchamayo from the Highland Department of Huancavelica. Although his real name was Anchuraycu, he quickly acquired his nickname from a reputation of bold and sometimes comical experimenting. 'El Loco' was notorious for moving plants or seeds of important crops between extreme climates on the Andean slopes where temperature and climates change rapidly as one climbs from the jungle to the mountains. He uprooted potato seeds from their cool Highland home and carried them downhill to the hot, sultry jungle. With the banana, he carted it up the mountain to the point where he suspected it would not do well just to see what would happen. He was an incurable grafter, planter of many varieties, but above all an expert in home-designed agricultural experiments.

We first met 'El Loco' in 1980 while surveying possibilities of introducing the potato *(Solanum tuberosum)* into the hot, humid tropics (Rhoades and Recharte n.d.). The International Potato Centre had established an experimental station on the valley floor of the Chanchamayo at 800 m to conduct basic research in the development of a tropical potato. Our job as anthropologists was to explore the surrounding countryside to see if any farmers had attempted to grow potatoes. We stumbled upon 'El Loco' while he was cultivating a maize field. Our altimeter told us we were standing at around 890 metres, approximately a thousand metres below where potatoes can be grown satisfactorily. To our amazement, hidden and shaded among his maize was a beautiful stand of potatoes. 'El Loco' was obviously proud of this experiment, in a way reminiscent of our biological science colleagues. 'I'll castrate anyone who touches these potatoes', he scolded while waving a large machete. Experimentation for 'El Loco' was obviously serious business.

'El Loco' was one of the more extreme cases we encountered, but he was not the only farmer in the Chanchamayo who experimented with potatoes. In fact, our 1980 survey revealed that 90 per cent of all settler farmers of the upper Chanchamayo were avid experimenters. Perhaps some were more active than others, but virtually all conducted *pruebas* or trials, particularly with the potato. Although the Chanchamayo is an in-migrant zone, which links two major climatic zones and agricultural systems (highlands and lowland jungle) and therefore particularly conducive to farmer-based experimentation, evidence is now rapidly accumulating that small-scale producers of the Andes and elsewhere in the world are systematic, folk scientists in the creation of their own indigenous technologies or in the testing of introduced techniques (Chambers, Pacey and Thrupp 1989; Rhoades 1987).

The objectives of this chapter are three-fold:

- to discuss farmer experimentation as revealed in the literature;
- to analyse case studies of different kinds of farm experimentation with potatoes in Peru; and
- to draw out the implications of this farmer-based research for scientists.

We will deal only slightly with the actual design, method and underlying epistemologies involved in farmer experimentation. The data for this chapter were collected as a by-product of several independent studies of potato production in Peru, in particular, an agrarian ecological study of the Chanchamayo Valley and adjacent higher lying communities of Peru's *ceja de selva* (Rhoades and Recharte n.d.; Recharte 1981; Bebbington 1988). At the time of data collection, we were impressed by, but not fully aware of, the significance of widespread experimentation by farmers.

Farmers as experimenters: what the literature tells us

In the vast literature on agricultural development, almost no attention has been given to farmers as active experimenters or innovators in their own right (Rhoades 1987). Farmers have been primarily seen as adopters of technologies introduced from the outside, but not as creators of their own solutions (*see* the 1962 diffusion/adoption literature of the E. Rogers' School of Rural Sociology). The image we have come to accept is that peasant agriculture is stagnant and impetus for change must come from extraneous credit, education, and new technologies (Schultz 1964). Peasants, although seen as rational actors in a constrained circumstance, have been portrayed as shackled by low state investment in agriculture, by traditional culture, or by a marginal environment. Any innovations or technological breakthroughs made by farmers on their own were thought to be accidental and to have developed unsystematically through trial and error.

A small but growing literature challenges this view of the passive, small-scale producer in developing countries. Carl Sauer (1969) was an early proponent of the inventiveness of such farmers. He based his arguments both upon Latin American fieldwork and deductions about the origins of agriculture – deductions that drew explicitly on the idea that proto-farmers with spare time would have been interested experimenters, who based their projects on their observations of the local ecology. Also in the cultural-historical/cultural-ecological vein, discussions of the pioneer experience at the frontier have documented conscious experimentation by farmers encountering new environments (*e.g.* Thompson 1973). For Thompson such experimentation is part of the process of ecological adaptation (1973: 14–15). Turner (1961: 3) also implies that this process of learning a new ecology – as 'Little by little...[the colonist]...transforms the wilderness' – is part of the essence of the frontier experience.

A more explicit discussion of farmer creativity is offered in the seminal article of anthropologist Allen Johnson (1972). He points to discrepancies between his, Harold Conklin's (1957) and others' observations in the field and anthropological assumptions about culture-bound farmers who blindly follow the dictates of cultural traditions. Rather than pursuing time-tested rules, Johnson's evidence suggests that farmers act creatively and individually. He argues that, like biological evolution, cultural evolution (including agricultural change) also requires individual variation and adaptation (*see* also Denevan 1983). In a later article, Stephen Biggs and Edward Clay (1981) drew an important distinction between informal and formal research and development systems. In the informal system, farmers engage in indigenous experimentation and purposive selection in a continuous process of innovation. The advantage 'lies in the users of the technology innovating to meet their own needs by drawing on detailed knowledge of their environment and exploiting the opportunities offered by natural selection' (Biggs and Clay 1981: 325). The generator and user is therefore the same. The problems of communication and relevancy are greatly diminished.

In a workshop held in 1987 at the Institute of Development Studies (U.K.), the 'farmer as experimenter' was more fully developed in a series of papers (Rhoades 1987; Richards 1987; Box 1987; Edwards 1987). Rhoades (1987) and Richards (1987) argue that the archaeological and historical record show a long string of important agricultural technology breakthroughs made by farmers in traditional societies, although their rapidity and diffusion might have been slower than innovations in modern agricultural science.

Rhoades (1987) further posits that a scientific method, broadly defined, is followed by experimenting farmers. This notion was developed earlier in the writings of Claude Lévi-Strauss (1966: 14) who, in commenting on humankind's great achievements including the development of agriculture and domestication of animals, noted: 'Each of these techniques assumes centuries of active and methodical observation, of bold hypothesis testing by means of endlessly repeated experiments.' Lévi-Strauss readily admits that the peasants *science of the concrete*' as opposed to scientists' *science of the abstract*, as in the natural sciences, represent different levels of science. However, the science of the concrete is 'no less scientific and its results no less genuine. They were secured ten thousand years earlier and still remain at the basis of our own civilisation' (Lévi-Strauss 1966: 16).

Howes and Chambers (1979), in contrasting Indigenous Technical Knowledge (ITK) and Institutionally Organised Science, also stress that: 'the mode of ITK is concrete, not abstract' (see Farrington and Martin 1987). Indeed, conditions inherent in farm reality may limit the relevance of abstract 'basic' science while enhancing the power of concrete, 'applied' science. Potato scientists, for example, study 'how potatoes grow' (physiological changes, tuber formation, and nutrient uptake), but they may not know 'how to grow potatoes.' Furthermore, scientists, out of touch with farm reality, may not know how to transform their important knowledge of 'how potatoes grow' into practical knowledge of actually growing potatoes. Farmers, on the other hand, are often experts in growing potatoes, but could not necessarily explain scientifically the basis of that growth. However, they may advance lay explanations of crop performance. The trick is to link productively the two levels of 'science.' Dovetailing indigenous farmers' experiments with scientists' experiments is one option to improve the generation and transfer of appropriate technologies for traditional agriculture.

Given the paucity of research on how and why farmers experiment, this chapter attempts to examine from a critical perspective farmer's experimentation in three situations in Peru: (1) a traditional potato producing zone, the highlands above 2,500 m above sea level; (2) a hot, humid non-traditional potato zone, below 2,000 m above seal level, where the crop meets its environmental limits;

and (3) a district where farmer experimentation succeeded beyond scientific and governmental imagination. The third situation illustrates both the great potential as well as the risks inherent in indigenous farmer's experimentation. It further shows how the learning process stimulated through experimentation will be tested against and brought back in line with broader ecological and economic realities.

Farmer experimentation in two Peruvian potato production zones

Experiments in the traditional zone The mountains of the Peruvian Andes, flanked by a rainless arid coast on the west and the humid, Amazon jungle on the east, are one of the earth's ecologically-diverse regions. As one of the great centres of plant genetic diversity and crop evolution (Vavilov 1949), this region still sustains wild species and land races of the potato, sweet potato, lima bean, tomato, sea island cotton, papaya, and tobacco, along with dozens of minor crops. Over the centuries, Andean women and men have experimented with and manipulated these plants so that both plants and people are interdependent for survival (Gade 1975).

Among the world's most experienced potato farmers and consumers are found in Peruvian communities located between 2500 and 4500 m above sea level. Both cash income and household consumption depend on the hardy potato crop more than any other. Since the Andean potato production system is both ancient and well-defined, experimentation rarely takes on a radical character. Three kinds of experiments with potatoes can be identified:

- curiosity experiments;
- problem-solving experiments;
- adaptation experiments.

Curiosity experiments Farmers, like most people, are curious. Indeed, Sauer (1969) identified such curiosity as a crucial factor in the original development of agriculture. He argues that populations, in stress-free environments and with time on their hands, would use that time to identify patterns of plant growth, experiment, and ultimately plant crops they had gathered previously. Farmers commonly set up a simple experiment to test an idea that comes to mind. These experiments may or may not have an immediate practical end. CIP anthropologist Gordon Prain (personal communication) tells of a farmer in the village of Chicche in Mantaro Valley who developed the hypothesis that cultivars expressing apical dominance would yield fewer but larger tubers, which would bring a better price, than cultivars without apical dominance, which have more shoots, but smaller tubers at maturity. To test this hypothesis, he has now planted two rows in his country yard garden: one row with apical dominance and the other row without. Although this experiment may ultimately have a practical end, it was stimulated fundamentally by curiosity.

Another example of the curiosity experiment is the planting of true botanical potato seed by farmers. Potatoes are almost universally planted using tubers or cut 'eyes,' and very rarely by true botanical seed produced by flowering cultivars. However, the authors have observed experimental plantings with true seeds along the shores of Lake Titicaca in Southern Peru. Farmers, and sometimes their children, who guard the fields over long periods, select out true seed balls, carefully separate the seeds, and then plant them in small, well-prepared beds near their guard huts. Such experimentation may arise out of boredom, but basic curiosity is the driving force. In similar vein, Christine Franquemont (1987: 3, 5) has described the experiments of *a highly skilled plant specialist*, Don Eugenio Aucapuma, of Chincheros, Cusco. Don Eugenio uses true botanical seed in experiments aimed at isolating new varieties of potato and improving existing varieties. One variety he developed has become widely used throughout Southern Peru. In fact, Carlos Ochoa (personal communication) posits that the continuing experimentation of farmers with true botanical seeds, which are sexually instead of clonally reproduced, explains in part the great genetic diversity of potatoes in the Andes.

Problem-solving experiments Farmers are keen to seek practical solutions to old and new problems through experimentation. In fact, propensity to experiment and try new ideas may be more pronounced in areas of diversified agriculture and poor extension services than in developed countries with less diversification and excellent research and extension facilities. Farmers' experimentation attempts to overcome recent perceived increases in insect damage in the Andean region provide cases in point. For example, increased attacks of the Andean weevil *(gorgojo de los Andes)* in improved potatoes led farmers to test effects of sunlight on seed. They spread potatoes to be used for seed in direct sunlight for short periods (Gordon Prain, personal communication). The effect was to drive the worm from the tubers. Tests are always done first on a small scale and later amplified if successful.

Farmers frequently develop ideas for experimentation that seem strange to scientists (Gupta 1987). For example, in adoption of diffused light potato stores, farmers often insisted that diffused light increased the incidence of the tuber moth pest *(Phthorimaea operculella)* in their stores. Since no scientific explanation for this observation had been developed, the suggestion was written off by scientists as absurd or more flippantly as 'now-they-can-see-the-tuber-moth, before-they-could-not.' However, scientists now suspect that the ecology of tuber moth may after all be tied to different intensities of light and darkness. After continued problems with tuber moth, scientific research verified farmers' observation that tuber moth does increase under diffused light conditions (Parker 1980–81: 35).

In the Guatemalan Highlands, farmers have difficulty with another pest, the aphid *(Myzus persicae)*. Through careful observation several farmers observed that aphids are attracted to green but not to red sprouts on potatoes. They were curious if colour attraction exists. Their pleas with local researchers to conduct experiments on this simple idea fell on deaf ears. So, farmers themselves designed experiments with small numbers of tubers. They insisted that their research showed the green aphid preferred green sprouts. The farmers concluded that one way to control aphids is to select red- or purple-sprouting potatoes (Rhoades 1986).

Farmers have two major advantages over agricultural scientists with regard to problem-solving experiments. First, due to the large numbers of farmers and their constant presence in the field, they have a greater opportunity to observe plants and the environment. On the contrary, most scientists spend much of their time at a desk or in a laboratory. Second, farmers are in a better position to determine which problems affect them directly and therefore to assist in guiding research directed toward solutions (Rhoades and Booth 1982; Lightfoot 1987; Ashby 1984). This advantage of farmers, when combined with the power of the natural sciences to trace connections and order data not visible to the human eye, can help us shape a new approach to experimental agricultural research (Richards 1985).

Adaptation experiments Adaptation experiments are conducted by farmers after they acquire a new technology, or after they have observed a new technology demonstrated elsewhere (for example, in another farmer's field, or in an extension service demonstration plot). Such experiments can occur in three contexts:

- when farmers are testing an unknown component technology within a known physical environment;
- when farmers are testing a known technology within an unknown environment, such as a zone of colonisation;
- when testing an unknown technology in an unknown environment.

Farmers expect experiments to answer such questions as:

- Does the technology work?
- How can it be fitted into the existing production-utilisation system?
- Is it profitable? (in cases of commercial markets)

Before they work out the economics, however, they must answer the first two questions.

Farmers' selection and use of new cultivars are a case in point. In the potato production zones of the Andes, the most intense interest in experimentation revolves around new cultivars. Planting of new cultivars, however, sets in motion a number of experiments on best use of the cultivars in specific locations (farmers generally plant in several agricultural zones and at different times in the production cycle). Because the Highland zone is where potatoes do best, experiments are aimed at discovering which cultivar does better than another, given the ever changing disease and climatic conditions.

Highland potato farmers realise that a broad genetic base of potatoes must be maintained, given the diversity of planting situations and potential risks (Brush *et al.* 1981). They do this through maintenance of individually-held 'germplasm banks,' generally consisting of six to seven varieties (Rhoades 1987). Whenever possible, either on trips or when government agronomists/extension personnel visit villages, farmers try to pick up an additional tuber or two. The 'reserve' potatoes are grown on a small-scale, while the majority of fields is sown to two or three 'proven' cultivars. Once a new cultivar is obtained, a few tubers are planted by farmers in a kitchen garden or a short row along a field boundary. This simple experiment they call a *prueba*, or trial.

Throughout the growing season, farmers monitor carefully the growth and performance of the new cultivar. If the farmer likes what he sees, then he amplifies production, restricted, of course, by the amount of seed available. Depending on the market and seed supply, they will put more and more of their land to the new cultivar. In the meantime, they maintain and replenish their 'germplasm' banks. Tubers will be counted, storability observed, processing qualities tested, culinary quality tasted, and so on. The storehouse of knowledge about cultivars is built up through such experimentation, giving farmers the ability to talk for hours about the pros and cons of different cultivars.

Another well-documented example of adaptation experiments by farmers is the well-known case of diffused light potato storage (Rhoades and Booth 1982). The basic principle that diffused light storage of potatoes, as opposed to dark storage, inhibits sprout elongation and improves overall seed quality was promoted by the International Potato Centre as a low cost solution to potato seed storage. Model demonstration stores were developed by over 25 national programs and introduced to thousands of farmers. Farmers exposed to the idea rarely copied the 'model'; rather, they adapted the principle of using diffused light to their own conditions, cultural preferences, and budgets (Rhoades and Booth 1982). Few farmers in the first year stored all of their potatoes in diffused light, preferring to test the idea on their own terms first. These initial experiments often consisted of placing a few tubers on a window sill just to see if the principle actually worked.

Experiments in the non-traditional potato zone

Peru's *ceja de selva* ('eyebrow of the jungle') is a tropical hill zone (also called the *montaña*), which links the high Andes with the lower Amazon Basin. Highland Indian and *mestizo* populations are colonising these lower elevations. Across Peru's high jungle zone, tens of thousands of settlers, such as 'El Loco,' the farmer we mentioned in the introduction of this chapter, carry out systematic experiments in an effort to define for themselves an appropriate land use and cropping patterns which will best provide for their needs. These experiments are similar in form to the literally thousands of experiments which have been conducted by farmers throughout the ages. Colonists of the high jungle bring with them their own agricultural systems/technologies and food habits to a new environment which must be understood and ultimately mastered. Experimentation, defined by Webster's Dictionary as: 'any action or process designed to find out whether something is effective, workable, or valid', is one of the fundamental strategies involved in the settlers' attempt to learn about and control their environment.

Two agroecological aspects of the Chanchamayo make it conducive for experimentation by farmers. First, the tropical hill zone is a major ecotone ('transition between two major biomes or vegetation communities') linking the Highlands and the Lowlands (see Rhoades 1978). This means that both Highland and lowland crops reach their effective limits around 1500 m (*i.e.* Highland crops, such as the potato, face more difficult growing conditions while lowland plants such as the banana or cassava face the same). Second, migrants from the Highlands come to the jungle area for land and the possibility of establishing a small plantation, primarily of coffee, tropical fruits, or coca. While their plantations are becoming established, farmers attempt, as much as possible, not only to grow their own subsistence food but also to replicate their Highland diets. Without potato, like bread in Europe or rice in Asia, the Highlander's meal is considered incomplete.

Because potatoes are relatively expensive in the local Chanchamayo market, farmers are keen to grow their own. For these reasons, experimentation with potatoes occurs on a widespread scale among Highland farmers inhabiting the ecological zone between 1000 and 1800 m. Virtually every farmer we interviewed in 1980 and living in this zone had experimented with potatoes over several seasons (Rhoades and Recharte, n.d.). Many had given up, but newcomers always tried their luck. Settlers from the Highlands, compared with farmers who have been in the area for many decades, did not initially carry with them the belief that potatoes could not be produced. In this regard, their innocence of possibilities is one of the positive points favouring creative experimentation.

Experiments in this transition zone are adaptation experiments with a crop or technology in a non-traditional environment. The challenge in this case is not to learn how a new technology fits a known system (*e.g.* new cultivars in the Highlands), but to adapt a known component or crop to an unknown environment and system. The immigrants have a knowledge of potato production but not of the new environment in which the new form of production is to take place.

The 15-member Colquechagua family, which resides in the high zone of the Colorado River, one of the tributaries of the Chanchamayo River, is a good example of how a household experiments. Among their subsistence goals is to produce enough vegetables on their land so they do not have to buy at the local market. Experimentation follows a 'start slowly, start small' pattern. They bring back from their Highland communities a few small sacks of the seed they want to try. In the first year, they brought approximately ten potato varieties: *Mariva, Revolucion*, *Renacimiento, Yungay, Huayro, Huamantay*, and several cultivars of a native type called *chaucha.* The first year they planted only a few kilos of each.

Gradually, they eliminated varieties which did not do well while doubling the amount of seed planted in the more adapted cultivars. During the first year, all *chaucha* varieties were eliminated due to their susceptibility to late blight *(Phytophtora infestans).* In the second season, *Huayro* and *Huamantay* were eliminated. This left only 'hybrids' among which two varieties, *Mariva* and *Yungay*, yielded best. After four years of experimentation, they were relying mainly on the variety *Mariva.* Small-scale experiments continued each year with newly-acquired varieties.

In addition to cultivar testing, the Colquechagua family experimented with different periods of planting. They first tried the schedule of the *sierra* planting calendar; then, they shifted to the drier season schedule. Mental notes were kept on performance, attacks of disease, insects, and rotations. Over time and with experience, they learned where and when the crop performs best.

When farmers' experiments succeed: a case study of agricultural change

Indigenous experimentation reflects important areas of interest to farmers. However, experimentation is only one part of the on-going learning process required by the farming enterprise. Adaptation to the farming environment is a continuous process with no given end-point (Bebbington 1988; Ellen 1982).

The purpose of this last section is to place experimentation within this larger context of technological change. It illustrates how perception of the environment, individual innovation, and experimentation can interact to bring about rapid technological change. However, for an experiment to be successful, the resulting innovations must survive longer-term changes. The following case traces experimentation of farmers and its subsequent impact in Oxapampa, a district located just to the north of the Chanchamayo Valley in the same high jungle ecological zone, although slightly higher in elevation. Farmers from the Highlands, who are called *serranos*, have been migrating into Oxapampa, bringing with them their 'cultural baggage' which includes beliefs about what foods taste best and what they might be able to grow. Like the Chanchamayo, therefore, Oxapampa has been a zone of intense experimentation by in-migrants.

Located at an altitude of 1800–1850 m in the valley floor, the climatic and ecological context of Oxapampa is, however, peculiarly two-faced for potato cultivation. The high rainfall and warm temperatures are extremely conducive for late blight *(Phytophtora infestans)*, a fungus capable of destroying the crop within a couple of days after summer rains if fungicides are not applied immediately. This rainfall can also be very variable from year to year (1250–3000 mm) and from month to month, and summer drought can hinder production. On the other hand, warm conditions and relatively fertile soils mean that an adapted potato or one grown under environmentally altered conditions could produce high yields in a cultivation period a month faster than in the Highlands. Return on production investment could theoretically occur in a very short time and deliver high profits.

The idea for developing potato production in Oxapampa was fostered among the *serranos*, the ethnic group culturally disposed to the crop, but not among the older settlers of European descent or the native Amuesha Indians of the region. Unlike the latter, migrants from the *sierra* were not psychologically constrained in their image of what cropping patterns were possible. Before the 1970s, potato production had been largely confined to small gardens for home consumption, but, as more and more settlers arrived from the Highlands, experiments with the crop proliferated. As in the Chanchamayo, production failed and migrants returned to the Highlands after using methods, particularly the use of planting cycles, that were appropriate for the sierra but not the high jungle. Those who stayed, however, continued to experiment with different techniques to grow their beloved potato.

In the early years of innovation, information on the results of these experiments was constantly exchanged among these Highland settlers, although, as in the Chanchamayo, no set ideal on how to cultivate potato evolved. An important figure in these patterns of information exchange was one enterprising, experimenting Highlander who served as information broker for the idea of expanded potato production. He first became a district-wide source of expertise for Highland migrants and later for the established European settlers of the region. The farmers he advised experimented consciously with cultivars of seed, types and methods of fertilization and pest control, and devised agronomic strategies that gave notable increases in yields. Because the yield increases provided visible proof of the technical feasibility of commercial production, such experiments by farmers became an important forerunner to the rapid expansion of potato cultivation that was to occur in the 1980s.

Contacts between this Highland group and the earlier colonists of European and *mestizo* descent were, however, limited and during the initial stages of experimentation the exchange of information about potato cultivation remained confined largely to the poor in-migrant group which had little ability to expand production. This began to change as innovators more socially accessible to the wealthier farmers of *mestizo* and European descent helped promote the idea of potato cultivation among this group. One such innovating unit was one migrant and his German-descended Oxapampina wife who, after planting smaller experimental plots in 1981 and 1982, planted over 20 ha in 1983. Together, these yielded remarkable profits that helped them purchase a house, car and tractor.

This evidence of the potential profitability of the potato, along with the decision of the Peruvian Agrarian Bank to lend money freely for potato production and the visits of Lima wholesale merchants to purchase potato, removed psychological, credit and demand constraints to expanded production. In sum, this prompted an explosion of potato cultivation in 1984 (Figure 22.1). This increase reflected both the entry of new producers, and the expanded acreages of existing producers. The former lacked experience on crop production and the latter entered domains for which their experiments had not prepared them. All were building on accumulated stocks of knowledge generated from experience of the economic and ecological environment, as it had been encountered up to 1984. There was no reason to expect that this experience included all pertinent dimensions of environmental variability. Moreover, should problems arise, there was no strong institutional support and assistance outside the farmers' community. Staff of the extension services and the agrarian bank and local agro-chemical dealers had little experience regarding the crop, especially in the ecological context.

All this added up to a vulnerable regional production system about which prior experimentation, although showing the technical feasibility of potato cultivation, had not taught farmers everything – in particular, the constraints and complexities of the wider and longer term marketing and production environment in which they were operating. The events of 1984, however, did reveal these constraints and shattered this vulnerable system. Three particular problems, not experienced beforehand, arose that year (Bebbington 1988):

- A late rainy season and wet summer brought severe late blight and tuber-rot problems, fungicide costs soaring as a consequence;
- The labour supply required to apply fungicides to such a large area immediately after the rains was not available when needed;
- As production costs rose, potato prices in Lima collapsed unexpectedly .

In the end, farmers suffered the worst possible combination of high production costs, low prices, and reduced yields (BAP, 1984). Fields went unharvested and widespread bankruptcy occurred. The number of ha in potatoes dropped drastically (see Figure 22.1). Farmers subsequently shifted back to livestock management and lower input, lower risk crops such as maize and beans. Today, a vastly reduced number of farmers in Oxapampa still try to produce potatoes, but with a seasoned knowledge of the technical, ecological and economic context in which they operate.

The relevance of the Oxapampa potato experience lies in its warning that experiments are only a part of the larger learning process in agricultural change. Experiments are capable of altering how a human population perceives and acts upon a farming environment, but experiments alone cannot provide the knowledge needed to implement new innovations successfully. Experimentation occurs in an economic environment that exists beyond the farm gate. This environment not only has a temporality and variability that the farmer cannot control, but also takes on new characteristics as the innovation is more widely adopted. Furthermore, experimentation occurs in an ecological context, which also has dimensions of variability and whose periodicity exceeds the time during which initial experiments were undertaken.

This is equally true of experiments or demonstrations organised by agricultural research scientists. All too often, the experiment becomes, in formal research and development, both an end in itself or, if successful, a model upon which farmers and extension agents are expected to act. This, like potato production in Oxapampa, is 'risky business'. Experiments are the seeds of change but they are not the final harvest. Experimental research must be kept in this broader perspective.

Conclusions

Recent years have witnessed both academics and practitioners lauding and describing, farmers' knowledge (Brokensha *et al.* 1980; Barker *et al.* 1977;

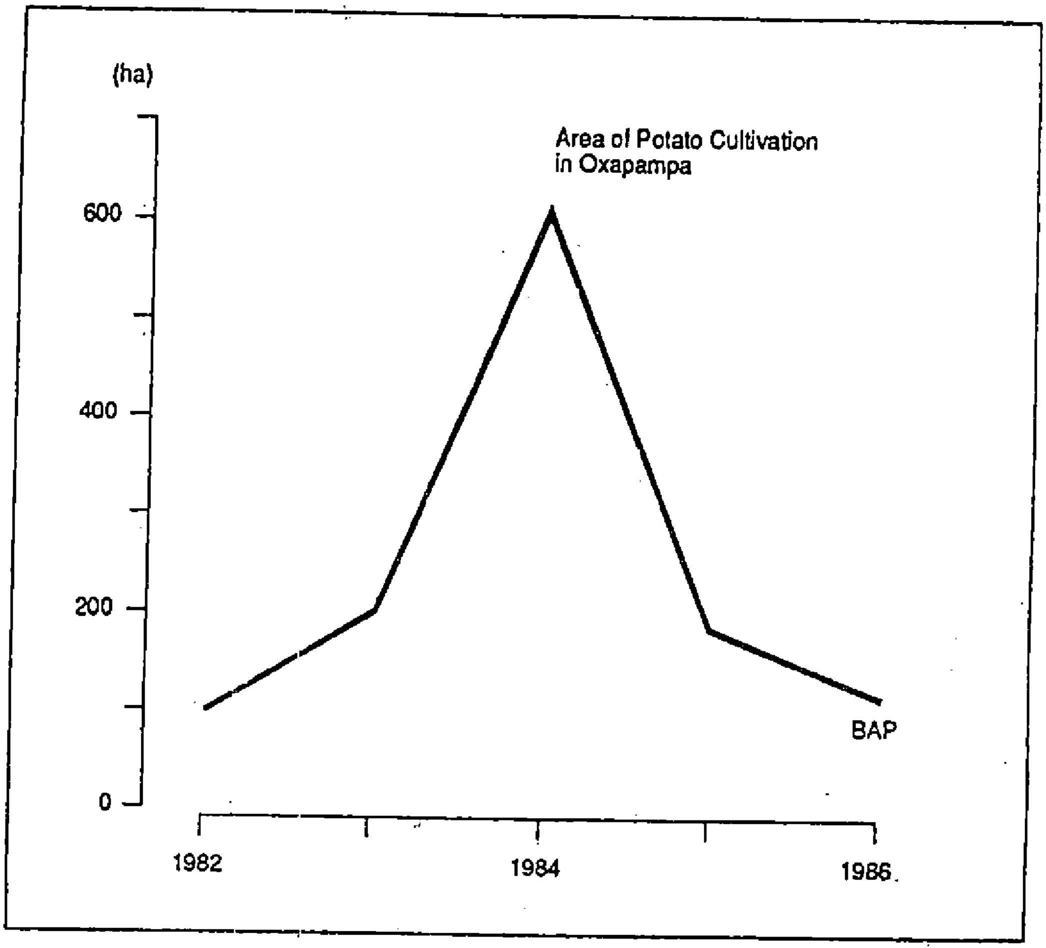

Figure 22.1: *Area of Potato Cultivation in Oxapampa*
Source: BAP (Banco Agrario del Peru), various years.
Note: 1986 area 10 July only.

Richards 1985), and making claims about the propensity of farmers to conduct experiments. However, the second claim has not been well-documented. In this chapter, we have offered empirical evidence of this propensity, and have suggested its almost ubiquity and irrepressibility.

Our extended examples have been taken from areas of considerable change ('adaptation experiments'), but we have also documented experimentation in more stable environments ('curiosity experiments' and 'problem-solving experiments'). This illustrates that such 'research' is not only the preserve of the colonist, migrant or recipient of a new technology.

The examples suggest that there is a thriving 'people's scientific community' out there, parallel to the community of formal agricultural scientists. Not all – but definitely much – of the knowledge or endeavour of the 'people's scientific community' is necessarily useful. The knowledge, and the willingness and ability to pursue it, together constitute a great resource with which agricultural science should engage. With Lightfoot *et al.* (1987), we therefore suggest that scientists should conduct cooperative research with farmers on technical issues by letting farmers participate in and, in many cases, lead experimental strategies. This is what Biggs and Clay (1989) termed a *collegial* type of farmer participation.

We dealt little with the actual design of farmers' experiments, or comparisons between them and those of formal science. Unlike scientists, farmers show limited concern with statistical proof and complicated replication. In general, their social and ecological context does not allow this. While they will conduct comparative treatments in one season, they will deal with replication by conducting experiments across several seasons. Moreover, while scientists tend to think in terms of generalisable results and laws (Norgaard 1984), we suspect farmers are much more sceptical of extrapolation and their knowledge remains more location-specific. These comments raise questions about the relationship between material context, epistemology, and experimental method.

While the discussion has been pitched primarily at the level of the experiment itself, the example from Oxapampa shows clearly that experimentation should be seen conceptually as part of a larger process. It is by experimenting that farmers learn about new environments, changing environments, and new technologies. Experimenting is thus part of a goal-oriented adaptation strategy. Nonetheless, because the social, economic and ecological environment is always changing (sometimes due to the very process of experimentation), these goals are rarely reached, and never maintained for long. As environment changes, new experiments are conducted. Thus, experimentation is just part of a broader process of agricultural change. This is true of experiments conducted not only on the farm, but those at the research station as well.

Note

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PEASANT KNOWLEDGE - WHO HAS RIGHTS TO USE IT?

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What is knowledge and who has the right to use it? Academics have their reasons, but does that mean robbing the poor? Anil Gupta poses some important reflections for himself and those of us working with farmers. What game do we play and who defines the rules?

Whose knowledge? Who defines what is knowledge? Who has rights to knowledge? Who defines these rights? These questions become crucial as the value of peasant knowledge for generating techniques of sustainable agriculture and extending the frontiers of science is increasingly recognised.

There is no term more inappropriate than 'resource-poor' when talking about knowledge-rich peasants. Consider the ethical, political and cultural biases underlying the use of this term. Disadvantaged, yes; resource-poor, no. Or only if we don't consider knowledge about micro-environmental relationships as a resource.

If peasant knowledge is a resource and if scientists recognise its usefulness, according to what rules should this resource be defined and used? For example, a multinational (or national) corporation becomes aware of a herb useful for treating a previously incurable disease. It can:

- camouflage the end use to make it difficult for other possible users to enter the resource market;

- collect the herb excessively and deplete it in its natural habitat;
- generate other ways/locations for cultivating the herb so that, if people in the original habitat become aware of its value to the corporation, business will not suffer;
- place a very low value on the local people's research (identifying the herb and how to use it) and a very high value on the corporation's research (making it into a commercial drug), rendering the drug out of reach of the people who originally conceptualised its possibilities.

And what is the residue after the resource has been used in the knowledge 'industry'? Does the local way of using the herbs lose its validity because it is traditional, superstitious, 'unscientific'? Rights to knowledge, extraction by outsiders, and the dominating knowledge systems which give validity to only certain ways of using a resource - all are part of the same problem.

Take us, for example: scientists, academics, people working in voluntary organisations, funding agencies and international consultancy systems, editors of journals, civil servants, whether national or international, i.e. the outsiders. How do we relate to peasant knowledge and the question of rights to this resource? I can deal with peasant knowledge in the following ways:

- I engage in research, systematic studies and interactions with peasants, to find technologies still in use and ones that were functional but have been discontinued. I document this information and share it with fellow professionals as an academic activity. I may also ask possible users of this knowledge, including large agribusiness companies, to support my research in return for sharing the documented knowledge with them.
- I attend international meetings and gain esteem and other career rewards without giving details about the peasants who generated the knowledge. I can thus prevent other outsiders from locating the source, validating the findings or looking into other dimensions of the local knowledge. Otherwise, I would be de-mystifying my role: revealing myself to be a mere chronicler rather than founder of a new school or faith.
- I don't mention the source of my knowledge because my professional peers ('noblemen') don't consider acknowledgement of the nameless-faceless poor to be a necessary professional act. In this case, I don't even realise that I have done anything inappropriate by not acknowledging the peasants.
- I hide behind the argument that the providers of knowledge are so numerous that it is impossible to acknowledge each one of them. I mention the study area, sometimes even the villages, but the particular individuals/groups who gave me the information remain unacknowledged.
- I want to give acknowledgement but think that the providers of knowledge don't care whether I do or not. Thus, absence of pressure not only from professional peers and gatekeepers of professional glory but also from the providers themselves makes me indifferent, lax or insensitive.
- I extract rent from the knowledge by helping set up a value-adding enterprise aimed at commercial profit. I share the due portion of the profits with my

employers, who made my study of peasant knowledge possible. In my contract they may even have denied me rights to use my findings without their consent. But there is no legal pressure on me to obtain consent from the peasant informants, so I feel no obligation to do so. I hide my rewards from the peasants, so that none of them can ask me to account for the rent I have extracted from their knowledge.

- I gain consultancies to identify and extract the conceptual insights of Third World scholars and grass-root workers about peasant knowledge and convert these insights into 'new' technologies. I treat these disadvantaged informants like the peasants. I don't acknowledge their contributions, not even how they facilitated my entry into the peasants' villages and homes. I assume it's simply the duty of a Third World public servant. I also assume that the journals in which I publish will never reach those nondescript grass-root workers.
- I make it possible, for example, that genes for resistance against a particular disease, genes that peasants preserved in a particular ecological niche, are transferred into a new marketed cultivar. I claim that this gene had no value until it was combined with other genes. It is the instrument of gene transfer which is important, not the resource: the original ideas and skills of the peasants. Rights to the instrument override rights to the resource.

  My peers judge that no injustice has been done to the providers. After all, didn't they get a new variety with a better combination of genes? When the cultivar needs replacement every other year, when terms of trade shift against the cultivators, when inputs becomes less productive because the soil nutrient balance has been disturbed, then subsidies can be demanded. The State provides these subsidies because it is difficult to withstand the combined pressures of the agribusinesses and the articulate, richer farmers who use agri-inputs. The resourceful people who provided the parent genes (often found in the most stressed environments, e.g. semi-arid, hilly or flood-prone areas) become 'resource-poor'.
- I plea for LEISA (Low-External-Input and Sustainable Agriculture), arguing that the future needs of the 'Third World' cannot be met through input-intensive, soil-depleting, pest-enhancing technologies. I re-import peasants' age-old low-external-input technologies under 'modern' labels given by well-meaning 'First Worlders'. I incorporate all this, including the labels, into official (low-budget) programmes of 'Technical Cooperation'. The peasant generators and providers of knowledge in disadvantaged rural areas remain 'resource-poor' and, thus, in need of external aid to cultivate with low external inputs.

While re-introducing LEISA (I have already been enslaved by this term) to its original inventors, I try to restore the pride of those 'irrational' resisters of change in rural areas whom I robbed in collaboration with colonial masters and post-colonial granters of professional esteem in the West. My reference point remains the same: the West.

But who said that poor people lacked pride in what they knew? If it were so, would they have maintained some of their sustainable technologies for so long? If pride has to be restored, it is my own and that of my peers in my own society.

As peasant expertise is site-specific and therefore limited in its diffusion potential, it does not lend itself to building up sociocultural institutions of rent extraction through secretiveness, private control and even manipulation, in the way that accumulation-oriented industrialisation does. On the other hand, some non-Western knowledge systems (e.g. the Ayurvedic of India) permitted, if not encouraged, local experts to retain control by family/kin over some popular recipes, i.e. over locally valued knowledge of using local resources.

If knowledge were truly a common property, the academic discussion about rights to it would be trivial. But if knowledge can be expropriated by free riders or rent seekers, rules of the game need to be evolved.

FARMERS' EXPERIMENTS AND PARTICIPATORY TECHNOLOGY DEVELOPMENT

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Experimenting is part of farming as much as tilling the soil, planting seeds and caring for animals. Yet, in many cases, the agencies established to support agricultural technology development appear to have tried to expropriate this activity from the agricultural community and reduce the farmers to simple adopters of technologies developed by others.

Certainly, the present interest in the possible contribution of farmers to formal research and extension is an improvement to the conventional Transfer-of-Technology approach. Yet, unless much more attention is given simultaneously to farmers' technology development in their own right and to outsiders' possibilities of strengthening the experimental capacity of farmers, the gap between farmers and the outside world will remain, and the potential for improvements in agricultural technology will be underutilised.

Most of the recent publications about the role of farmers in technology development (Rhoades 1987, Gips 1987, Chambers et al. 1990, Farrington & Martin 1987, McCorkle 1990, Gupta 1987) focus on the important contribution farmers can make to the work of researchers. This book is a compilation of experiences and cases in which the farmers are the main actors in the process of technology development, with outsiders playing a supportive role.

Conventional research and development

Research and technology development policies have been criticised for being misguided and resulting in technological interventions that have failed to significantly improve low-external-input farming systems, as they focused mainly on irrigated agriculture and export crops (e.g. Chambers & Jiggins 1986; OTA 1988; Arbab & Prager, this volume). In some cases, interventions have actually upset the equilibrium of the old methods of land use without producing equally balanced new systems of farming.

These problems arise because introduced technologies are often inappropriate for resource-poor farmers and herders, whether for economic, sociocultural, managerial or environmental reasons. Too often, research efforts have focused on sophisticated systems that require high levels of external inputs (e.g. hybrid varieties, irrigation, agrochemicals, machinery), not taking into account that most farmers and herders have restricted or no access to these inputs and usually cannot afford them.

The role of women in agricultural production, postharvest food processing and household chores has often been neglected, and many technical interventions have been inappropriate because they do not meet women's needs and priorities. Nonformal education for women most often covers their non-income generating activities, including home economics and nutrition, but women have limited access to training activities dealing with income-related activities such as cooperatives, agricultural production and animal husbandry. Considering the major role of women as food producers and caretakers of livestock, this is a serious failure of the system.

Another problem is that most extension services focus on providing information and inputs for export crops rather than food crops. In addition, the approaches used are generally 'top-down', with information flows supposed to be going through the extension agent to the male farmer.

Projects and extension systems in so-called 'low-resource' areas face special problems. They generally lack staff, supplies and technical support. Communication between researchers, extensionists, project staff and farmers is inadequate. There is also a lack of appropriate and profitable technologies to transfer.

Low-External-Input and Sustainable Agriculture (LEISA)

Conventional agricultural research and development methods have not led to the creation of durable agricultural systems and have not been able to increase productivity substantially in rainfed farming areas. The need for a new approach to technology development is now widely accepted: The Brundlandt Commission (WCED 1987), FAO (1983), World Bank (1986), CGIAR (1988) and many bilateral donor agencies, national governments and nongovernmental organisations (NGOs) put great emphasis on sustainability.

Although largely unperceived by mainstream agriculturalists, many farmers, sometimes supported by development workers, have been developing sustainable farming techniques. Systematic inventories in, e.g., the Philippines and Peru reveal numerous cases of farmers' experiences in site-specific agriculture, primarily based on optimal use of locally available resources (Padilla 1990; Gupta 1988; PRATEC, this volume). Also development support programmes give increasing attention to enhancing this type of agriculture, which is referred to here as Low-External-Input and Sustainable Agriculture (LEISA).

According to experience thus far, the following types of LEISA technologies show the greatest promise:

- multiple cropping, including agroforestry (Steiner 1984, Beets 1990, Gregerson et al. 1989);
- soil management methods which enhance organic matter and soil life, make use of natural processes such as N-fixation and mycorhizza, and maximise recycling (Lal 1987);
- use of improved hand tools and animal traction (Carruthers 1985);

- integration of cropping and animal husbandry including aquaculture (Bayer & Waters-Bayer 1989, FAO 1983, Lightfoot 1990);
- crop protection by natural methods (Stoll 1988);
- use of genetic diversity, including those crops and animals which are regarded as unconventional by mainstream agricultural scientists (ILEIA 1989); and
- techniques for harvesting nutrients and water (Wright 1985, Reij et al. 1988).

Conventional research basically follows a disciplinary and reductionistic approach. In order to give research greater relevance and more perspective to enhance LEISA systems, conventional agricultural research may need to be complemented with the following:

- a holistic approach, i.e. giving attention to the whole system, including rather than externalising environmental and social effects;
- a focus on processes related to synergy, complementarity and integration rather than control and specialisation;
- building on indigenous knowledge, i.e. seeing research and farm advisory services as complementary to existing farmers' knowledge, and recognising farmers' own experimentation as the motor for site-specific technology development;
- generating general principles that can enhance further development of LEISA, identifying a number of site-specific options and technologies, and increasing the understanding of the conditions under which these options could be applied.

Participatory Technology Development

In the continuum of basic/applied/adaptive research, adaptive research in tropical countries (contrary to the situation in most Western countries) generally appears to have been considered the exclusive domain of research scientists. The active role of farmers in actually developing technologies has been largely underestimated and underutilised.

Despite claims of researchers that they base their work on elaborate assessment of farmers' perceptions of constraints, despite on-farm research and farmer-first rhetorics in extension, the step to acknowledge farmers' role as technology developers in their own right has not been made by mainstream research and development organisations. Such a step would imply that, in addition to on-station research, on-farm research and extension activities, a separate domain of development intervention needs to be put in place, geared toward enhancing farmers' capacity to develop technology.

In LEISA, because of its site-specificity, farmers play a key role in technology development. The role of researchers, extensionists and NGO fieldworkers is to contribute to and improve local capacities to adjust to changing conditions through experimentation and adaptation of technologies. This approach is known under different labels such as Community-Based Experimentation and Extension or Local Management of Natural Resources. In this book, we use the term Participatory (or People-centred) Technology Development (PTD). This encompasses activities in which the farmers' experiments are supported by outsiders with the goal to increase the effectivity and effectiveness of these experiments. The outcome of PTD is twofold: locally-adapted improved technologies and improved experimental capacities of farmers. Practical field experiences reveal that impressive results can be achieved when farmers and outsiders 'join hands'. These experiences have been built up by a host of NGOs, researchers and extensionists who had the courage to challenge the conventional approach.

Participation

One of the key issues in the process of PTD is the way participation is made operational. McCall (1987) distinguishes three levels of participation:

- as a means to facilitate the implementation of external interventions;
- as a means to mediate in decision making and formulating policy about external interventions;
- as an end in itself, to empower social groups to gain greater access to and control over resources and decision making.

In practice, participation is often only used as a means to legitimate top-down approaches. In the past, local 'participation' meant that local people were expected to provide their physical labour as their contribution to projects, the outsiders' contribution being not only finance but the whole design of the project. More recently, participation has come to mean that local people also assess their own needs and priorities.

In PTD, participation implies an acceptance that people can, to a large extent, identify and modify their own solutions to their needs. It means that researchers and development workers support farmers in order to increase their capacity to manage change in their farming systems. In promoting participation in this sense, there are numerous obstacles to be overcome:

- Local government agencies and bureaucratic forces, despite their rhetoric of support, have reasons to fear local participation and may contain the threat by diversion or incorporation. Prejudices exist among professional agronomists and development workers against the assumption that rural population may have something to contribute to the development of agricultural systems.
- The majority of the rural population - women - face special obstacles: heavy labour demands prevent them from taking part in meetings; cultural restrictions prevail against appearing or speaking at open meetings; there are also socio-psychologically inflicted senses of the inferiority of women's work and interests; the majority of development workers and state personnel communicating with villagers are men, and most traditional societies have a patriarchal culture, reinforced by the colonial and postcolonial ideologies of the peasant household.
- In most countries, certain rural minorities are marginalised on grounds of their race, tribe or religion. Participation of such minorities in local-level development initiatives is resisted by the dominant groups.

The poverty of certain categories means a lack of access to, or absolute scarcity of, resources and lack of hope of any improvement. Thus, the rural population may have developed a certain strategy toward dealing with risks; risk-aversion strategies have to be taken into account.

Professionals engaged in agricultural technology development will need a great deal of creativity and endurance to identify and overcome these obstacles. This requires not only agronomic qualifications but also special social skills and socio-anthropological techniques. There will be no specific guidelines for overcoming these obstacles; the diversity of the phenomena requires a diversity of solutions.

Indigenous Knowledge

The experiences with technology development have made clear that new technologies have to be imbedded in the local society, its ecological and physical environment, its (agri-)cultural experience and its socioeconomic structures. For people who have not grown up in the local society, it is very difficult to understand the entire livelihood system in all its complexities of physical, socioeconomic and cultural interrelations and in its historical context.

In the process of technology development, knowledge of the indigenous livelihood system is an indispensable resource which is possessed and can be managed by the local community. Indigenous knowledge (IK) is not abstract like scientific knowledge; it is concrete and relies strongly on intuition, historical experience and directly perceivable evidence (Farrington & Martin 1987). IK reflects the dignity of the local community and puts them on equal footing with the outsiders involved in the process of technology development. In this way, IK is the key to participation. The participatory process of technology development based on IK provides the initial self-confidence needed to counter the fatalism of poverty and leads to some form of self-development (McCall 1987).

IK also has its limitations: Biggs and Clay (1980) mention that IK is far from uniformly distributed within or across communities. This distribution depends on:

- the capacity of individuals to manage knowledge;
- monopolisation of knowledge by different social and gender groups;
- economic stratification, as richer people use and generate other knowledge and use other skills than poorer people.

Therefore, IK cannot be manipulated independently of the social, political and economical structures within which it occurs, e.g. manipulation of the knowledge/skills of men may directly affect gender interrelations, their power base and division of resources (Fernandez 1988).

In any specific case, there are bound to be areas of knowledge and skills which exclusively belong to IK, but there are also data and concepts which local people cannot possibly have because they depend on types of experimental work which are out of reach of rural peasants. There are also domains of knowledge within IK which can be added to by 'formal scientific' research.

Farmers' experiments

Rhoades and Bebbington (this volume) state that farmers, like researchers, are experimenters. They identify three types of farmer experiments: curiosity experiments, problem-solving experiments and adaptation experiments. Modern science rests upon the foundation of at least ten millenia of informal experimentation by farmers. The experimental methods used by farmers vary widely. As they are specific to the local communities and rooted in long history, their validity and limits will vary and may be difficult to assess.

Some strengths of farmers' experiments are that:
- subjects are chosen which are relevant for the farmers;
- they start with the farmers' own knowledge and could be directed to improving the use of locally available resources;
- their results expand and deepen farmers' knowledge;
- they use criteria which are directly related to the local values related to taste and utilisation;
- the observations are made from within, as they take place during actual farmwork, and are not only based on final outcomes such as yield.

However, farmers' experiments also have their methodological limits:
- the search for improved technologies may be based on limited scientific understanding of the processes involved;
- farmers may have the tendency to use a technology over their whole field, so that comparison can only be made with a crop of a previous year or in a neighbours' field;
- farmers may attribute crop performance to one obvious factor and not see the interrelatedness of factors or the intervening effects of less observable factors because of their limited theoretical understanding of biological or other processes;
- errors in experimental design such as replication of trials may lead to injustified conclusions;
- methods of measuring and weighing may not be adequate;
- communication about the results may be limited to certain geographical areas, gender and/or socioeconomic categories.

In the final analysis, the major advantage of PTD is the combination of complementary domains of knowledge: those of the farmers and those of outsiders.

Experiences with Participatory Technology Development

From the many case studies collected for the workshop on 'Farmers and Agricultural Research: Complementary Methods' held in July 1987 at the Institute of Development Studies (Chambers et al. 1990) and the ILEIA workshop on 'Operational Approaches for PTD in Sustainable Agriculture' in April 1988, it can be concluded that there is already a wide range of PTD approaches and methods. There is a growing number of regional networks of agencies and persons engaged in this activity who exchange experiences and support each other in the further development of the approaches, methods and techniques. Some 200 cases with descriptions of practical experiences have been documented, and some of these have been outlined briefly in the matrices in ILEIA (1988). The experiences have been documented according to six categories of activities in PTD:

1) *How to get started.*
   Building up a relationship of confidence aimed at cooperation with local networks of farmers and other actors. Making a joint analysis of the existing situation, farming systems and problems.
2) *Looking for things to try.*
   Identifying indigenous technical knowledge and relevant formal knowledge. Screening and selecting topics for further development, using criteria leading to optimal use of local resources and sustainable systems of production.
3) *Design of the experiment.*
   Planning and designing experiments, based on farmers' criteria and measuring techniques, but improved with methodological suggestions of outsiders.
4) *Trying out.*
   Actual implementation of the experiments and evaluation of the results.
5) *Sharing results with others.*
   Communication of results with other local and scientific networks to scrutinise and interpret them, and to encourage others to adapt and test the results for their circumstances.
6) *Sustaining and consolidating the process of PTD.*
   Creating favorable conditions for farmers' organisations, local institutions and support at policy level. Establishing physical infrastructure and educational facilities to strengthen local experimental capacity and local management of the processes of innovation.

Some methods used in carrying out these activities and some examples are given in Table 1 and elaborated in more detail by Jiggins and de Zeeuw (forthcoming).

From the list of activities, it can be concluded that PTD is more than research. It combines the generation, testing and application of new techniques with the creation of the physical and institutional infrastructure to sustain the application and further innovation of the technology.

The descriptions range from scientist-dominated research to the support of farmer technology development entirely based on local initiative and oriented toward the farmers' needs and possibilities. The sequences of the activities undertaken vary, and rightly so. The sequence suggested by the above list of activities is an artificial one, produced only to be able to compare the many different experiences. In practice, a linear stepwise sequence does not occur; instead there are iterations, gaps and overlaps.

Table 1. *Six Steps in Participatory Technology Development*

Activity	Description	Examples of Operational Methods	Examples of Output Indicators
I Getting started	- building relationships for cooperation - preliminary situation analysis - awareness mobilisation	- organisational resources inventory - community walks - screening secondary data - community surveys - problem census & projective techniques	- inventories - protocols for community participation - core PTD network - enhanced agro-ecological awareness
II Looking for things to try	- identifying priorities - identifying local community and scientific knowledge and information - screening options, choosing selection criteria	- farmer experts workshop - techniques to tap indigenous knowledge (case histories, diagramming, preference ranking, local 'repertoire' and indicators, critical incidents - study tours - options screening workshop	- agreed research agenda - improved local capacity to diagnose a problem and identify 'options for improvement' - enhance self-respect
III Designing experiments	- review existing experimental practice - planning and designing experiments - designing evaluation protocols	- improvement of natural experimentation on 'the spot' - design workshop & prompting questions, slides/videos, case histories - testing alternative designs - farmer-to-farmer training	- experimental designs which are manageable, evaluable, reliable - protocols for monitoring and evaluation - improved local capacity to systematically design experiments

Table 1. Continued

Activity	Description	Examples of Operational Methods	Examples of Output Indicators
IV Trying out	- implementation of experiments - measurement/observation evaluation	- stepwise implementation - regular group meetings - fielddays/exchange - supporting activities	- ongoing experimental programme - enhanced local capacity to implement, monitor and evaluate experiments systematically - enlarged and stronger exchange and support linkages
V Sharing results with others	communication of basic ideas and principles, results, and PTD process - training in skills, proven technologies, and use of experimental methods	- field workshops - visits to secondary sites - farmer-to-farmer training & hands-on training	- spontaneous diffusion of ideas & technologies - enhanced local capacity for farmer-to-farmer training & communication - increasing number of villages involved in PTD
VI Sustaining the PTD process	- creation of favorable conditions for on-going experimentation and agricultural development	- organisational consolidation - development of resource materials - participatory monitoring of impacts on agri-ecological sustainability	- consolidated community networks/ organisations for agricultural self-management - resource materials - consolidated linkages with R&D institutions

Important questions to be answered

The activities related to PTD are still in a stage of development. Many questions still need to be answered as we proceed:

- *To what extent can PTD make technology development more cost-effective?*
  Most of the cases reported so far imply a high labour input from outsiders. With further development of the approach, the labour input required may diminish. Issues of cost effectiveness are very important if PTD is to be more widely applied.
- *How can PTD be institutionalised?*
  Most cases reported are project based, and many are carried out by NGOs. How can farmers' groups and organisations be encouraged to form networks for strengthening technology development? How can national agricultural research systems be encouraged to apply PTD? What will be the role of the agricultural extension services? Is the present institutional differentiation of tasks between researchers and extensionists beneficial or detrimental for applying PTD? How can organisational development and in-service training which stimulates the application of PTD be encouraged?
- *How can sustainability be built in as an important aim of PTD?* The use of local resources as such does not necessarily lead to sustainable agricultural systems. The approach offers some perspectives, but additional conditions need to be formulated and additional insights developed to ensure that new agricultural technologies coming out of the PTD process are not only based on low levels of external inputs but are also sustainable.
- *How can agricultural education and training be reformed* in such a way that the new generation of technicians will be able to communicate with farmers and understand their complex systems?

How to continue

It is advocated here that emphases in agricultural research and development be shifted away from commodity-focused or specific 'stand-alone' techniques toward the development of a more broadly based technology based on local resources and the use of linkages between components of a diversified system. In agricultural research and development, the complementarity of science-based knowledge and local knowledge must be optimised.

A change in emphasis by no means implies that present basic and on-station research should be reduced or abandoned. They should continue to play their role, inspired - in part - by questions which emerge during the PTD approach to LEISA development. Fundamental questions related to, e.g., the conditions under which linkages promote productivity and sustainability (i.e. factors explaining competition, symbiosis and synergy) require research of a type that cannot be carried out at field level alone.

If this type of research could be accomplished, assessments of the production potentials of certain agroecosystems would most likely change, and investment programmes for agricultural development could be based on different assumptions. In this way, development opportunities would be provided for areas and populations which have not benefitted to date from conventional technological innovations.

Research and extension therefore need to adopt a different set of values (Chambers 1988):

- *A philosophy of decentralisation, diversity and choice,* emphasising the primacy of what people need, want and can achieve in their environment, stressing the importance of diversity and aiming to manage diversity through decentralisation and local initiatives.
- *A new role for outsiders* as development workers who - instead of playing the role of missionaries who transfer exogenous technology - should adopt the role of convener, catalyst, colleague and consultant. The outsider convenes discussions and analysis by farm families and speeds up reactions. He or she is a colleague of farmers in their experiments and acts as a consultant who can search for and supply ideas and technologies unknown in the rural community.
- *A wider repertoire,* not a new fixed model like Transfer of Technology but rather a fluid process in which a development worker is a performer who improvises and adapts for each situation. Just as diversity of environment and farming system is recognised as positive, so diversity of repertoire in interaction with farm families is seen as necessary and beneficial.

These changes may imply that existing entities for research and extension at international, national, regional and local level will have to ask themselves about the justification of their existence, the relevancy of their programmes and their staffing policies and, on that basis, reflect on possibilities to adjust and change in a new direction. History determined, to a large extent, the existence and functioning of research and extension agencies, but the present activities and output will determine their future.

FARMERS EXPERIMENT WITH A NEW CROP

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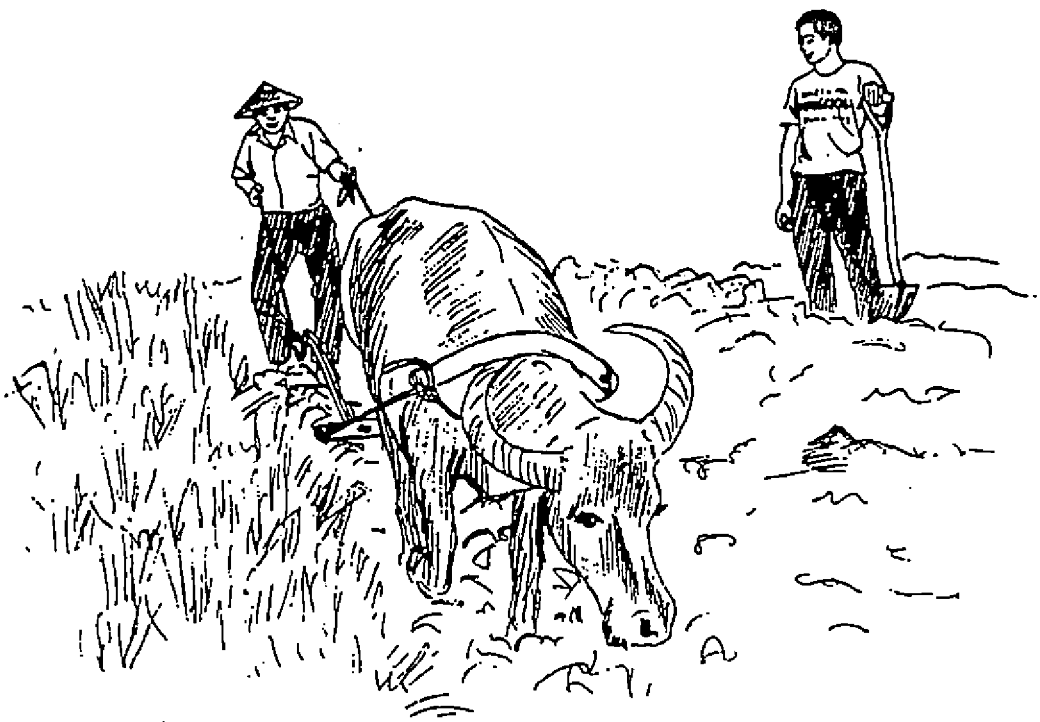

Farmers were having problems with the official wheat-growing technology until some began developing technologies of their own. It now looks as though future wheat production in Thailand will be based on their alternative technologies. John Connell tells how a 'minimalist approach to PTD' stimulated their development.

Thailand is a major rice exporter, but has no history of wheat growing. In view of rising consumption, the Government began promoting wheat in 1983, mainly in the irrigated paddy fields of the Upper North after the November/December rice harvest. The region is mountainous, and the paddy fields in small valleys and on lower hill slopes present a diverse production environment.

The recommended production technology was meant to avoid waterlogging in the paddy soils. It involved full soil preparation, raised seed beds, row seeding and furrow irrigation, but this led to problems. For instance, raised seed beds prompted farmers to irrigate by letting water flow unattended, overnight or longer, through the channels between the beds, leaving the soil completely saturated. The technology itself was viable, but would have required a long and costly training programme before it could be adopted widely by farmers.

Some of the extension agents did not promote wheat aggressively and were satisfied to enlist a few farmers interested simply in trying the new crop. These agents were also aware of alternative technologies, e.g. broadcast sowing or minimum tillage, and suggested that the farmers also try these out on small areas. In the first village where farmers started doing this, 11 of 23 farmers who tried growing wheat used a total of 12 different component technologies. With 2 varieties sown in 4 distinct soil types, a total of 24 specific interactions of technology/variety/soil-type occurred in their fields.

Two factors stimulated farmer experimentation: technical options were presented to them, inviting comparison; and plots were kept small, limiting not only the farmers' risk but also the possible monetary return, so that their initial motivation for looking at the new crop was their interest, not cash.

In the following seasons (1988/89 and 1989/90), this approach was consciously applied in 13 villages through extension workers of various government and NGO programmes, and bilaterally-funded highland development projects.

Farmer-developed technologies

At all sites, 15-50% of the farmers began investigating alternative technologies in the first year, and more in the second. Most farmers tried only one new component, but each village had at least one experimenter who compared two or more. The components investigated covered the whole range of management practices from soil preparation, through small equipment development, to irrigation. Most importantly, the technologies the farmers tried were not limited to the initial options presented. These were just the starting point.

Three key production technologies have emerged out the farmers' experiments:

- minimum tillage or direct drilling of seed into unprepared paddy soil, applicable where farmers have no access to tractors for tillage, or where weeding would be facilitated by row seeding;
- broadcasting seed onto prepared soil followed by harrowing to cover the seed, applicable where quick seeding is desired and farmers have access to tillage equipment/labour;
- dibble or hill-seeding, applicable in rainfed production on sloping land, usually by minority hill-tribe farmers.

Farmers in separate areas have converged toward these technologies with little outside influence on their decisions. While the main technologies have crystallised, farmers are still evaluating and modifying them. In one village, for example, farmers have used six harrowing methods, giving different seed cover and seed depth.

Limits to farmers' technology development

Some limits to this unguided process of technology development could be seen. The farmers' evaluation of the technologies was hampered by their tendency to use the chosen technology over their whole field so comparison could be made only with the crop in a previous year or in a neighbour's field. The farmers often attributed crop performance to the most obvious difference in technologies, e.g. broadcasting vs row seeding, when some other factor such as irrigation practice actually had greater effect on yield.

An attempt was made to overcome this analytical weakness of the farmers. In a post-harvest meeting in one village, the farmers counted the number of people whose yields fell into each of four yield levels on a rough bar chart. On this basis, they discussed different management practices in relation to yields achieved. Thus, what had been learnt by individual farmers became common knowledge for the group, and factors which some farmers had not considered important were recognised.

Toward participatory extension

Despite its limitations, this approach in the Thai Wheat Programme helped identify a number of viable production technologies. With these, farmers can expect to achieve grain yields of 2.5-3.5 t/ha in irrigated areas and 0.8-1.5 t/ha under rainfed conditions. These technologies have been applied in only a few villages so far, but all extension workers growing wheat this year were informed of them in a preseason workshop. It will be interesting to see how this information is used and what technologies now appear in farmers' fields.

This approach allows a step-wise adoption of participatory extension. If participatory strategies are to be widely adopted by government agencies, they must fit into the existing bureaucracies. Much participatory work has been done with special funds and committed workers, which government agencies find difficult to replicate. The Wheat Programme's approach could be adapted and better defined to permit its use for general extension of new crops and component technologies. This approach should appeal to extension departments on purely pragmatic grounds, as a means of delivering appropriate technologies to farmers in diverse environments, and stimulating farmers to generate appropriate technologies.

Adoption of such an extension approach would not require great changes in existing procedures. It would thus give extension departments experience with participatory work, preparing them to adopt more participatory strategies in the future. While the extensionists play a role in developing appropriate technologies, research institutions could then focus their scarce resources on the issues which farmers cannot handle well. The interaction between research and production could be facilitated by organising joint tours by scientists and extension workers to farmers' fields to identify any recurrent problems, and any farmers' innovations that could be added to the extension 'basket of technologies'.

Many PTD workers might regard this as a superficial attempt at participatory work with farmers. The extension-farmer contact (merely presenting technical options) may be minimal and there is little attempt to form farmers' groups. Extension workers could easily apply this approach mechanically with little of the mutual respect between extension worker and farmers that is implicit in genuine participatory interaction. Even so, the approach does have two effects:

- it stimulates farmers' latent ability to experiment, and
- it tends to modify extension workers' behaviour to be less directive.

During a visit by scientists to the first village where this approach was used, the farmers enthusiastically led them from field to field, explaining the various technologies. The scientists then went on to another village 20 km away, where the extension worker had insisted that the recommended technology be followed exactly. And the crop was indeed excellent. But here the farmers stood by shyly, somewhat concerned whether they had done the right thing with the new crop, while the scientists did the talking, making comments and suggestions for further improvements. This approach then, in leaving the final choice of technologies to farmers, injects a minimal but effective participatory content into the extension work. Thus, the farmers experience a sense of accomplishment and self-determination from their investigation and adoption of new technologies.

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Indigenous Communication and Indigenous Knowledge

PAUL A. MUNDY AND J. LIN COMPTON

Introduction

MOST DEFINITIONS OF indigenous knowledge refer to the accumulation of experience and the passing down of information from one generation to the next within a society (Wang 1982, CIKARD 1988). Yet, despite frequent expressions of concern for enculturation, little attention has been given to how knowledge is accumulated and shared within local societies. Communication is one of several processes essential for the continuity and spread of knowledge and the culture in which it is embedded.

Every society seemingly has evolved elaborate ways for transmitting information from person to person. Such indigenous communication includes the transmission of not only technical information, but also all other messages: entertainment, news, persuasion, announcements and social exchanges of every type within the expansive sweep defined by Doob (1960). This chapter deals primarily with the communication of technical information, though it will be necessary to mention other types of content also. We choose to concentrate on technical communication because this has been relatively ignored in the literature. The neglect by outsiders of the interface between indigenous knowledge and indigenous communication is despite its central place in the perpetuation of culture. This chapter describes indigenous communication and proposes a heuristic framework for studying this interface.

In the following discussion we must keep in mind the distinction between knowledge and information. Knowledge is the process of knowing, of individual cognition (Freire 1971, 1973). It resides in people. It cannot be communicated but is created in the minds of individuals as a result of each person's perceptions of the environment or through communication with others. An information sender must first encode knowledge into a form of information and transmit this. The receiver then decodes and analyses the information, forming connotations with schemata and memorised experiences and relating it to knowledge he or she already has. The receiver's verbal or other reactions form feedback, which in turn may create new knowledge in the mind of the sender. The communication process thereby enables both partners to create new knowledge in their minds.

Communication may occur without any conscious or deliberate attempt by an information sender. Observers may infer much from others' actions, dress and body language. Much childhood learning consists of imitation. Animals, plants, and inanimate objects such as stars and clouds convey much information to those able to interpret it. The receiver must similarly decode the incoming information and match it with existing knowledge.

This encoding, decoding and matching process produces 'noise' in the communication channel and results in no two people having exactly the same knowledge about anything. It also means that rural people and scientists see the same item of 'indigenous knowledge' in completely different ways. For this reason, in this chapter we are careful not to talk of the 'communication of indigenous knowledge'; rather, we talk of the 'communication of indigenous information' to refer to the process of encoding and decoding and the associated generation of new knowledge in the sender's and receiver's minds.

What is indigenous communication?

The problems of defining indigenous communication are very similar to those facing a formal definition of indigenous knowledge (*see*, for example, Swift 1979 and Howes and Chambers 1979). Gradations, overlaps and exceptions abound. Wang's (1982: 3) definition of the indigenous communication system implies that changes in technology and organisation make it difficult to draw a firm line separating indigenous from non-indigenous, or exogenous, communication: 'the communication system which existed before the arrival of mass media and formally organised bureaucratic system, and is still existing today despite changes.'

This historical perspective fits the developing world – where mass media and bureaucracies are relatively new – better than the developed world. One might argue, however, that small-circulation newsletters, telephones, personal correspondence and electronic mail in the West perform the same functions as more traditional channels in developing countries. Wang (1982: 3) goes on to list examples of indigenous communication: 'folk media such as puppet shows; folk drama; storytelling; interpersonal communication channels, including the Korean village meetings, the Chinese loaning club; or even local meeting places (community teahouse and open market). Although the primary function of these media and channels may not be communicative, together they interact with one another to form a network which constitutes the information environment of people in most of the rural areas in the Third World.' We will mention many other instances of indigenous channels in this chapter.

We can see indigenous communication as operating at different levels in society. Interpersonal communication operates primarily at the individual and small group levels. Grassroots organisations such as irrigation associations and housing cooperatives allow structured discussions involving organisation leaders and larger audiences than is possible in unstructured situations. The audiences of folk media are larger still and may involve virtually everyone in a community as well as people from outside.

Why study indigenous communication?

Indigenous communication has value in its own right It is an important aspect of culture and is the means by which a culture is preserved, handed down, responds to new situations and adapts. The erosion of indigenous communication systems by exogenous education and media endangers the survival of much indigenous knowledge.

Exogenous channels have limited range Television and newspapers are largely confined to urban areas in the Third World. Even the most widespread of exogenous channels, extension personnel and radio, fail to reach many rural people. Indigenous channels, by contrast, are ubiquitous. They are needed to convey messages to people out of the reach of exogenous channels.

Indigenous channels have high credibility Because they are familiar and are controlled locally, indigenous channels are highly credible. Audiences throughout the world often greet with scepticism or hostility messages transmitted through the externally controlled mass media.

Indigenous channels are important conduits of change Because of the above factors. Research on the diffusion of innovations has shown the importance of informal, interpersonal contacts in persuading people to adopt, or reject, innovations (Rogers 1983). Such contacts are often made through indigenous channels.

Development programmes can use indigenous communication For both information collection and dissemination. Outsiders can tap indigenous channels for information about the local situation and responses to outside initiatives. Much can be learned by attending village or organisation meetings and interviewing local individuals who have accumulated knowledge through direct experience and communication. Integrating indigenous and exogenous communication systems can strengthen both (Howes 1979): for instance, Schwabe and Kuojok (1981) propose an animal disease surveillance system using indigenous veterinarians in southern Sudan. Collaboration between the local hospital and indigenous healers in central Ghana has allowed the healers to refer patients to the hospital and vice-versa (D. M. Warren 1989).

Many projects rely on information diffusion processes to carry innovations and development messages to their intended beneficiaries. Some projects target opinion leaders and people likely to be innovators in the expectation that indigenous channels will spread the message. Others have made explicit use of indigenous channels such as folk media and village organisations.

Indigenous channels offer opportunities for participation by local people in development efforts. They allow local people to communicate among themselves and with development professionals and decision makers. Local people can retain control over more indigenous more easily than over technologically intensive media.

If ignored, indigenous communication can result in inappropriate development efforts For instance, failure to recognise the role of a network of 'water temples' in controlling irrigation in Bali, Indonesia, led to the introduction of cropping technologies and the construction of canals and dams that were not appropriate to local conditions (Cowley 1989; Lansing 1987).

Indigenous and exogenous communication compared

We may conveniently contrast indigenous communication channels with exogenous channels: mass media (radio, television, newspapers, magazines, and the like) and such bureaucratically organised networks as firms, schools, banks, postal and telephone services, agricultural extension and other government agencies.

In general, indigenous communication systems have three features: they have developed locally, are under local control, and use low levels of technology. Many indigenous communication systems share a fourth characteristic: a lack of bureaucratic organisation. However, some systems we might regard as indigenous (mosques, churches) are organised bureaucratically, while some exogenous forms (computer bulletin boards, small-circulation newsletters) are not. Despite these exceptions, we might describe exogenous systems as 'institutionally organised communication,' a phrase parallel to Compton's (1984a) term for science and technology 'institutionally organised knowledge systems'.

As with exogenous and indigenous knowledge, there is sometimes no sharp line between exogenous and indigenous communication. The two systems overlap in all four elements of the SMCR model of communication: source, message, channel, and receiver.

- While the two systems are distinguishable primarily by the *channels* used (radio, TV and the printed word vs. informal face-to-face communication and folk media), exogenous communication also makes ample use of interpersonal communication, as in extension activities and telephones.
- The *sources* often are different. Exogenous communication is originated by an outside institution such as a television or radio station, while indigenous communication derives from local people. But here too there is overlap. A television program may show a local source such as a village farmer who has adopted and benefited from a new technology, while folk media such as puppets have been widely used to convey family planning and other developmental messages designed by national governments.
- *Messages* conveyed by the two systems are sometimes similar. News and entertainment may travel through either network, for instance. However, most indigenous information flows through indigenous channels, while exogenous information typically is carried by exogenous channels. Later in this chapter we discuss exceptions to this. The smaller, more intimate audiences typical of indigenous channels mean that messages are more easily tailored to local conditions than is possible in mass exogenous channels (Wang and Dissanayake 1984: 22). Some forms are unique to exogenous communication systems (television soap operas and satellite weather forecasting, for instance) while others are found almost exclusively in indigenous systems (such as indigenous healing methods). Even here there may be mutual borrowing, though, as in a TV documentary about traditional acupuncture methods or the puppet shows about family planning mentioned above.
- The *receivers* of both types of communication also coincide, though the mass media forms of exogenous communication typically reach a much larger audience than do indigenous channels (Wang and Dissanayake 1984: 22). While television and newspapers have limited ranges, radios are common even in remote areas. And even the most highly educated urbanite still relies on indigenous communication for much information.

We discuss each of these aspects of indigenous communication in more detail below.

Indigenous communication channels

We divide indigenous communication channels into six types: folk media, indigenous organisations, deliberate instruction, records, unorganised channels, and direct observation.

Folk media Folk media are the indigenous equivalents of exogenous mass media. This broad range of art forms is used primarily for entertainment, but also is used to promote education, values and cultural continuity. They are distinguishable from indigenous organisations, the following category, because they entail a performance by an actor or actors before an audience.

Types of folk media include festivals, plays and puppet shows, dance, song, storytelling, poetry, debates such as the Filipino *balagtasan*, parades and carnivals (Valbuena 1986). These traditional forms of entertainment were thought to be in danger of being superseded by radio and television, but fears of cultural imperialism and realisation of the limitations of the mass media have sometimes led to their revival (Wang and Dissanayake 1982). This sometimes has occurred with the aid of modern broadcast media, with traditional performances, albeit somewhat changed in form, being broadcast over television and radio (Lent 1982).

Indigenous organisations and forms of social gatherings Indigenous organisations include religious groups, village meetings, irrigation associations such as Balinese *subak* (Lansing 1987), mothers' clubs and loan associations. These organisations orchestrate much communication through formal meetings of members, by messages sent about activities and obligations, and through work activities. There is inevitably overlap between this and other categories. For instance, indigenous organisations often arrange folk media performances, though performance is not usually their major aim. They provide many opportunities for unorganised communication among organisation members.

Deliberate instruction A large part of the enculturation process occurs through what C. P. Warren (1964: 10) terms 'deliberate instruction': 'an institutionalised act or set of acts performed by an individual to modify the behaviour of another individual and induce habit formation'.

Thus defined, deliberate instruction includes both 'directed learning' ('...informal acts of teaching...') and 'schooling' ('...formalised institutional activity...found only in literate societies with a few exceptions') (C. P. Warren 1964: 3-4). It includes child-rearing practices such as feeding, sphincter control and weaning, training during childhood and adolescence, as well as traditional (often religious) schools, and the instructions given by parents and other older people as a child works and plays in the fields or at home (Mosende 1981). It continues during adolescence and adulthood through initiation rites and other rites of passage, apprenticeship arrangements and the instructions given by indigenous authorities.

C. P. Warren (1964: 22) points out that the number of *agents of deliberate instruction* (those giving the training) increases as an infant grows into an adult. An infant typically receives training only from immediate kin (parents and older siblings); as the child matures, he or she interacts with larger and more diverse groups of kin and non-kin as a result of greater awareness and mobility, increasing reciprocal obligations and numbers of siblings. The relative influence of the immediate kin consequently decreases. Deliberate instruction continues after adolescence, however (C.P. Warren 1964: 6): 'any individual can learn and habituate something – an act or an idea – throughout the entire life cycle; the ability to learn is a matter of degree and is not confined to any particular phase of the life cycle.'

Despite the importance of deliberate instruction in enculturation and innovation diffusion, this topic has received little attention from development specialists. It seems that deliberate instruction is far more important in the communication of information than are occasional Indonesian *wayang kulit* puppet performances or village festivals, or even than the more ubiquitous exogenous channels of radio, television and schools.

Records Formal records – written, carved, painted or memorised – are another way of communicating indigenous information. Examples of this are the South Asian treatises on animal management written on palm leaves (FAO 1980), ancient scripts on *bai lan* leaves preserved in Thai Buddhist temples, and similar leaves containing records of land ownership and tax obligations in Bali (Geertz 1980: 179; Rupa 1985). Perhaps a study of 'indigenous librarianship' would turn up many examples of knowledge thus recorded. Such records do not have to be written. African storytellers narrate memorised historical epics and genealogies at length. Proverbs and folklore are other vehicles for transmitting cultural information.

Unstructured channels Indigenous communication occurs in many other settings: talk at home and at the well, in the fields and on the road, in the teahouse and coffee shop, in the chief's house and at the market, and wherever else people meet and talk. This communication is not organised or orchestrated but is spontaneous and informal. Communication among peer groups forms a major part of it. Folk media and indigenous organisations provide many opportunities for such unstructured communication before, during and after meetings and other activities. The importance of such channels is illustrated by the role of informal networks in Iranian bazaars in the overthrow of the Shah (Mowlana 1979).

Direct observation Doob (1960) points out that communication does not have to be intentional to take place. A farmer may see another's bumper crop and infer that the variety or technique used is good. An example of this process is given by Johnson (1983), who describes how a group of Machiguenga Indians in Peru began planting coffee after seeing others experiment with the crop. Nor does the source have to be another person. A dark cloud alerts us to a coming thunderstorm just as clearly as a verbal warning from another person could.

Indigenous communication sources

Not everyone in a society has the same indigenous technical knowledge (Swift 1979). Differences among individuals occur because of age, gender, experience, profession and personality. A person may be a highly skilled smith but know little of farming; another may be held in high esteem for her midwifery or gardening skills. In general, we can differentiate five different types of sources of information:

Indigenous experts are referred to as 'farmer paragons' by McCorkle *et al.* (1988: 71), are generally recognised as being skilled in areas such as crop or livestock raising. Everyone engaged in these activities has these skills to some degree; but the indigenous experts are sought out for advice on farming and other problems. These experts are probably opinion leaders in their specialties. Because men and women often perform different tasks, knowledge may be gender-specific or held in common by people of both sexes (Norem *et al.* 1989).

Indigenous professionals are a special type of indigenous expert with knowledge and skills not widely distributed among others in the society. This category includes healers, sorcerers, shamans, scribes, midwives, blacksmiths, irrigation-tunnel builders (in Bali) and water-temple priests who oversee irrigation systems in whole watersheds (also in Bali) (Lansing 1987). They may belong to certain clans or guilds and derive status or income from their skills, which they learn through long apprenticeships or on-the-job training. The 14 categories of indigenous veterinarians in Nepal, for instance, receive various types of training, ranging from formal government-sponsored instruction to experience and observation on the job (FAO 1984: 4-8). Non-indigenous counterparts of this group also are seen as professionals: doctors, lawyers, car mechanics and accountants; however, their knowledge and skills are based on exogenous knowledge and are acquired through formal education as well as apprenticeships.

Innovators are often considered deviants in their societies; they deliberately experiment and try out new ideas. Examples in the literature are 'Mr. Radio' and 'Mr. Researcher,' Nigerian farmers who experimented with new millet varieties (McCorkle 1988); 'El Loco,' a Peruvian farmer who successfully planted potatoes 1000 m. below the lowest elevation at which the crop normally grows (Rhoades and Bebbington 1988); and Mukibat, an East Javanese who developed and gave his name to a method of grafting hardy cassava tops onto high-yielding roots (Aumeeruddy and Pinglo 1989: 26). These innovators may develop new knowledge themselves, or they may introduce ideas they have obtained elsewhere through their frequent travels. They are a major source of the indigenous innovations that enter the society.

*Intermediaries1*who are formally designated as such. One example is the *juru arah* or herald in Balinese irrigation associations, who is responsible for informing association members about meetings and maintenance duties (Rupa 1985). Other examples are the linguists attached to West African rulers' courts (Doob 1960), town criers in West Africa, *akyeame* in Ghana and griots in francophone West Africa (McCorkle 1989a, personal communication). Non-indigenous equivalents of this group are the extension agent, interpreter and journalist – who do not originate but merely report, information.

Recipient-disseminators (Doob 1960) are informal intermediaries in the information chain. Unlike the previous category, the recipient-disseminator may receive an item of information and react to it (for instance by testing a new crop variety) before passing it on. Everyone in a communication system acts as a recipient-disseminator at some time. Recipient-disseminators who have links outside the local society are important conduits for the lateral exchange of both indigenous and exogenous innovations.

Table 7.1: Typology of the interface between knowledge and communication types

Communication systems	*Knowledge systems*	
	Exogenous	*Indigenous*
Exogenous	A. Technology transfer	C. Indigenous knowledge-based development
Indigenous	B. Diffusion; co-opting of traditional media	D. Cultural continuity and change

Information diffusion theory and network analysis provide a useful approach to studying the roles of these sources. Much indigenous communication occurs within highly homophilous groups or cliques. Such cliques facilitate efficient communication among their members but act as a barrier preventing new information from entering the clique. Boundary spanners such as bridges, liaisons and cosmopolites have links with people outside their own cliques; together with innovators, they introduce information to the network (Rogers and Agarwala-Rogers 1976).

A typology of the knowledge and communication interface

Despite the overlaps between types of communication, and corresponding problems in distinguishing indigenous from exogenous knowledge, it is helpful to think of a matrix that opposes both exogenous and indigenous types of each system (Table 7.1). The four quadrants represent the communication of each type of information through each type of channel. For ease of explanation, we deal first with the two quadrants on the diagonal (A and D) and then briefly discuss quadrants B and C.

Quadrant A: exogenous communication of exogenous information

Exogenous communication systems are used for many functions: to entertain, inform, educate, persuade and advertise. Perhaps the main channel for exogenous *technical* information in many countries is the school system. Technical information is a small part of most mass media fare; entertainment has the lion's share of most television and radio programming, while newspapers contain mainly news and advertising. The transmission of technical knowledge typically is relegated to unused time slots at inconvenient hours on the broadcast media and to the inside pages of newspapers. Books, pamphlets, newsletters and – in the developed world – magazines, are the main printed channels for technical information. The extension service is charged with delivering exogenous information to farmers through interpersonal contacts and the mass media.

This quadrant is the focus of most research in advertising and development communication. Much of the literature on agricultural technology transfer (for example, see Hornik 1988; World Bank 1985) is devoted to discovering how best to disseminate researcher-developed crop varieties and agricultural practices through the mass media and extension system. The idea behind the technology transfer strategy is to develop technologies that are clearly superior to current practices and to disseminate them through channels over which the disseminating agency has some control. Indigenous channels are seen as multipliers that will take over the dissemination process once the innovation has proven superior.

Quadrant D: indigenous communication of indigenous information

Just as exogenous information is communicated mainly by exogenous channels, indigenous information is transmitted almost exclusively through indigenous channels. But there seems to be very little in the communication literature about this topic. Most studies have concentrated on the spread of exogenous innovations rather than of locally generated information. Study of traditional communication systems has fallen largely into the realm of cultural anthropology rather than communication. But many anthropologists have not regarded the communication of technical knowledge as worthy of study, and what information there is on this topic likely is buried within ethnographies and studies devoted to other topics. There is a need to search for clues on how these communication systems work and to incorporate this knowledge into communication studies and development projects.

Information about technical knowledge forms only a small percentage of the total volume of messages in indigenous (or exogenous) communication. Other information in the realm of indigenous knowledge pertains to social organisation, actions and decision processes, values and beliefs, while entertainment, news, instructions and everyday social discourse account for the greater part of messages. Each of the six indigenous channels described earlier can carry technical messages, though some are more suited to this task than others. It seems that deliberate instruction is likely to be more important than folk media, for instance, despite the disproportionate attention the latter have received from anthropologists and communication scientists.

Technical messages may contain information, take the form of an object, or both. *Information* may be about an indigenous innovation or an item of traditional knowledge. It may relate to knowledge (cognitive domain), skills (psychomotor) or attitudes (affective). It may encapsulate the indigenous knowledge in verbal form ('plant maize on this type of soil') or may be in the form of news ('the store has some new seed' or 'the healer in the neighbouring village cured my daughter'). The distance travelled by such messages is shown by the far-flung reputations of traditional healers in Central Ghana, who attract apprentices from as far afield as Mali, Burkina Faso, Togo and Ivory Coast (D. M. Warren, personal communication).

The message also may take the form of an *object:* tools, for example, or germplasm such as seeds or cuttings. McCorkle *et al.* (1988: 38) describe how a man collected millet grains that had fallen to the ground after hearing a neighbour describe the benefits of the seed. Markets enable the exchange or purchase of such items as the orange cuttings that farmers in Central Java planted in their rice fields after the price of rice plummeted and that of oranges soared in the mid 1980s.

As Richards (1989) points out, indigenous knowledge is not static; it is constantly changing, adapting to new conditions and technologies. We can thus view indigenous knowledge, and hence messages about it, as having stable and dynamic components. The *dynamic* component arises through the introduction of innovations from outside (such as from neighbouring villages) and through the generation of innovations locally. These innovations are generated by farmers and other local people through a variety of means: deliberate experimentation, chance discoveries, or adapting practices introduced from outside. Rogers (1983) calls the last process 'reinvention'.

Intergenerational communication The *stable* component is derived from the stock of existing knowledge held in the society. This is re-created through communication from one generation to the next – the process of accumulation and passing down referred to by Wang (1982) and CIKARD (1988) and alluded to earlier in this chapter. This component has a stabilising function because it perpetuates the knowledge base of the society and serves to maintain the culture.

Much indigenous knowledge is not written but is preserved in peoples' minds, often with remarkable accuracy. Because of the failings of memory, however, it must be repeated to ensure it is not forgotten. Such repetition can take two forms: *use*, as when an indigenous professional practices his or her skills, and *communication* to others. The process of communication can thus be seen as a method of preserving the body of indigenous knowledge within a culture.

Breakdowns in intergenerational communication can have disastrous effects on culture. For instance, the Kayapó Indians in the Amazon are thought to have changed from a peaceful tribe to a number of warlike, mutually hostile groups because introduced diseases wiped out the tribe's older people, destroying the seat of culture (Posey 1987). Barth (1975) mentions a tribe in Papua New Guinea that lost most of its traditional initiation rites because all the older men died. Similar cultural destruction is occurring today in refugee camps in many parts of Africa.

Lateral communication Lateral communication is the diffusion of information, including indigenous innovations, from one area to another or among peer groups. These lateral networks bring new ideas into the culture; they are thus a *dynamic* aspect of indigenous communication. McCorkle *et al.*'s (1988) case study of the spread of indigenous innovations in Niger is one of the few studies of such mechanisms. It is possible that the same networks are active for indigenous as for comparable exogenous innovations. Techniques used in diffusion research (Rogers 1983) could be applied to the study of these networks.

Through the process of development, acceptance, adaptation, use and communication to others, both indigenous and exogenous innovations may enter the corpus of knowledge that is replicated in successive generations. The acceptance and communication of such information to the next generation within the culture are features that distinguish indigenous from exogenous knowledge.

Quadrant B: indigenous communication of exogenous information

As with indigenous technical information, any of the six indigenous communication channels may transmit exogenous messages, though some are more likely to than others. For instance, news about a successful new crop variety will spread quickly through direct observation and unorganised channels. Lent (1982) gives several examples of successful uses of indigenous opinion leaders in spreading family planning and other innovations. The spread of exogenous information and technologies through such interpersonal networks has been the focus of much of the vast literature on innovation diffusion. While most of this research has been conducted in the United States, numerous studies of innovation diffusion also have been made in Third World societies, identifying such features as opinion leadership, the importance of homophily, socioeconomic status, interpersonal networks, and so forth. Much effort has been put into identifying characteristics of key actors (innovators and opinion leaders) in order to target them for development messages (Rogers 1983).

Organised channels and folk media are also frequently coopted to spread exogenous information. Many extensionists try to use traditional organisations to spread family planning and agricultural messages. In the last two decades much attention has been given to the folk media. Kidd (1982) lists 1779 references on their conscious use to promote social change. Successful examples include Cashman's (1987) use of plays to advertise the 'fertiliser bush' (alley cropping using leguminous trees) in Nigeria and the Indonesian government's use of *wayang* puppet plays to spread family planning messages (Surdjodiningrat 1982). Kidd (1982), Lent (1982), Parmar (1975), Rangagath (1980), Valbuena (1986), and Wang and Dissanayake (1982, 1984) discuss such uses of folk media. The advantages of using these media as an element in a communication campaign include their familiarity and credibility to local people and the potential for the involvement of the audience in performances.

Two problems are evident in using folk media to spread development messages produced by others. The first is that even though in their original forms they may contain morals or substantive messages, these media carry primarily entertainment in the same way as Western mass media do. Audiences may therefore not perceive or understand the development messages included in the script (Lent 1982).

The second problem is that audiences may resent the use of traditional forms to convey development messages (Lent 1982; Diaz Bordenave 1975; Compton 1980). Because message production is outside local control, such adaptation may lead to 'domestication' ('the process whereby groups in power seek to channel and neutralise...oppressed peoples' (Freire 1973)) rather than 'liberation.' One way to avoid this is to enable local people to develop their own messages and performances, as described by Compton (1980) in the Philippines.

There is also a need to follow up the folk media campaign with practical support, as with the use of literacy workers to organise reading groups following performances by Filipino *barrio* cultural groups.

Quadrant C: exogenous communication of indigenous information

Few examples exist of indigenous information being transmitted via exogenous channels, though this has great growth potential. One example if the Foxfire Project in Georgia, in which school children collect information on traditional skills from older people in the area and public it in the form of magazines and books. Another example is the growing scientific literature on indigenous knowledge (for example, Brokensha *et al.* 1980) and the documentation efforts of Iowa State University's Centre for Indigenous Knowledge for Agriculture and Rural Development (CIKARD) and other institutions described elsewhere in this volume. A third example is the emphasis given to farming systems research in many countries, and within this, the movement toward farmer-managed research. Technology emerging from field surveys and on-farm trials is inserted into the scientific information system, and from there may filter through to the extension services or is disseminated directly to neighbouring farmers (*e.g.* McCorkle 1989b).

A major area of potential growth is in the use of exogenous communication techniques to enable farmers to learn directly about indigenous knowledge. Among the few examples of this in the developing world is *Minka*, a low-cost magazine devoted to recording and disseminating the knowledge of local farmers to other farmers in the Peruvian Andes (Altieri 1984). The 'farm tips' pages of US farm magazines and the growing number of sustainable agriculture newsletters are First World equivalents. The potential for developing research and extension systems that draw on indigenous knowledge and farmers' proclivity to experiment is enormous.

Indigenous communication: where do we go from here?

Indigenous communication has been touched on by specialists in various disciplines, including development communication, extension, sociology, cultural anthropology, education, folklore and theatre, as well as by scientists in several agricultural and health-related disciplines. Much of this work has, however, concentrated on using indigenous channels to promote exogenous innovations (quadrant B in Table 7.1). While more work is clearly needed in this area, development efforts are likely to be less effective if we continue to ignore the communication of information on indigenous knowledge (quadrants C and D). It is necessary to study communication patterns to design interventions that benefit from this knowledge. While each of the disciplines mentioned has a role to play, we believe that ethnographic methods will prove particularly useful in discovering how indigenous communication operates.

Any development strategy based on indigenous knowledge must consider the repositories of that knowledge. The benefits of integrating indigenous and exogenous specialists into a single system are illustrated by a benefit-cost analysis (Zessin and Carpenter 1985) that showed that Schwabe and Kuojok's (1981) proposal to use indigenous veterinarians as a disease surveillance system in southern Sudan was cheaper than a conventional mass-vaccination programme.

We echo Compton's (1973) plea that indigenous specialists not be regarded as paraprofessional aides to exogenous professionals. Rather, they must be seen and treated as experts in their own right, for that is what they are. Training activities for such specialists should seek to build on their existing knowledge rather than replace it with alien practices. And these specialists should be used as expert consultants to advise in the planning and implementation of development efforts.

We are deceiving ourselves if we think we can manoeuvre local people into doing what we think is best for them. Local initiative has often been neglected in the design of development efforts. Tapping indigenous communication channels can help ensure that this initiative is incorporated. An understanding of indigenous communication improves the chances of true collegial participation by local people and outsiders in such efforts.

Indigenous Knowledge as Reflected in Agriculture and Rural Development

S. OGUNTUNJI TITILOLA AND DAVID MARSDEN

THE PIONEERING WORK of Brokensha, Warren and Werner in 1980 serves as a point of departure for this bibliographical essay. A number of hitherto disparata fields of interest were brought into closer alignment through that publication; the concerns of ethnosientists and anthropologists were married with those of development administrators and agricultural economists. This alignment has been considerably strengthened over the intervening decade.

The links between agriculture, rural development and indigenous knowledge are not new. They have been at the heart of the anthropological enterprise since its inception. The evolving relationship between anthropology and other disciplines concerned with development has a more recent history. It reflects wider developments in the social and natural sciences which increasingly emphasise cross-disciplinary cooperation in an era when disciplinary specialisations themselves are being torn down. As the social sciences become more reflexive and interpretative, the old axioms no longer hold.

The reflexive search for alternative moves centre stage; alternative forms of development, alternative means of interpretation and alternative evaluations of the meaning of development which require the elaboration of alternative mechanisms for the execution of development policies. In addition, the political ideologies which clearly separated left from right and entrenched thinking behind dogmatic boundaries, are being radically re-thought.

A number of themes have become dominant in development discourse and underpin thinking across a broad spectrum of interests. All focus on a clearer understanding and intensified utilisation of indigenous knowledge systems. These include:

- Participation and decentralisation of decision-making;
- Encouragement of the private and the voluntary sectors associated with the retreat of the state;
- A focus on the poor and on disadvantaged minorities; and
- An increased concern with gender issues.

Development initiatives are prefaced with calls for 'reversals' – to put the last first, to empower the 'hitherto excluded', to break down the professional and technical barriers that mystify rather than clarify the development process, to put farmers themselves centre stage in the planting and execution of development project (Chambers 1985; Chambers and Jiggins 1987; Chambers *et al.* 1989). The problems of rural development are no longer seen to reside in the 'traditional' cultures of under-developed people, but rather in the partial and biased understandings that have emanated from the unreflexive application of a western scientific rationality, and in the results of a rapacious and selfish capitalism that has exacerbated rather than reduced inequalities. Indeed 'traditional' cultures are now seen as containing the bases for any effective development.

For all these reasons there is a heightened awareness of the central importance of indigenous knowledge systems in the construction of sustainable strategies for rural development. These should be developed from where people are rather than from where the disqualified 'experts' would like them to be. The 'blue-print' approach is giving way to a negotiated, situation-specific approach which demands a dialogue between the different parties to the interventions that are constructed in the name of development, and which recognises the important, often crucial, knowledge that the traditional recipients of development aid have to offer.

Much of the literature in this area has stressed the importance of anthropological knowledge and the use of much more qualitative methodologies as the 'top down', 'high technology' approaches to rural development are challenged (see Barlett 1980). An attempt is made here to highlight what are perceived by the authors as key texts in this realignment of interest. It is impossible to do justice to the wide variety of material that has been published over the last dozen years which bring together agriculture, rural development and indigenous knowledge systems. The present volume provides extensive proof of the richness of the research effort. It is difficult also to categorise the various contributions into discrete compartments as much of the work is cross-disciplinary and comes from a wide variety of sources – the academic community, multilateral organisations such as the World Bank and the various UN bodies, and non-government organisations, but the isolation of a number of major themes, might help in this endeavour.

Two sorts of analysis might be identified which underpin discussion of these different themes. Firstly there are those analyses which are rooted in particular disciplinary pre-occupations and which emphasise indigenous technical knowledge. Soil scientists (see Guillet, this volume), agronomists (Thurston and Parker, this volume), agroecologists (Altieri 1983), agroforesters (Gomez-Pompa 1976) and range management experts (Niamir, this volume; 1990) are utilising local knowledge to overcome problems of rural development, and devising more appropriate natural resource management methods, supported by a variety of institutions concerned with raising agricultural productivity. Their efforts build on and are supplemented by that of ethnoscientists (Juma 1988). Indigenous knowledge systems are being recovered for the elaboration of more effective irrigation management systems (Lansing 1987), for developing more effective credit systems for resource poor farmers (Moseley 1989; Cashman 1988) and for developing less harmful systems of pest control (Thurston and Parker, this volume). Secondly, there are those analyses which emphasise the construction of what has been termed 'people's science'. these latter analyses call for fundamental 'reversals' in the ways in which development projects and programs are conceived and executed. They tend to be more holistic in their interpretations and to focus on indigenous knowledge systems.

The two sorts of analyses are not mutually exclusive but, rather, proceed from different understandings of the research process and from different intellectual traditions, rooted in the natural and social sciences respectively. The former tends to be instrumental, development from a positivist western scientific tradition. The latter tends to be more interpretative, developed from a changing appreciation of the nature of knowledge and the processes surrounding its acquisition and use. It tends to be rooted in a more reflexive understanding of the partiality of the western intellectual tradition and serves as a basis for rethinking the whole nature of the development task.

As Thrupp (1989) has argued, in the legitimation of local knowledge there is a danger of 'scientising' it; merely incorporating it into pre-existing and unquestioned frame of reference and thereby enhancing the ability to appropriate it and use it as an instrument of oppression and exploitation. If the interpretive understandings of local knowledge are to be developed then this means a fundamental re-alignment of the interests of donor and beneficiaries. The recovery and utilisation of local or indigenous knowledge becomes a major instrument in the empowerment of local people (1989: 138). This is also reflected in the work of the United Nations University (see Programme on Indigenous Intellectual Creativity and Marji-Liza Swantz 1987).

Bringing the instrumental and the interpretative types of analysis into closer alignment has been a major pre-occupation of much work in the last ten years; building the links between natural and social scientists and between outsiders and insiders. This has not been easy and, although one would have thought that the systematic use of indigenous agricultural knowledge would have been regarded as a pre-requisite for the design and implementation of rural development project, this has seldom been the case.

Many efforts have been made over the last decade to address this problem, some with more success than others. Multi-disciplinary teams have attempted to construct common frames of reference that will allow them to learn from each others specialisations and there are many examples of the ways in which the incorporation of indigenous cultural values might enhance development efforts. These range over a wide variety of fields and involve a whole variety of different organisations.

In the field of Social Development, a recent compilation (Cernea 1986), serves as an introduction to the ways in which an understanding and incorporation of different cultural values and indigenous knowledge based on them can enhance the design and implementation of rural development projects. Social Development has continuously stressed the needs to take such values into account. Some early general works (Conyers 1982; Hardiman and Midgeley 1983; MacPherson 1982; Rondinelli 1983) stand out as contributions to this effort, as does the seminal article on Counter-development by Galjart (1981). The work of the Dag Hammerskjold Foundation through its Journal Development Dialogue and the dossier produced by the International Foundation for Development Alternatives have consistently provided ammunition as well as fora for those struggling to redefine the nature of development.

More recently the work of Uphoff (1986) and Korten (1987) has focused on the utilisation of local human resources and organisations as the basis for building effective development strategies. Westview and Kumarian Press have been instrumental in the publication of many works which reflect new thinking in the integration of rural development strategies with local knowledge systems.

Perhaps, the most widely known work in this general area is that of Robert Chambers and his colleagues (Chambers 1983; Chambers and Jiggins 1987) based at the Institute of Development Studies in the University of Sussex. Attempts to institutionalise reversals in thinking by putting the last first, by the application of Rapid Rural Appraisal techniques, by the development of Farming Systems Research and appropriate extension methodologies are reflected in this work. They are all underpinned by an appreciation of the importance of understanding the knowledge systems and values of the different actors in the project community.

Building on this base, the work of the International Institute for Environment and Development stands out with its sustainable agriculture programme and its Rapid Rural Appraisal Notes and its Gatekeeper series. The Agricultural Administration, Social Forestry, and Pastoral Networks established by the

Overseas Development Institute in London have provided opportunities for the publication and dissemination of much relevant research material at often early stages in its development. It has been particularly useful in disseminating the results of Farming Systems Research (see Farrington and Martin 1987).

The Development of a 'people's science' is advocated in the influential work of Paul Richards (1985). It draws on a 'populist' tradition within the social sciences while eschewing the gross over-generalisations of both the modernist and the materialist perspectives in favour of an analysis of the many ways in which sustainability has been enhanced through local experimental responses to changes in both the natural and the cultural environment. Earlier interests in what came to be known as 'eco-development' are reflected in the work of I. Sachs (1984).

The eco-development movements of the seventies extended the holistic insights derived from ecosystems research into the social world and crystallised in a concern for integrated approaches to rural development which stressed the interconnected nature of activities within the rural environment. The ecodevelopment movement has been transformed in the eighties with the growing interest in environmental issues. This is highlighted through the report of the World Commission on Environment and Development (the Brundtland Report, 1987) and the adoption of its recommendations by the World Bank in its 1988 Annual Report (Vanek 1989).

These interests take a variety of forms but all feed into a growing appreciation of the importance of indigenous knowledge, either in conserving the diversity of genetic resources, natural and cultural, or in creating the pre-conditions to enhance sustainability (Klee 1980, McNeely and Pitt 1985; Marten 1986; Riley and Brokensha 1988). Several manuals have appeared in the 1980s designed to provide the foundations for the development of sustainable human settlements which recognise the negative effects of modern intensive production methods and the complexities of natural ecosystems that are being disrupted by current practice (see Mollison's comprehensive manual on Permaculture, 1988). Central to these strategies is the commonsense knowledge of everyday interaction with the environment which is the hallmark of indigenous knowledge systems.

Recent work on sustainable agriculture focuses on the utilisation of fewer external inputs and on utilising the traditional knowledge of farmers on the assumption that their methods, having been tried and tested over generations, represent the best fits under circumstances which are often marginal, but also under conditions in which the concentrated use of chemical fertilisers, pesticides and herbicides is causing concern for human health and the long-term sustainability of agricultural practices and the environment generally. A major recent study by the National Research Council (1984), draws attention to these dangers and advocates taking advantage of naturally occurring beneficial interactions rather than relying heavily on off-farm input in the interests of greater diversity and of increased long term profitability. Traditional agricultural resource management is dealt with in the work of Carlier (1987), Dommen (1988) and Niamir (1989).

A major impetus to the utilisation of local knowledge in the development of rural areas has been given by the work of the various non-government organisations. For a variety of reasons their work has expanded considerably in the last decade and organisations like Oxfam, the Intermediate Technology Development Group (ITDG) (Garnser, this volume), and ActionAid have produced important information on ways in which the rich resources bound up in indigenous knowledge systems are being and might be more effectively utilised in the search for self-reliant and self-sustaining development. A major focus of this effort has been on enhancing participatory strategies. This focus is represented in the contributions to be found in *The Greening of Aid*.

It is complemented by the work of a number of UN organisations. The International Labour Office for example as well as the Food and Agriculture Organisation (People's Participation Programme) and the International Fund for Agricultural Development have all initiated major programmes which emphasise local self-sufficiency and the utilisation of local human resources and organisations. The Man and the Biosphere programme of UNESCO has also done important work in this area.

An associated area of work has related the whole issue of culture to that of conservation, recognising that external inputs reduce diversity and increase risk (Redclift 1984; Blaikie 1985). People themselves are the best indicators of what will or will not work, what can be sustained and what cannot.

While the language they use to express this knowledge may not be that of the western scientist, their often emotional and sometimes visionary responses to changes over which they feel they have little control need to be interpreted as significant interventions in the planning process (see *The Hidden Voice*, ZED Press).

This focus has been given a sharper edge through a concentration on gender issues and an increased recognition of the singular contributions that women make to agriculture. The hitherto ignored contributions that women have made to agricultural development is gradually being recognised and the distinctive knowledge that they have of the local environments in which they operate finally is being recognised (Moser 1979; Norem 1983; Jiggins 1986; Illich 1985). In addition gender issues are gradually being incorporated into farming systems research as more attention is given to the family as a unit of production and consumption, and attention is shifted from the farm to the people who provide the definition for that 'farm'.

An impetus to the incorporation of indigenous knowledge in research and development strategies has been given by a number of the different International Agricultural Research Centres, in particular CIMMYT, CIP, and IRRI and by ISNAR. Their work has provided the foundations for a systematic incorporation of the rich natural resources that remain part of a largely oral tradition into the international research effort aimed at maintaining diversity, developing flexible varieties for higher productivity, and building on the often complex methods and techniques employed by farmers in their pursuit of livelihood strategies (see Rhoades 1984; and the work of the Office of Technology Assessment, US Congress 1984).

In the field of agricultural extension, the seminal work of Paulo Friere in the seventies has sensitised many extensionists to the top-down nature of much extension activity and of the need to incorporate the different local and cultural perceptions of risk and acceptability into any extension scheme. A recognition that the extension process is not the one way exchange that was traditionally accepted allows for the incorporation of people's knowledge through a dialogue which enhances the development of locally conceived and locally specific solutions to problems of rural development (see Röling and Engel 1989; Compton 1989b).

THE PROBLEM CENSUS: FARMER-CENTRED PROBLEM IDENTIFICATION

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'To a child, experience is something which happens to him; to an adult his experience is who he is. So in any situation in which an adult's experience is being devalued, or ignored, the adult perceives this as not rejecting just his experience, but rejecting him as a person' (Knowles 1973).

Extension workers and agencies in developing countries are coming to accept the idea that extension is a farmer-centred process and a problem-centred process. Hence it is important for them to know how to draw upon information provided by farmers at the village level, and to involve farmers in a process that will enable them to identify and solve problems themselves in order to achieve their own goals. Such a process is an essential component of the problem-census technique, an extension method in which farmers are fully involved as a viable human resource. This article discusses the steps involved in organising and conducting a problem census.

1. HOW TO WORK WITH FARMER GROUPS

For an extension worker to work successfully with a farmer group or the larger village community, he or she must want to explore problem areas with the group but be willing to let them identify and solve problems themselves. The prerequisites for such extension worker involvement are a total trust in the farmer group and the underlying group principles that explain their behaviour, and an understanding that a farmer or village discussion group is a socially determined reference group with common goals and a frame of reference based on common attitudes and values toward many issues, including new technology.

If the extension worker can establish that there is a common interest among the farmers in meeting to discuss problems, he or she is in a position to bring them together as a cohesive group.

The extension worker should let the group complete its task without interfering. His or her major concern is with *group processes*, not with *content*. 'Group processes' refers to how the group is communicating: who talks with whom; how much each member is contributing; which members, if any, are being ignored; who is emerging as a leader; whether key information is being suppressed; and so on. Extension workers often regard this approach as an abdication of their leadership role, but they are fooling themselves. Leadership is a group characteristic - it comes from the group, not from the extension worker. It is absolutely essential to keep clear of group activities and let members get on with their job. Once the groups understand their task, they will determine the procedure to be used to accomplish it. In a problem census, the task is simply identifying and ranking problems on their farms or in the village.

2. THE PROBLEM CENSUS

Establishing a problem-census group

The discussion group may arise in several ways:

- A farmer or several farmers may approach the extension worker with a problem. He or she suggests to them that there could be more farmers likely to have the same problem.
- The extension worker can approach village leaders who are known to be influential among many farmers and point out that he or she is interested in meeting with local farmers to discuss their problems. In these cases, the worker should ask the persons contacted to check with the rest of the farm community they know (their reference group) and discuss between themselves whether it would be worthwhile to meet as a group to discuss problems. If the farmers say it would be worthwhile, they can arrange the time and place of the meeting.
- If the extension worker meets regularly with farm groups, one of these meetings can be used to conduct a problem census.

No matter which of the above approaches is used by the extension worker, the farmers must decide whether they consider it worthwhile meeting together in order to identify problems. It is pointless imposing such an idea on them without consensus (see case study).

The extension worker should ensure that the village leader knows of his or her intention to arrange a problem-census meeting. Village leaders should be involved in such meetings. It is sometimes preferable to work through the village leader in requesting farmers to meet to conduct a problem census.

It is important to involve the village leader in problem-census meetings so that he will be inclined to accept the outcome of the meeting and use his influence to carry out any decisions made there. If he is not involved in the meeting, he is certain to feel that his role as village leader has been undermined and he may resist any further efforts made by the extension worker to work with village members.

In all instances, it is for the community to decide who will attend the meeting. The usual expectation is for farmers to attend. In practice, women and children from households may also come to the meeting. Women in particular should be encouraged to participate in discussions and they should certainly be included in small-group work.

Objectives of a problem census

The objectives of a problem census are to:

- bring together a group of farmers or encourage an existing group to meet with the goal of identifying major problems in the farming system of concern to them; if the meeting is made up of a more diverse membership of villagers, their problems are most likely to extend beyond farming to matters of concern to the total village;
- create a learning situation which is farmer- or village-centred;
- identify existing attitudes and the extent to which attitudes differ between group members;
- draw on and rely on the combined knowledge and experience of group members;
- make possible a consensus on the problems that exist and their rankings;
- encourage involvement by *all* group members in group discussions to increase their motivation to share knowledge and experience and to gain new knowledge as a result.

The total output from group work far exceeds the information, experience and opinions contributed by any one person. Each group member gains from this shared experience, both in receiving new knowledge and in increased social awareness. For example, a farmer initially may consider a particular problem of paramount importance, but his view may change in favour of problems raised by other farmers. This compromise is made by many farmers, and is the first step toward group consensus.

In achieving these objectives, the extension worker has the following responsibilities:

- once the task is set for the farmers to identify problems and they have formed into a number of small groups, to leave each group to choose the direction taken in discussion to achieve this goal;
- to ensure that all participants have an equal opportunity to express views and provide knowledge inputs in group discussions;
- to act only as a facilitator, being concerned with *process* and not with the *content* of group discussion; the content is provided by participants;
- to contribute to any of the small groups only if and when asked; during the problem census, the extension worker's contributions are normally confined to clarifying to a group what their actual task is; the worker's ideas of problem areas are irrelevant at this stage and must never be disclosed;
- never to assume leadership or assume that he or she is leader. The extension worker is the 'helping hand', a facilitator who through careful structuring of the meeting ensures that the farmers work effectively toward the goal they have chosen. If the extension worker tries to impose ideas or influence the farmers he or she will probably succeed, but in doing so the meeting reverts to a pointless exercise in which farmers see no purpose in continuing since their goals cannot be fulfilled. Traditionally, the extension worker provides information to farmers but in the problem-census technique information-giving is the extension worker's least significant task.

Steps in conducting a problem census

Materials. Once the meeting date and venue have been decided, the extension worker should ensure that paper and pencils are distributed to everyone attending the meeting. He should also make available a number of felt pens and large sheets of butcher's or newsprint paper about 50 x 150 cm, so that every small group can record the outcomes of their discussions. These sheets are displayed so that everyone at the meeting can see the recorded information. They can be attached to the walls of the room with adhesive tape in order to be seen clearly. They can be collected after the meeting and saved for subsequent meetings.

Language. Local people may not be able to participate if the discussion is not conducted in their native language. As with any decision made by the meeting, the extension worker should support the group's decision about which language they prefer to use. The extension worker need not be concerned if he or she does not know the language or is not particularly competent in its use. Using the language or dialect of the village ensures that communication between farmers is much more efficient and effective and places the farmers at their ease.

Locally recognisable symbols can be substituted for words if illiteracy hinders effective communication. Obviously, an interpreter will need to be provided if the extension worker has no knowledge of the native language. It is strongly recommended that the extension worker has several helpers; each issued with clipboard, sheets of paper and pen. Each helper is allocated one or more groups (depending on total number of groups). It is his or her responsibility to translate information coming from the group(s), as it is being recorded on the newsprint paper. This work is so valuable, because the extension worker can read any group's work, in his or her own language.

Statement of task. In order to help clarify the problem-census technique, Figure 1 shows diagrammatically the various steps involved in plenary and small-group activities. It should be referred to in conjunction with the following discussion on the problem census.

At the beginning of the meeting, the extension worker explains that the meeting was organised by agreement among the farmers attending, and that the intention is to identify major problems within the community. The task set by the extension worker will obviously vary from situation to situation, but a typical question would be: 'What are the most important problems you face in running your farm?' or 'What are the most important problems you face within the village community?' With the latter task it is obvious that the problems arising from the problem-census meeting will be diverse and will extend beyond the farm.

For the sake of simplicity, the remainder of this discussion on the problem census will deal only with farm problems.

Forming small groups. Once the task is clear to the members of the group, they are divided into small groups of no more than four to six people. Five is a comfortable number to work with. Larger groups are more difficult to handle, since they tend to split into cliques, thus defeating the objective of involving everyone in the task set forth at the beginning of the meeting.

When groups are forming, it is essential that the seats be arranged in circles to ensure maximum interaction among group members. If chairs are not available and people have to sit on the floor or on the ground, each small group must still be arranged in a circle.

Small groups generally form quite naturally. However, if more than six people want to belong to a particular group, the extension worker will have to ask some of them to form another group. People coming from outside the village will usually form a group of their own; although they may sometimes choose to join small groups made up of local people.

Having said this, there is nevertheless no hard and fast rule on group size. Firstly, the extension worker must not insist on members shifting out of a group, even if the group has more than six members. Also, there is a limit to the amount of groups from which information can be processed and discussed. For example, 100 participants could divide into 10 groups of 10. No one at the meeting would have time to process and discuss outcomes of 16-17 groups of six.

A major advantage in dividing a meeting up into small groups is that it reduces the adverse influence of the few members who might normally be regarded as know-it-alls: those who talk too much and tend to dominate the meeting. They impose their own views, excluding the opportunity for discussion and the representation of all views and thus make if difficult for shy members to speak up.

The use of small groups also precludes any conflict or stalemate which could occur in a plenary meeting, thus speeding up the process by which farmers can reach consensus.

Selecting group recorders. When small groups are being formed, the extension worker asks each group to select a recorder. It is the responsibility of each small group, not the extension agent, to decide which member will be recorder and reporter. The role of the recorder is to list the final set of problems that arise from group discussions. Occasionally, the recorder may also report the outcome of group discussions to the meeting.

Individuals list their problems. Make it clear to the meeting that before group discussion commences, every member of each small group must write down the problems as they see them on their own farms (or in their own village). This is done *without* discussion with other group members. About 15-30 minutes must be allocated, because this is an important starting-point for group discussions. If everybody is going to participate and make a contribution to the group discussions, each group member must consider the problems that concern him or her. In meetings where not all participants are literate, additional time will be needed so that those who can write (usually younger family members) can list the problems stated by those who cannot.

Small-group discussions. Each individual then reports his or her information to the group, which discusses all the problems presented by all members of the small group. It is up to the group to reject any information considered irrelevant to the discussion and to decide on those problems which should be recorded. If a farmer's problem is excluded by the group as relatively unimportant but he still considers it important, it must be retained on this list. The plenary meeting will subsequently decide its importance when the recorded list of problems is displayed for ranking.

At this stage, the extension worker should make sure that everyone in each small group is involved in the discussion and that nobody in any of the groups is dominating the talks to the exclusion of others. It is usual, and quite consistent with the theory of small groups, that groups have sufficient social control mechanisms to prevent such dominance from taking place, without the direct intervention of the extension worker.

There is no set rule as to how long this step in the problem census will take: it may be 30 minutes to an hour or even more. It would be unwise to suggest a time limit since groups work at their own pace and the information being obtained is most important for future decisions.

Recording group discussions. After agreeing on a list of problems, each small group records them on the large sheets of paper. When all these sheets have been completed, it will be clear to the extension worker that all the groups have completed their tasks. The extension worker will then invite each small group to display to the meeting the information recorded for that group.

If the meeting is indoors, the sheets can be attached to the walls so that everyone can see the results. If it is outside, they can be attached to the side of a truck or suspended from a line or rope by clothes-pegs. It is a good idea for the extension worker to take to each meeting several sheets of plywood or the like, just in case a meeting will be held in the open.

Reporting group discussions. It is important that everyone knows what has been written and understands it. If anyone in the plenary meeting is uncertain as to what is meant by a recorded statement, it can be clarified by the group who prepared it. It is not necessary to be able to read to participate in group work and group discussions.

Identifying common problems. Once all the problems from the groups have been read out, the extension worker can then ask the farmers to compare lists and indicate which problems are common to some or all of the small-group lists. This may take almost as much time as the group discussion, but the time spent is worthwhile. The extension worker initiates this stage in the problem census by pointing to a problem on one group's list. He or she then asks each other group, in turn, to indicate whether they have recorded essentially the same problem. Those problems which are the same or similar can be identified on the worksheets with a common number, symbol or letter of the alphabet. Under no circumstances does the extension worker make the selection or interpretation. All the work must be done by the farmer group members.

During this step in the problem census, any group can still claim that a problem they have stated should not be grouped under a common heading with others. It is normally expected that they will explain why this is the case. As these situations often arise, the whole discussion is left open and within the control of the farmers themselves.

Once the meeting has gone through all the lists and accounted for problems recorded by more than one group, the extension worker or a recorder writes down the shorter list of problems (together with the letter, number or symbol that identifies each problem), and reads them to the plenary meeting.

Placing priorities on problems. At this stage, the extension worker might conclude that the task has been accomplished because the problems have been identified, but this is not the case. The extension worker now asks the farmers to return to their small groups to consider the order of importance each group places on the short list of problems. It cannot be assumed, and usually is not the case, that every group will rank the problems they identified as most important.

Every farmer in the meeting has been exposed to new information and the problem-census technique gives him a chance to evaluate this information. As a result, the small groups may concur that the most important problem is one originally mentioned by one or only a few groups. Hence the need for ranking as an important additional group exercise. As with any group exercise, each group is allowed adequate time to discuss and rank the problems. Once small group decisions have been recorded on large sheets of paper, these are displayed so that all the farmers can see them. A simple example of ranking problems is shown in Tables 1 and 2 and relates to the case study presented later.

The extension worker can then work through these lists with the farmers, noting the extent to which any one problem is ranked as the most important by all or some of the groups. The one that has been ranked first by most groups will be regarded as the most important problem, and so on. Again, the decision rests with the farmers as to the relative ranking of these problems.

The small-group approach to problem identification provides a highly supportive atmosphere and has a unifying effect on the groups because they begin to work with a common purpose. They realise that they have problems in common with each other and that the extent of disagreement that exists between group members is not great, and certainly not insurmountable. Individual members do not feel threatened because they are not singled out to provide information to the whole meeting and they are working with people they know. All this leads to a consensus in the plenary meeting. This agreement arises because of compromise and varying shifts in the attitudes of farmers so that a decision acceptable to all farmers can be made.

Consistent with small-group theory, once the meeting agrees to take any specific action arising from the problem census, all members are committed and social mechanisms (sanctions), which normally operate in the village situation, will also be employed to ensure that all farmers attending the discussion group are committed to action.

Most problem-census meetings take about three hours. Participants become involved during the census and will continue the discussion until they are satisfied that their goal has been attained.

Problem-census technique - a visual interpretation

Figure 1 depicts the various steps used in the problem-census technique and is divided into two major sections: plenary activities and group activities. The solid boundary around all members of the meeting means that they are a cohesive group irrespective of the extent to which they may break up into small groups for discussion. In group activities, there is a solid line dividing each of the four groups. This indicates that the members of each small group confine their attention to working within that group and do not have any communication with adjoining small groups. However, all groups are enclosed by a broken line. This indicates that all small groups are accessible to the extension worker so that he or she can listen to discussions in order to know what progress is being made in any small group.

During a plenary activity, the line between each small group is broken. This means that, during discussions and feedback involving the total meeting, the small groups can remain intact or re-form as a plenary group. During plenary sessions, the communication between members of all small groups is essential.

Figure 1 shows the extension worker as central to the farmer meeting at the beginning. This represents his or her role in organising the members into small groups and setting the task to identify key problems. When the plenary group is sorting out the final ranking of problems, the extension worker is free to assist in processing information. This does not mean the extension worker tells the group a preferred ranking. He or she is there merely to assist in the process. During the whole problem census, all farmers will realise that the responsibility for making decisions has been placed entirely on their shoulders and they will not be willing to allow this responsibility to revert to the extension worker. If, at any stage during the problem census, the extension worker either writes or reports information with which the meeting does not agree, they will certainly inform him or her of this. Figure 1 also shows that there is no division between any of the group members and the extension worker at the conclusion of the meeting. Although it is acceptable to the meeting that the extension worker takes on a leadership role in the initial step of the problem census, such identity does not exist at the conclusion of the meeting.

3. CASE STUDY

This case study will give the reader some idea of the amount and quality of information that can be obtained from a problem-census meeting. This problem census was one of several held in villages in the northern region of Thailand (Crouch

1980). The village is not identified. This anonymity does not affect the validity of the case study.

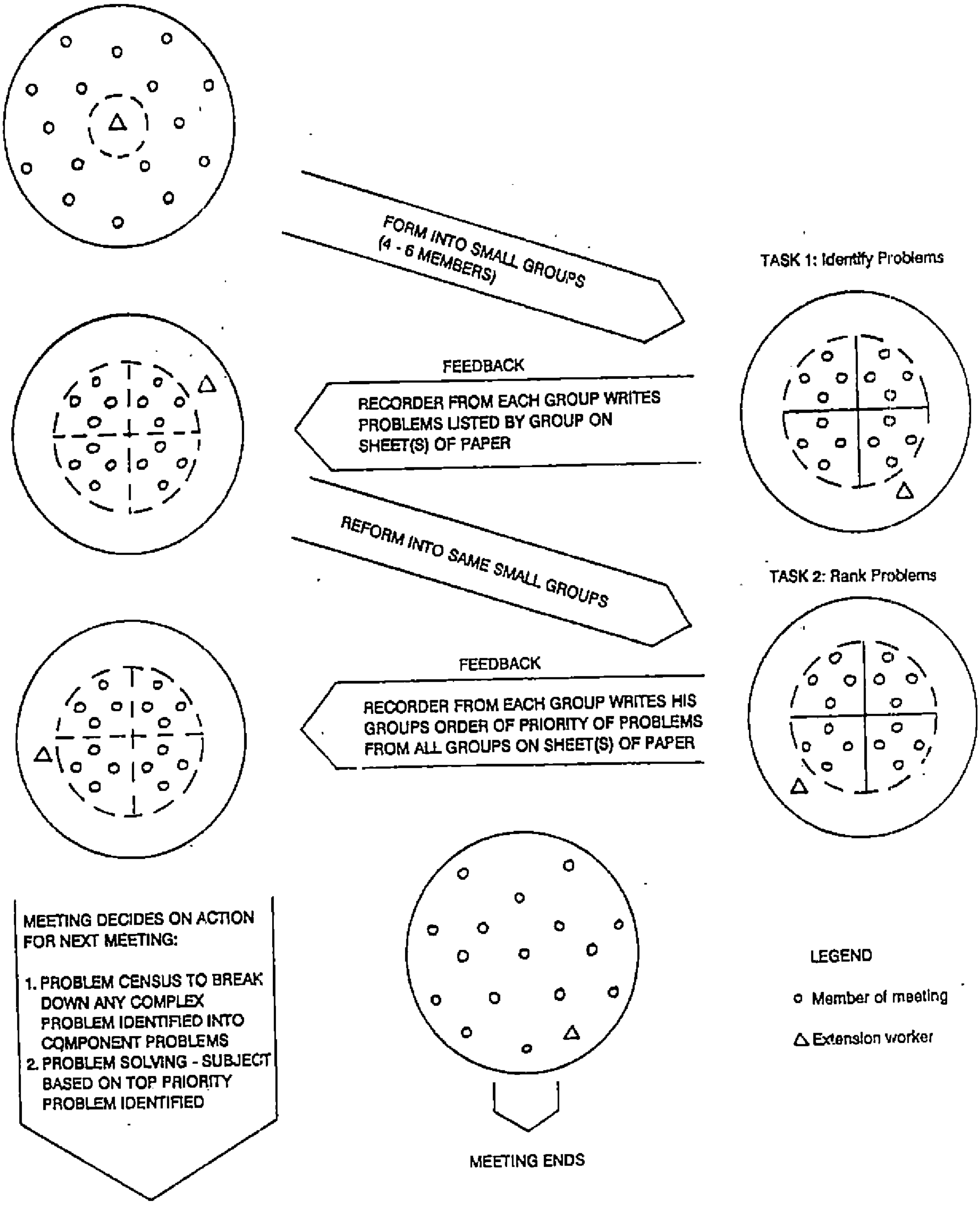

Figure 1: *Diagrammatic presentation of the problem census technique*

The problem census was arranged through a meeting with the village leader (*Kumnun*). Even at short notice, the *Kumnun* was able to contact 18 farmers who agreed to come to a meeting in his house. The problem census took 2.5 hours to complete.

As a basis for the problem census, the question was asked: 'What problems do you face in working upland farms?' Before handling this question, the 18 farmers sat in circles on the floor of the *Kumnun's* living area with 4-5 members in each group. The results of farmer discussions were written on sheets of paper and displayed on the walls of the room. These results are shown in Table 1.

Table 1: *Problems in working upland farms cited in problem census*

Problem	**No. of groups with problem**
Need direct access to upland farms from village *	4
Soil very hard to cultivate **	4
Soil lacks fertility ***	3
Soil looks poor ***	2
Lack of water at cultivation/planting	4
No money for investment ***	3
Insect damage on rice and groundnuts ***	2
No insecticides or herbicides ***	1

* Family members now travel 10 km to upland areas (6 hr/day return trip).

** Group expressed need for tractors.

*** Related problems.

Once the farmers had discussed the various problems, the small groups were asked to list what they saw as the four most important problems of the eight presented in Table 1. The result of the small-group discussions and the farmer consensus arising are recorded in Table 2.

Table 2: *Importance of problems ranked by groups*

Group	1	2	3	4
Rank				
1	Direct access	Direct access	Direct access	Direct access
2	Soils too hard	Soils too hard	Soils too hard	Soils too hard
3	Soils infertile	Lack of water	Soils infertile	Soils infertile
4	Lack of water	Soils infertile	Lack of water	Lack of water

These results show that there was no change in the importance to all groups of access to farms and the physical characteristics of soil. However, although all four groups saw lack of water as a major problem, only one group ranked this as third in importance. The other three groups remained unchanged in their belief that soil fertility (chemical characteristics of soil) was more important.

No other problems were included in this set of four main problems. The farmers' immediate problem was direct access to the farms. The next two problems related to the physical and chemical characteristics of the soil. Finally came the problem of water availability. Short of offering detailed explanations, their resolving of problems relevant to water availability and soil fertility on the farm blocks is eventually dependent on the more immediate problem of gaining access to farmland.

The outcome may appear oversimplified because of the limited time available for discussion with the farmer groups. However, the farmers' expectations and motivation were raised as they recognised their common problems and saw how they could be solved. Each problem was logically linked and could be handled one at a time.

The effort and technical input of this farmer group were commendable and disclosed more information and understanding than an extension worker could hope to achieve alone. The problems in operating rainfed farms came together and were clarified.

The farmers involved in the village claimed that the problem census was successful. It helped them to organise and put into perspective the problems identified. Their level of interest and involvement was high because it was the first time that someone had asked them to give their opinions on farming.

The problem census was conducted in the northern Thai language. Since the author lacks this language, it was hard work concentrating on what was happening during the meeting. It is emphasised, however, the lack of language was not a barrier, since the author was kept fully informed by an interpreter of the outcome of group discussions, results obtained and decisions made. Any questions and observations to the farmers were also made through the interpreter. All key information was obtained as a result of the problem census and the original intent of the meeting was also retained throughout.

4. CONCLUSIONS

The problem-census technique is a comparatively simple extension method which is both farmer-centred and problem-centred. It is a dynamic educational process aimed at changing the values and behaviour of farmers or a village community so that they can successfully adapt to continually changing situations. This goal is achieved by providing a social and learning environment acceptable to farmers.

The problem-census technique is not an end in itself. Problem-solving meetings are the logical consequences of a successfully completed census meeting. Through the problem census, extension becomes important in enabling the village community to acquire and develop problem-solving and decision-making skills. As the village community obtains these skills, it is better able to handle new problem situations without difficulty and independently of outsiders. Extension thus achieves its fundamental goal of enabling village people to become an effective and fully utilised human resource.

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PARTICIPATORY RESEARCH WITH COMMUNITY-BASED FARMERS

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The experience on which this article is based was gained within the Project for the Validation of Technologies for Highland Communities, implemented by the Small Ruminant Collaborative Research Support Program (SR-CRSP) in conjunction with the National Institute for Agricultural Research (INIAA) of Peru. Additional support was provided by the University of Missouri, Columbia and Grupo Yanapai, Huancayo. The comuneros - men and women of the region of Sincos - and the interdisciplinary field team did the actual work of searching for solutions to production problems defined by the peasant farmers.

1. THE PROJECT APPROACH

The Project for the Validation of Technology for Highland Communities was initiated in 1983 in communities on the southern side of the Mantaro Valley at an altitude of 3500 m. From the outset, it was decided that activities would be carried out on a community basis and with individual farmers only upon community approval. This decision resulted in a shift in the definition of the farm unit generally used in Farming Systems Research. The limits of the system were defined as the community, and the household was considered as a sub-unit of this.

Setting a research agenda with farmers' committees

After initial visits by the field team to the communities' elected leaders, they suggested that the following proposal be placed before the community assembly:

1) implementation of agronomic experiments, with the community, on production problems which the community identified as priorities;

2) technical support in discussing and evaluating these problems, together with provision of information and methods which would lead to the selection of useful alternatives;
3) appointment of a collaborating committee by the assembly which would be responsible, together with the field team, for planning, implementing and evaluating the experiments previously approved by the community assembly.

The decision to accept the proposal was slow in coming on the part of all communities involved. Not only did they find the approach strange in comparison to that of other projects and institutions, but they carefully considered the capability of the project to carry out a sustained effort.

Farmers who were appointed to the collaborating committees were on the whole not resource-poor in the micro-situation of the community, although they may be considered so in the context of national income. They shared common techno-productive interests and experience and a motivation to work together to overcome specific production-related problems. The committees prioritised the production problems they wished to solve. It was a challenge to the research team to balance research activities so as to include those which would show short-term results with those which required longer-term implementation periods.

Setting the research agenda was a joint effort of community farmers and project researchers. All problems to be researched were explicitly defined by the participating farmers or were directly complementary to these. For example, if a farmer group had defined external parasite control in sheep as a problem, treatments used locally (e.g. plants) as well as alternatives produced by chemical firms or generated on experiment stations were tested. Information was gathered with the farmers as to parasite control methods in use, and possibilities of selecting animals to build up flocks with greater natural resistance to the parasites were discussed. The three research areas were thus opened up by a collaborative search for solutions to the problem of external parasites in sheep.

After the research needs had been defined by the farmers in a joint effort with researchers, appropriate methods for evaluating a given technological alternative were agreed upon. During the five-year period, the research team was limited in its ability to discuss research designs with the farmer groups. The tendency was to chose a design, attempt to implement it and, if it did not work, modify it to fit the conditions under which the experiment was taking place.

All trials were implemented by community farmers. This part of the trial phase was the most successful in terms of participation. The problem which arose here was whether the participating farmer was more of a labourer than an agent in the research process as a whole. When his or her participation in the implementation phase was more that of a labourer, the understanding of the results and, therefore, the possibilities of evaluation and future selection were hindered.

Roles of the researchers

The interdisciplinary field team was made up, over the five-year period, of different combinations of researchers in the areas of crop, livestock and veterinary science, agricultural economy, anthropology, rural sociology, forestry and communication. The minimum size of the field team was three and the maximum six. The disciplines represented in the team were modified over time and responded to community research needs as well as to funding capacity.

All activities carried out by the team were considered to be interactive and complementary. Within a context of high levels of disciplinary specialisation along academic and/or technical lines, the degree of interdisciplinary interaction required by the organisation of the project often put great stress on field team members.

None of the total of 23 field team members had previous experience with interdisciplinary work and only one in five had experience with multidisciplinary biological research. Since new team members were incorporated in small numbers (one or two at a time), initial team-training activities were not possible. Orientation sessions were organised, however, where current team members shared experiences with new members, and methods of organisation and task implementation were discussed. Consciousness gradually increased among the team members that interdisciplinary collaboration and a capacity for organisation and effective communication were essential for working within the team and with the farmers.

During weekly group sessions, team members planned and evaluated their work with the farmers in identifying and prioritising problems and planning activities. Each consideration being discussed was looked at from ecological, economic, organisational and crop and animal production perspectives. Problems encountered in team interaction and organisation of tasks were also discussed. These meetings served as a kind of on-going training in both farming systems perspectives and interdisciplinary research.

The project aimed to involve farmers in all phases of the research process, including problem definition, trial design and implementation, recording and analysis of results and readjustments for future research agendas. The team was most successful in involving farmers in problem definition, trial implementation and analysis of results. Working with farmers on trial design and evaluation was found to require fundamental changes in the attitudes of researchers as well as in the methods used.

The performance of researchers in this context can be observed from two points of view: firstly, how the project conceived of our role and, secondly, what each researcher was able to do on a day-to-day basis. The methodological framework of the project defined the role of the researcher as fourfold:

- stimulater and catalyser in identifying farmers' ideas and needs;
- provider of complementary biological and methodological knowledge;
- adviser in analysing and selecting alternatives and designing trials;
- facilitater in explaining and analysing research results.

A researcher's ability to stimulate farmers' ideas is directly related to the degree s/he recognises the farmer as a capable and innovative agent operating within a specific agroecological and socioeconomic context. In Peru, this ability is influenced by historical processes which have led to community-based peasants' being viewed as the most backward group within national society.

The field team was more successful as advisers and catalysers. Experienced researchers were more capable of providing farmers with the biological knowledge not available to them through simple observation. The main problem that arose was a tendency to confuse complementary biological knowledge with technical prescriptions which were not necessarily adequate for high-altitude, rainfed, small-scale farming.

It was difficult to overcome the temptation to keep trial results in office files. Even where the team realised the importance of farmers' having access to detailed experimental results, the form that the reports took often resulted in their being filed away by the collaborating committee or the community. The team therefore saw the need to work on methods of communicating information in ways which could be better used by the farmers. This problem became more specific in communicating the results of the economic analysis of trials. Some of the team members then began designing graphs, posters and other ways of making information more easily comprehended by the farmers.

One of the most stimulating results of our research in communities was the adoption of useful technologies defined by farmers, despite our inadequacies in communicating research results. For example, 50 kg of a native variety of potato seed tested with five farmers was found to have been multiplied and distributed informally among 100 farmers over a two-year period. Farmers who obtained portions of the original yields multiplied the tubers for seed so that they could plant the variety on a larger scale.

The project team recognised that, in taking on the challenge of research with community-based farmers, it had assumed a difficult task. Few of the team members had experience working with Andean community groups. The specialised knowledge of each researcher had to be applied within the context of a production system which differed in ecological, economic and organisation terms from the systems with which most of the researchers had direct experience. It was the comuneros who had direct production experience under these conditions. Participation then became a necessity to the project. In addition, most team members had been used to looking at research problems from a disciplinary point of view and making results available to specialists rather than to small-scale farmers.

2. THE PROCESS OF DESIGNING PARTICIPATORY ACTIVITIES

Accommodating the dynamics of production systems

The project goal was adaptive research and technology validation within the context of the production process. The focus was thus on *people* involved in organised production systems. Biological research is based on an assumption that variables under study can be isolated and maintained in stable states at least over the experimental period and that external conditions can be regulated at least to the extent that they can be described and repeated for all replications. These methods can be easily applied to work with plants and animals, since they can be controlled and manipulated by humans.

As community-based farmer organisations and their agricultural production processes are in a state of constant change, social variables cannot be controlled like biological ones. A proposition made to a farmer not to treat his animals against parasites for two years in order to measure the cumulative effect of parasites on production would be immediately refused. The farmer's objective is the most efficient production possible, using the skills, knowledge and inputs available to him or her, and it makes no sense to leave animals untreated. Furthermore, it is unacceptable to a farmer to maintain production practices static for sake of comparison with another farmer who is implementing technical modifications which raise levels of productivity. Over a period of, say, three years it is probable that the farmers themselves (individually or as groups) will modify some elements of their farming system independently of project influences.

The initial challenge to the team was to carry out research within the social process of production, defining relevant problems yet controlling enough variables to measure results. Attaining this goal required modifications in the criteria according to which biological results of experiments are measured as well as in the parameters used to measure the effect of modifications on the system as a whole.

Reaching agreements about implementing experiments

When it came time to implement the experiments planned with the collaborating group, discussions centred on three points:

- which land would be used,
- who would commit the necessary labour, and
- who would provide the inputs.

The farmers' apparent unwillingness to carry out activities at this point indicated the high risk of experimentation for the community. Allocating prepared cropping areas to experiments could waste resources, especially if the yield was not satisfactory.

Furthermore, the community had little confidence in the researchers' ability to produce in the first place. If the experiments were to be carried out on communal lands, a communal 'faena' would have to be organised. This meant that farmers would have to take time and inputs away from their family production efforts. The high level of risk for the community and its individual members made it difficult to maintain group commitment to the experiments. In more than one case, the experiments were left unattended between planting and harvest, or the crop was harvested before yield could be measured.

At this point, the team decided to make two changes during the second season:

- work would be done with individual farmers on experiments requested and approved by the communal assembly, and
- the project would enter into sharecropping arrangements (*al partir*) common to the region: one farmer provides land and labour or seed while the other provides chemical inputs and labour or seed, and the harvest is divided according to each collaborator's investment.

These modifications in the adaptive research programme solved many of the problems encountered previously. On the one hand, the number of people involved in day-to-day decision making was reduced and, on the other, the investment risks were distributed. The *al partir* arrangement also permitted the project to generate its own genetic resources which, in the following season, served as a basis for the validation trials carried out at the community level.

Community-level trials ended up having two purposes for community members. Since all production on communal land is done by the community as a whole, all farmers participated in all cultivation phases. This meant that all took part in the fertiliser and pesticide management activities, which served as a group training effort. When the harvesting was done, the communities decided that the product should not be sold, but rather used as a basis for seed production which would, in subsequent seasons, be distributed among the individual farmers to improve the quality of seed on their own farms.

This alternative, developed by the farmers themselves, guaranteed a horizontal interaction between individual and group interests, on the one hand, and between research and action, on the other. As a result, organisation and technology were integrated so that community and individual as well as research and application processes complemented each other.

Although the collaborating committees had been rather shaky organisational structures when their only purposes were problem definition and experimentation, they gained strength as the resource management role was incorporated into their activities. It became apparent that adaptive research and validation lead increasingly to a need for group decision-making concerning technology use. The committees became active not only in defining problems for research, but also in decisions as to how the technologies considered adequate could be put at the disposal of other community members.

Incorporating the livestock component into the research

Because of the way the community assembly was organised, the field team assumed that the male farmers were not only the household heads but also in charge of all agricultural activities in the community. It was puzzling, however, that - in a farming system where half the land resources were allocated for grazing and where each family possessed an average of 30 head of livestock - knowledge about animals could be so limited.

Men knew little of grazing patterns and of health and breeding practices. If the men were responsible for the production unit as a whole, they should have access to the technological knowledge related to all areas so that they can make decisions and distribute tasks adequately. If they did not have this knowledge, someone else must. This deduction led to a redefinition of the idea that women were merely the herders. At an early stage, we began to look at what the women were doing with the animals and observed that they were castrating, treating, giving supplementary feed, culling and herding. It became clear that the women were responsible for managing animal production and not only for carrying out herding tasks.

The team made a proposal to the community assemblies that women be included in the collaborating committees. It was unanimously accepted. Women were appointed on a volunteer basis and invited to the meetings. Some of the women came a couple of times but sat silently at the edge of the group while the discussion centred around problems related to crop production. Soon they stopped coming, stating that they had no time. We initially took this motive at face value and continued work on crop production priorities defined by the men.

After 18 months, the project was still unable to work systematically on the livestock component. The women were then invited to informal gatherings to discuss production problems of importance to them. Within a month, about one third of the women in each community were coming to the weekly meetings. They defined their problems in the following order of priority:

1) parasite control
2) providing supplementary fodder
3) improving natural pasture quality
4) seed selection and storage
5) adequate planting densities.

Before the first month of meetings had ended, the women's groups had requested and obtained recognition by the communal assembly. The contrast between the organisational functioning of the collaborating groups appointed by the communal assembly and the Women's Agricultural Production Committees was notable. However, these groups were formed in the second year of the project's activities, when the first hurdles of team credibility and experimental risk had been overcome. In addition, as women are the main animal-keepers and as the nutritional base for production is communal land where animals from all family herds are grazed, it is likely that group interaction is more important for experimentation and innovation adoption in livestock production than in the case of crops, where land is managed by the household.

Work was begun with the women's agricultural committees on their first priority. In group meetings, the women's knowledge about parasites and ways of controlling them was elicited and systematised. This effort permitted not only identification of technological and economic constraints but also the socialisation of available information among the participating women. Subsequently, the team parasitologist talked with the groups about the habitats and life cycles of the different parasites found in the area. Then the team went on to determine, together with the women, which available (traditional and introduced) control alternatives might prove viable in ecological, economical and organisational terms. Having screened all possible alternatives on the basis of these criteria, adaptive experiments were designed with the women, to be carried out in their herds.

To overcome the problem of maintaining control groups, experiments were carried out with farmers who were willing and able to take risks, and the nonparticipants served as control groups. Within the concept of the scientific method, this alternative is questionable, as the fact that one farmer is willing to participate and others are not may reflect differences in management conditions. To overcome this, experimental and control farmers with similar characteristics in relation to access to land and animals and family size were chosen. The control and treatment farmers could be matched rather easily in the initial agricultural season of the experiment. When the two were well matched, it was found that the control farmers soon wanted to participate in the treatment stages of the experiment.

The alternative then was to incorporate these farmers into the experimental group and incorporate other nonparticipants of the same community or of another as controls. Those of the initial experimental group and the last control group would become less similar at any given moment, and those in the experimental group would become more similar.

It became necessary to make a detailed description of the criteria used to select the matched groups over time so that, in the long run, not only the biological results but also the social conditions under which each experiment was carried out could be compared.

Farmer participation from the problem definition stage through to evaluation permitted the team to overcome some of the limitations presented by carrying out biological research within the socioeconomic situation of small-scale farming. Continued redefinition of production problems with the farmers made it possible to take changing production goals into account. By doing this, it was not necessary to understand the subtleties of these changes and, at the same time, changes in problem definition indicated the direction the new goals were taking.

3. ASSESSING THE VIABILITY OF NEW TECHNIQUES

The next challenge was to measure the viability of the new techniques and their possible effects upon the system as a whole. Criteria for assessing techniques which account for the interactions of resource (labour, land, capital) management over time and for the various production goals (cash, exchange, renewing resources, and family and community well-being) were nonexistent. In the initial phases, it was decided that the evaluation would be left up to the farmers and the team would content itself with noting the type of technique incorporated and the rate of incorporation by individuals and groups in and outside of the community. This method assumed that the farmers have the most complete knowledge of how their farming systems function and will integrate only those alternatives which complement resource management and production goals.

Over time, however, some of the criteria which the farmers used to select techniques could be identified:

- rusticity (climate, pests, diseases);
- minimum requirements for external inputs;
- multiple use value (food, fodder, sale, exchange);
- storage capacity over time;
- size of available (sale, trade) units;
- adaptability (season, space and quantity) of labour requirements.

These criteria differ substantially from those generally applied on experiment stations. In addition to yield, one of the main criteria used by on-station researchers, the farmers' criteria for evaluating potato varieties, for example, included their colour, their resistance to pests, plagues, frost and hail, their capacity for long-term storage, and their taste and texture when cooked. Grains were evaluated not only for size and colour (larger and whiter ones bring higher prices) but for the palatability of the residues as fodder.

With respect to sheep, size turned out to be important from the producer's perspective, since one animal is the smallest unit of convertible cash for momentary cash requirements. For this reason, the larger animals were not necessarily the most advantageous. Different colours and qualities of wool were used for different types of weaving, making uniformity of colour and quality less important than researchers had assumed. Resistance to parasites and infections, together with adaptability to range and fodder quality, made rustic breeds more valuable than the 'improved' ones.

4. INDICATIVE EXAMPLES OF COLLABORATIVE RESEARCH EXPERIENCE

As the field team did not have first-hand knowledge of the production technology and human organisational system of the area and in view of the communities' need to solve immediate problems, the initial phase of the field team's activities was devoted to:

1) developing a participatory process with the comuneros;
2) preliminary data collection, on the basis of which specific criteria for more systematic information gathering could be established; and
3) gaining credibility within the community, while offering basic technical services to solve immediate problems.

During the first growing season, priority was given to a community information series (programmed talks and discussions to which the whole community was invited), technical assistance, and general data collection on interrelationships between social, ecological and technical aspects of the system.

The method of data collection was based on the anthropological techniques of participant observation and descriptive recording. Each team member recorded on a daily basis the observations or incidents which were considered not to be common knowledge to team members or which would help gain more insight into the system. Three copies of the 'cards' were prepared on a small portable typewriter, one for the community file, one for the writer and one for the project office.

These 'cards' included information on various subjects such as climate, soil, vegetation, crops, livestock, use of inputs, disease treatment, labour allocation, family organisation, decision making, community action; as well as notes on crop and animal yields and on the consumption, exchange and sale of products.

During this first phase, the field team consisted of two agronomists, two veterinarians, a livestock specialist and an anthropologist. The agronomists and livestock specialist resided during three weeks of the month in the central community of the project area. The livestock specialist and the anthropologist were women.

The following short case histories indicate a few of the particular problems confronted when attempting to follow the participatory approach. It is on experiences and data such as these that the second phase of the project was planned.

Outsiders gaining credibility among farmers

The community where this incident took place was one of the first to become involved in the collaborative research. It is the central community in a group of fourteen smaller ones. Here, the others gather for livestock markets and other activities of a district nature, and traders from the higher surrounding mountain area and from the valley centres come to exchange or buy.

From the beginning, the community authorities were wary of being 'taken' again. The previous two seasons, they had prepared agricultural plots for experiments with another project that never received the necessary funding.

Eight months after the initial contact, we took part in a community assembly meeting held at the corral of the communal sheep farm. As the meeting took place during a communal work party, the number of women present was larger than usual. (When the family head cannot participate in the work parties, another member of the family is sent in his place.) The livestock specialist described the objectives of the project, the partnership agreement that could be signed and the working method proposed. Only a few of the men showed interest - the younger ones - but two women stood up in turn to state that the dry season was unusually harsh and that many of the lambs were dying. If they agreed to the project, they asked, would there not be a chance of solving some of the animal health problems? The men remained skeptical.

In response, the livestock specialist explained the problem of increased parasite incidence when nutrition is poor. She explained that most of the sheep were infested with intestinal parasites. This was causing the wool to fall out and general physical weakness, especially in the young. When the shepherdess mentioned that a lamb had just died in the corral, it was immediately suggested to dissect the carcass to see what the cause of death had been.

While the woman went to get a knife, the whole assembly gathered to see the livestock specialist at work. In front of everyone, the abdomen and then the intestines were opened to show an enormous quantity of parasites. The point was made. Standing around the specimen, the villagers decided to take part in the project and the collaborating group was named (five male comuneros who volunteered their time) in representation of the entire community.

The most important conclusion to be drawn from this incident is that any project which enters a community has to confront the comuneros' lack of confidence in outsiders. This attitude is due to many historical factors, not the least of which is the general disillusionment with government programmes which have promised much and solved little. The comuneros in their desire to better their situation have, in many cases, tried new ideas and methods suggested by specialists. Most will say half-jokingly that the 'engineer' doesn't know how to farm and can offer evidence to illustrate a lack of practical experience.

The fact that the community was finally persuaded when they observed the livestock specialists' competence at her job as well as her respect for their own concern and diagnosis in a practical situation speaks for itself. The fact that the women were highly influential in giving the specialist an opportunity to prove herself and also influenced the final decision of the villagers is not surprising, as the women have greater responsibility and therefore interest in the livestock component of the system than do the men.

Rediscovering traditional technology

A group of five collaborators gathered one morning with the livestock specialist and the veterinarian to discuss the most common diseases in the community's sheep population. A list was drawn up which included liver fluke, hydatidosis, diarrhoea, 'worms' and ectoparasites.

The main contributor to the discussion was a man who had almost no cropland and had been a shepherd on a large landholding (*hacienda*) in the area before the agrarian reform began in 1968. After reviewing symptoms and causes as the farmers saw them, an attempt was made to evaluate which of the diseases was considered the most urgent to tackle. As the discussion took place in the dry season, when forage was scarce, it was felt that the most urgent problem was parasites, which were further weakening the animals.

Dipping and dosage with veterinary products was mentioned but the group members pointed out that, although they had used these treatments until the end of the 1970s, the products were now too expensive for all but a very few families to afford. The discussion then turned to alternatives and two suggestions were made. One was the use of a 'green salt' which was said to contain copper and had been used on the *hacienda* to control internal parasites. The other was the use of a wild tobacco, locally named *utashayli*, to control external parasites. As the 'green salt' was not to be found in the community, it was thought that possibility should be left aside until the researchers and collaborators could identify the properties and source or an economical alternative.

That left the possibility of starting a trial for the control of external parasites. The young comunero who had suggested the *utashayli* explained that he had seen his grandmother use it together with black soap on horses, cows and donkeys. The leaf itself was rubbed into the animal's hide and the parasites fell off seconds later. The possibility of using the plant on sheep was discussed. The group felt that, if it were ground and diluted in water, it could be used as a dip. A day was set for the trial. The group of collaborators were responsible for collecting the plant and preparing the mixture they considered appropriate.

The group decided that, for the first trial, as many families as possible would be encouraged to bring a few of their sheep to be dipped so that they could observe the results first-hand. Careful measurements would be made of the mixture that was prepared.

On the day of the experiment, two veterinarians joined the community in observing the effect of the dip on the animals. The villagers agreed that its action was even more immediate than that of the chemical products they had used previously. In evaluating the experience, the group decided on the next steps to be taken:

1) to begin talking with all families of the community about the need for dipping all animals at the same time so that contamination could be reduced;
2) to give new impulse to the construction of the community dip (an oil drum had been used for the trial) which had already been planned;
3) to begin observing areas where *utashayli* could be found and estimate its supply so that provision could be made for protecting and multiplying the species, as present supply was probably insufficient.

The research team proposed that the properties of the plant be analysed in the laboratory, that successive experiments be carried out to verify the initial results and that the minimum concentration of *utashayli* needed to make the dip effective be determined.

This example shows that, in evaluating the possibilities of validating technologies dependent on external inputs within a peasant farming situation, it must be taken into consideration that the overall contraction of the national economy affects the smallest producer first. Here, a technology had been discarded not because of its lack of effectiveness, but because of its cost. It is an example of the exchange of an adequate or adaptable traditional technology for an input-dependent one. As a result, over a period of less than ten years, there was an extreme decline in animal health and management practices.

The recuperation of the traditional technology and its adaptation to present needs, on the basis of the comuneros' experience, has probably greatly reduced the amount of time required for developing appropriate technology through pure research. However, the alternative tested is not adequate for individual use, as the availability of the plant requires joint action by all community members to conserve the plant in the native habitat, as well as to distribute it.

Combining folk science and formal science

When the problem of internal parasites in sheep had been discussed with the community collaborators, a high incidence of liver fluke was cited. On-station researchers considered this to be endemic to the area and identified the means of control as breaking down one or more links in the life cycle of the organism.

The community members expressed the belief that the 'illness' was caused by ingestion of a small leaf found in marshy areas or along streams. They therefore kept cattle away, when possible, from areas where the leaf was found. The field team clarified that it was not the leaf itself which was responsible for the disease, but that the cysts which later developed into the parasite were to be found on vegetable-type leaves found in humid places. Being aware of the comuneros' misconception, the team included a talk on the life cycle of the liver fluke in the community information series.

The talk was prepared by a research professor, with complementary graphics, and offered consecutively in three participating communities. The three sessions were attended by mixed groups of 50-100 men, women and children. At the first meeting it became evident that, although the specialist had made great efforts to explain clearly in common Spanish vocabulary, the public had problems relating to what was expressed verbally and in the graphics. At the end of the meeting, when petri dishes were passed around with specimens of the shell in them, it became clear that people had envisioned the size of the snail to be about 10 times that of the real one. The colour terms had also been misunderstood, leading the participants to identify in their minds a benevolent snail, commonly found in the same areas, as the carrier of the liver fluke cyst.

Between the first and second session and with the aid of the community collaborators and the field team, an effort was made to identify the local vocabulary used to designate relevant plants, animals and insects in order to facilitate clearer communication of the problem. The petri dishes were passed around both before and after the second session and a size comparison was made between the real-life specimen and the graphics, to avoid the size misconception. During this second talk, the interest shown and the questions asked immediately revealed that much more was being understood.

In this example, detailed and complex knowledge of cattle anatomy and disease symptoms was exhibited by all comuneros involved in the discussion. The fact that they attributed liver fluke infestation to ingestion of a certain kind of leaf was logical, given their sources of information and observation. By taking the necessary time to understand this rationale, the team found it a simple task to make more complete information available to the comuneros.

Our attempt to explain facts and organisms not directly observable to the naked eye made us aware of the distinctness of the visual and verbal codes the comunero uses, which seriously impaired our capacity to make the information understandable. It could be inferred that in many situations, even when there is a mutual openness to exchange between researchers, extensionists and peasant farmers, this type of communication gap may be a major reason for misunderstandings or lack of confidence on both sides.

5. PROBLEMS AND IMPLICATIONS OF PARTICIPATORY RESEARCH METHODS

Implementing a research programme to develop technical alternatives for small-scale mixed farmers who produce first for subsistence and second for the market and who operate under highly variable agroecological conditions, confronts the conventional organisational structure of agricultural research. The experience gained with high-altitude community farming led the team away from 'commodity' research on sheep toward research which took into account the interactions of the various activities of the farming system which influence, directly or indirectly, small ruminant production. This shift in focus was a requirement for working with community-based farmers and came with the realisation that conventional discipline-oriented research would not solve the problems of peasant farmers.

Although different researchers may be housed in the same institute, they often work on a non-integrated research agenda. If scale-specific and adapted technology is to be designed to improve community-based farming, modifications in the organisation of research institutions, as well as in the focus of research, are required.

Participatory agricultural research is often seen to have more of a flavour of extension than of research. When farmers are involved in the research process, there is a need to orient it toward action. The difference between extension and participatory research is that, in the case of the latter, the aims are to identify problems and to test and evaluate possible alternatives together with farmers.

Working with the community farming system means working with groups of farmers. The community members make joint decisions as to project activities in the areas of identifying research problems, designing forms of implementation, and community education. The possibility of making all these efforts more efficient over time depends on the community's organisational capacity not only to decide as a group, but also to work together. It is on the basis of collective action that the community as a whole will be able to improve its productivity in the shortest time possible. The project therefore gave much attention to strengthening the organisational structure of the community.

When better organisation is a goal, positive accomplishments are a corollary. The notion of positive accomplishments is a very simple one. A group which carries out actions that are successful is willing to try another group action. An action which fails raises questions whether the effort was worth it. It might even be postulated that the progressive weakening of community organisation in the Peruvian highlands is partially the result of unsuccessful efforts on a group level. While the population of a community was small enough to sustain its members, the land redistribution system and the communal management of crop rotation were successful group accomplishments. As land pressures increased, however, even the most organised communities were unable to deal with the assignation of adequate land areas to new families and with the design of rotation plans for ever more numerous and increasingly smaller plots. The failure of the community structure to deal with these problems (and to find a viable alternative to them on a community level) has resulted in the loss of the part of the community organisational structure which dealt with these areas.

The balance between positive and negative accomplishments provides the motivation for an organisation and, in the final analysis, defines its usefulness. No one would question the greater possibilities afforded by group over individual action. The problem is how to build or, in the case of Andean communities, rebuild collective action. In a strong organisation, the balance between positive and negative accomplishments may tip toward the negative more than once without destroying it. In the case of new or recovering organisations, however, it is important that the positive accomplishments of the collectivity outweigh the negative ones. The nature of this process is a challenge to participatory research efforts. The production problems must be assessed not only for their importance within the system but also for the potential to achieve advances toward a solution within a relatively short time. Otherwise, the failure of an experiment (totally acceptable in scientific terms) may result in a loss of participation and a further weakening of the community's faith in its capability to carry out successful collective action in other areas.

It is for this reason that basic research cannot be carried out in the community situation. Furthermore, there are risks in carrying out adaptive research in communities where the research experience itself is new. Our experience shows that the most appropriate kind of initial research for communities where the organisational structure is weak is technology validation. As the organisation becomes more confident in its ability to succeed, adaptive research may then be undertaken.

In cases where adaptive research is necessary from the beginning (where appropriate technology is not available), this stage can be carried out with individual farmers with the approval of the community as a whole, as long as it remains only a step in providing the group with new information and experience. The group must become incorporated into this process as soon as possible, or there will be a tendency for the individual participators to gain an advantage over the group as a whole, resulting in further social and economic differentiation within the community. All members of an interdisciplinary team working with groups of farmers have a role in facilitating this incorporation.

In the selection of problems to be tackled, it must be kept in mind that it is easier to work in areas where the technological weight of the constraint is greater than the social one. For example, determining appropriate fertiliser levels for potato is more of a technical problem than is improving natural pasture. Applying fertiliser affects the work habits of one or two people within the household. Trials would require little more than differential application of fertiliser by these people on small areas of their plots. One growing season gives sufficient time for evaluation.

In contrast, as natural pastures are used by all households in the community and improvement requires modification in use patterns, large numbers of people (in this case, women) must be involved in the decision to carry out such an experiment. Furthermore, even if all agree to allocating land for experimental purposes, the experiment itself will require adjustment in the labour patterns of the producers who participate directly. The results of the experiment will hardly be visible over one agricultural period. This is not to say that experiments with a high social weight should be avoided, rather that group confidence in itself and commitment to solving the problem must be greater than in the case of primarily technical problems.

Doing research with community participation requires high levels of creativity and flexibility on the part of the researchers involved. It also requires a large measure of institutional flexibility, especially at the field level. Researchers must not only be willing to look at new problems, but also be able to adapt research methods to the farmers' production system and take ecological, economic and social organisational factors into account.

The researcher, as part of an interdisciplinary team, must be capable of contributing to the evaluation of dynamic social processes. Researchers must be willing to take part in a mutual learning process with the community as well as to contribute specialised information in down-to-earth language which will stimulate the process itself.

Research plans must be simple and specific enough to permit their rapid modification or adjustment to new findings as well as to unforeseen climatic and organisational factors. Research results must be analysed rapidly (before the beginning of the next farming season) and communicated in ways which are easy for the farmer to understand.

All of these requirements put new demands on the researcher as well as on the research methodology itself. The advantage, however, is the generation of information, technology and knowledge which can be quickly translated into action. In addition, in a collective effort, evaluation of and experience with methods as well as with technology permit rapid adaptation by making use of the experience and ability of whole groups of farmers. Although the educational and organisational processes of the participatory method appears time consuming, this investment pays off in more efficient technology generation. The end result is an increase in the number of farmers who gain more control over the processes required for improving their own production system and, consequently, in a reduction in their dependence on outside agencies to solve their problems.

On-farm Research and Household Economics

Allan Low

Introduction

Although there is in theory a close relationship between the two new philosophies of farming systems research and household economics, this relationship has not been sufficiently recognized or adequately developed in practice. This paper focuses on the need to orient on-farm research methodologies towards household economics concepts.

By 'on-farm research' I mean farm-level research to (1) understand farmers' circumstances, (2) generate hypotheses about how best to improve farm productivity in the near term, (3) design and test new technologies based on these hypotheses, or (4) guide station research towards the development of more relevant technologies, practices or systems.

By 'household economics' I mean the concept of household production behaviour that has its basis in the theory of consumer choice developed by Becker (1965), Lancaster (1966) and Muth (1966). This theory sees households as production/consumption units in which market goods and household resources (mainly time) are combined in a household technology to produce intermediate non-market goods ('Z goods') which are then consumed in combinations that generate maximum utility (or satisfaction or welfare) for the household.

On-farm research seeks ways of increasing farm production, for either the market or home consumption. On small African farms, crop and/or livestock production is organized within the context of the farm household, which is both a production and a consumption unit. The production of non-market goods forms an important part of household activities. In addition, a high proportion of household resources is devoted to non-agricultural, 'household production' activities such as household maintenance and child care.

If farm production is increased through technologies that use more household resources, fewer resources will be available for household production. This implies either that more farm goods will be consumed, or that the proceeds of increased farm production will be used to purchase more market goods. The appropriateness of new technologies depends not only on the extent to which they increase the productivity of household resources used in farming but also on a comparison of current production with potential future production (the investment/security aspect) and on a comparison of the subjective value of the non-market household production goods that have been foregone with the utility and/or price of the substitute goods consumed (the consumption aspect).

Logically, household economics theory and the study of intra-household processes should form an important part of on-farm research, yet this is not the case in practice. On-farm research tends to concentrate on the interactions among different farming activities. Although some attempt is made to account for the opportunity costs of time and money used in non-farm market production, little attention is given to the opportunity costs of resources used in non-farm, non-market production, investment and consumption. Moreover, the relationship between agricultural productivity and household welfare is generally perceived as a one-way process and assumed to be positive. That is, increased agricultural productivity is supposed to lead to increased household welfare. But welfare is a function of the total mix of monetary and non-monetary, tangible and intangible goods. Moreover, perceptions of welfare affect the goals of farm household members and, in turn, their allocation and management of resources. Thus, welfare is not only a function but also a determinant of agricultural productivity (Caldwell 1983). Where household welfare and the household's commitment to farming are affected by non-farm factors, such as the wage employment market, access to consumer goods and household composition, these factors become highly relevant for on-farm research aimed at generating appropriate technology.

On-farm research results are indicating the need to think more in household terms. The new household economics perspective, together with an appreciation of intra-household processes, can contribute to the effectiveness of on-farm research and help move us beyond the notion of a one-way link between farm income and household welfare.

The Consideration of Intra-Household Processes

On-farm research normally focuses sharply on the farm, with minimal consideration given to non-farm household activities and decision-making processes. Research concepts and techniques of analysis have tended to concentrate on how farmers' adoption of new technologies is influenced by natural circumstances, institutional support or cash costs and risks. Farmers' multiple objectives have been less thoroughly treated, partly because there is little theoretical basis for analyzing the multiple market and non-market objectives of a household and partly because many agricultural factors can be handled purely within the context of the farming system. The need to adjust input rates (fertilizers, plant population, etc) to fit local soil conditions or to adapt a new crop to an existing cropping system can be established without reference to non-farm activities and intra-household decision-making processes.

Taking account of farmers' multiple objectives, however, implies extending the area of analysis from the farm to the farm household and from production to consumption. This broadens the focus and complicates the analysis. Nevertheless, experience with on-farm research in Eastern and Southern Africa points towards the need to consider links between the household and the farm more thoroughly in technology generation, and suggests that there may be a case for extending the concept of on-farm research beyond the boundaries of the farm to encompass the larger farm-household unit.

Some On-Farm Research Findings

The importance of the time constraint

According to household economics theory, the time of the household's members is the basic resource of households. The opportunity cost of this resource varies over time and at any one point in time among household members of different genders, ages and skills. An implication of the theory is that time and cash are interchangeable. Time can be 'sold' to generate market or non-market goods, and it can also be 'bought' by spending cash on time-saving technologies or other inputs.

Diagnostic work in on-farm research is indicating that farmers very often compromise on crop and livestock management, not because of lack of knowledge or cash to purchase inputs, nor because inputs are not available, but because of time constraints.

Often, seemingly appropriate production-increasing innovations are not adopted because of their implications in terms of time. Commenting on the results of experimental work on livestock feeding in the Kenya Dryland Farming Research and Development Project, Tessera (1983) concluded that the rate of adoption of innovations was disappointingly slow. He observed that:

- Kenyan farmers tended to value their leisure more than the income they could earn from clearing bush to encourage good forage growth
- Most farmers grazed their crop residues *in situ*, in the knowledge that they were wasting about 40% of production by doing so. They were choosing the least laborious way of doing a job even though they knew that increased labour inputs would give a higher return
- The growing of fodder crops required additional labour and time spent by draught oxen, which the farmer could not provide if he also had to plough, plant and weed for food crop production. Thus, only a handful of farmers could be persuaded to include fodder crops in their cropping system.

Household differentiation

Household economics theory relates differences in behaviour among households to differences in their characteristics and composition and, in particular, to the way these affect the relative time values of household members. On-farm researchers generally recognize that differences in the economic and natural circumstances facing households will affect their ability to adopt new technologies. The identification of different recommendation domains (homogeneous groups of farmers) in on-farm research has tended to be based on external factors such as agro-climatic conditions and access to markets or inputs. However, as research proceeds, the importance of internal household factors in determining appropriate technology is beginning to emerge.

In Table 1, which shows data from Zimbabwe, we see that cattle owners achieved higher crop yields than non-owners. The yield differences are related to management factors. Cattle owners planted and weeded earlier, and a greater proportion of them winter ploughed and applied manure. These management differences are in turn related to internal household factors. As Shumba (1983) states:

> While non-owners and owners obtained the same absolute income from off-farm sources, this represents a much higher proportion of total income for non-owners, who have lower productive capacities in farming because of their smaller labour forces, lack of oxen and greater tendency for the household head to be away. The greater tendency for household heads to be absent in non-owning households is related to the younger age of these households. Job prospects for younger household heads are better than for their older counterparts, and wages provide a relatively low-risk means for young households to generate the necessary funds to hire cattle and purchase fertilizer. The incentive for members of non-owning households to seek wage employment is therefore quite high and, given their already smaller work forces, this further reduces time available for farm activities and contributes to the lower levels of crop management, lower yields and lower farm incomes of non-owners compared with owners.

From a household economics perspective, the influence of the domestic development cycle on the productive capacity of farm households is clear. Ox ownership is a critical factor allowing better crop husbandry, and the distribution of cattle in this society is associated with household maturity. This leads to poorer crop management by the less mature, non-owning households.

Given the relationship between cattle ownership and crop productivity and the decline of cattle in the area owing to drought and to the breakdown of health control, on-farm researchers have looked towards interventions such as improved feeding to increase the size and capacity of the draught cattle pool. However, recognition of the link between ox ownership and the household development cycle poses two questions: (1) would additional cattle be any better distributed between households? And (2) would having cattle enable less mature households with smaller work forces to practise better crop management and would the incentive to seek wage employment be sufficiently reduced to encourage them to do so?

An answer to the distribution question is suggested by the situation in neighbouring Botswana, where cattle numbers have increased at 4.7% per annum over the past decade and the average herd size has increased from 30 to 43 head. Despite this sustained increased in the size of the draught cattle pool, the proportion of households owning cattle has remained unchanged and more than 50% of farmers still do not own their own draught animals.

Women farmers

On-farm researchers in Eastern and Southern Africa have increasingly found themselves dealing with women farmers. At farmers' group meetings women invariably outnumber men. It is said that 50-70% of all farmers in Africa are women.

Table 1 Characteristics of two recommendation domains in Mangwende, Zimbabwe

	Cattle ownership	
	Owners	Non-owners
Resources:		
Family size (persons)	8.4	6.4
Farm workers	3.4	2.8
Size of holding (ha)	3.9	2.9
Area cultivated (ha)	3.6	2.1
% farms with head working away	7	13
% farms with head less than 55 years	17	42
% farms with woman head	12	30
Crop yields (t/ha):		
Maize	3.2	2.1
Groundnut	0.7	0.5
Sunflower	0.2	0.04
Income sources (Z$/year):		
Maize sales	347	168
Vegetable sales	140	84
Groundnut sales	40	26
Off-farm income	159	149
Total income	752	449

Because women everywhere are responsible for household production activities (household maintenance, child care, etc), it follows that much of the agricultural work in Africa competes with household production activities for the allocation of women's time.

On-farm researchers and farm management economists are accustomed to assessing potential interventions in terms of the labour demands of competing farm activities, and to accounting for alternative market-oriented activities by imputing an opportunity cost of time. But the demands of household production are seldom considered.

Rural household studies are beginning to highlight the large amounts of time allocated to non-farm, non-market household activities, especially by women. Often the costs of not performing some of these essential or socially necessary tasks (such as fetching water or working in a neighbour's field) would be very high and would significantly reduce the real benefits of technologies that took up the time that should have been allocated to them.

Factors affecting who does what within farm households and the number of hands available for farming clearly have significant implications for the appropriateness of new farm technology. Tessera's observations, cited above, to the effect that farmers value leisure more than gains from bush clearing, and choose the least laborious way of feeding crop residues, sacrificing higher feed production, are made in a farming systems approach that lacks a household economics perspective.

Towards a Household Economics Perspective in On-Farm Research

The application of a household economics perspective can contribute to the effectiveness of on-farm research in three areas:

- Understanding farmers' objectives and strategies
- Defining recommendation domains
- Evaluating new technologies.

Understanding farmers' objectives and strategies

On-farm research looks at technology development from the farmer's point of view. As Norman et al. (1982) suggest, understanding farmers' objectives and values is crucial to this: 'The goals and motivations of farmers, which will affect the degree and type of effort they will be willing to devote to improving the productivity of their farming systems, are essential inputs to the process of identifying or designing potentially appropriate improved technologies.'

While on-farm research recognizes that farmers have multiple objectives, these objectives are generally considered in terms of the farming system. Multiple and intercropping strategies are manifestations of farmers' multiple objectives as regards cash, preferred staple foods, food security and maximization of returns to farm resources. Non-farm and non-market objectives have been given less, if any, attention. As Behnke and Kerven (1983) state, this concentration on the farming system may have two undesirable results:

> First it may encourage researchers to think of those who farm as primarily or solely farmers, and thereby underestimate the role of non-agricultural activities in the larger household economy. Secondly, an exclusive concentration on farming may ill equip FSR to address one of the major issues in agricultural development in Africa: the withdrawal of labour from agriculture due to rural-urban migration.

In Eastern and Southern Africa farming is seldom the only source of income for rural households and in many cases it is not even the major one. Wage employment, beer brewing, handicrafts, trading and teaching are common additional sources.

While on-farm researchers are concerned with measuring and increasing farm income, farmers are concerned with stabilizing and increasing their entire welfare, much of which may come from non-farm production. Thus, in order to understand farmers' goals and objectives, on-farm researchers need to adopt a household economics perspective and to see how diverse production activities are combined to maximize household utility.

Wage employment is an important risk-reducing strategy. Over the past 2 drought years in Southern Africa, households with a wage-earning member have suffered much less than those without this source of income. Clearly, where the chances of earning off-farm income are good, any farm-based risk avoidance strategy, such as planting an extra area of cassava or using tied-ridging, must be compared with the returns and security obtained through wage employment. Norman (1983) notes that in the case of Botswana it may be necessary to accept that farmers will be reluctant to invest much money or time in crop production because this is a riskier venture than livestock production or off-farm activities. This insight has important implications for technology generation in Botswana.

Defining recommendation domains

The concept of the recommendation domain has become central to on-farm research methodology. A recommendation domain is a homogeneous group of farmers who share the same problems and possess similar resources for solving those problems. The group is expected to adopt (or not adopt) the same recommendation, given equal access to information about it. In much of Southern Africa, different recommendation domains occur not only because of differences in farmer resources, cropping opportunities, market access and inherent land fertility but also because, at any one time, farm households have different opportunities for non-farm wage employment or other income-earning activities. Often it is the nature of these non-farm opportunities and the extent to which farm households exploit them that most strongly influence farming practices and the aims and objectives of farm production.

It is commonly observed that, within homogeneous agroclimatic locations with similar market opportunities, neighbouring farmers with similar incomes and/or resource levels farm in very different ways. Households that are less able to exploit non-farm opportunities look on farming more in terms of production and income and tend to give more time and attention to farming activities than their wage-oriented neighbours, who farm for social and security reasons and tend to manage their farms less thoroughly. The cultivation practices of these two types of farmer differ, as do relevant interventions and recommendations.

A recommendation domain exercise was recently carried out in Swaziland, with the expectation that different farming systems would be observed in the very different ecological conditions of the high veld, middle veld and low veld zones of the country (Watson 1983). However, it was found that variations in cropping systems within the zones were much greater than the variations between the zones. The within-zone variation stemmed from differences in internal household circumstances. Table 2 gives a breakdown of household types, relating the differences beteween them to the cropping practices typical of each and to the interventions that might be suitable for each.

The farm household types have been broken down on the basis of off-farm income/resource endowments and labour committed to farming. These factors are, as we have seen, not independent. Three categories are distinguished. Some households find that they are able to exploit off-farm earning opportunities but that, in order to do so, they compromise on time devoted to farming. These fall into Category 1 in the table. Other households have relatively little potential for exploiting off-farm income opportunities but possess reasonable labour and resources for farming. This is Category 2 in the table, which often consists of older households or women-headed households. However, there is a third group of households (Category 3) that are able both to exploit off-farm income opportunities and to commit time and attention to farming. Generally, these are households whose head is not engaged in off-farm employment.

Group 1 households may have the cash and incentive to buy inputs but will tend not to manage them very intensively. Group 3 households, on the other hand, can contemplate more expensive inputs and have the resources to manage them reasonably well. Thus, fertilizer top dressing may be a relevant intervention for both groups, but the conditions under which it is tested should differ. To reflect real life conditions, trials with Group 1 households should be conducted with poor seedbed preparation, late planting and little weeding. The results are likely to be very different to those of trials conducted with Group 3 households, which practise good land preparation, early planting and adequate weed control. The value of yield increases is also likely to be different. For Group 1, who are deficit producers, the value will be the cost of equivalent food purchases. For Group 3, who tend to be surplus producers, it will be the market price of maize.

Another example of the different values of interventions is seen in the introduction of an early maturing short-season maize variety. For Group 3 farmers, this opens the door for double cropping, in which case the benefits attached should take the value of the second crop into account. For households in Groups 1 and 4, however, where circumstances dictate late planting, the advantage of a short-season variety will be that it can better exploit the limited growing period. It should therefore be valued in terms of its production compared with current varieties when planted late. Once again, the composition of the household affects the relevance of improved technology.

This has implications for the definition of farming units. Little thought has so far been given to the question of how the family farm unit is defined and whether it is managed within a nuclear family or through an extended family. There may well be a case for on-farm researchers to pay more attention to this issue in future.

Evaluating new technologies

Researchers now recognize that yield increasing technologies are not the only ones that can benefit small-scale farmers. Technologies that make more efficient use of time or cash are often equally acceptable.

Table 2 Household types, cropping systems and technology generation in Swaziland

Farm household type	Distinguishing features	Cropping practices: Fixed non-experimental variables	Cropping practices: Potential interventions
1. Cash/resource rich but labour poor	(a) 4 adult equivalents in family farm work force (b) Access to significant non-farm income (c) May or may not own oxen	(a) Only 1 ploughing, late planting, 1 weeding, use of planter (b) High levels of input use, e.g. fertilizers and top dressing, hybrid maize, but no tractors	(a) Top dressing (b) Botswana plough/planter (c) Botswana improved planter (d) Winter ploughing (tractor) (e) Short-season varieties (f) Herbicides
2. Cash/resource poor but labour rich	(a) 4+ adult equivalents in family farm work force (b) Poor access to non-farm income (c) Own oxen	(a) 2 x ploughing, early planting, 2 x weeding (b) Lower levels of input use, e.g. no top dressing, less hybrid maize, no tractors	(a) Winter ploughing (b) 2 x ploughing (c) Better weeding (d) Double cropping (e) Intensive sweet potato production (f) Cutworm banding and scouting (g) Early planting (h) Fodder conservation (i) Tied-ridging
3. Cash/resource rich and labour rich	(a) 4+ adult equivalents in family farm work force (b) Access to significant non-farm income	(a) Winter or 2 x ploughing, early planting, 2+ weedings (b) High level of input use, e.g. fertilizers (top dressing), hybrid seed, tractors	(a) Top dressing (b) Tied- ridging (c) Winter ploughing (tractor) (d) Early planting (hybrids) (e) Double cropping
4. Cash/resource poor and labour poor	(a) 4 adult equivalents in family farm work force (b) Poor access to non-farm income (c) Few if any cattle	(a) 1x ploughing, late planting, 1 x weeding, hand planting in furrow (b) Low levels of input use, local or open pollinated varieties, no tractors	(a) Minimum tillage (b) Tyne plough, e.g. Zimbabwe (c) Short-season varieties (open pollinated)

Technologies which save labour are particularly attractive to small family farm units. The rapid uptake by small-scale farmers around the world of improved implements, herbicides and mechanization, as well as farmers' own labour-saving strategies, bear witness to this.

From a household economics perspective, utility is maximized by producing the desired set of goods at the lowest cost in terms of the ultimate resource—the time of household members. Given the many demands for family labour in farm and non-farm activities, market and non-market production, and work and leisure, household economics sees family labour as being at a premium, with the major objective being to employ it as efficiently as possible. This implies that households seek to maximize the subjective return to the labour of their members, and that what tasks are performed and by whom depends on the opportunity cost of members' time.

The opportunity cost of labour often forms an important component in the evaluation of farm technologies by on-farm researchers. However, these costs are generally assessed in terms of alternative farm activities or of the wages that can be earned off the farm. (The cost of women's time during parts of the season when there is little crop work is generally assumed to be close to zero.)

Commenting on the unresponsiveness of farmers to advice on bush clearing in western Kenya, which experimental results had shown to be productive, Tessema (1983) says: 'Many were unwilling to carry out the work because they say it is a hard and difficult task even though it does not conflict with other operations, as it can be done in the dry season when there is little other activity.' Even when there are few tasks on the farm, the demands on family labour are many. It is therefore wrong to assume that that the opportunity cost to family labour is negligible at such times.

Taking a household economics perspective will help researchers to avoid falling into Tessema's trap, and will provide a basis for making some assessment of what value to place on family labour used outside farming and wage employment. The question researchers need to ask is: what other tasks are being performed by the relevant household members at the time? Answering this question will probably be easier than going on to the next stage and estimating the subjective value of a unit of the member's time spent in the proposed new activity. What value do you put on an hour spent looking after children or collecting firewood or drinking beer with friends? The important point though, is that the answer is certainly not 'zero' just because the activity does not relate to farming.

Even where positive opportunity costs are assumed, the farm-based and household economics approaches to evaluating technologies can give markedly different results. For example, Table 3 presents a typical partial budget analysis in which the opportunity costs of labour are included and a reasonable return on capital is obtained when extra management time and fertilizer are applied.

Moving from the traditional to the new technology gives an increased net benefit (gross benefit less total variable costs) of 298 cedes. This additional net benefit is achieved at a cost of 642 cedes (1252–610), which implies a return to capital of 46% (298/642x100). On the basis of this conventional analysis it is probably worthwhile moving to the new technology.

Table 3 Farm-based partial budget analysis of benefits of moving from traditional to new technology

	Returns per hectare analysis	
	Traditional	New technology
Yield (kg/ha)	1300	2400
Adjusted yield (–15%)	1100	2040
Gross benefit at 1 cedes/kg	1100	2040
Cost of fertilizer	-	192
Labour input (person-days)	61	106
Cost at 10 cedes/day	610	1060
Total variable costs	610	1252
Net benefit per hectare	490	788

Source: Bruce et al. (1980)

Compare this approach with the following analysis of the same data based on the household economics theory that farm households seek to minimize the costs of producing goods for their own consumption in order to maximize returns to family labour. Table 4 presents the analysis of the data in Table 3 based on a comparison of the costs of producing each unit of the crop, rather than on the returns to capital invested per hectare.

With the new technology, each ton of crop can be produced with 3 fewer person-days of labour input, giving a saving of 30 cedes per ton. However, since the new technology requires an extra cash outlay of 94 cedes, it is 64 cedes more costly than the traditional technology per unit of produce. On a per-ton basis then, the traditional technology, which requires more labour and less cash, is the lower cost alternative (at the given opportunity cost of labour time).

For subsistence producers, the cost of production analysis is probably more relevant than the returns per hectare analysis.

More important than the different answers given by each analysis are the different implications of changes in the value of time of household members. In the farm-based approach, the new technology becomes less attractive as the opportunity costs of time increase, since it uses more labour per unit of the enterprise, reducing net returns per hectare. In the household economics approach, the new technology becomes more attractive as the opportunity costs of time increase because it uses less time to produce each unit of the consumption good.

Table 4 Household time efficiency analysis of the benefits of moving from traditional to new technology

	Costs per ton analysis	
	Traditional	New technology
Time costs/ton		
Person-days required [1]	55	52
Time costs at 10 cedes/day	550	520
Cash costs/ton		
Fertilizer costs [2]		94
Total costs/ton	550	614

1. Person-days per na/adjusted yield per ha
2. Fertilizer cost per ha/adjusted yield per ha

It seems that, where labour hiring is not prevalent and scarce family labour time must be used in a subsistence crop activity, increasing the values of members' time (or household welfare) is likely to encourage the use of a cash-expensive technology that reduces the labour required per unit of production, rather than to discourage it, as the farm-based analysis implies. Thus an understanding of household circumstances, aims and objectives is crucial to the evaluation and design of appropriate technology for small-scale farmers.

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Source

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Farmers' Networks: Key to Sustainable Agriculture

Bertus Haverkort

Introduction

Not only is there considerable variety in the origin, goals and organizational structure of farmers' networks, but these networks are also continuously adapting themselves to changing circumstances. Recent changes in the economic, agro-ecological and political environment have led to a new flexibility and dynamism in farmers' attitudes. This is evident both in their practices at village level and, through their organizations, in their responses to challenges at the national, regional and international levels. Conventional development approaches have tended to use farmers' organizations and networks to increase their control over the development process, influencing them in the direction deemed desirable by outside agencies.

This paper advocates a development support policy whereby farmers' networks are seen and respected as a way in which farmers can take control of the agricultural development process. Outside support, if required at all, would be given only to further empower them.

New Interest in Farmers' Networks

Farmers are the 'carriers' of agricultural development. They have their own approaches to the development and application of technologies, and their own patterns of decision-making. While farming itself is done mainly on individual farms, the broader rural community plays an essential role in farmers' strategies for survival and development. Rural people, like city dwellers, like to get together to share information and other forms of mutual support with others whom they trust. There is nothing new under the sun, and networking between farmers is as old as farming itself. Yet a renewed interest in farmers' networks can be detected.

Compton and Joseffson (1993) state that this new interest can be seen as a reaction to two major social problems of modernizing societies. First, increasing fragmentation of society as a result of commercialization, specialization and large-scale production leads to the loss of a sense of community. This leads to the adaptation or revival of traditional forms of information exchange and cooperation, or to the emergence of new ones. Second, people start to rebel against human service systems such as bureaucracies and businesses, especially if they feel that these have largely failed them or work against their interests.

New forms of farmer networks are thus arising out of a need to gain access to power, new technology and information relevant to the farming community. Established research and extension systems have, until recently at least, had little relevant information and advice to offer small-scale family farmers. These farming systems did not fit the way most researchers and extensionists perceived agricultural development and progress (specialization/monoculture, chemicalization, mechanization and large-scale production). The large-scale farmers who fit the establishment's view of agricultural development were seen as progressive. It has repeatedly been demonstrated, both in the North and in the South, that agricultural policy instruments such as subsidies, price systems, legislation, research and extension have been designed and used predominantly to benefit these progressive farmers. By giving priority to these farmers, policies have neglected the needs and damaged the potential of smaller farms. The rationale for this selective policy is reflected in the frequently heard admonition, 'get big or get out'.

In spite of being deprived of support, small-scale family farms have persisted, and the farming strategies adopted by their owners and operators remain viable. The long-standing deprivation faced by such farmers is a major driving force behind their new determination to draw upon each other's strengths. Farmer networks enable them to share their experience. The cooperation they encourage offers them the opportunity to create alternative development models and to influence policy.

Potential Benefits of Farmer Networks

It is important to recognize who benefits from farmer networks. In addition to the participating farmers, the rural community as a whole benefits from the improvements in agriculture promoted by a network's influence.

Agricultural research and extension organizations can benefit in two ways. If they establish a relationship of confidence with the network's farmers, they will gain a local partner that will participate creatively and critically, bringing a qualitative improvement in the research programme. In addition, farmer networks can take on more responsibility for local agricultural experiments and demonstrations, helping to disseminate the results of research and so bringing a quantitative gain in impact. In both cases, the cost-effectiveness of research is improved.

Compton and Joseffson (1993) mention the following advantages of farmer networks:

Risk sharing
A basic function of farmer networks is to build confidence among member farmers and to provide support and encouragement in risk-taking. Especially in risk-prone areas, it is common for families to look after each other in difficult times. Self-initiated and self-directed farmer networks can provide a safety net and a buffer at such times.

Sharing experiences
New farmers can learn from older farmers and inexperienced farmers can learn from experienced ones. All farmers can learn from each other and so avoid the unnecessary repetition of mistakes.

Experimentation and demonstration
The experiments conducted by farmer networks can effectively and efficiently serve to develop farming practices that respond to local conditions. The network can assign different parts of an experiment to different members. This avoids duplication and enables farmers to investigate a proposed new practice more completely and more quickly. Cooperation in the network will help to improve the design of farmers' experiments and to develop farmers' research skills. When experiments and demonstrations are carried out by farmer networks they naturally include appropriate consideration of risk, labour requirement and community values—factors which researchers working by themselves have often had difficulty in building into their programmes.

Networks allow participating farmers to discuss and analyze each other's observations and experiences. This process results in valuable research questions. When forwarded to agricultural research organizations, these questions and requests should, presumably, carry more weight, because they are put forward by a network rather than an individual farmer.

Extension and communication
In addition to generating and exchanging knowledge based on farmers' experiences, farmer networks can obtain and disseminate agricultural information from outside the network. They can serve as a link not only between individual farmers but also between farming communities and the agricultural extension system. Networks have often emerged in response to the absence of an adequate extension service. Yet the existence of such networks can facilitate the work of extensionists and researchers provided these accept the network for what it is—namely a forum for the articulation of collective needs.

Empowerment
Farmer networks can focus around many areas of common interest and needs. As farmers join together and begin to support and learn from each other, a network develops strength. It becomes increasingly able to command respect and attention, and to promote the

common interests of its members and the larger community. Practical outcomes can be cooperative purchasing of supplies, cooperative selling, and marketing of produce. Well established networks can become effective advocates of policy change, claim improved access to public services for their members, and help to enlist public sympathy for, or at least interest in, the issues of environment and development which affect farmers' lives.

During a workshop on networking for low-external-input agriculture held in the Philippines in 1992, it was generally agreed that the most essential ingredient for the promotion of low-external-input and sustainable agriculture is the existence of strong farmer-based networks in the rural community. Development support networks, such as those of NGOs or of research institutions, should therefore aim to cooperate with and/or support the needs of farmer-based networks. The first step in this direction is to understand how farmers' networks operate. Recent research has provided important insights in this area, which is one that is frequently overlooked by development organizations.

Indigenous Knowledge and Communication

Warren and Cashman (1988) define indigenous knowledge as the sum of experiences and other forms of knowledge of a given ethnic group that forms the basis for their decision-making. Farmers have sophisticated ways of looking at the world. They have names for many different kinds of plants, ways of diagnosing and treating human and animal diseases, and methods for cropping both fertile and infertile soils. This knowledge has accrued over many centuries and is a critical and substantial aspect of the culture and technology of any rural society. Indigenous knowledge about agriculture is intimately connected with knowledge in other spheres of life, notably health, social systems and spirituality. It is being preserved, communicated and changed. The last point is important: indigenous knowledge is not static, but is continuously adapted to meet the changing needs and circumstances of the rural population. In this process, networks play important roles.

Thrupp (1989) stresses the importance and unique value of indigenous knowledge, but warns against romanticizing its potential. The type, extent and distribution of knowledge varies greatly in different societies, but all resource-poor farmers have valuable knowledge. The capacities of individuals to innovate (create new knowledge) and to apply and transfer existing knowledge are also diverse. She concludes that indigenous knowledge continues to be marginalized by the dominance of top-down development approaches, the pressures exerted by agrochemical firms, scientific professionalism and other political and economic forces. She advocates enabling people to establish legitimacy of their knowledge for themselves as a form of empowerment.

McCorkle et al (1988) showed that, in Niger, knowledge exchange takes place in more or less regular ways in a wide range of places. Informal networks frequently emerge spontaneously around traditional institutions such as markets, village wells, grain mills, blacksmiths' workshops, health centres and churches/mosques. Funerals, festivals, rituals and tribal meetings may all be occasions for the exchange of knowledge. Within these traditional institutions, predetermined roles are given to certain persons. At markets, specific areas are frequently reserved for certain commodities, where producers, traders and customers meet to exchange goods, money and information. A market can thus be seen as a conglomerate of different networks, each focusing on a specific aspect of the indigenous knowledge system. Village wells are known to be places where women exchange information. Religious meetings and rituals are often led by spiritual leaders, and offer the opportunity to exchange experiences and develop community consensus on important local issues.

Influence of the cultural environment

Schuthof (1990) has shown that, in Zimbabwe, within a specific farming community there are at least two different types of network: those of Christians and those of non-Christians. Whether a person is a Christian or a non-Christian to a large extent determines the way he or she views the 'management' of nature. Within traditional society the ancestors and spirits play an important role in determining the success or failure of agricultural production. The rainmaker is a kind of medium between the spirits and the farmers, and is regularly consulted on agriculture-related activities and decisions. The introduction of Christianity in the 1960s resulted in considerable change. Christians do not offer beer to the ancestors. Nor do they consult the rainmaker for blessing the seeds. Participation in traditional or modern social activities was also an indicator of whether one asked the government extension agent or the rainmaker for advice on agricultural problems. Schuthof found that there was hardly any information exchange between the rainmaker and the extension worker. Both claimed to know how plant diseases should be eradicated, but the logic of their respective knowledge systems differed radically. Schuthof concluded that rural peoples' knowledge networks were embedded in a cognitive framework that was religous as well as social and economic in nature, with the result that farmers' rationales and goals were essentially subjective and varied substantially among farmers. This cognitive framework determined the way in which farmers give significance to their lives. Belief in the Christian God or in the spiritual world of their ancestors determined the network to which farmers belonged.

Similar observations were made by Haverkort and Millar (1992) in their research in Ghana. They found that in traditional society the priests, soothsayers, elders, village headmen and chiefs played important roles in local experimentation. New ideas could be tried out and changes made as long as the Gods' consent was sought by the local priests, through the ancestors and after consulting the soothsayers. Sacrifices were made and traditional rituals performed before experiments were conducted. Here, the traditional institutions had an important regulating function. The outcomes of experiments were indicated not only in terms of yield or economic returns, but also by other signs of the Gods or ancestors, such as health or accidents. In Ghana, the traditional institutions that connected the different people responsible for local governance and decision-making and allow for the rituals to take place formed an important network. These institutions also played a role in the exchange of information and in farmers' experiments. The authors concluded that there was a great lack of communication between extension agents and researchers on the one hand and indigenous leaders on the other. They advocated an approach whereby outside agencies established contacts with indigenous institutions, so that the knowledge, resources and influence of both parties could be combined in a mutually beneficial way.

In his paper on indigenous knowledge in Bolivia, Rist (see p.93) describes similar mechanisms for farmers in the Andes. The indigenous cosmology invokes both the natural and the spiritual worlds, which are intimately related. Both worlds are worthy of attention. Rist also describes how this traditional knowledge system is being eroded by the influence of outside agencies such as the school, religion, non-government organizations and rural extension, and by factors such as temporary migration, emerging new needs and food donations. Among the many connections re-established by learning once again to set a value on this knowledge are those between different agro-ecological zones, as illustrated in the in-situ conservation and exchange of germplasm and in the exchange of knowledge about erosion control.

Pereira and Seabrook (1990) describe the indigenous knowledge system of the Warli tribe in India, illustrating its richness and appropriateness through many examples. Here too, knowledge is embedded in, modified by and transferred through indigenous networks. The Warlis's agricultural experiments are part and parcel of community activities. The authors go further than most anthropologists in concluding that outside development agencies need to have faith in the validity of the principles on which the traditional system is based. This requires a radical change in agencies' ways of thinking and values. Indigenous knowledge is often not seen as valuable and valid in itself, but merely as something to be taken into account when introducing Western concepts of development. Enforcing conformity with mainstream beliefs through education, health, agricultural and other services based on modern science and technology is a sure way of destroying indigenous knowledge systems. According to Pereira, modernization, if necessary at all, should be an adaptation of good traditional principles and methods to the problems of today, with inputs from new science and technology used only if they are not seen as destructive.

Power, politics and progress

Bebbington (1991), van der Ploeg (1990) and Toledo (1992) draw attention to the power and political aspects of indigenous knowledge and knowledge networks. Bebbington describes farmers' organizations in Ecuador, where indigenous rural peoples are formally organized at a variety of levels. Community-based organizations federate into second-order organizations at parish, county or provincial level. Often, these organizations were originally formed to campaign for land rights. Later they became active in implementing rural development programmes. The struggle for land has often been presented as a struggle for the right to protect and recover a traditional way of life. For many farmers' organizations in Ecuador, the steady modernization of indigenous societies is not merely a matter of technical change but part of a process of cultural assimilation into a dominant society, that is to be resisted. Bebbington describes a meeting of indigenous peasants' federations that made a collective declaration denouncing the activities of the 'so-called' extension agents of the state as 'cultural aggression' and 'instruments of manipulation', used by the dominant Hispanic society to subjugate them. Some organizations argue that indigenous social and technological practices should be researched and reinstated. These practices demonstrate the feasibility of an indigenous way of living, producing and organizing. Indigenous knowledge is also a symbol of and tool for resistance to socio-cultural assimilation. Chiriboga (quoted in Bebbington) argues that the concern to identify an alternative model of development based on local resources, local forms of social organization and indigenous practices is inspired by a conscious effort on the part of the peasants' organization to distance itself from the pressures resulting from dependence on the market and from the policies associated with structural adjustment.

Bebbington also draws attention to another form of reaction to modernization: selective modernization or resistant adaptation. This occurs when traditional technologies cannot generate sufficient local income to prevent out-migration. The introduction of cash crops and yield-increasing technologies is seen as a strategy for accumulating resources that will reduce migration and help to maintain other traditions such as dress, language and organizational forms.

Toledo (1992) observes similar changes in Mexico. Farmers' movements that focused initially on land rights and farmers' control of the production process now fight for the defense of nature, for the survival of the very ecological system on which their livelihood depends. This new focus leads to a revaluation of traditional concepts of the relationship between man and nature, in which notions of respect for nature, reciprocal maintenance, self-sufficiency and equality prevail. These changes are likely to mobilize national and international support for these movements.

A great number of politically oriented farmers' organizations are reported to exist in Latin America. And there are powerful examples from other continents too. The Chipko movement in the Himalayas was started by village women in the Reni forests of the Chamoli District of Uttar Pradesh, India, who wished to prevent trees from being felled. The movement spread to many remote areas of India, Nepal and Bhutan, and has successfully brought commercial forestry to a standstill, stopped the construction of several large dams and greatly reduced unregulated mining. Guha (1989) emphasizes that Chipko is the successor of earlier peasant struggles in the area, but at the same time it goes beyond them. It has made a dynamic contribution to the public debate on the environment, both in India and abroad.

Linking with Indigenous Knowledge: Opportunity or Risk?

Van der Ploeg (1990) sees as a dominant and central feature of modern agricultural science that it systematically expropriates farmers' knowledge and therefore their control over their working and living conditions. Science and technology rupture existing development patterns and indigenous systems of learning, experimenting and teaching. The knowledge of farmers is made superfluous and their labour is subjected to external interests and perspectives. It is this that, increasingly, makes farmers say: 'Up to here and no further'. They draw up a line of defence to protect their own essential interests and perspectives. Their local knowledge is the primary weapon they use in self-defence. Farmers' knowledge is not just a neutral set of items to be exchanged for or blended with other forms of knowledge It is the key to their sense of identity and power, and therefore to their survival.

Van der Ploeg questions whether, through simple expedients such as networking, on-farm research and participation, the profound contradiction between farmers' knowledge and scientific knowledge can be superseded. Should not the struggle to consolidate, reinforce or even reinstate local knowledge be oriented primarily towards increasing farmers' power and independence, thereby creating better conditions for the further development of indigenous knowledge?

I feel that this question addresses the heart of the matter. The current renewal of interest in indigenous knowledge is both an opportunity and a risk. As shown by O'Brien and Flora (1992), focusing on indigenous knowledge can further empower rural communities, but it can also—and this despite the good intentions of development workers—lead to a further sell-out, preparing the way for further control of rural communities by outsiders. Despite the rhetoric of empowerment, development agencies (multilateral, bilateral and non-government) have generally failed farmers in their support. Much farming systems research continues to aim at increased use of purchased inputs and Green Revolution technologies.

In short, I join van der Ploeg, O'Brien and Flora in raising the question: Will support to farmers' networks lead to the further appropriation of indigenous knowledge and further control by outside agencies, or will it lead to greater empowerment of farmers?

Documentation of farmers' knowledge

The international development set has recently given much more attention to indigenous knowledge. At grass roots level several experiences have now been recorded in which development initiatives began with an inventory of existing farmers' knowledge and subsequent activities were built on this. Cases of documenting farmers' knowledge for the purpose of empowering farmers have also been described.

Pereira and Seabrook (1990) give an example of a 12-year-old girl of the Warli tribe in India who knows the names of over 100 herbs, shrubs and trees and their varied uses. She knows which plants are a source of fibre, which are good for fuel and lighting, which have medicinal use and which can supplement the basic diet of cereals and pulses with essential proteins, vitamins and minerals. She possesses a vast, complete knowledge system on animal husbandry, agriculture, meteorology, herbal medicine, botany, zoology, house construction, ecology, geology, economics, religion and psychology. Of course, not all of this knowledge is valid in Western eyes: the authors assert that some superstition is undoubtedly involved, and a few practices are positively harmful. But this is a tiny fraction of the Warli's 'science', and in general they have the wisdom to use their knowledge well.

McCorkle et al (1988) describe some 20 case studies of successful farmers' innovations. These include the introduction of short-cycle millet varieties, new land preparation methods, the construction of mini-catchments, seed pocket manuring, dry-season gardening, forage utilization, biological pest control, and a range of ethnoveterinary medicines. The authors found that farmers in Niger are open to seeking out and applying new agricultural ideas. They can plan, implement and evaluate on-farm research trials, and demonstrate a sophisticated understanding of the complex interactions among the many variables they manage. The case studies also show that there is a rich body of local technical knowledge in Niger's agriculture that could be useful to farmers throughout the Sahel. Farmers choose technologies because these reduce risk, generate income, are affordable and readily available, save labour and fit into current farming practices. Research and extension offer very few technologies deemed appropriate by farmers. The authors recommend efforts to strengthen farmer-to-farmer communication of indigenous agricultural knowledge, offering farmers more opportunities and incentives to experiment for themselves and strengthening farmer feedback loops in research and extension.

The case of the Agroecology Programme of the University of Cochabamba (AGRUCO), described by Rist (see p.93), shows how the documentation of indigenous knowledge can yield important new insights into feasible technical options. Field workers collaborate with farmers to develop handbills on topics such as soil management, mixed cropping and weather forecasting. These handbills serve to prevent the disappearance of knowledge on these topics and to redisseminate useful technology to the community. Such efforts can also be the starting point for joint research. In Peru the Andean Project for Indigenous Technology (PRATEC) has documented over 600 Andean technologies and has made these available for farmer-to-farmer communication.

Gata and Kativhu (1991) provide an overview of indigenous farmers' knowledge in Zimbabwe. They describe indigenous ways of conserving and managing natural resources (trees, wildlife, soil and water) and crop production. They conclude that women in particular have developed a sound scientific and technological knowledge system for agriculture which should be integrated into formal knowledge systems.

However, many examples show that documenting farmers' knowledge may have a questionable effect. The growing international emphasis on biotechnology and biodiversity has led to increased research in ethnobiology—the study of indigenous peoples' knowledge of local plants, animals and biological processes. This research is likely to yield more academic degrees for the students who conduct it than useful technologies for the resource-poor farmers owning the raw materials under research. Worse still, samples of such farmers' materials can easily be used by commercial organizations to identify and isolate active ingredients, mass reproduce them and commercialize and/or chemicalize production. In some cases commercial organizations even patent the products they have developed on the basis of such research. An example from Christie (1993) shows how farmers' intellectual property rights need protection:

> The African soapberry, or *endod*, has been cultivated by Ethiopians (and other Africans) for generations, for use as a laundry soap and shampoo, and to stun fish. While doing field research, an Ethiopian scientist noticed that the soapberry also seemed to kill freshwater snails downstream from laundry and bathing sites. He spent 29 years collecting and conducting research on more than 400 varieties of the soapberry plant, and on schistosomiasis. He identified a few soapberry varieties which are particularly effective against the snail that carries schistosomiasis. American scientists wondered if *endod* would also kill the zebra mussel. It is an import into the Great Lakes water system of Canada and the USA which causes multi-million dollar damage by blocking water intake pipes in the Great Lakes waterway. *Endod* did kill zebra mussels, and the University of Toledo has applied for a patent for any applications of *endod* used in controlling the zebra mussel. The Ethiopian scientist would receive a portion of any royalties paid when a commercial product is developed. But what of the people who originally cultivated and used *endod*? Without them and their knowledge, none of this subsequent research would have happened.

Farmer networks may help to protect farmers' intellectual property rights somewhat better in future. To avoid expropriation, indigenous networks will need to guard their knowledge carefully. Yet there is an intrinsic conflict of values between many rural societies in developing countries and Western industrialized society: land, water, genetic resources and knowledge are mostly seen by the former as common property, for which systems to protect property rights would be inappropriate. This makes them highly vulnerable to expropriation, as the colonial and neocolonial eras have made painfully clear. An essential element of future outside support to indigenous knowledge systems may therefore be help in establishing or supporting local systems for the protection of property rights.

Although the same indigenous knowledge is often widely shared, different individuals or groups may have different degrees of access to specific subject areas. Knowledge is then a source of power or privilege. Juma (1989) found that in Eastern Kenya only certain elders of certain tribes know certain aspects of medicine and the collection sites of valued plants. These elders have high status because of their secret knowledge.

Combining indigenous with outside knowledge can be very fruitful since both, in isolation, have their relative strengths and weaknesses. But the most important condition for success is the willingness of outsiders to recognize the authority and cultural values of farmers. This recognition does not mean making an inventory of useful knowledge in the hope of capturing something of economic use in the outsiders' world. It means turning over the right to direct the development process to farmers and entering into a dialogue with them of which the outcome is not certain.

Bridging the gap between related networks

Farmer networks do not exist in isolation. Box (1989) analyzed the knowledge network on cassava in the Dominican Republic. He concluded that there were four or five different networks for this crop alone: farmer networks, research networks, extension networks and networks of traders and coordinators of development projects. Although these networks co-existed in the same area and referred to the same crop, there was very little interaction between them. Among these different networks the values and priorities of members differed considerably and the information exchanged referred to different aspects of the crop. There was even a tendency to disqualify other networks in priority setting and problem formulation. This led to the waste of opportunities for cooperation and crop development. Box describes his experiences in bringing together the different networks in workshops. This presented farmers, researchers, traders and extensionists the opportunity to learn from each other and to start or intensify cooperation. Such an approach may be highly cost-effective and illustrates a useful role of outside development agencies in working with farmer networks.

Linking farmers' networks

The success of the Campesino a Campesino Movement in Central America (see Holt-Giménez and Cruz Mora, p.51) is partly due to farmer exchange between countries. Farmer leaders of one country visit another and receive encouragement and technical support to launch farmers' experiments in their own country and community. Among the important mechanisms for strengthening the voice of the South is the organization of South-South exchanges of experience and knowledge.

The Western approach to agriculture currently faces many problems related to equity and the environment. In these areas Northern organizations could learn a great deal from the South. The same applies to women's networks and to the ethical and intellectual values they represent—much can be learnt from these by men.

In efforts to redesign the agenda of agricultural development, the contributions of these underutilized resources may be essential. Networking at all levels is therefore of the utmost importance.

Conclusion

Successful networking, whether in purely indigenous forms or in linking different types of network, depends to a large extent on people 'daring to share', instead of using the 'net' to catch a prey.

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Daring to Share: Networking among Non-government Organizations

Paul G.H. Engel

Introduction

In recent decades non-government organizations (NGOs) have invested a great deal of time and money in networking. Numerous formal and informal networks are the result. At the same time, the study of networking as a social phenomenon has received increasing attention. Social scientists have noted how people 'capitalize on' their social relationships in order to deal with the challenges of life. Following theorists like Bourdieux (1991), some would say we have finally understood the importance of investing in 'social capital'.

In my view the new emphasis on networking has brought us numerous advantages, but some disadvantages too. The advantages stem from the fact that networking entails explicit recognition of ourselves as social beings. Our knowledge, technologies and practices are not created by individuals in splendid isolation, but socially, as a result of interaction with each other. Our fascination with networking for development purposes reflects the fact that we no longer feel that there is only a single source of knowledge for dealing with a given problem, but rather that there may be as many sources of knowledge as there are people involved—and people of different walks of life too: scientists are just one of many communities trying to come to grips with development issues.

Finally, our investment in networking is intimately connected with our concern for sustainability. As is painfully clear from the various theatres of war in the world today, sustainable development can only be achieved where people have worked out a way of living with each other. In other words, it can only be built only upon sustained social relationships. We can no longer point at either farmers, or policy makers, or researchers, or development workers, or even money lenders, as the prime culprits for what is wrong with agriculture. To be successful, our analysis and actions will have to involve all of these groups. Current efforts at networking are at the forefront in helping effective relationships to emerge.

The disadvantages have to do with the fact that we haven't yet been able to conceive of networking in such a way that it can permanently and successfully compete for resources with our other important activities. In other words, most NGOs and, I might add, most donors still see networking as an overhead, to be kept to the bare minimum. In my opinion such a point of view is at odds with achieving sustainable, socially integrated development.

This is the argument I would like to advance in this paper. In doing so I cannot and do not pretend to be exhaustive. I can only draw on the networking experiences with which I am familiar. I hope my perspective will contribute to a better understanding of networking, and to the improved management and evaluation of networks.

First I will describe what I mean when I say 'networking' amongst NGOs, and why I think networking is work. In the process I will try to say why I believe networking deserves a place of its own in our budgets—not as part of administrative costs, training, field work or documentation and information, but as a separate line item, a complementary set of activities which creates a specific added value to whatever else we do. Second, I wish to draw out some of the central issues in the current networking experiences of NGOs as documented in this book. Third, I will try to define the added value of networking, and make some suggestions for developing a conceptual framework for evaluating network performance. This, I hope, will help us make the networking process more manageable.

What's It All About?

My primary interest is not with networks but with network*ing*—the process resulting from our conscious efforts to build relationships with each other to further the cause of sustainable development. Networks are the more or less formal, more or less durable relational patterns that emerge as a result of such efforts.

One of the most intriguing questions about networking is: what exactly does it contribute to our work? And how do we recognize this contribution when it occurs? One may safely assume that networking makes a great contribution to NGO work the world over. The proliferation of networking activities is proof enough of that. Yet, what exactly is this contribution? Why is it so difficult to put our finger on it? Padrón (1991), one of the outstanding networkers of Latin America, was among the first to recognize the need for more systematic analysis, precisely because it is so difficult to establish what networking is, why it happens, and how its advantages can best be used to develop the NGO community's efficiency.

From his own vast experience with both thematic and institutional networks in Latin America, Padrón suggests a central thesis for understanding NGO networking: networking is about *sharing*. And he warns: sharing may be one of the most demanding requirements in development work, yet it is the most essential common denominator developed by the poor in order to provide for each other and live under adverse conditions. 'Daring to share', as he puts it, 'is neither easy nor automatic. It requires a willingness to be open-minded, it requires having enough confidence in one's own work to expose it to others, and at the same time, the necessary humility to understand one's position as one among many.'

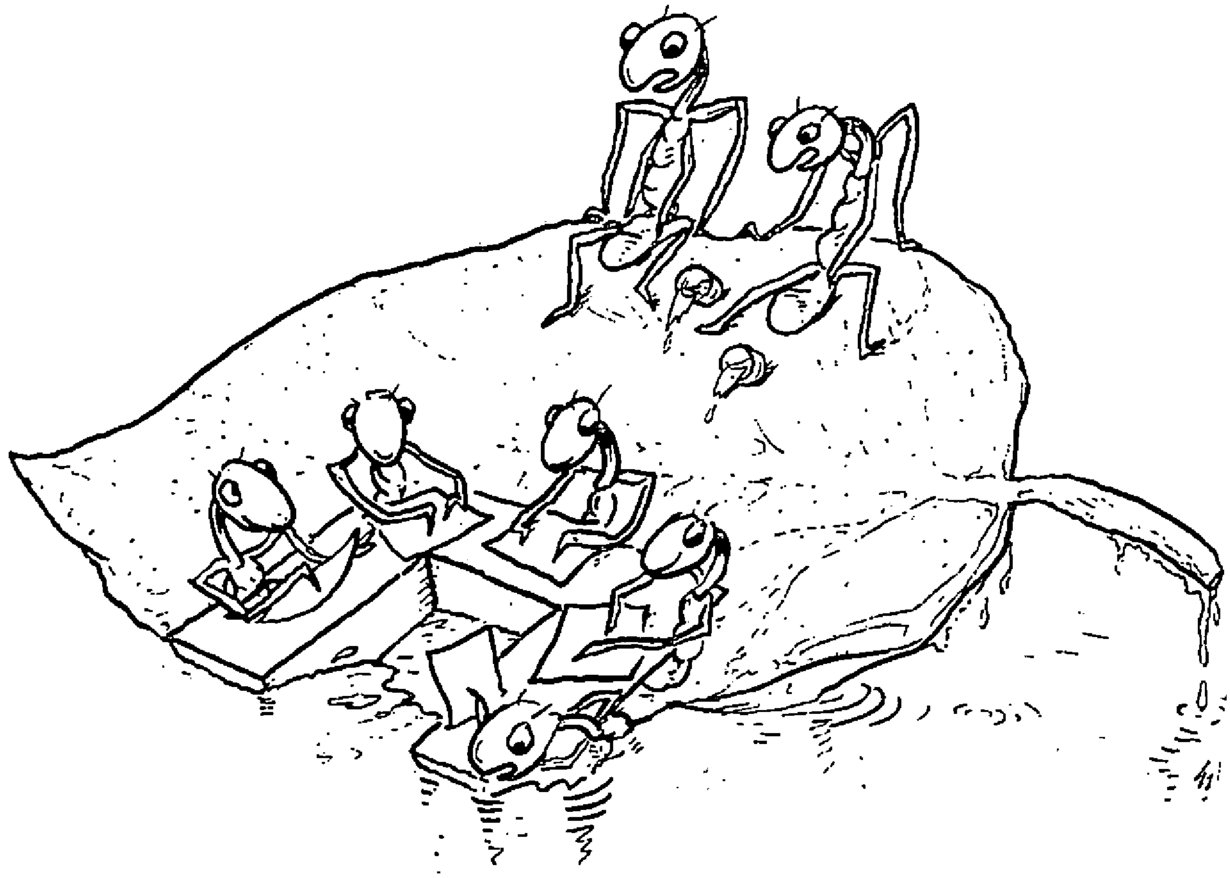
In my view, this makes networking more than simply working together—more than the mere collaboration of individuals and institutions on the basis of common interests. Networking has to do with achieving 'social synergy', as Haverkort and Ducommun (1990) put it. Networks represent 'communities of ideas', a space for like-minded people to interact on the basis not only of common interests but of conflicting ones too, building mutual trust and learning to accommodate each other's needs. The core businesses of networks are not so much the manufacture of products and/or the provision of services, but social learning, communication, and the making of meaning. In focusing on 'mind' rather than 'matter', networking adds a fundamentally new quality to human cooperation. It enhances inclusive thinking, creativity and dialogue.

As a consequence, networking activities show fundamentally different characteristics to more product- or service-oriented ones. A good example of such a characteristic is redundancy in communication between people. In product- or service-oriented organizations, this is checked and, if possible, eliminated. Meetings, informal discussions, coffee breaks, personal mail and instructions are to be kept lean so as to avoid stealing time from productive work. Networking, in contrast, is an activity in which we positively indulge in dialogue, are encouraged to exchange ideas and experiences, are urged to take the time to listen to each other and to work towards a new way of understanding old problems. On the face of it unproductive, this actually provides a space for reflection, for breaking down barriers and stimulating creativity. As we will see, this can often lead to a considerable increase in the quality, if not also the quantity, of our work. A certain amount of redundant communication may well be a prerequisite for bringing about such improvements (Engel, 1990).

As far as I'm concerned, any attempt to manage networks which overlooks this fundamental characteristic is doomed, for it misinterprets the reasons for networking, the social needs and forces which lie behind it. This is not to deny the importance of specifying products and services in the realm of networking. Indeed, as we will see, this is important too, since it provides indicators for evaluating networks and measuring their success. But the understanding of networks can never be reduced to the simple 'production' logic so commonplace in institutional thinking today. The added value of networking is strongly tied to the development of ideas, to shared experiential learning and to making sense of the world through communication. The challenge is to develop a framework for planning and evaluating networking activities that is concrete enough to be serviceable but that does not lose sight of this fundamental issue.

The Central Issues

Several key issues emerge from the experiences of NGO networking documented in this book. In this section I will refer to these experiences, and also to those of the global



Non-formal communication is essential

networks El Taller and Huridoc. (El Taller is a Tunis-based foundation with a membership of 100 NGOs worldwide; Huridoc is a long established international human rights organization.)

What all these networks have in common is that they have reached a stage of consolidation. All of them have survived the uncertainties of institutional infancy and matured into respected adolescence, carving out a niche for themselves in the local, regional and/or global NGO community.

My main interest will be in looking for the value added to NGO activities by networking. In the view of the NGOs themselves, what makes networking worthwhile? I will look into this issue by raising three questions:

- What triggers networking amongst NGOs?
- What makes networks take a more permanent form?
- What activities characterize networks?

What triggers networking among NGOs?

NGO networks appear to develop when NGOs themselves, or members of their staff, perceive a lack of access to relevant knowledge to be a critical factor hampering their work. This lack is not looked upon as absolute. On the contrary, it is perceived as being surmountable if a sharing of ideas, experiences and information is organized among relevant parties.

In Tamil Nadu and Pondicherry States of India, NGOs and farmers agreed that many sound traditional practices existed which needed to be brought to light and were worth disseminating (see Quintal and Gandhimathi, p.177). In the case of the Andean Council of Ecological Management (CAME) in Peru, severe droughts and floods convinced NGOs that they were unable to respond adequately to the needs of Andean farmers. They attributed this failure partly to their lack of familiarity with Andean and other appropriate technologies, partly to the inadequacy of current ways of managing climatic risks and partly to the absense of inter-institutional coordination (see Manrique et al, p.167). Participants at an Oxfam workshop in Cotonou identified the isolation of local project staff as a handicap to their work, giving rise to the formation of the Arid Lands Information network (ALIN) (see Graham, p.271).

In some instances a more general lack of coordination appears to have stimulated networking efforts. This was the case with the Association of Church Development Projects (ACDEP) in northern Ghana, which arose from the perception that church projects operated in isolation and tended to replicate each other, offering similar and sometimes competing services within the same locality. In this case coordination was based on the vertical administrative structure of the church. Coordinators could not provide the necessary technical back-up, and different approaches to development existed without the benefit of a learning process between projects. Under these circumstances networks are required to assume a broader role, facilitating organizational integration and change. This may lead to the establishment of new specialized units or agencies dedicated to specific tasks in support of all the NGOs concerned.

Similar perceptions account for networking initiatives at the global level. The networking activities of Huridoc were based, according to its evaluators, on the premise that information about human rights is hard to obtain, difficult to dissiminate and essential to the protection of human rights (Tajaroensuk et al, 1992).

However, if a lack of knowledge or coordination alone is identified as the motive for networking, this falls short of recognizing the full urgency of the intentions behind NGO networking efforts. In an increasing number of cases these efforts spring from the growing awareness of NGOs that their need is an acute one—far more than just a casual search for knowledge. Networking in such cases is a response to the wish to put heads together, to join forces, to search jointly for new ways of understanding and intervening in circumstances that are complex and defy simple analysis. Often, it is triggered by a rejection of mainstream or conventional thinking, by the struggle to articulate an alternative, more sustainable approach to development. In the case of CAME, as we have just seen, the NGO community realized that its grasp of Andean and other appropriate technologies was inadequate. In India, the environmental problems caused by modern technologies led to the search for alternatives that would be more sustainable. At a global level, the founding members of El Taller experienced a similar sense of having been let down by conventional approaches. In the words of its Secretary-General, Sjef Theunis: 'El Taller was born from the need for reflection voiced by NGO leaders from around the world. Women and men who work at the heart of their society are feeling that citizens and politicians have lost their direction and focus' (El Taller, 1990). In some cases a theory or slogan is adopted to provide guidance in developing an alternative approach. Whether this is called low-external-input and sustainable agriculture, or environmentally sound agriculture, or ecological agriculture, the effect is the same: a banner is raised and serves to rally the troops.

A third factor that often triggers networking among NGOs is the wish to participate in the public and/or government debate about development and so to influence policy making. One reason for the creation of CAME was the wish of its members to transcend their isolation and make themselves heard at regional and national level. NGOs have realized that matters of policy are beyond the scope and competence of any single one of them, and that they must combine forces to achieve an impact.

With respect to the first two factors triggering networking efforts, most of the networks in the cases presented in this book show a remarkable degree of similarity. With respect to their involvement in the policy debate, however, there is more diversity. CAME and the Red de Agricultura Ecológica (RAE), in Peru, aim explicitly to contribute to the debate. Other networks, such as ALIN in Africa and those in Tamil Nadu and Pondicherry States of India, seem to put much less emphasis on this, at least for the time being.

To sum up the answers to my first question, networking efforts appear to be triggered when three perceptions are widely shared by NGO leaders, staff and clients:

- A lack of access to the knowledge of others is hampering effective performance and causing specific problems.
- At a deeper level, there is a need to gain a more comprehensive and more subtle understanding of the complex problems NGOs are dealing with, and to create new ways of supporting grass roots development.
- The experiences of NGOs at grass roots, and the interests of the poor on whose behalf they work, need to be voiced at national (or higher) level, in order to contribute to the formulation of more effective development policies.

The first perception leads to the wish to *upgrade* the performance of NGOs through collective action. It leads networkers to emphasize the sharing of ideas and experiences, whether through meetings, communications technology or documents. The second impression leads to a wish to move *upstream* in terms of both analysis and activities. In so doing NGOs question the very relevance or efficacy of field operations themselves, 'reaching beyond the evident consequences of the problem at hand to address its source', as Korten puts it (p.25). This process emphasizes shared diagnosis, reflection, the making of sense and meaning, and coordination at a strategic level. The main concern is to achieve a better paradigm of development—a challenge seen as beyond the powers of any single agency acting alone. This need emerges especially clearly now that NGOs carry major responsibility for developing more sustainable alternatives to the conventional chemical-based technologies that have dominated agricultural development in recent decades. Accordingly, the third impression leads to what may be termed an *upshift* among NGOs. In shifting the focus of their activities, NGOs give expression to the need to articulate alternatives and lobby for them through the media and in the corridors of power.

All three U's reflect, in one way or another, the desire to improve the quality of NGO work and the contribution NGOs make to rural development. However, each network reflects a specific blend of these ingredients. From local networks of service-oriented NGOs, interested mainly in the practicalities of upgrading their performance, to global strategic networks, concerned almost entirely with advocacy and directing their efforts to a specific cause, no two networks combine them in the same way or to the same degree.

What makes networks last?

Why do some networking activities lead to the establishment of institutionalized networks, while others do not? Many networks have been designed and initiated but have quickly petered out as the initial momentum was lost and (prospective) members reverted to business as usual. Yet many survive, and it is these 'sustainable' networks that can teach us lessons about the conditions under which networking activities become more institutionalized and less casual.

Before going into this, we have to deal with the often heard argument that networks function best when they are informal and for that reason no attempt should ever be made to institutionalize them. This is exactly why we have to distinguish between networks and networking. Every individual, every organization engages in building relationships with others, that is to say in networking. Most of these relationships remain informal—personal and rather subject to chance. Some, however, acquire such relevance to the life and work of the individual and the institution that these decide to formlize them in order to guarantee them a more permanent future and a 'place' in the institution's life, including, perhaps, offices and other facilities. Arguing that networks should always remain informal is akin to saying people should eat, but never build a kitchen.

Formal networks, then, are neither a prerequisite to, nor the necessary outcome of, networking activities. Under what conditions do networking relationships become more permanent and take the form of an institutionalized network?

For the NGO networks described in this part of our book, a first condition is that many people must share the view that networking will add value to their work. These people, moreover, must be in a position to articulate such views and to develop a mission for the network. This means that the organizational mechanisms for formulating a shared mission must be in place. That is, the question of who may or may not be a constituent actor, having the right to co-determine the ground rules or constitution of the network, has to be answered, and a procedure agreed upon for developing a shared perspective, or a 'theory of poverty' as Tim Brodhead puts it (quoted in Korten's paper in this book, see p.25). Often such questions are not dealt with very explicitly by those constituting a network. And as most networks start off very informally, they do not have to be. Networks tend to evolve around a closely knit group of charismatic leaders. Initially at least, they determine who is 'in' and who is 'out', and set the agenda for network activities. However, when networks become larger, the need to develop more transparent and more broadly participatory ways of taking such decisions arises.

This brings us to a common point of origin for all formal networks. They start with a phase of planned activism on the part of a 'motivator group', as Manrique et al call it—a phase in which, first, ideas are exchanged, then a few trial activities lead to recognition of the value of sharing with others, then one or a small group of enthusiastic 'prime movers' promotes the idea of networking and, finally, a meeting with prospective network members is organized. During this phase, a lot is done, but often in a rather unplanned fashion. The outcome is usually a workshop or a meeting at which, among other things, the idea of forming a network is discussed and agreed on.

The extent to which this phase can be spontaneous and unsystematic depends to a great degree on the scale of the operation. While national and even regional NGOs may organize for a network in a very informal way, for international efforts such as El Taller it tends to take years of programmed activities to prepare the foundations for the network. Yet, though the scale differs, the mechanisms seem pretty much the same: the combined efforts of a group of prime movers, network facilitators and prospective members lead to the formulation of ideas, plans and activities which eventually result in the establishment of the network. Prime movers are the people, generally leading members of respected NGOs, who create the idea, the vision on which the network is to be built. Network facilitators are those who, by virtue of the space and time allowed to them by their own organizations, engage in actual networking—organizing and supporting a first set of activities closely attuned to the needs and wishes of the prospective members of the network. In some cases prime movers and network facilitators are the same people. Mostly, however, facilitation is the function of an embryonic secretariat attached to one of the prime movers. The planned activism phase always requires a direct or indirect sponsor to cover at least some of the operational costs.

During this phase a number of issues arise. First, the importance of communication and participatory methods is directly felt by the participants. If the network is to embrace a wide group of NGOs and their staff, these must participate intensively in the formulation of its objectives and the organization of its initial set of activities. Often, this is easier said than done. For those working in isolated rural areas, especially, taking the time to share ideas with others working elsewhere and developing the habit of doing so is, however enriching, far from axiomatic. Networking must compete with other activities on an already overcrowded agenda. And there may be severe communication problems, even with the next-door village, let alone across national or regional boundaries.

A still more difficult but essential task is the development of a shared conceptual framework which facilitates the exchange of ideas and experiences. Kolmans, in describing experiences in Peru, notes the unrealistic goal setting and the extensive theoretical discussions that took place during the first year of preparations But he also indicates why these were necessary: to overcome ignorance on the topic of environmentally sound agriculture among prospective members; to 'work through' one-sided viewpoints, such as the idea that all that is traditional and Andean must be sustainable; to integrate a social science perspective into the technology generation process; and, last but not least, to convey to donors and other potential supporters the actual needs of rural people. In my view, what Kolmans is referring to is a classic case of 'making sense' of the idea of setting up a network—checking the real need for it, defining its potential to support its members, adapting the basic concept as more people provide ideas and inputs. This process takes a lot of time, yet it is an essential preparation for the network to be. It transforms a set of diverse people and organizations, each with a different opinion and an ill-defined sense of common purpose, into a like-minded group with many interlocking relationships and a shared perspective, thereby enabling them to start learning from each other.

This process of acquiring a common understanding and a shared purpose or mission is in all cases linked closely to the existing activities of prospective members in their respective areas. The immediate needs arising from the field work of each of the founding institutions provide the network's basis and its raison d'être. From the very beginning, the network is intended to support the work of the NGOs involved. Only if this support, or the potential for it, is directly perceived by members can they assess the added value of networking and set this against their other obligations. And only then can the principle of reciprocity apply. Or in other words, as Manrique puts it in describing the CAME experience, if an NGO fails to contribute to the network, 'there is no networking, no network'.

The phase of planned activism is possibly the most difficult phase for a donor to support. Because no shared frame of reference, values and discourse have yet been developed, the network, in so far as it exists at all, will not be able to articulate its processes, services and products in a satisfactory way for an outside audience. What is needed during this phase is sponsorship—the provision of seed money from an institution that is prepared to be a prime mover without interfering too much in the detail of plans and preparations. Rather than 'knowing' the network is going to be a success, the sponsor should be open-minded, believing or hoping that this will be the case. The provision of seed money by ILEIA to support the nascent Tamil Nadu network is a good example of sponsoring.

An old Dutch proverb seems to fit network building nicely: 'a good beginning is half the job'. To succeed, networks must have firm foundations. These are best laid not by pushing things along as fast as possible but by taking one step at a time.

To sum up, from the cases reviewed here, the following factors appear critical to the successful establishment of formal networks:

• Planned activism, facilitating and supporting (*never* replacing or ignoring) the existing activities of members.

• The will and the opportunity to discuss, negotiate and agree on the mission of the network in a way that is transparent and agreeable to all or most of the prospective members.
• A cast of actors, including prime movers, network facilitators, prospective members and sponsors, willing and able to carry the networking process through its initial, ill-defined phase.
• Broad participation of prospective members in the design and implementation of initial activities.

What activities characterize networks?
Networks span an enormous range of activities: from field trips to communication by satellite or electronic mail, from project planning to education and training, from editing a newsletter to organizing a conference, from lobbying ministers to admonishing a member for the late delivery of data, to name but a few. This is one of the reasons why it is hard to define networking as a phenomenon. Since the activities of many networks are discussed and illustrated in detail in the different contributions to this part of the book, I will not repeat them here. Instead, I would like to try to categorize them.

I suggest that networks generally concentrate their efforts in four clusters of activities: the provision of services; learning together; advocacy; and management.

The provision of services refers mostly to information and training. In providing or commissioning services, the network seeks to make optimum use of the capabilities and facilities of its members, supplementing these with inputs from elsewhere when necessary. A needs assessment and/or a diagnosis of strengths and weaknesses among network members often serves as the starting point. Typically, the network secretariat is attached to the member organization considered most capable of running its most important services. The service function is supported by what might be called the network communications infrastructure. Almost all networks have a newsletter, which acts as a major vehicle for the exchange of ideas and experiences. Documentation and library services are often provided as well, as also is the development of training materials. Publications are not limited to the proceedings of events, nor to technical matters and development issues. Methodological and project support documents are often a high priority as well.

Services may expand into other domains, including technical consultancies (as in CAME), product certification (as in RAE), or the coordination of input supplies (as in ACDEP). The common denominator in the services provided by networks is their responsiveness to members' needs. In addition to the general emphasis on training and information, network-specific packages of services may therefore evolve.

Learning together embraces all the joint activities undertaken to raise members' level of understanding of the complexity of development problems. These may include mutual appraisals, exchange visits, workshops and other meetings. Sometimes permanent working groups on specific topics are formed. The emphasis varies from network to network, but common elements are diagnosis, exchange, comparison and synthesis. Many networks stress, as ALIN does, the importance of visits and workshops, not as ends in themselves but as the starting point for reflection. Diagnosis and the making of an inventory of available technological and methodological options are often part of the process. CAME and RAE aim for gradual synthesis, and the standardization of scientific and technical approaches may also be involved (although this is more typical of research networks).

Advocacy refers to those activities performed or facilitated by the network on behalf of its members and clients that enable them to participate in the public or government debate about development policy. It is the defence of the interests of members and clients, particularly when these are, or were previously, disadvantaged members of society. Advocacy involves the network in formulating proposals on contemporary development issues and voicing these to government and/or in the public media. The network may also organize conferences on controversial issues, contribute articles to scientific journals, or distribute relevant publications to key decision-makers. Coalition building with relevant parties from outside the network, or with other networks, is often on the agenda as well. The advocacy function of NGO networks is not currently as widespread or as transparent as their learning and services functions. For example, NGO leaders chose not to include advocacy among the tasks of the El Taller network, feeling that political lobbying was something that had to be done by individual members, on a case by case basis.

However, as Korten (p.25) points out, the theory and practice of strategic networking is making considerable progress among NGOs at present. And there is indeed a potential for conflicts of interest between a service orientation and the advocacy function. Yet this need not be a matter of 'either/or'. Advocacy and services are two sides of the same coin. How could we possibly do without either of them? What does seem to happen in the more permanent networks is a greater emphasis on the services and learning functions, particularly during the early stages of network development. The dedication to advocacy in a network is very much a matter of the personal choice and initiative of its leaders.

Finally, the management function consists of facilitating the networking process. This includes maintaining or improving its communication infrastructure, overseeing its operating procedures, monitoring its resources, activities and outputs, and linking with other organizations and networks. Without going deeply into this function, many aspects of which are discussed in detail in other papers, let me point out some common characteristics of network management today.

First and foremost it is important to emphasize what is *not* being done under the management function. Networking secretariats are kept lean, delegating as many tasks as possible to member organizations. The decentralization of functions and the autonomy of members is emphasized continuously. A directory of members and their organizations is often among the first fruits of a new network. It is generally motivated by the wish to facilitate networking without having to go through the secretariat. The network facilitators' mandate usually stems from a meeting of prospective members who decide to initiate a more formal networking process, but it is generally a mandate to advise and support, not to organize and command. Most networks decide not to engage in the management of funds for members, however expedient this may seem at a certain moment. In the words of Manrique (p.167), this can turn the network into a 'battlefield for acquiring money'.

It seems important to define clearly the composition, responsibilities and prerogatives of the network board, secretariat and, if applicable, implementing bodies. The degree to which the secretariat or hub of the network should engage in implementing activities itself is an issue that frequently arises. Whether formal rules should replace the largely unwritten rules that govern operations during the early stages also tends to be an issue. Although it is difficult to generalize, experience suggests that a degree of formality is desirable in larger, older networks, and that the secretariat should have a mandate to take decisions on membership, on the provision of advisory and other services, and on monitoring and evaluation issues, particularly where these are sensitive.

Even if network activities are mostly delegated to members, they still require time and money. The moment networks become more permanent, therefore, the issue of fund raising comes up. During the early days, prime movers free up the energy and other resources required for networking from somewhere else, often from within their own programmes. Donors enter the scene only when the contours of the new network have already been delineated. This means that during the early stages exchange and communication is often limited to those who are able to provide the necessary facilities and funds themselves. This limits the participatory process precisely at the stage when broad participation appears most desirable, even mandatory. Sponsorship during the early stages can thus make an important contribution to ensuring broad initial participation.

How do these four categories of network activity help us in understanding the networking process? From the above analysis I conclude it is particularly the emphasis on learning together that sets successful NGO networks apart. Networks, as it were, are 'learning organizations' by definition. They are designed and operated to break down isolation and facilitate social learning processes among actors within the development arena, to achieve a more comprehensive and innovative understanding of complex development situations. In evaluating network performance, it is therefore appropriate to pay special attention to the quality of the learning process.

Evaluating Network Performance

The value added by networking

What is the value added to development through networking? What impact does it have on NGO performance? And how can we measure it? Does networking have a direct impact of its own, or only an indirect one, through improving the impact of network members? We are as yet far from being able to answer such questions convincingly. The study of networks among NGOs, and their effects on the work they do, has only just begun. Hence, opinions vary widely between supporters and critics of networking.

To be able to answer such questions more systematically, the first thing we ought to do is to set a standard, to state what we expect networks to contribute. This is what all networks do for themselves, but no universally applicable formula has evolved so far. What follows is my contribution as a first step in this direction. This is, however, only a first attempt, a contribution to the discussion rather than the definition of a detailed standard at this early stage.

As we have seen, NGOs and their leaders are motivated to network because it helps them to improve their operations. If we take this as a point of departure, we may look at networks of NGOs as 'quality circles', designed and operated to sustain and raise the quality of our work, outputs and impact. This is exactly what networks ought to be. Networks are successful when they help us improve our performance. If they do not, they collapse under the pressure of our other day-to-day obligations. Such a contribution to performance can be of a temporary or a permanent nature. So not all networking activities become permanent or institutionalized. Yet, if they do, it is because those investing in the network expect its contribution to performance to continue.

Following the analysis presented above, networking efforts can be evaluated against their contribution to the three U's, as follows:

- They may help *upgrade* the quality of the activities, outputs and impact of member NGOs, by providing mutual support and services on the basis of a joint assessment of needs.
- They may facilitate a collective learning process among their members, helping to move the analysis of development problems *upstream*.
- Networks may contribute to an *upshift* of NGO activity, redirecting it towards national and international audiences.

Finally, networks may also be expected to incur costs for developing, administering and evaluating networking activities. These are the only overhead costs associated with network operations per se.

There is no reason why we should not try to be as rigorous in evaluating network performance as we are in evaluating NGO performance in general. Donors rightly expect any network they fund to specify its expected outputs and impact, and to define indicators for measuring these. However, at our more general level in this paper we will focus mainly on the nature of networks as instruments for learning together, for helping NGOs in the permanent reformulation and adaptation of their role with respect both to the rural poor and to government institutions. Taking the above criteria as a starting point, I feel we may be able to do just that.

A framework for self-evaluation

As a first attempt, we may formulate a framework for evaluating network performance and impact, as summarized in Table 1. The table presents possible indicators for assessing network achievements for each of the four criteria outlined above. I suggest retaining a distinction between performance and impact, the latter word being reserved for the ultimate impact of the network on the lives of its members' clients. Performance, then, means the contribution the network may make towards improving the effectiveness, efficacy and efficiency of members, or in other words their ability to achieve an impact. The performance of the network is to be the prime focus of evaluation, not its ultimate impact. This must be so because the latter is hard to measure, as a Dutch NGO impact study illustrated recently (de Wilde et al, 1991). The difficulty lies in separating the effects of networking on impact from the effects of members' other activities. In addition, as we have seen, it is the quality of the learning process created by the network among its members that determines to a considerable degree whether the network will succeed or not.

In formulating both performance and impact indicators I have used the terms efficacy, efficiency and effectiveness (Checkland and Scholes, 1991). Efficacy refers to whether the means we use (i.e. functional groups, savings programmes) actually work in producing the desired effect (i.e. use of improved farm technologies, better health care, or increased savings among the poor). Efficiency refers to whether the same results could have been achieved with fewer inputs, in other words the ratio of outputs to inputs. Effectiveness refers to whether our efforts and outputs have in fact contributed to achieving our longer term aim (i.e. the eradication of poverty).

In the following paragraphs I will briefly consider the main indicators outlined in Table1, saying why I feel them to be relevant.

Evaluating services

One of the prime functions of networks is to make optimum use of the resources available within member organizations to strengthen the performance and impact of other members. A joint assessment of strengths and weaknesses is therefore one of the first outputs we may expect of a network. The existence of a systematic needs assessment and a resource inventory (i.e. expertise and facilities), and their quality, may therefore be taken as an indicator of network performance. Obviously, both will need regular updating. The degree to which they are up-to-date and the frequency with which they are used by members will be important indicators of their quality.

The quality of the services provided by members of the network to others, or by the network organization to its members, should be the focus of continuous attention, adaptation and refinement. The evaluation may assess the 'closeness-of-fit' of services with the mission of the network and the needs articulated by network members, the frequency with which members make use of services, and the content of the services themselves.

A tricky issue in the provision of network services is the allocation of costs. Although the benefits of services can be clearly located with individual member NGOs, deciding whether to make individual members pay for services is difficult. It is not simply a matter

Table 1 A possible framework for evaluating NGO network performance

A. Main objective B. Main function	Network performance indicators	Network impact indicators
A. Upgrade NGO performance B. Services	• Quality of resource inventory and needs assessment • Closeness-of-fit of services with mission • Quality of services • Intensity of use of services by members • Allocation of costs	• Total change in efficacy and efficiency of members
A. Move NGO activities upstream B. Learning together	• Quality of joint learning processes • Coverage/distribution of learning experiences • Definition and transparency of technical and methodological standards • Clarity of analysis of development issues	• Total change in efficacy and effectiveness of members
A. Create upshift in NGO activities B. Advocacy	• Frequence and relevance of external contacts • Articulation of alternative development proposals • Increase in members' participation in public development debate	• Total increase in members' impact on development policy and debate
A. Network development and maintenance B. Network management	• Roles of different network actors in developing the network's mission and organizational plan • Relevance of participating NGOs to network's purpose • Design and operation of network communications infrastructure • Design and operation of financial and administrative structures • Quality of decision-making procedures • Efficacy and efficiency of secretariat or facilitation unit(s)	• Effectiveness of network operations

of money, but also of time and good will on the part of the service provider. Moreover, the people and organizations who most need a given service may be the ones least able to pay for it. Within each network, therefore, decisions must be reached as to which services should be paid for through a general (membership) charge and which should be directly charged to users only. Evaluations should address both types of services, and the ways in which decisions on cost allocation were reached. A service that is paid for by users yet much in demand even by the least affluent members of the network is clearly a good service.

Evaluating learning together

Learning together lies at the heart of networking, yet it is the most difficult activity to evaluate. Most network members can tell you whether the network provides them with new ideas, stimulates them to learn and to try out new practices, but they will be hard-pressed to put their finger on exactly how it does so. Still, given the importance of this activity we will have to try to find appropriate indicators.

To evaluate learning together we will have to adopt a qualitative approach, looking at the process rather than seeking only to define the products. One approach could be to look at the settings in which learning takes place (Rap, 1992). How do network members learn from each other? Do they do so by working together, perhaps experimenting together, or by developing a policy document in a task group, by attending a course or workshop, by watching and discussing each other's practices during exchange visits, or by temporarily swapping jobs with each other, or even in a sort of apprenticeship, understudying more experienced staff in other member NGOs? Rap touches on another issue relevant to our discussion here: to what extent are visual, discursive and physical experiences part of our learning settings, or do we mostly concentrate on one of these only? The ancient Chinese distinction between hearing, seeing and doing, and the degree to which we can learn from each, also applies to networks.

An important part of the evaluation of learning together consists of assessing the degree of participation of network members in the learning experiences organized by the network. Is participation distributed evenly among the staff of different members? Does the network actively stimulate wider participation? And, if participation appears limited, is this for logistical or financial reasons, or do the subjects covered in learning experiences simply not relate to the needs of different member organizations as expressed in the needs assessment?

Two questions can be asked which may be considered apt for a more product-oriented evaluation. First, has the learning process led to a clearer definition of the technical and methodological standards to be set for NGO interventions? The degree to which a network achieves consensus in these areas may be one of the best ways of evaluating its performance. Second, have members achieved a better understanding and a clearer analysis of current development issues? Again, this should be an important output of the learning process.

Evaluating advocacy

Several indicators may be useful here. We could begin by looking at the type, relevance and frequency of the external contacts organized by the network. The degree to which the network succeeds in facilitating the formulation of alternative development proposals could also be examined. Lastly, the actual participation of network members in the public debate or in the development of government policies needs to be assessed.

Evaluating management

Networks have to be managed as learning environments, as a space for study and reflection. Management is to be evaluated in its role as facilitating rather than controlling.

The type of facilitation needed during different phases of network development, may differ greatly. To account for this, I distinguish three different phases : (1) planned activism, (2) creating social synergy, and (3) maintenance and development. The first phase, as we have already said, is the one in which the network passes from an ill-defined sense of 'we should do something' to the formulation of a mission and a plan of activities. In the second phase there is more emphasis on facilitating interaction, activities are further developed and a communications infrastructure is created. During the third phase, the network has reached a certain maturity.

During the planned activism phase, network start-up is the key management objective. Evaluation may look both at the process and at its results or outputs. On the process side we may consider the role of participants in developing the network's mission and plan of activities. Broad, effective participation of (prospective) members is essential here. Only in this way will they acquire a sense of ownership of the network.

However, a network probably cannot come into being without a motor, that is to say an active secretariat or facilitating unit. That is why, in evaluating network experiences, the role of the network secretariat almost always emerges as an important theme. In the view of ALIN's organizers, it is one of the crucial issues. How much initiative should the secretariat take? How much leadership should the network staff show? Echoing the ALIN evaluation team, one might ask: is a network anything more than an information service run by a secretariat? In my view, we should not try to set rigid standards for participation during the early stages of network building, but we should study carefully the level of participation achieved and compare this with the available means and intentions of the network's prime movers At a more general level the roles of different actors may be assessed, including prime movers, sponsors, facilitators and prospective members, along with that of the secretariat. What contributions did each of them make, in terms of time, energy, ideas and, last but not least, funds?

On the output side, important issues for evaluating management during the planned activism phase are the procedures which have evolved for taking decisions within the network. How effective are these in achieving consensus on important issues? In addition, the clarity and focus of the network's mission statement can be studied. And we may also consider whether the NGOs included in activities at this stage are those deemed relevant to fulfilling the network's mission. Finally, the proposed outlines for the organization of the network, its finances, and its communication infrastructure can be studied, so as to gauge the progress made in building the network.

In the social synergy phase the participants build on the foundations laid during the planned activism phase. A more complex web of interactions between members evolves. Pilot programmes and activities are launched, and special problems are addressed through task groups. Crises are part of this phase. Evaluators should be aware of the role conflicts play in building up a healthy organization. Again, participation is fundamental, as is the effectiveness of procedures for achieving consensus.

During this phase probably one of the most interesting issues for evaluators, and for managers too, is the degree to which the management style of the secretariat and other facilitators stimulates or suffocates innovation and learning within the network. Those involved may wish to consult recent management literature on innovative or learning organizations. Decentralizing decision-making, stimulating broad participation, allowing space for dissent and managing conflicts are recurrent themes.

In the maintenance and development phase the core activities of the network are well established, its services operational, and its mandate and decision-making procedures well defined. During this phase, outputs and results can be described in more detail, and monitoring and evaluation become less qualitative and more quantitative. Quantitative indicators revolve essentially around the costs and benefits of the network, seeking to specify monetary and other outlays, and benefits in terms of impact on the work of member NGOs.

Understanding network impact

While the conclusions we may draw with respect to the efficacy and efficiency of networks are necessarily limited, this is even more true of their effectiveness. Evaluating impact would mean comparing the network's mission with the wider needs of society. How does 'networking for sustainability' help to bring about more sustainable forms of agriculture? We normally reply to such questions in the negative: without networking, what chance would sustainable agriculture have? It seems obvious to most of us, but this sort of answer will not convince the sceptics, who ask: aren't there better ways of achieving sustainable development than these endless conferences, workshops and discussions you people have? Even to people like me, who believe in the value of networking, it is obvious that the process needs a lot more thought. Social research into the effectiveness of networking should, I suggest, be a priority.

Conclusions

Networking among NGOs has increased over the past decade, particularly among NGOs active in the field of sustainable agricultural development. From the experiences presented in the papers that follow this one, we can easily see why: sustainable agricultural development requires a level of action and reflection beyond the powers of any single development organization.

Increasingly, too, networking experiences are documented, reviewed and analyzed from the point of view of performance. The papers in this book are but a few examples. It is a sign to those responsible for NGO operations and funding to take networking seriously. Networking is a valuable tool in the kit NGOs have at their disposal. Moreover, networks can be understood, facilitated, managed and evaluated systematically—although their full implications are not known to any of us yet.

A major effort is needed to develop better ways of designing, managing and evaluating networking activities. The evaluation process, in particular, needs to take into account the special characteristics of networks, which set them apart from other forms of human cooperation. The simple transplantation of monitoring and evaluation models designed for conventional organizations is not enough. Some interesting approaches to this challenge are found in Checkland and Scholes (1991). These have been further developed for sustainable agriculture and natural resource management by Bawden and his colleagues at the University of Hawkesbury, Australia (described in Wilson and Morren, 1990).

Finally, serious research into networking and network management may help to solve some of the critical issues which remain unclear: how pro-active can the secretariat be without suffocating the network? How formal must a network become to be permanent? At what levels should networks intervene, and how should networks operating at different levels relate to each other? What is the ideal structure of a network? What are the consequences of networking for the relationships of NGOs with other parties, notably the grass roots organizations they are working with? How should costs be allocated to meet efficiency criteria on the one hand and participation criteria on the other?

As I see it, research on networking will have to be on our priority list for some time to come.

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Survival under Stress: Socioecological perspectives on farmers' innovations and risk adjustments

ANIL K. GUPTA

Introduction

IT HAS BEEN suggested that it did not matter if the natural scientists did not interact with the farmers as long as they were developing technologies relevant for ecologically uniform and well endowed conditions such as irrigated plains areas. But, simulating on research stations conditions similar to the wide variety of production environments under which people try to survive in high risk environments is extremely difficult. As a result, most national and international centres of agricultural research recognise the need for on-farm research. Linking the context in which farmers' work, and the context in which scientists work –at station or at farmers' fields – requires precise understanding of the risk adjustment (RA) mechanisms evolved by different classes of rural producers.

We first present the socioecological paradigm in which household adjustment with risks can be studied in a multi-enterprise, multi-market context. In part two we discuss the institutional aspect of research on farmers' RA mechanisms. In part three we have presented a framework in which local/indigenous technical knowledge, and the experimental process of generating this knowledge, can be linked with formal research processes. Empirical examples drawn from historical studies in India, China and other parts of the world dating back to the second century BC are presented. Finally, a case is made for natural scientists to consider research on indigenous knowledge systems as a necessary complement of formal laboratory research. It is hoped that plant physiologists might find the innovations evolved by the farmers with regard to survival of crops/trees in high risk conditions worthy of formal testing before rejecting or accepting any innovation.

Farmers' experiments are not the only prime precursor of generating new technologies. The role of scientists in anticipating future needs of marginal farmers and generating technological options will always remain. However, indigenous knowledge can make in generating at least a few *new* relationships among *old* variables. Some ask. that if extraordinary contributions in farmers' own experimental repertoire, was so strong, why would there have been so many famines in olden times? Our reply is twofold: (a) famine induced distress was not always due to net decline in food availability, a thesis quite popular now; the political economy of 'entitlement', that people lose, may make all the difference. Thus famines may have been caused even when enough food existed; (b) over the years, the excessive emphasis the 'lab-to-land' approach has reduced the appreciation in the minds of the scientists of farmers' risk adjustment strategies. Moreover, massive relief-oriented policy of providing succour to drought affected people, also weakened their self-reliance. Instead of strengthening markets, public delivery systems and local R&D in such regions, we have relied on using famine prone regions as a cheap source of labour (NCDBA 1981). Arguments in this study should be seen in the light of mutual learning, linking formal and informal R&D (Biggs 1981; Gupta, unpublished) rather than one substituting for another.

Part I: socioecological paradigm for household survival under risk

Several studies on the subject of farmers' adjustments with risks have shown a multi-market multi-enterprise approach to survival (Jodha 1975, 1979, 1985, Gupta 1981, 1986, 1987, Spitz 1979, Wisner 1986, Torry 1986, Turton 1985). These studies are reviewed elsewhere (Gupta 1984, 1987). Here we first define the terms and then discuss the socioecological perspective. The multi-market approach implies that farmers tried to adjust to the risks through simultaneous operations in factor and product markets. The factor markets imply land, labour, capital, and information, the product markets imply crops, livestock, and trees, including various technologies of land water use. The higher the amount of risk in the environment, the greater is the dependence between the decision made in one resource market with the other. Also these links are important in developed regions. The difference is that many imperfections in markets in the developedregions can often be offset through market mechanisms.

The multi-enterprise framework implies that farmers' adjustments with risks cannot be understood by concentrating on any one enterprise such as crops, livestock or trees at a time. The 'Four S model', linking Space, Season, Sector and Social stratification given below will further clarify the multi-enterprise focus. Each dimension can be dichotomised for ideal typing purposes. For instance, a 'space' can be dichotomised in terms of population density, or low lands and high lands, or undulated and plain topography. 'Sector' can be dichotomised as agriculture or industry; public or private; specialised or diversified; single crop or diversified crop region; cash crop or food crop.

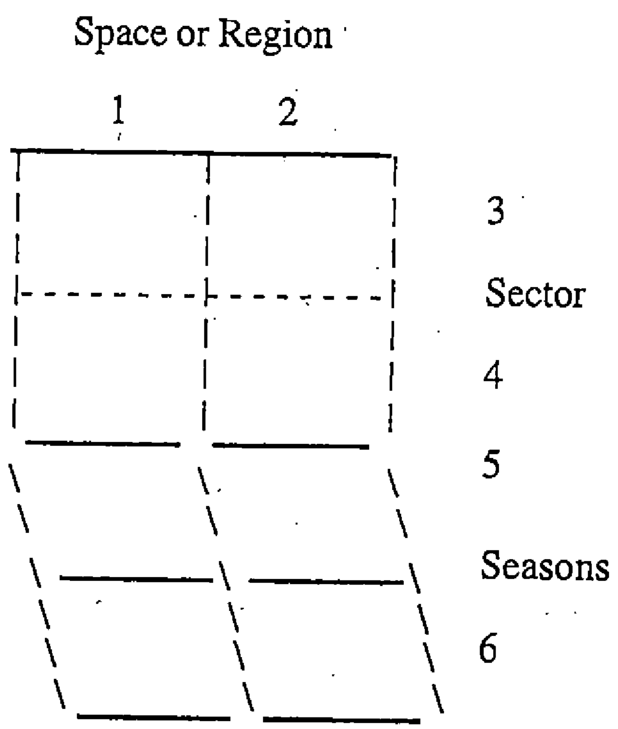


Figure [illegible].1: *The 'Four S model'*

'Season' can be dichotomised into uni-modal or bi-modal rainfall regions, arid or humid, low rainfall or high rainfall, low seasonality or high seasonality region.

Given any two parameters, the third can be anticipated. For instance, in a region with low population density and high seasonality (*i.e.*, low rainfall), the sectoral characteristics are expected to be intercrops. Likewise, household rather than being dependent on any one enterprise such as crops, livestock, trees or labour, may simultaneously pursue many of these activities at the same time. The social stratification in such regions is expected to be quite different compared to the regions with high population density, low seasonality and specialised sectoral activities involving only one or very few enterprises, In the former case, households may draw assurances from kinship and extended family networks in order to hedge risks. Thus we may find in high risk environments a preponderance of non-monetary exchanges, pooling of bullocks, and implements. In this manner the farmers try to deal with differential demands for draft power, or inputs in different villages or plots at different points of time due to the erratic nature of rainfall, through informal social and economic networks.

As we will see with the help of the socioecological paradigm illustrated in Figure 32.2, the interactions between space, season, and sector generate a range of choices which are not equally available to rich and poor farming households. Understanding of these differences may help natural scientists in developing technologies which will either be amenable to easy adaptation by farmers or will make minimum demands on the system in the short run. In developed regions no such constraint is needed to be taken into account because of strong market forces. Therefore, if a technology required several inputs simultaneously and in a particular proportion, it would not be difficult to organise that in well endowed regions.

The plant architecture cannot be divorced from social and institutional architecture evolved in a given region in a historical context The socioecological paradigm involves two assumptions: (1) ecology defines the range of economic enterprises that can be sustained in a given region; (2) the scale, at which different classes of rural producers manage each enterprise depends upon access of households to factor and product markets, kinship networks, public and other relief mechanisms, and common property resources (such as common grazing land, water tanks, and tree groves).

The asset portfolio is a mix of enterprises which evolved in a given ecological region and resulted in specific production conditions. These conditions could be understood with the help of a mean and variance matrix as shown below.

Households having portfolios with low mean productivity with high variance in output would be most vulnerable. Historically, the extent of poverty has often been most intense in regions, where low mean/high variance is the dominant characteristic of the portfolio. We will discuss in the third section the survival under such conditions of high risk through experimentation and innovation by the farmers.

Reverting back to the socioecological paradigm, we notice that the time frame and the discount rate chosen to appraise the investment choices depends upon (a) the portfolio characteristics, (b) the access to kinship networks, (c) access to intra and inter-household risk adjustments and (d) communal and public RA options. The time frame has a bearing on the sustainability of a technological choice. The shorter the time frame in which households or even the

Variance \ Mean Return	Low	High
Low	Low varieties of millets, cattles, long gestration multipurpose tree species, etc.	Mexican varieties of wheat, well adopted small scale vegetable cultivation
High	Pulses, oilseed, crops, sheep herd, etc.	Crossbred cattle, hybrid varieties of millets, cotton, other cash crops, etc.

Figure 2: *The RA feedback mechanism*

scientists appraise their choices the less likely it is for technology to be sustainable. The discount rate indicates the way future returns from present investments would be converted into a net present value. The more uncertain the outcome, the higher may be the discount rate. The certainty itself may depend upon (a) the previous experience with a particular enterprise/crop, (b) immediate past experience, (c) successive losses or gains, (d) accumulated deficit or surplus in the household cashflow, (e) future expectations of returns, and (f) the complementarity between other assets/enterprises and the proposed investment.

The intra-household RAs include asset disposal, migration and modified consumption. Inter-household imply tenancy, credit and labour contracts. For further details see Jodha and Mascarenhas (1983). The communal RAs include reliance on common property resources. The public relief mechanisms include employment programs as well as aerial pesticides sprayed against pest or disease epidemics.

The result of various RA strategies available to different classes of households may reflect in some households having deficit/subsistence in the budget while others having surplus in the budget. This would have a bearing on the stakes different classes have in the sustainable ecological balance in the given region. This would finally feedback as shown in Figure 32.2 into the portfolios of economic enterprises evolved by different classes.

The purpose of the above discussion is to understand the macro (Four S model) and micro (Socioecological paradigm) context of household decision making in high risk environments. This will provide us with a basis for analysing the institutional contexts in which research on peasant innovation may or may not be done. This will also help us relate the principles of homeostasis as evolved in plant physiology and the socioecological systems.

Homeostasis

The plant physiologists generally define homeostasis at two levels, developmental and physiological. The former deals with adjustments made by plants at different stages of growth while the latter refers to the concurrent adjustments at any particular stage of growth. Likewise, farming households can make adjustments concurrently or over time depending upon the nature of contingency and their repertoire of risk adjustments.

Institutional contexts of research on farmers' risk adjustments

The detailed evidence with regard to this aspect is presented elsewhere (Gupta 1987a, b). We summarise here some of the most important findings which may be of interest to the natural scientists in so far as these may influence the future resource allocation in this direction.

In 1941 Saver recommended 'that the improvement of the genetic base of agricultural crops be predicated on an understanding of the relation of such work to the poorer segments of the society' (Oasa and Jennings 1983: 34). In India more than two decades ago Y.P. Singh pioneered two of the earliest studies aimed at unravelling the traditional farming wisdom regarding animal husbandry practices. A decade later, another study was initiated to understand indigenous dry farming practices (Verma and Singh 1969). Review of post-graduate theses in five disciplines from more than two dozen universities and colleges during 1973 to 1983 did not reveal any other research on similar subjects. Perhaps the contempt for farmers' knowledge is far too deeply embedded in the very structure of formal research institutions. Some of the important factors influencing perception of farmers' practices may be summarised here:

- A considerable body of knowledge has accumulated on the linkage between formal and informal R & D (Biggs and Clay 1981; Gupta 1980, 1981; Richards 1983; Rhoades 1984; Chambers 1985, 1987; Verma and Singh 1967; Bush 1984). Still the formal scientific institutions consider research on farmers' practices/survival strategies as something non-glamorous. Perhaps the peer pressure, the monitoring system in the research bureaucracies, the norms of accountability of the scientists towards various constituents and the inability of a majority of the social scientists to act as a bridge between farmers and the natural scientists may all contribute towards this problem.
- There has been an excessive bias in the technology generation process towards individual household oriented alternatives. The common property resource oriented solutions have generally been neglected. For instance, if cooperation in terms of sowing time of a crop could influence the pest build up and eventual intensity of crop damage, then research on such alternatives should take precedence over individual level pest control. Even otherwise, pests cannot be controlled at the individual level efficiently in the long term. Likewise soil and water conservation and consequent availability of moisture at critical stages of crops through common property resources such as farms, ponds, or other means of watershed management call for collective choice alternatives. Historically there are examples of such cooperation amongst farmers for a specific technological alternative.
- Single disciplinary research could deliver some results when technologies for low risk and well endowed irrigated regions were to be developed.

However, the need for inter- and cross-disciplinary research for dry-farming areas does not need to be emphasised. The management principles which determined or influenced the formation of teams around riskier problems may not be the same as would be the case for easily predictable or less risky problems. How do we build teams to work on farmers' problems when division of responsibility cannot be very precise along disciplinary or functional boundaries?

- Another implication of crop-livestock-tree interactions is not only to have convergence in breeding, and other technological objectives, but also to take into account farmers' survival options while giving primacy to one or the other consideration. For instance, studies have shown that 'present trends in plant selection may be by-passing two important trade offs in the objectives of the farmers, i.e., fodder content of cereals or millets and lignin content of cereal stalks which affects bio-degradation in the soil and has implications for soil fertility' (McDowell 1986). Likewise recent studies have shown that most of the technologies even in dry farming areas are appraised only on the basis of grain yield rather than on the basis of both grain and fodder yield and quality. The data are collected on the entire biomass but are not used for the purposes of screening the lines.
- The purpose of extension in most agricultural universities has become merely to extend knowledge from lab to land rather than vice-versa. Our contention is that given the weak social science departments in most agricultural research institutions there is no substitute to direct interactions between natural scientists and the farmers. We also believe that biological scientists can learn social science concepts far more easily than otherwise.
- The socioeconomic class background of the scientists has some bearing on their perception of the farmers' problems. We do not suggest that scientists with low-risk backgrounds would not be competent to do research on problems of small farmers in high risk environments. However, there may be a tendency on the part of such scientists to consider basic problems as lying with the farmers, banks, and extension systems rather than with the technology itself. The implication is that reorientation of research priorities would require taking note of these worldviews so that alternative perspectives can be better argued. In general, far more scientists perceive farmers'.innovations than the ones who decide to work on them.

The scientific context of research on farmers' innovations as are biased towards certain tools and techniques. As Richards (1983: 15) suggests, scholars are sometimes guilty of presenting peasant knowledge as practice without theory. In a historical account of Indian science and technology in the eighteenth century it was noted that many of the scientific discoveries being made in Europe were preceded by the actual farming practices based on the same principles in India (Walker 1820). What are the processes which snapped the link between technologies evolved by the farmers and the researchers who tried to derive a scientific basis for the same? Why did formal research systems in developing countries neglect their own reserve of ancient peasant knowledge? Is it not possible that farmers sometimes may do the right things for the wrong reasons? If so, how do we discriminate ritual from rationality? Is there no comparative advantage in tropical countries with so-called backward agriculture in high risk places?

In the next section we review some of the contemporary as well as ancient practices evolved by the farmers in high risk environments. This may help us in reinitiating a process of reverse transfer of knowledge and concepts. This may also help in building bridges between what farmers know and demand and what they do not know and therefore cannot demand. We have argued elsewhere (Gupta 1987a) that no farmers had demanded dwarf wheat simply because they never knew that such a plant type was possible. The role for supply side interventions by the scientists cannot therefore be ignored or under-played. At the same time what we are suggesting is that in high risk environments because of the complexity inherent in the farming systems the close interaction between scientists and farmers may be far more productive and efficient.

Perception of peasant innovations

In a recent paper (Gupta 1987c) we have tried to understand the barriers to scientific curiosity with regard to perceiving the peasant innovations but not subjecting them to scientific/formal scrutiny.

While arguing for transferring science and not just the technology to the farmers we have suggested the need for abstracting the science underlying farmers' practices. Any value added to such knowledge when transferred back would have far greater diffusion potential. The problems of classifying peasant innovations and building a theory of innovations for survival are beyond the scope of this article. We do however, review some practices which may hold the key to the issue of survival under risk through experimentation and innovation.

Chinese knowledge in the first century BC and the sixth century

An extremely rich account of farmers' knowledge existing in the first century BC (Sheng-Han 1963) and the sixth century (Sheng-Han 1982) provides instances where research on peasant innovations may extend the frontiers of science if pursued properly. We summarise some of these practices derived from these two sources.

- To get drought tolerant plants the seeds of the cereals could be mixed with a paste of excrement of polyvoltine silkworms with melted snow; *after five or six days when the excrement becomes well softened rub it between hands* (Sheng-Han 1963: 13).
- The treatment of seeds in extract of certain types of bones from which a decoction is obtained helps the seeds withstand stresses better. In case the described bones are not available the boiled steep of silk reeling basins may be used. When the rains fail in the sowing season of wheat, treatment with sour rice drink (lactic fermentation of cooked rice steep) may help the wheat to become drought resistant while bombyxine excrement may help in the wheat cold tolerance.

While commenting upon practices of these types Sheng-Han (1963: 59) suggests that high content of calcium carbonate in bombyxine excrements is mixed with lactic and acetic acids produced by fermentation of sour rice-grain.

These acids dissolve the calcium carbonate forming a solution of calcium salts of organic acids. Drawing upon the work of Henckel (of the Timiriazeff Institute of Moscow) it was found that wheat corn treated with a solution of $CaCl_2$ enhanced the drought resistance of wheat seedlings. The author has suggested the prescription by Sheng-Chih of treating wheat corn with organic calcium salts given in the first century BC might have the same effect.

The seed treatment rather than the soil treatment has been analysed from another angle. Excrement of the silkworm was very hygroscopic. While sowing the seeds of millets side by side with the excrement of silkworms, it was thought that the soil in the immediate vicinity of the seed might get enriched by moisture through vapour condensation from atmospheric air. This might improve germination ability. Further, bombyxine excrement contained quite a good amount of easily available potassium, nitrogen and phosphorous together with auxins and vitamins derived from mulberry tree leaves and a host of microbial action. Perhaps under suboptimal temperature and humidity such an inoculation of microbes and the nutrients of the darkness triggered the physiological activities. Perhaps the temperature and the moisture would then rise to the optimal level. The soil surrounding the seeds is expected to undergo changes favourable to the growth of the young radicals.

The author has critically analysed the significance of melted snow as a substitute for bone decoction while treating the seed. In arid Northwestern China, water from the river and particularly from the well was heavily charged by soluble salts present in the soils. Perhaps the sodium and magnesium salts available there might have some undesirable effect on the soil microbes and the seeds. The melted snow would obviously have a far lower content of salts and thus be devoid of harmful ions. The author has strongly recommended further experimental tests of these speculations.

- The bombyxine excrement when mixed with seeds of spiked millet is assumed to protect the millets from insects and other pests.
- To prevent the frost injuries in spiked millet it is advised to look at the night temperature 80–90 days after the sowing. If frost or white dew was suspected, two persons facing each other could drag a rope horizontally right through the crop to remove frost or dew. This should be stopped only after sunrise.

Interestingly, precisely this practice of taking a rope or even a bamboo pole through the nursery of paddy in the early hours of the day was noted in Bangladesh. The explanations offered were to protect the rice from the frost but more importantly to provide dew to the roots of the plant. It does not need to be mentioned that formal research on physiological aspects of such a practice had not been initiated in Bangladesh and for that matter in other countries as well.

- Drawing upon the work of Yao Shu compiling a sort of agricultural encyclopedia as of the sixth century, several suggestions have been given for linking the type of bone decoction to be used for treating the seeds *vis-à-vis* the type of soil. For instance for red hard soil the bone decoction of oxen has been suggested, whereas the decoction of the bones of hogs has been suggested for sowing in the clay soil. Research on the effect of gelatinous coats and the salts on moisture absorption and microbial activity remains to be seriously pursued.
- Extremely meticulous recipes have been given for preparing the shallow pit manure for growing melons and other crops.

In a study on indigenous knowledge of women around homestead production in Bangladesh we had found a similarly rich variety of manure compositions.

Chinese philosophical thinking very strongly underlined harmony of three cardinal factors, proper season, proper soil and proper human efforts, similar to our Four S model. While much more work remains to be done on the subject we will now review some of the practices noted in our own work in India.

The contemporary Indian experiene

We may add here, that there is a vast inventory of practices recorded from different parts of the country including both drought and flood-prone regions. These are a few examples to underline the importance of generating hypotheses from farmers' practices for formal research.

- *Early planting of gram* During field work in 1985 in collaboration with Hiranand and Mandavkar as a part of our study on Matching Farmers' Concerns with technologists, Objectives in Dry Regions, we studied the issue of farmers' innovations and their recognition or lack of it by the scientists. In some cases we took examples of so-called irrational practices of the farmers from interviews with the scientists. And we pursued with farmers a more in-depth explanation of their rationality.

  Early planting of gram was reported to make it more vulnerable to wilt attack. Sowing was begun in the month of October and the main factor taken into account was soil temperature. The method of taking soil temperature varied in different villages at a small distance in the area of the study in Western Haryana. Soils in the village of Kasoli were predominantly loam rather than sandy loam. The soil temperature was noted by walking bare foot at noon time or by smelling the odour which emanated when water was dropped on the ground while drinking. In other villages another indicator, the rising of dust in the evening when animals returned after grazing, was investigated. Some other farmers felt that blooming of certain plants or sighting of certain birds could also indicate the appropriateness of the temperature. A farmer proposed a counter hypothesis about wilt attack and early sowing of gram. He felt that gram sown early might yield higher despite higher vulnerability to wilt attack because grain setting was completed by mid-February. By this time the strong winds or increase in temperature might affect the crop adversely.

  It is possible that none of the hypotheses mentioned above may be valid even if practice was still considered to be useful. The issue is not whether hypotheses derived by the farmers would prove superior to the ones generated by the scientists. The issue is, are there some relationships between biotic, edaphic, climatic and human factors important for survival of crops and the cultivators which people have derived intuitively even if not systematically. To what extent do these intuitive hypotheses deserve to be scientifically probed?
- *PPST (Patriotic and People Oriented Science and Technology Foundation, Madras)* PPST recently brought out a bibliography on Indian agriculture and plant sciences (April 1987) which is a very rich reference source on the subject in the country. Perhaps the issue of linking formal and informal research cannot be delayed or ignored any further. The Academy of Development Science, Karjat, Maharashtra, and the Academy of Young Scientists, Chandigarh are other groups which are engaged in research on indigenous knowledge systems including plant sciences. If the community of plant physiologists consider some of these issues worthy of attention that they might consider initiating not only a formal dialogue but also

institutional innovations that can link knowledge that people have with the knowledge that they need to have to improve their livelihood systems.

Innovations from humid tropics: Bangladesh

The author recently had an opportunity of spending a year with agricultural scientists in Bangladesh, with specific reference to the development of methodologies and systems for on-farm research. One of the important objectives was to draw upon peasant innovations while developing a formal research agenda.

Some examples which might interest plant physiologists are mentioned here.

- When it was found that farmers were able to market tomatoes kept quite fresh even in the off seasons the agricultural administrators were keen to find out the reasons. Abedin and his colleagues were confronted with this problem. The best way to understand this problem was to ask the farmers themselves. Farmers uprooted the whole tomato plant before tomatoes were ripe and hung upside down in well-aired, shady places. The flow of chemicals responsible for ripening was impeded by this process. If this method has some validity, by adding modern scientific knowledge a useful technology could be developed as was done in the case of diffused light for the potato storage system.
- In case cucurbits, a widely found problem is the delayed transformation from the vegetative to the reproductive stage or sometimes excessive flowering without culmination into fruiting. Farmers in Bangladesh tried different methods to overcome this problem. They provided a vertical incision in the vine and inserted opium, tobacco, or just left it like that and found onset of fruiting.
- The jute capsularis seed abstract was used for controlling stem borer in paddy. The planking and laddering after 30–45 days in paddy and 20–25 days in wheat was found to have a positive effect on tillering of the crop.
- Women scientists who studied various household practices discovered several innovative strategies of risk adjustment which deserve further study. For instance it was noted that a banana plant grown in between four betelnut trees in north-west Bangladesh held in moisture available to the betelnut roots through banana suckers in stress periods.

There could be a large number of other practices which deserve to be studied systematically if for no other reason than to extend the frontiers of science.

Conclusion

We have suggested in this article that in the process of adjusting to risks various classes of household devise numerous risk adjustment strategies. At the macro level these could be studied with the help of the Four S model, which includes interaction between space–sector–season–social stratification. At the micro level, the socioecological paradigm could be of help. It essentially builds upon access of households to factor and product markets, and ecological and other resources; these include assurances available regarding risk (climatic, social *i.e.*, how would others behave given one's own behaviour, temporal *i.e.*, future returns from present investments), and abilities (skills) of the households to convert access to investments, given various assurances.

We have reviewed some of the institutional factors which influence perception of peasant innovations. Later we have drawn upon some of the specific examples of farmer experimentation in high-risk environments in China, India and Bangladesh. We have a far richer inventory of such practices than what has been presented in this chapter.

Our contention is that while in some cases rituals might dominate the rationality of peasant survival mechanisms, there are certainly many cases where peasant knowledge deserves to be systematically understood, analysed and built upon while generating new alternatives for technological development. In this process we would have not merely start to the process of transferring science, instead of only technologies, to the farmers, but also generate an alternative 'college of peers' involving poor farmers, pastoralists, and tenants who would collaborate in research and also validate knowledge so produced. There would still remain a case for some research being guided by scientists' own vision and imagination. What we are submitting is a small step, linking peasant science with modern science and technology in a manner that the knowledge generating systems in the rural areas are not converted into just the knowledge receiving systems. We believe that this is possible and would perhaps be pursued even by those who wonder whether we are not moving the wheel backwards!

Appendix 1: Upland research and development strategies

Function / Methods	Prob. ident	Sel site	Plan	Diag	Under-stand	Screen tech	Inter-vene	Basic res	Vali-date	Extn	Moni eval.	Inst. Inno.
Socioecon. Survey	?	?	?	?	x	?			?		?	
RRA	x	x	x	?	?	?		?	////?////		?	
Sondeo	?	?	x	?	?	?		?	?		?	
Diagnostic			?	////x///	////x///	////x///		////?////				?
C.I.P.S.	?	?	x	?	?							
Farmers Expt.							////x///	////?////				
Agroecology	x	?	x	?	x	?		?			?	
Farm to Farm												
Ethnographic	?				x					////x///		
Transect	x	x		?	x						?	
Situation anal.					x						?	x
Benchmark Surv	?	x	?	?	?						x	
2' Data	x	////x///									////x///	
COBARMS	x	?	?	?	?	?				?	?	?
PDR			x		x						////x///	////x///
People Sch.										////x///		?
Demo/Pilot										?		
CPI/OFT						?	x	x				
T & V	?		?	?	?					?		
Lab/Stations						?		x	?			

Participatory plant breeding: emerging models and future development

LOUISE SPERLING AND JACQUELINE A. ASHBY

Introduction

PARTICIPATORY PLANT BREEDING (PPB) is distinguished by the involvement of end users—particularly farmers—in plant breeding and variety selection. These methods are participatory because farmers help define the priorities, beginning with the early stages of varietal development, and because both farmers and formal breeders have well-defined roles which allow them to take advantage of their respective skills and experience.

The following discussion employs the term PPB to cover a wide range of activities. It includes both farmer participation in testing stabilized varieties as well as farmer selection (and at times crossing) of materials that are still segregating. Although some authors (e.g., Witcombe and Joshi, 1996a) reserve the term PPB for the latter type of activities, this chapter will focus on the common participatory elements that distinguish all of these innovations in variety improvement. The chapter provides a review of the alternatives for farmer participation in plant breeding, to foster the decentralization of public sector variety testing advocated in Chapter 4.

The PPB approach is the product of a critical assessment of the strengths and weaknesses of classic breeding programmes. Centralized, research-driven breeding (or supply-driven research) has been extremely effective in higher-potential uniform environments, and for those farmers who can afford external inputs to modify production systems. It has been less effective in difficult environments, in reaching farmers with fewer resources, and in reaching users with specialized concerns, such as those found in sophisticated marketing systems featuring rigorous product quality requirements. Classic plant breeding can deliver productive technology when the target is widespread and relatively uniform. It is less successful in dealing with variable environments, diverse clients and differentiated product criteria.

PPB has also been encouraged by a growing appreciation of farmers' varietal selection skills. Studies of local production systems reveal that farmers' expertise in germplasm management can be very precise—especially in regions with broad varietal diversity (Richards, 1985; Sperling, 1992; van der Heide *et al.*, 1996; Voss, 1992). Farmers have been selecting varieties over generations, promoting the better adapted and higher quality entries, and matching cultivars to particular production niches. Documentation of local experimentation methods also indicates that farmer variety testing is widespread and dynamic in most rural communities. PPB aims to benefit both from farmers' insights on criteria for variety development and from farmers' ability to lead the way in site-specific testing.

The fundamental rationale of a PPB programme is that joint scientist-farmer efforts can deliver more than if each side works alone. Ultimately, justification for PPB will depend on combining indigenous and scientific knowledge in a way that maximizes genetic diversity and increases productivity, developing a greater number of usable products, more quickly and at less cost, than conventional plant breeding.

Basic elements of participatory plant breeding

The greater involvement of farmers in formal breeding research programmes is a development only of the last 10 years. Experimental PPB programmes are being designed for a range of crops and regions: for instance, pearl millet in India (Witcombe and Joshi, 1996b), barley in Syria (Ceccarelli *et al.*, 1996), common beans in Brazil (Zimmerman, 1996), rice in Nepal (Sthapit *et al.*, 1996). Farmer participation in these formal efforts spans a broad set of activities ranging from involving farmers in developing the plant ideotype to decision-making about the release of varieties or seed production. While PPB organizational forms and methodologies are still very much in the testing stages, and vary significantly by research programme, there are several basic features which should be central to PPB and which are characteristic of participatory R&D in general.[1]

First, PPB has to be client-driven. This means that knowledge, needs, criteria and preferences of farmers (that is, the principal clients) have weight in decisions about varietal development. More fundamentally, it implies that farmers are actively involved in decision-making about innovation early in the process, when the agenda for breeding research is set and when varietal traits are given their relative importance. In practical terms, before the initial germplasm pool is prepared for screening and, before crosses are made, research programmes should have a clear idea of what farmers want and need. The initial aim is to construct a 'client-sensitive germplasm pool'. During the subsequent experimental phases, research must also have a sharpened capacity to modify plans in response to client critique.

Client-driven agendas differ markedly from those geared towards basic, long-term plant breeding research. Clients have differing needs, specific to their own agronomic and socio-economic situation. Farmers always select varieties in a given locality, and with particular constraints and opportunities in mind. Addressing client needs means that the varietal development process itself must be sufficiently decentralized to meet diverse

1 This section draws extensively on Ashby and Sperling, 1995.

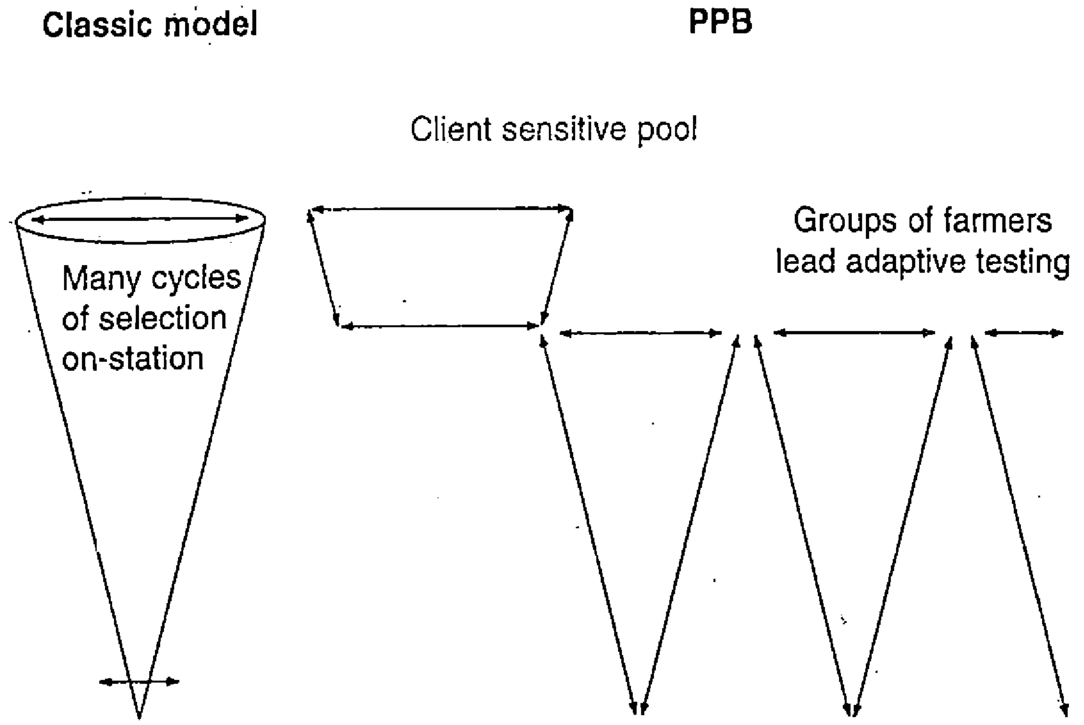
farmers' goals, and to allow for site-specific, local adaptation. Such decentralized varietal technology development suggests other features central to PPB.

To anticipate diverse client needs, applied research must produce an increased range of technology options that farmers can adapt to their particular needs. National research programmes and regional experimental stations need no longer aim at final recommendations. Instead, researchers should think in terms of 'prototype designs', which would then be shaped or contextualized to fit specific niches. This second feature of PPB, the development of prototypes, rather than finished products, may involve clients throughout the varietal development process. To pre-screen or create prototype designs, farmers have been taught to make crosses themselves (Kornegay *et al.*, 1996); they have been involved in screening segregating populations (Sthapit *et al.*, 1996); and they have been brought directly on to experimental stations (Sperling *et al.*, 1993) and farm sites set up for screening pre-released lines (Weltzein *et al.*, 1996a). Such early involvement can help to target a new variety, re-orient research on an unacceptable one or stimulate farmers to offer new ideas for further breeding work.

Effective decentralization of varietal testing is a task beyond the resources of most public sector research services, however. The requirements for testing many different 'varietal menus' tailored to different preferences and localities imply the third major feature of PPB: the devolution to farmers of major responsibility for adaptive testing. Farmers take the lead in organizing experimentation, evaluating results and transmitting local recommendations. Such devolution potentially allows for increased scale of testing, better targeting of varieties and more realistic variety evaluation. As will be discussed below, devolution is best managed through organized groups of farmers.

Finally, the fourth important feature of any truly client-driven agricultural programme, including PPB, centres on the sharing of accountability. Those involved in research (state research and extension programmes; NGOs; producer organizations; local communities; informal farmer groups) share responsibility for the relevance and quality of the technology on offer. One of the biggest obstacles to institutionalizing participatory programmes in the public sector is that the staff of most agricultural research systems are neither penalized for producing technologies which farmers cannot use, nor rewarded for having reached particular clients. A necessary feature of PPB is that clients must have the right to support or reject a research programme via their control over a significant proportion of the programme's resources.

Is the PPB approach really distinct from an effective conventional plant breeding system? Haven't formal breeders always promoted varieties with farmers' interests in mind? Figure 10.1 suggests that there are important



Modified from Sperling and Berkowitz, 1995; and Ceccarelli *et al.*, 1996

Figure 10.1 *A comparison of classic plant breeding and participatory plant breeding*

conceptual and practical differences. In the conventional model, researchers make all the major decisions on germplasm creation and promotion, from the initial stages when germplasm choices are wide through to the restricted stage of on-farm testing. Screening criteria, of necessity, focus on areas of breeder expertise—principally yield and adaptation in controlled experimental plots, and tolerance to important diseases. If researchers do assess client opinion, it is only immediately before varieties are to be released for diffusion. At this stage, farmers' only option is to accept or reject a few finished cultivars. Finally, formal breeding research usually seeks these opinions from a few individual, and often unrepresentative, farmers.

As Figure 10.1 shows, a PPB approach enhances farmers' involvement and responsibilities. The initial germplasm pool is directly shaped with strong client input. Screening criteria include quality concerns and local production requirements, for example the maturity or plant architecture characteristics required to fit varieties into multi-cropping systems. As farmers screen or help develop subsequent prototype pools, they are generally exposed to a more diverse range of germplasm and, to meet their different needs, the PPB format has to be decentralized very early on. This farmer leadership role can potentially shift some of the costs away from the formal research system, with farmers effectively integrating experimentation into their ongoing farm management. Group work early in the technology development process also produces important spin-offs: promising entries are multiplied and exchanged among farmers, variable entries are shifted to fit more appropriate production niches and unpromising material is rapidly discarded.

PPB is truly participatory only when the clients have real decision-making power—from the first stages of setting the agenda through to deciding what varieties should be moved forwards. Decentralized breeding can take place at many on-farm sites, but this does not necessarily imply strong farmer input. For example, researchers may use farmers' land but not seek farmers' observations. Or researchers may ask farmers' opinions of on-farm trials, i.e. consult with them, but retain control of all final decisions. Thus, decentralized breeding formats are not synonymous with PPB.

The next section describes how prototype development and the devolution of adaptive testing have been operationalized. These are the features of PPB which bear most directly on discussions of seed regulatory frameworks. The discussion is organized around a review of some of the major examples of PPB that have been developed.

Participatory breeding: select case studies

Prototype screening and development

A major feature that distinguishes various types of PPB is the status of the entries used for testing. In several examples of PPB, much of the prototype testing has focused on advanced, pre-released entries. This strategy can be easily integrated into ongoing national breeding programmes and it allows breeders to control their materials and to screen for factors such as disease susceptibility that may not be readily apparent to farmers. But in many cases the initial germplasm pool of advanced lines will hold little of client interest, and researchers and farmers will have to collaborate during the earlier stages of crossing and screening segregating material. This more labour-intensive collaboration has been practised most widely in very marginal environments, for example, drought-prone areas, where it has been difficult to introduce any new varieties through conventional breeding.

A range of cases illustrates the promising involvement of farmers in varied forms of prototype testing. The examples below are ordered along a continuum: from screening of released lines developed for other locales to working with farmers in the crossing stages. In these examples farmers have worked with anything from one up to 100 different materials.

Rice (and other crops) in India (Witcombe and Joshi, 1996a, b). The formal research system in India has released a relatively large number of rice cultivars: 525 in all, and 88 in the period from 1988 to 1993. Despite this relatively diverse choice, the two most popular cultivars across India are IR36 and Rasi, released in 1981 and 1977, respectively. A PPB effort was initiated in the belief that variety replacement rates were low, not because released material was unacceptable to farmers but because farmers had never been exposed to a range of choices. In India, many crop varieties are released and used in only a single state (although a state may encompass tens of millions of farmers). Researchers believed that simply by moving released material from one state to another, a more relevant choice of varieties could be presented to farmers.

In 1992, the Crops Programme of the Krishak Bharati Co-operative Indo-British Rainfed Farming Project (KRIBP) launched a process to: a) identify farmers' varietal preferences, and b) find matching suitable material. To increase the basket of choices, pools of released and pre-released lines available from Indian public breeding programmes were screened. In subsequent on-farm trials, farmers were randomly assigned to grow a single variety alongside their local one. Using this very simple technique, two varieties of rice, one of maize, three of chickpea and two of blackgram were identified as being markedly preferred by farmers. These results were achieved in only three years.

A strategy of working with released varieties has significant advantages in India's well-developed public plant breeding system. Any organization working with farmers can, in principle, readily procure seeds of a released variety in sufficient quantities for testing. Further, if such varieties prove to be acceptable, they should be able to be shifted across state boundaries, and could be fed into the conventional, large-scale seed multiplication channels and extension systems.

Of course, such a programme would have enhanced results only if the researcher-constructed pool contains entries of potential interest to farmers. In many countries, this approach of screening finished varieties is similar to a well-conducted programme of on-farm trials. Advanced lines are tested on farmers' fields, under farmer management and with comprehensive farmer evaluations.

Common bean in Rwanda (Sperling *et al.*, 1993; Sperling and Scheidegger, 1995). Rwandan farmers have considerable experience in managing local bean diversity: some 550 varieties exist countrywide and farmers adjust mixtures of varieties for specific soil types and crop associations (Scheidegger, 1993). Despite such diversity, the selection sequence of the national agricultural research institute (ISAR), following Western models, sharply narrows the range of varieties on offer: some 200 entries are initially screened, but only 2–5 enter on-farm trials, the sole means of client feedback. An experimental programme, conceived by the International Centre for Tropical Agriculture (CIAT) and ISAR from 1988 to 1993, sought to draw on farmer experience early in the selection process, when

Table 10.1 *On-farm performance of varieties selected from on-station trials by Rwandan farmers versus varieties selected by breeders*

Season	*No. of trials*	*Trials where new variety out-performed local mixture (%)*	*Yield increase of new variety over local mixture (%)*
Farmer Selection—Central Plateau			
1989A	11	73 ns	3.9 ns
1989B	19	89 **	33.4 **
1990A	36	64 ns	12.9 ns
1990B	18	83 **	38.0 *
Breeder Selection—Central Plateau			
1987A	32	34 ns	−8.8 ns
1988A	45	49 ns	−18.9 ns
1988B	15	53 ns	0.7 ns
Breeder Selection—Countrywide			
1987A	131	51 ns	6.7 *
1987B	83	41 ns	−6.0 ns
1988A	204	50 ns	2.6 ns
1988B	204	50 ns	7.6 *

ns = not significant * P<0.05 ** P<0.01

Source: Sperling *et al.*, 1993

varietal options were still extensive. During a first phase, local farmer experts evaluated 15 cultivars in on-station trials 2–4 seasons before normal on-farm testing. These evaluations revealed that women experts select bush beans on preference and performance criteria, with many of the attributes not easily anticipated in a formal breeding framework. On-farm trials also showed the farmers' ability to extrapolate from experimental station fields to their own home plots; farmer selections out-performed their checks with average production increases of up to 38 per cent, while breeder choices in the same region showed insignificant gains (Table 10.1). During a second phase of the programme, participants screened a broader range of cultivars earlier in the breeding process: 80–100 entries were placed in on-station trials 5–7 seasons before conventional on-farm testing. Longer-term results suggest some of the advantages of offering these options to farmers. The number of varieties adopted from the first phase of the work, 21, matched the total number of varieties released by ISAR in the 25 years previous to this programme. In the subsequent trials of the second phase, 26 varieties were selected for home testing during the first two seasons alone (Sperling and Berkowitz, 1995). The experiment suggests several benefits of prototype screening: enhanced and diversified production in heterogeneous environments and significant savings in on-station research time.

Rice in Nepal (Sthapit *et al.*, 1996). Chilling injury and Sheath Brown Rot (ShBR) are serious problems for rice production in the hills of Nepal and significantly limit the area planted under rice and the length of the potential growing season. Of the 39 cultivars recommended by the National Rice Research Programme (NRRP), only two have been released that are suitable for the high hills (>1 500m). Screening of international cold-tolerant materials has failed to identify productive varieties. In 1993, the Lumle Agricultural Research Centre (LARC) decided to test F_5 bulk seed of select lines with farmers, directly on their fields. This radical departure from the standard practice was motivated by a series of very practical concerns. LARC did not have the land or resources to do such breeding on station; researchers felt they did not have the means to address the high variability of farming systems and management practices via the conventional centralized testing approach; adoption levels of formerly released varieties had been low; and researchers were concerned about the future possibility of reducing genetic variability on farmers' fields through the promotion of uniform varieties. The PBB programme has had promising results in only two years. Two populations, selected independently by farmers in two sites, are showing unusually high yields, even in researcher-managed trials. The entries have very good resistance to the two major stresses, ShBR and chilling, and the straw yield is judged by farmers to be superior to that of the local varieties. Both populations are spreading quickly and the lines have been entered in the formal testing system in anticipation of official release. Researchers emphasize that the success of their programme has hinged on identifying expert farmers (i.e. not all farmers have skills in variety selection) and on identifying a problem relevant to the farming community. The LARC experiment focused only on white rice varieties—the type highly preferred by the local farmers.

Common bean in Colombia (Kornegay *et al.*, 1996). 'If farmers were taught the basics of plant breeding, would the varieties they develop be higher yielding and more acceptable to other farmers within the region?' This question formed the basis of a PPB study undertaken by CIAT in Colombia in the early 1990s. Eighteen F_2 populations were grown in five environments—two research station sites and three farms. A simple breeding strategy was used by CIAT bean breeders and farmers to advance segregating populations to homozygous advanced lines. While the segregation of different traits within each population was pointed out to the farmers, they were instructed to use their own criteria in making selections.

The results showed that farmers can indeed follow a breeding methodology recommended by researchers and successfully develop advanced lines. However, differences were found between breeder-selected and farmer-selected lines. Farmers tended to focus on commercial qualities, and their selections had more attractive seed colours, patterns and desirable sizes.

The farmers' most preferred lines did not have the highest yields or best disease-resistance combinations, traits on which breeders' had put emphasis. Interestingly, all the advanced breeding lines developed, whether by farmers or breeders, had yields as high or higher than the local check.

This Colombian case differs from the preceding ones in that it took place in an area of very demanding consumer preferences. It shows that participatory approaches can be highly effective for delivering varieties that are acceptable to commercially oriented farmers. The range of materials that these farmers chose was very narrow, however, and this may be an outcome of PPB (Voss, 1996). PPB *per se* does not necessarily lead to wider varietal diversity on-farm.

Reflections on prototype screening One of the challenges of each PPB programme is to find the most efficient division of labour between breeders and farmers. Scientists should be challenged to offer a diversity of varietal options, rather than finished products. In many contexts, their comparative advantage lies in generating new options and screening for disease susceptibility or anti-nutritional traits which may not be immediately apparent to farmers.

A related goal of PPB programmes should be to identify the stage in prototype screening which is most cost-effective. For example, if the selection of finished varieties proves to bring significant results to a range of farmers, it may not be necessary to pursue direct collaboration during earlier stages of the plant-breeding process. (This point is also emphasized in Chapter 4.)

Much of the debate on prototype screening has focused on whether the early involvement of farmers and early access to varietal material increase risks. Fears are expressed that disease incidence may rise or that yields may decline. In addition, there are concerns that farmers may lose confidence in formal agricultural research or that they may receive materials that are not uniform. In fact, disease incidence should decline, as materials will be screened in the actual environments where they will be used. In terms of yield, the empirical results are already suggesting that a more acceptable product is developed when farmers and breeders collaborate. The other concerns raised show how much PPB may demand important attitudinal shifts. Researchers no longer take sole responsibility for delivering solutions: failures, as well as successes, are shared enterprises. And varietal uniformity is not a reasonable strategy for improving production in low-input farming.

Devolution of adaptive testing to farmer groups

Recent experiments suggest that decentralization of testing may be a technical as well as a logistical imperative. Genotypes selected under optimum conditions simply do not perform well under low-input conditions: there is a 'crossover effect' (Ceccarelli *et al.*, 1994). To have an impact in heterogeneous environments, and to address a broader range of client preferences, a genepool has to be screened under multiple actual farming conditions (ibid.). But allowing technologies to be shaped in many locations can easily multiply the demands on scarce formal sector professionals, so PPB programmes aim to shift the responsibility of adaptive testing towards farming communities themselves. Experience has shown that such participatory activities are most effectively organized through farmer groups. PPB may have to develop farmer groups or work with existing ones. The following cases provide examples of each option.

CIALs in Colombia (Ashby *et al.*, 1995). One strategy for devolving adaptive testing has been to establish community-based organizations of experimenting farmers expressly for this purpose. From 1990 to 1994, the IPRA (Participatory Research in Agriculture) project of CIAT acted as the catalyst for such an approach in the Cauca Department of Colombia. Considerable effort was devoted to identifying principles for durable farmer research committees (*Comités de Investigacion Agropecuria Local*, or CIALs). CIAL members were trained to carry out diagnoses, set priorities and use the basic tools of scientific experimentation.

Eventually some 55 CIALs were formed, with many building up independent capacity to diagnose problems, design and implement trials, analyse the results and deliver a community report. The themes of experimentation within and across CIALs were broad, including agronomic practices, the composition of feed mixes, the integration of green manure and varietal experimentation. In four years, the farmer committees had tested some 1 000 varietal materials of crops such as beans, maize, peas and groundnuts.

The involvement of farmer groups also had direct spin-off effects in terms of seed production. Six of the CIALs set up small seed production enterprises to multiply the varieties selected, with the groups having received training in simple seed production, processing and quality-control techniques. More than 10 000 farmers have purchased CIAL seed, which over one season has generated a gross value of over US$2.5 million. In terms of the direct value to participating farmers, on a per capita basis, earnings from the seed multiplication were equivalent to a month's income (Ashby *et al.*, 1995).

The capacity-building indicators of the CIAL programme have been particularly promising. The results of the majority of trials, independently conducted by farmer groups, were interpretable (75 per cent of the experiments were statistically analysable, while 90 per cent generated useful knowledge according to farmer criteria). Devolving an on-farm trial to a fully trained CIAL also costs 60 per cent less in labour costs than running

Table 10.2 *Labour requirements of an on-farm trial managed by CIAL and by extension*

Trial management	*Days required*	*Total cost of salaried labour (US$)*
Extension research	8	62
New CIAL	11	46
Fully trained CIAL	5	23

Source: Ashby *et al.*, 1996

the same trial with an extension agent (see Table 10.2). Some CIAL members are now spurring the formation and training of new CIALs.

The close monitoring of the CIAL experience has also suggested some of the limitations of group work – even in the most carefully controlled of circumstances. CIALs were designed primarily to promote experimentation; the participating farmers were to build up community capacity to test technology and develop products which could then be used by neighbours. Distribution of knowledge about the CIAL activity, rather than direct participation in it, served as an important indicator of whether broader community interests were being served. Studies showed no significant differences in knowledge about CIALs along wealth parameters; the very poor were as aware of the experiments as the better-off. However, women seemed to have removed themselves from direct participation in many of the CIALS and, therefore, from setting community research priorities. Several options are now being proposed, including stimulating the formation of women-only CIALs, and allowing women's groups to evaluate trials they themselves may not have the time to manage.

Building on existing organizations: Rwanda (Sperling and Scheidegger, 1995). Another option for devolving variety testing is to build on existing farmer groups. The potential for this strategy, and the pitfalls of relying on hastily formed *ad hoc* groups, are illustrated by experience in Rwanda, where researchers sought to institutionalize and scale up the promising results of earlier farmer involvement in variety selection. From 1990 to 1993 several types of local groups of women bean farmers were involved in variety selection. These included members of groups that had been formed by NGOs for specific development projects, as well as farmers who belonged to a Rwandan administrative unit known as a 'commune'. The contrast between the two experiences is instructive.

In other countries in the region, such as Zaire, PPB has been conducted with well-organized farmers' co-operatives. Unfortunately, Rwanda has a limited tradition of co-operatives or indeed of any rural grassroots organizations that might represent farmers' interests. There were, however, several farmers' organizations that had been established with the backing of

NGOs that participated in the attempt to diffuse PPB methods. In one case, a women's co-operative, supported by a Belgian NGO, took charge of the work. Five experts were sent to the experimental station to select varieties for further testing. These were subsequently tested on the plots of designated group members, and an evaluation was completed by means of a walking tour of the plots (PAMU, 1993). The NGO produced a written evaluation of the results for the Rwandan national bean programme.

The experiment with the co-operative was successful because the women managed it themselves and because they saw themselves as truly representing a larger community. Once the varieties had been chosen, the co-operative multiplied and distributed over a ton of seed for its members.

The experiment within the 'commune' units was conducted in a more formal manner but without the benefit of a well-established group. The local agronomist took control, station researchers designed a standard trial (varieties sown in lines, at given densities) and some local farmers were invited to evaluate the plot and select varieties for home use. One advantage of the centralized format was that more farmers were exposed to a greater range of cultivars than in the first example, and, due to their greater involvement in commune evaluations, researchers received feedback more quickly. Such a top-down research strategy at the community level is not atypical of many local grassroots groups who collaborate with trained technicians. But the limitations of the approach were obvious, as there was little progress towards adaptive testing on individual plots and very restricted diffusion of promising varieties.

Some of the weaknesses of trying to conduct PPB through an *ad hoc* group were evident in this example. Within the communes, the male power structure distorted the expansion of the experiment at several key points. In the selection of farmer representatives to screen on-station trials, some of the so-called community-selected experts were neither very well informed nor very representative of community interests. For instance, one community was represented by the sister of the government agronomist and the wife of the sector head. The local government agronomists also sometimes fell short on their obligations to community participants; the community plot was planted and the evaluations were completed, but seed of selected varieties was never distributed to evaluators.

Devolution: reflections. Whether it creates new farmer groups or builds on existing farmer organizations, PPB opens up a range of issues that must be addressed. Fundamental issues include the quality of on-farm testing achievable with farmer participation and the representativeness of groups involved.

When farmers are involved in trial design and management, data sets can be heterogeneous within and among locations, although such results may represent the variability of actual farming practices. Should participating farmers be encouraged to follow more standardized experimental designs? Should farmers be taught to internalize and manage Western scientific methods, or will this hamper their creativity and independent insights? The costs and benefits of different approaches need to be addressed empirically (see Ashby, 1986).

The basis on which farmer groups are involved in PPB also raises important issues. If PPB is to be institutionalized, significant attention has to be paid to exactly who is involved. Groups need to cover the range of potential beneficiaries and to be able to show accountability to their own constituents. In some cases PPB may be able to rely on existing groups to articulate demands and orient formal research. In other cases, special groups will have to be created. The issues of who participates and who benefits are certainly not unique to PPB, but they take on special importance, given the biases and inefficiencies of formal plant breeding systems that have led to this search for alternative methods.

PPB: future directions

Participatory Plant Breeding is still in an incipient stage. Many programmes are taking a step-by-step approach, testing one or two innovations at a time. ICRISAT's work on diagnostic methods for breeding pearl millet in India, for instance, has been unusually rigorous in detailing the range of farmer preferences and selection practices (Weltzein *et al.*, 1996b). Other programmes are seeking to understand the logistical boundaries of PPB better; scientists at ICARDA are proposing to screen over 200 lines, including some F_2s, directly on farmer-managed and -evaluated plots (Ceccarelli, personal communication). While PPB is sometimes perceived by outsiders as heretical, those actually involved in such efforts feel they have proceeded with caution: propositions are being tested and a small but growing literature is reporting the results and providing guidance for further experiments.

Additional work is needed on understanding both the technical and organizational issues related to PPB. With respect to technical breeding itself, the Consultative Group on International Agricultural Research (CGIAR) is proposing a programme with its national research partners and NGO collaborators to take a critical look at PPB methodology. Frameworks are being designed to make controlled comparisons between PPB programmes and their conventional breeding counterparts. These comparisons would examine cost-effectiveness, the most appropriate technical breeding strategies for PPB and the role of participation in upstream as well as adaptive research. Three to four field projects should help clarify how, and under what circumstances, PPB programmes should be institutionalized (Systemwide Programme on Participatory Research and Gender Analysis, 1997).

With respect to the organizational dimensions of farmer participatory research, and particularly the issue of devolution, the Overseas Development Institute and the International Service for National Agricultural Research (ISNAR) have been conducting a series of studies looking at local-level research partners, NGOs and farmers' organizations (Farrington *et al.*, 1993; ISNAR, 1994; Carney, 1996). These examine the institutional environment which successfully fosters NGO and farmers' organizations as well as the internal organizational features which enable such groups to serve their members effectively. Critical concerns include how farmer organizations can better identify and aggregate their constituencies' technological demands; how they can more effectively work as partners with formal research agencies; and how they can provide the necessary support services required by location-specific technology development. It is important to reiterate that participatory breeding can only take place if testing can be decentralized, and testing can only be decentralized if local groups take the lead.

PPB: current implications for national variety testing, variety release and seed systems

Beyond understanding the organizational and methodological dimensions of PPB, there are a series of regulatory issues which need to be addressed if PPB is to link with existing national testing programmes, variety release committees and seed systems effectively.[2] The implications of PPB for the organization of formal plant breeding programmes have been discussed in Chapter 4. The following points relate to the implications of PPB for variety release and seed production.

Varietal release systems

The increasing use of PPB for developing useful varieties will involve serious conflicts with most conventional variety release systems. A number of adjustments will have to be made in order to take advantage of the results of PPB.

Utilization of PPB data. A PPB approach implies that data on farmer acceptability should be an important basis for varietal release. Some practitioners have also suggested that data generated from farmer-designed and managed trials should be considered as legitimate evidence in variety release decisions. Mechanisms need to be developed for aggregating and communicating community-level assessments to variety release authorities.

2 This section draws heavily on a discussion among PPB practitioners at an IDRC/IPGRI/FAO/CGN-sponsored workshop on Plant Breeding, 26–29 July 1995 (Eyzaguirre and Iwanaga, 1996).

Uniformity. A PPB approach does not necessarily lead to uniform varieties. On the contrary, segregating populations, evolving in different locales, take on diverse characteristics. Release criteria need to accommodate this notion of heterogeneity.

Release recommendations. An important advantage of decentralized variety development is the resulting site-specificity of adaptation: varieties are targeted to suitable production niches. Variety release recommendations need to be able to respect this diversity.

Release system capacity. PPB systems can result in the identification of many farmer-acceptable varieties, particularly in heterogeneous environments with diverse farmer groups. Formal variety release systems need to be able to handle a relatively larger number of varieties than is currently the case.

Rewards for variety development. Within conventional plant breeding programmes, breeders are rewarded for finished products and officially released varieties. A PPB perspective encourages breeders to make available unreleased varieties or segregating materials that farmers can use for further selection and development. Reward systems need to be developed that recognize this early breeder contribution and the subsequent impact it has for specific groups of farmers. Similarly, farmer breeders should be given due recognition for their work. If a variety produced by PPB is accorded some type of plant variety protection and is subject to royalties, then farmer participants should share these rewards.

Seed production and PPB

Innovative variety development is of little use if seed of the new varieties is not easily available to farmers. Both formal and farmer-level seed systems need to establish better links with PPB.

PPB and public seed enterprises. PPB leads to the development of products that fall outside the public research system's links with supporting seed multiplication services. Procedures need to be developed that allow the finished products of PPB to be produced by public seed enterprises.

Strengthening local seed channels. It is well known that farmer seed systems often produce the majority of seed for many crops. Their effectiveness needs to be scrutinized more carefully and, if appropriate, selected features might be strengthened. Procedures need to be made explicit as to how the products of PPB can move into a range of local channels. For instance, should traders be encouraged to package and sell them in local markets, or are farmer-to-farmer seed exchange mechanisms sufficient?

Decentralized production. The site-specificity of PPB efforts suggests that complementary seed systems (whether formal or informal) need to have strong decentralized multiplication and distribution capacity. Seed production projects and enterprises will have to be capable of multiplying many different varieties and targeting the distribution of these varieties to the appropriate locales.

Conclusion

The incorporation of participatory methods into plant breeding began in the mid-1980s by involving farmers in the evaluation of pre-release varieties. The gap between users' and breeders' criteria for acceptability of new varieties identified through this type of participatory research has stimulated plant breeders to introduce user participation at earlier stages in applied plant breeding research. As experience accumulates, participatory methods are perceived by some plant breeders as comparable to biotechnological techniques in opening up new frontiers in breeding (Kornegay *et al.*, 1996; Zimmerman, 1996; Iglesias and Hérnandez, 1994).

However, this brief review of PPB programmes suggests that an effective participatory strategy still has a number of challenges to address. The scientific division of labour itself—what scientists should do, what farmers should do—has been brought forward as a researchable question. On-farm research methodologies are being scrutinized for their reliability, usefulness, interpretability and useability. Most fundamentally, PPB touches the heart of the breeding decision-making structure. The approach suggests that demand-driven rather than supply-side models can best deliver useful products to farmers.

Is it all worth it? The answer should become clearer in the next few years. Initial PPB results suggest that there may be options for greater cost-effectiveness in breeding, opportunities to achieve greater production impact and the prospect of reaching a greater range of resource-poor farmers.

Mainstreaming Gender in Participatory Technology Development: Dynamics between Farmers' Groups, NGOs and a Support Organisation in South India

Edith van Walsum and Rama Devi Kolli[1]

INTRODUCTION

Gender, sustainable agriculture, participatory technology development—buzz words of the 1990s—have been assimilated into the development discourse. Over the past 10 years good research has been done on relations between these three concepts. Tools, conceptual and methodological, have been developed, which have proven to be useful in development practice (Feldstein and Jiggins 1994). Nevertheless, in trying to address realities on the ground, we realise that mainstreaming gender in agricultural development, geared towards higher productivity, sustainability and equity, is very complex and a long-term process.

This case study reflects on the collaborative efforts of Agricultural Man Ecology (AME), a professional support organisation, and a number of NGOs involved in sustainable agriculture. There are two interdependent processes at work in this collaborative effort—one of participatory development and testing eco-friendly and potentially sustainable technologies in agriculture, and the other of comprehensive capacity building—of farmers, NGO staff, AME and researchers involved in a joint learning process. We will hereafter refer to this twin process as participatory technology development, or PTD. A discussion on this joint effort to bring a gender perspective into this process forms the core of this paper.

This paper is divided into three parts. In Part I we describe the context within which our PTD efforts take place. Part II is a case study on the PTD process with women and men farmers and three NGOs in the Rayalaseema region of Andhra Pradesh. In Part III we discuss the lessons learnt about gender mainstreaming in PTD processes and how this contributes to the larger objective of women's empowerment.

THE CONTEXT

Dry-land Agriculture on the Deccan Plateau

The Deccan Plateau is a chronic drought-prone region in south India covering substantial parts of Andhra Pradesh, Karnataka, Maharashtra and Tamil Nadu. Eighty-one per cent of this region is under rainfed farming. Overexploitation of the natural resource base is an all-pervasive phenomenon here. The Green Revolution has largely bypassed this area. New technologies have helped some of the better-endowed pockets here but this is offset by declining productivity in the vast marginal areas. Traditional systems of resource management have weakened and no substitute options are readily available (Jodha 1996). This leads to indiscriminate exploitation of natural resources, and inequalities prevail in the present distribution of and access to natural resource assets.

Increase in poverty has lead to conflicts in family and community relations. Male migration has risen and there is an increasing burden on rural women. In many situations, women are responsible for managing the farms but do not have the authority to take important decisions. Many a times, women are left behind just to make sure that somebody else does not occupy the land. Agriculture, though marginal, is still an important source of livelihood for the rural poor, and for women in particular, as there are few alternatives. But sustainable land use is far beyond their day-to-day concerns.

Policy makers and the prevailing system of research and development of agricultural technologies have so far paid far less attention to dry-land agriculture as compared to irrigated agriculture. Moreover, the few approaches that *are* applied to dry-land agriculture often do not address these problems in an adequate manner. By and large, they copy the experience of research strategies in well irrigated areas. Consequently, rainfed farming research can neither properly identify and fully harness the niche of these areas nor can it understand and incorporate the rationale of traditional farming systems in these generally fragile, diverse, high risk and low productivity environments (Jodha 1986).

This situation is beginning to change. During recent years more importance has been given to the development of dry-land areas, not just because of social/poverty considerations but also due to the realisation of the productive potential of dry-land regions. Most remarkable is the increased attention by the government of India to watershed management. However, watershed management alone does not solve the complex environmental and poverty problems in dry-land regions. In these highly diverse areas, location-specific solutions have to be found for the location-specific problems in agriculture. Development of suitable technologies, which redress the degraded ecosystem and are economically feasible for small and marginal dry-land farmers, will in most situations be a gradual process of small steps, as the margins are narrow. It is not just technology that has to be developed but also the necessary forward and backward linkages, such as supply systems for suitable eco-friendly inputs, credit facilities for the same, market niches and adequate forms of social organisation, to enable farmers to use the technologies effectively.

AME's Approach: PTD Processes with NGOs and Farmers

In this context, PTD can play a catalytic role as it is participatory, location-specific and systemic, rather than crop oriented. It is an approach that addresses the gap left by formal research. More significantly, it is not just concerned with the development of technologies, but with strengthening the capacities of people, farmers and others, to analyse ongoing processes and develop useful innovations.

PTD has been described as a process of purposeful and creative interaction between rural people and outside facilitators. Through this interaction the partners try to increase their understanding of the main traits and dynamics of local farming, to define priority problems and opportunities and to experiment with a selection of 'best bet' options for improvement. The options are based on ideas and experiences derived from both indigenous knowledge and formal science. This process is geared not only towards finding solutions to current problems, but also towards developing sustainable agricultural practices (Veldhuizen et al. 1997).

Since 1994, AME has initiated several PTD processes (see Box 1 for details on its role in a PTD process). The strength of PTD lies in the fact that the farmers themselves set the agenda. Through PTD, all the stakeholders collectively try to find specific solutions to local problems identified by the farmers. But we also give importance to interactions between farmers and organisations from different areas, which helps to differentiate location-specific variables from more general underlying problems.

PTD as an approach is related to Participatory Rural Appraisal (PRA). We often use PRA methods in a PTD process. We see both approaches as complementary to each other. Whereas in PRA the focus is on the participatory appraisal of issues and problems in the community, in PTD we further build on this appraisal, by identifying specific options for improvement and trying them out with the farmers, in a participatory and systematic way.[2]

Because women's role in dry-land agriculture is a central one, we consider them key actors in a PTD process. The participation of women and men should be functionally linked to the gender division of labour in agriculture and to their respective responsibilities in agricultural decision-making. This is what we will hereafter refer to as gender mainstreaming in the PTD process. The immediate objective of gender mainstreaming is that the PTD process itself becomes more effective and its results more sustainable. The long-term objective is that gender mainstreaming in PTD should contribute to women's empowerment, by providing them access to knowledge and institutions, and giving an added impetus to ongoing processes of social organisation and empowerment.

Methods Used to Bring a Gender Perspective into the PTD Process

We use a focused combination of individual in-depth interviews, group discussions and observation to articulate the gender perspective in a PTD process. Discussions are held not only with the members of the

Box 1

> *AME's Role in a PTD Process*
>
> - Training NGO staff and farmers in the PTD approach.
> - Identifying problems and possible solutions with the farmers and NGOs, often in consultation with research institutions.
> - A step-by-step-wise technical field based training for NGOs and farmers, directly relevant in the context of the PTD process.
> - Monitoring the PTD process in the field, with the NGOs.
> - Establishing links with suppliers of eco-friendly inputs whenever required.
> - Guiding farmers and NGOs in evaluating the results of their experiments and the process of experimentation itself.
> - Facilitating the exchange of experiences and information between farmers and NGOs in different areas.
> - Support to farmers and NGOs in gender mainstreaming in the context of the PTD process.

groups, but also with their spouses/household members. Repeated interaction with both women and men in different contexts (individually, together, in single gender groups and as mixed groups) helps to strengthen gender perspective.

Most group discussions take place with women and men separately. On some occasions a few men take part in a women's discussion, and vice versa. We use group discussions for problem analysis, to discuss learning points from the experiments as well as group organisational matters and group dynamics, and for the evaluation of the PTD process. We use visualisation tools whenever relevant.

We find that both women and men are generally comfortable with single gender group discussions. They engage themselves in intense discussions and manage to arrive at some common understanding in the end. Intra- and intergroup comparisons (between women and men) often helped us to ratify some of the conclusions made within a group. We observed this phenomenon with problem analysis and PTD evaluation.

Women as well as men sometimes hesitate to talk about matters pertaining to intrahousehold affairs. This hesitation surfaces when they have to discuss decision-making and loans. Men hesitate to talk about decision-making when issues of women's involvement arise. Therefore, discussions on these issues are always held for women and men separately and complemented by individual discussions.

As we are always working with and through other organisations (mostly NGOs), training the field staff in gender analysis and planning is essential. It addresses the following issues:

1. Understanding gender division of labour, intrahousehold allocation of resources, communication and decision-making.
2. Who should be involved in the PTD process—why, when and how?
3. How to identify gender specific constraints with respect to different technologies.
4. Women's constraints with regard to venues and times of meetings.
5. The use of PRA tools, interview techniques and group discussions to understand and appreciate gender differences in the PTD process.

NGO Approaches to Gender and Sustainable Agriculture

There are enormous differences between NGOs, in terms of size, ideology, organisational culture and focus of work. This has a bearing on their approaches to gender issues and sustainable agriculture. However there are some broad characteristics which are shared by many of the NGOs we work with.[3] These characteristics have important implications for AME's role as a support organisation.

1. Most NGOs started to look at agriculture as an area for intervention only recently (late 1980s or early 1990s). Many NGOs started as social action groups or community development organisations, hence their strength lies in social organisation more than in agriculture. NGOs have contributed to the creation of a social infrastructure that can be very helpful when initiating PTD processes. Technical capacities in the majority of NGOs are, however, limited.

2. Some but not all NGOs implement women's programmes. This does not automatically imply that their agricultural programmes have a gender perspective. These women's programmes are often geared towards the formation of savings and credit groups, and have little or no link at all with other land-based programmes of the organisation. Very few NGOs have women staff with training in agriculture.
3. The majority of organisations that do implement agricultural programmes tend to have a somewhat fragmented approach; the focus is on the promotion of specific technologies rather than on understanding the total production and livelihood system.

As a principle, AME works with different types of organisations and encourages the exchange of experiences between them. For us, an organisation's potential to learn and share, and its integrity and commitment to participatory development, are more important criteria than 'inherent' gender sensitivity or systems perspective on agriculture. The underlying rationale is that it is more useful to seek a constructive dialogue on these issues and create broad platforms of actors than to work with a select few.

CASE STUDY OF A PTD INTERVENTIC..

The Entry Point: Groundnut

In 1995, AME initiated a PTD process in groundnut with an NGO in Chittoor district, Andhra Pradesh. Groundnut was chosen as the entry point[4] because it constitutes a major source of income to a large number of small and marginal farm households in this region, besides being an important source of fodder and providing energy and protein in the daily diet. Groundnut has become a very popular crop among women and men farmers alike.[5] It is a female labour intensive crop and, traditionally, women's participation in this cropping system has been very high (Kolli and Bantilan 1997).

Farmers say that yields and profits from groundnut crops have declined over the past few years. The major causes of this are the declining organic matter content in the soil and the increased extent of monocropping, resulting in a drastic rise in susceptibility to pests and diseases. From discussions with farmers it became clear that, though they were aware of the problems, they did not know effective ways of addressing them. Thus the search started for sustainable technologies that could address these problems.[6]

Experiments conducted in 1996 with an NGO and a few farmers' groups created interest among other farmers and NGOs in neighbouring areas. In 1997, a collaboration was initiated with two more NGOs in southern Chittoor and Anantapur (Andhra Pradesh), one in Dharmapuri (Tamil Nadu) and with an NGO network in Kolar (Karnataka). Collaboration continued with the same NGOs in 1998 and more farmers joined the process. This case study concentrates on the PTD process with three NGOs in Andhra Pradesh. We describe the process over a period of two agricultural seasons. At the time of preparing this case study, the 1998 season was not yet completed, hence the outcome of two years of PTD could not be discussed.

Social Organisation and Implications for the PTD Process

The three NGOs in this case study shared an interest in sustainable agriculture and PTD, but their approaches to social organisation and the involvement/participation of women were different. Thus, we started a PTD process with a dozen individual male farmers who had been brought together for the purpose, one existing young men's self-help group and one women's self-help group (SHG).

From Individual Farmers to Women's and Men's PTD Groups (APRRM)

In 1997, Andhra Pradesh Rural Reconstruction Movement (APRRM) conducted groundnut experiments with 12 individual male farmers in three villages of Chittoor district in Andhra Pradesh. APRRM's organisation till this time had focused on organisation of trade unions for agricultural labourers, which was not the most suitable starting point for PTD. APRRM approached individual farmers (all men) who were interested in taking part in the experiment. Monitoring and evaluating the PTD process without social organisation, however, proved to be difficult. After a joint PTD evaluation meeting and further interaction with farmers, partner NGOs and the AME, APRRM decided in 1998 to change its approach. A group approach was now adopted. Three groups were formed for the purpose of joint PTD experimentation—one women's group and two men's groups. AME provided training to the farmers and the APRRM staff in group formation and facilitation skills.

At the end of the 1998 farming season we observed that the women's group had done a serious job—they had kept the groundnut harvested from the experimental plots separately from those of the control plots, thus making possible a detailed analysis of the results. Some of the yield from the men's control and experimental plots, however, had got mixed up. It is too early to derive any firm conclusions, but women seem to be more meticulous about their experiments.

Women's Group (RRS)

In 1997, Rural Reconstruction Society (RRS) encouraged a women's thrift and credit self-help group to take up PTD experiments in Chittoor district. Several changes have occurred in the women's group after they got involved in the PTD process. They started using this forum to discuss several problems amongst themselves. The women as well as their male household members realised that PTD is the job of both women and men, and some men got actively involved in the process. The women's group made decisions regarding new input use, quantities of inputs to be used, etc. Seed selection and decisions to purchase a particular improved variety were performed by women members, after discussions with men. The women's group resolved where the 'leaf wetness counter'[7] (one device for the entire village) should be installed, and why.

Because the women could not travel as far as Anantapur (about four hours by bus) to buy Mussoorie phosphate, they sought the help of male household members. However, women took the initiative to negotiate subsidy with the Department of Agriculture for the supply of gypsum, as this office was not too far from their village. A few women from the group attended a farmers' meet organised by the Department of Agriculture in another town. These were the only women from that area, among 200 farmers, who attended the meet. The decision to attend this meet was taken by the women alone, though in a few cases, their spouses accompanied them.

The women belonging to the group which started in 1997 had a clearer view about the PTD process by 1998. They took more conscious and systematic decisions about the experiments during the second year. They were also clearer about the financial aspects of the experiments. One of the members took the responsibility of recording the expenditure incurred on inputs by each of the members. The group assumed full responsibility for sampling cuts of the 1998 experiments. They measured the area, harvested, weighed and separated the various components and stored them.

By 1998, two more women's self-help groups joined the PTD process. Men's involvement varied across the villages. In the village wherein their participation was higher, we noted that *1*) the relative importance of groundnut in the total farming system was higher, and 2) the NGO fieldworker in this village was a health worker and had a good rapport with both women and men. His colleague in the other village, on the other hand, was a women's group organiser and had a good rapport only with women.

From Men's Groups to Women's and Men's Group (Myrada, Kadiri)

In Kadiri, in Anantpur district of Andhra Pradesh, one young male farmers' thrift association (an SHG) supported by Myrada got involved in PTD experimentation in 1997. In the course of the process, the group started functioning as a multifunctional group. Cooperation among group members increased, as did their confidence to handle different technical as well as social matters. Women household members of the men's group also showed interest in the experiments.

Three new groups (two women's groups and one men's group) joined the PTD process in 1998. One of the two women's groups is a member of a broader network called Praghati Mahila Samakhya comprising 120 SHGs constituted by the UNDP for women's empowerment.

Perceptions of Women and Men Farmers about Problems in Agriculture

In 1997, we held discussions with each of the groups (women/men) to find out the constraints in their cropping systems. We wanted to learn about the differences between women's and men's perceptions (see Table 1).

A closer look at their perceptions shows that men's concerns are focused on productivity of land and crops, and their sustainability in the long run. Soil deterioration due to repeated use of chemical fertilisers and stagnation of yields due to repeated use of the same variety of seed are some examples. Women's concerns are more towards day-to-day management of the farm, crop activities and the physical labour involved. This is logical, considering that women's involvement in

TABLE 1

WOMEN'S AND MEN'S PERCEPTIONS OF PROBLEMS/CONSTRAINTS IN GROUNDNUT PRODUCTION

Perceptions of Women	Perceptions of Men
– Erratic rains causing problems in pod formation	– Repeated application of chemical fertilisers leading to soil deterioration
– No proper facility for drying and storing seed	– Deforestation—depletion of cattle population
– Pest and disease problems	– Repeated use of same variety of seed over the years
– Depletion of cattle population—less farm yard manure	– Increase in weed problems due to increased use of chemical fertilisers
– No or low access to credit	– Labour shortages during peak agricultural activities
– Less access to draught power and implements	
– Undulated terrain—soil erosion and soil fertility problems	
– Difficulty in quantifying yields	

groundnut work is higher than that of men. The women said that they find it difficult to assess monetary outputs from their farms as that is men's domain. Their concerns reflect that they are poorly equipped to make decisions related to their farms as they do not have access to relevant information to do so. The women expressed the desire to develop a more comprehensive understanding and more skills which would help them to better plan and implement their farm work.

Perceptions of Women and Men Farmers about Technologies Being Tested

As women and men experimented with the groundnut package, we recorded their respective responsibilities against each practice and their perceptions about them. Table 2 provides a summary of these.

Most technologies require the involvement of both women and men. Their perceptions about the technologies are closely related to their physical involvement in implementing them. Again we see that women mentioned labour related problems more often than men did. One such problem—women's complaint about the dirty, slippery consistency of Mussoorie phosphate—could be solved by slightly modifying the practice. That is, mixing the Mussoorie phosphate with farm yard manure (FYM).

Information gaps within members of a household seem to frequently occur when only women or only men are directly involved in the PTD process. Our limited interaction with the non-participating household members created in them a interest in the PTD process, but was not sufficient to bridge this information gap. Though household members communicated with each other about PTD experiments, it was mostly limited to getting consent from the family members to share the workload. This was more significant with men's groups than with women's groups.

Most of the experimenting women farmers were non-literate. They found it difficult to comprehend new names of inputs, figures related to money, yields and outputs. Their entire interaction was based on their memory power and mental abilities to describe changes or recapitulate the details of the inputs used and the outputs realised. For a better appreciation of money spent and returns got, women require some basic training in numerical literacy.

Women and Men Farmers' Perceptions of the PTD Process

At the end of the 1997 farming season, after harvesting the crops and comparing the results of experimental and control plots, the experimenting farmers and NGOs evaluated the process and the results. The yields were generally below average in the area due to bad weather conditions. The yield from the experimental plots were, however, higher than those of the control plots, and the quality of the pods was superior in the experimental plots. In spite of the losses incurred, farmers (women and men) decided to continue experimentation, hoping for better weather conditions in 1998. The women's groups expressed a strong desire to continue with the PTD process. They mentioned that, while experimenting, they had learnt many new things; they had acquired new knowledge and skills and shared many experiences.

TABLE 2

WOMEN'S AND MEN'S RESPONSIBILITIES AND PERCEPTIONS ABOUT TECHNOLOGIES TESTED

PTD Practice	Responsibilities of Women and Men	Perceptions of Responsibilities
Improved seed varieties[8]	Women and men: seed selection	Women have more refined selection criteria. Personal selection by women is not possible if seed is procured outside the village.
Testing Mussoorie phosphate (natural phosphate fertiliser)	Men: transport (by cart) Women: application to soil, carry fertilisers in sari	Women have carrying and application problems because it is dusty, slippery and heavy. *(Practice changed in 1998. Mussoorie phosphate is now mixed with FYM and carried in a basket.)*
Seed treatment[9]	Women: preparation of jaggery syrup and seed treatment with three bio-agents	Information gaps where men's group is involved in PTD—method not accurately followed by women.
Increased seed destiny	Men: operation of bullocks and seed drill Women: dropping seed	Information gap where men's group is involved; women believe that passers-by may cast an evil eye if there is a large plant population.

Gypsum application—calcium and sulphur management	Men: transport (by cart) Women: application	As in Mussoorie phosphate, but there is no texture problem.
Leaf wetness counter	Women and men: observation, recording leaf wetness score, sharing information with others in the group	If women are directly involved in PTD, there is more accurate observation about the disease intensity and decision-making about need to spray fungicide.
Fungicide application for leaf spot control	Women: carry water Men: spray	Women face problems in carrying water for fungicide spray to the upper regions, where the groundnut fields are located.

PTD had literally opened a window for them to more knowledge on agriculture.

Women and men expressed the need for simpler combinations of experiments so that they could more easily manage them. For the 1998 season, men farmers decided to take up different types of experiments in small groups so that they could measure the impact of each factor in crop production. They also felt that if there was a problem, everybody should not suffer.

Women gradually developed a detailed interest in the PTD process and did their work in experimentation with a high level of accuracy. They had made it a habit to regularly observe their crop and registered even the slightest changes. Their alertness in observation was more noticeable than that of men. We tentatively concluded that women enjoy learning and observing new things in agriculture, which is very closely linked to their day-to-day work, as it gives them some kind of a new perspective on it.

A REFLECTION ON GENDER MAINSTREAMING IN PTD PROCESSES

Lessons Learnt

During the past few years of PTD experimentation with women and men farmers, and with NGOs that have different visions on gender in the context of their development work, we have learnt a few useful lessons about gender mainstreaming. First of all, we learnt about stumbling blocks. Perhaps the most important stumbling block is the assumptions about gender which guide the attitude and behaviour of many a fieldworker, researcher and policy maker. Some of these assumptions are well known, while others are hidden. All of them help to maintain distorted gender relations. Second, we learnt about stepping stones. There is a tremendous potential to build on the inherent strengths in individual women, men, communities and organisations, as each of them has the capacity to learn and share, and overcome prejudices and barriers. Key words in activating this potential are social organisation, interaction not only within but also between groups and organisations, mobilising, and sharing knowledge and information.

Stumbling Blocks

Women Do Not Have a Say in Agricultural Decision-making

Though it is by now well recognised that women do play an important role as agricultural workers, it is still difficult to perceive women as decision-makers, sources of knowledge and as stakeholders whose opinion matters.

It seems to us that perceptions within the rural community regarding women's role in agriculture are in most cases more realistic and less fixed than those in intermediary institutions, be it NGOs, government extension departments or research institutions. Within the rural community, it is commonly accepted that women do most of the work in agriculture and that they play an active role in decision-making. However, the main obstacle at the community level which prevents women's active participation in PTD processes is the fact that, when it comes to extension, marketing, purchasing inputs, etc., men are the official interface with the outside world. Men's higher mobility is an important factor here. Hence, the initial tendency, at the start of a PTD process, is for men to come forward as 'the farmers'. Our experience has however shown that, with some initial encouragement, many women are able to come forward and participate along with men, often more articulately.

Efforts to change gender perceptions should address various institutional biases. This is what we try to do in a PTD process. It is not only the village women and men who are drawn into a learning process on agriculture and gender relations, but also the NGO field staff, AME staff and collaborating researchers.

Participatory Approaches are 'Naturally' Gender Sensitive

It is often assumed that once an organisation decides to adopt a participatory development approach, there will be participation from different segments of the community and from different segments of the household, i.e., women and men. Even if women do not directly participate, it is assumed that, in the background, they will be in the know about what is happening.

However, PTD, like any other participatory approach, provides no guarantee that women also participate in the process that is being initiated. Women's participation will not automatically happen, it needs to be facilitated. An appropriate gender focus has to be brought into the PTD process by those who implement it.

Trickle Across; from Women to Men, from Men to Women

The so-called trickle across assumption, often made in agricultural extension, has been challenged since the late 1970s. It can never be taken for granted that once men are being reached in extension, the message will find its way to women as well. Since the early 1980s, we have seen many examples of what could be called a reversed trickle across assumption—rather than addressing men, organisations started to directly interact with women. But here too, the same problem on non-trickling or partial trickling of information has been seen.

Therefore, effort must be made, at all critical stages of a PTD process, to involve the direct as well as 'indirect' participants, i.e., the spouses or other relatives involved in the same farming enterprise.

Organisations Implementing Women's Programmes Naturally Have a Gender Perspective on Agriculture

Assessing an organisation's gender sensitivity on the basis of parameters such as the percentage of female staff in the organisation, or the fact that they work with women's self-help groups, can be deceiving. Even NGOs which run women's programmes have a tendency to approach agriculture as a male domain, separate from their activities with women. There is a strong tendency to think of farmers as male individuals, rather than as farm households, which consist of women and men, with different roles and different needs.

'Gender Specialists' Take Care of the Gender Aspect

It is often taken for granted that once there is a 'gender specialist' within a development organisation, she (mostly 'she', whoever she is) will take care of the gender aspect (whatever that is). In AME, in spite of having three in-house gender specialists, we face the problem of insufficient gender focus, sometimes combined with a tendency to separate the technical from the social part of reality. The only way to overcome these obstacles is real teamwork and a very systematic, enduring effort to mainstream gender in all our activities. This has to be supported by a gender balance in the team and an adequate budget for mainstreaming gender activities.

Understanding Intrahousehold Dynamics

When interacting with farmers (whether women or men) we need to keep in mind that they are members of households and that our farm activity with them is only one of the many activities they are involved in. Other family members are likely to influence and be influenced by the PTD process. It is therefore important to develop an understanding of intrahousehold dynamics and to build a rapport with various members of the household, also those not directly participating in the PTD process.

The reality in many NGOs is that they work with women's groups, or with men's groups, or with both, but the overlap in membership—women as well as men from the same households—is, at best, partial. In practice, many NGOs work with individual household members rather than with all. In our case study we have seen that communication gaps within households hamper the process of experimentation and the learning from it. It is therefore important to make a concerted effort to effectively involve women and men in PTD processes.

Learning with Groups

Our case study shows the important role played by groups in the PTD process. Groups provide the forum for learning, sharing and disagreeing/agreeing on the merits and demerits of technologies and on the constraints and opportunities presented by sustained use of technology. Especially for women, the fact that they are members of a group has encouraged them to venture into trying out new things in agriculture.

Most women who got involved in the PTD process had already been functioning as part of other groups for some time. This contributed to a rapid take-off. Adding PTD as a new function to an existing group gave it a new impetus. The fact that these groups had been involved in thrift and credit was very helpful, as they could take up the responsibilities of procurement and distribution of inputs among their members and operate a revolving fund to support them.

Learning from Different NGO Strategies

The approach of an NGO to social organisation is a direct reflection of its ideology. There are often strong dividing lines between NGOs, based on differences in ideologies. Working together on PTD with a mixed group of NGOs, therefore, poses its own challenges. Our experience is that this collaboration has enriched the learning process of all parties involved. Initial barriers gradually reduced as each NGO got more involved and became curious about experiences in other areas. Meetings were organised at different stages in the farming season wherein NGO staff and women and men farmers from different areas participated. These occasions provided opportunities to learn about how PTD processes work in different organisational contexts, and about the requisite conditions for successful gender mainstreaming.

In the 1997 farming season, two NGOs made a conscious effort to involve women in the process, whereas the third NGO was not convinced of the necessity of women's participation. During the season, the reasons why it is important to involve women gradually became clear to all parties involved. This learning was reinforced during review meetings at the end of the season wherein women themselves clearly articulated their perceptions and concerns, and where there was a lot of sharing between NGOs and farmers. The result was an overall tendency in the NGOs to give more importance to women's participation in the 1998 season.

Mobilising Knowledge-empowerment

Women have substantial and detailed practical knowledge about agriculture. However, they do not have access to certain knowledge domains which would help them to develop a better overall picture of their farming enterprise, their own contribution to it and the relative benefits of different technologies. A critical issue is the fact that they do not have detailed knowledge about the field output of their farms (yield as well as its translation into monetary terms). The output and the knowledge about its quantity are being controlled by men. Enabling women to access this knowledge will help them to put their existing knowledge into a larger perspective. Women's involvement in the PTD process does give them access to detailed knowledge about crop yield, as the measurement of the yields of the experimental and control plots is a critical step in the process.

Women's limited mobility restricts their access to knowledge. Their access to agricultural extension and to information available outside their villages is lower than that of men. During the PTD process we saw examples of how women could overcome such barriers. Having built up their self-confidence as farmers, women decided to attend farmers' meets and PTD review workshops, which were three to four hours away from their villages by bus. It was primarily the group that gave them the confidence to do these things.

Our conclusion is that this process of mobilising knowledge gives women more self-confidence, control and respect in the domain of agricultural decision-making. It enables both women and men to improve the quality of decision-making—'best bets' regarding choices of technologies, how to allocate labour and money, etc., become more focused and based on systematic comparisons. Last, but not least, mobilising knowledge and putting it to new use is a joint learning process which reinforces existing groups and helps to build new ones.

Notes

1 We would like to acknowledge our friends and partners in this learning process—the women and men members of the experimenting groups, field staff and management of APRRM, Myrada (Kadiri) and RRS, and our AME colleagues in Madanapalli and Bangalore.

2 For example, in the groundnut PTD process, we identified several promising seed varieties. Through a ranking exercise (a PRA method) we assessed women's and men's criteria underlying their preferences for particular varieties. The next step in the PTD process was to try out the most promising varieties. Farmers were trained to lay out test and control plots and monitor aspects of crop growth during the season, keeping their own criteria in mind. They were trained to take samples of the yield. The experiment was evaluated at the end of the season and the farmers thus decided which seed variety best suited their conditions.

3 Not all characteristics apply to all NGOs, but the pattern that we describe here is a fairly common one.

4 This particular crop and the problems farmers face in its cultivation became an entry point for addressing various other related problems in the farming system.

5 The increasing popularity of groundnut can be attributed partly to the fact that the government has actively promoted the production of oilseeds, and partly to the deteriorating land conditions in rainfed areas, which have forced the farmers to opt for short-duration and more drought-resistant crops.

6 A package of practices for PTD experimentation was evolved with the help of farmers, NGOs and research institutions. Farmers' knowledge about local production practices, information provided by research and extension institutions and literature on eco-friendly alternatives served as the basis. The package consisted of the following elements—improved seed varieties (made available by ICRISAT and local research stations), seed treatment for biological nitrogen fixation with biofertilisers, improved

sowing methods, a package of organic soil nutrient management practices, and forecasting and control methods for major pests and diseases.

7 This is a weather-based device for forecasting disease in groundnut.

8 K 134, K 1128, JL 24 and ICRISAT varieties.

9 Chlorophyriphos, Rhizobium culture, Phospho bacteria and Trichoderma.

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Participatory Technology Development : Implications for Research and Extension

The relevance of farmer participation in research and technology development is being more passionately discussed at present. Both FPR and PTD are approaches based on the belief that farmers are capable of developing viable systems of farming in accordance with the constraints felt and potentials assessed by them. Experimenting with new ideas has always been a part of farming. Farmers observe the results of these trials and arrive at their own conslusions. Their perceptions, preferences, and needs seldom coincide with those identified by scientists and extension personnel.

Farmer Participation in Research: Experiences

Experiences on farmers' participation in agricultural technology development in different parts of the world are presently available. (Okali *et al.* 1994, Haverkort *et al* 1991, Martin and Sherrington, 1996, Scoones and Thompson, 1994 etc.) Some important features of these experiences can be summarised as follows :

1. Most of the initiatives reported are from NGOs. The share of NARS is almost nil, except when supported by special projects of various kinds.
2. About 85 per cent of the cases are from Africa, and the rest from Latin America and Asia. In all these projects, farmers are involved in the diagnostic stages of research and there is an increasing emphasis on PRA techniques.
3. In more than 90 per cent of the cases, participation is mainly in on-farm trials.
4. Most of the firm trails are related to varietal selection. (e.g. : KRIBHCO Indo-British Rainfed Farming Project, India) and plant protection (eg.control of Cassava Mosaic, Uganda). Some cases provide for farmers' involvement in trial design (e.g. Effect of body condition at calving and subsequent nutrition on health and productivity of Ndama cows) and in trial management (e.g. community tsetse trapping, Kenya). Experiences of collaborative experiences have also been widely reported. In India, for instance, Qayum (1995) has reported a successful collaborative programme for non-pesticidal management of red hairy caterpillar involving various ICAR institutes, farmers and NGOs in Hyderabad.
5. Experiences of collegiate interface are very few (e.g. Farmers screening for cassava green mite resistance and solving African Cassava Mosaic disease, both from

Uganda).

6. There are also a few attempts to organise farmer research groups (e.g. : Dryland Applied Research and Development Project, Kenya; Community Tsetse Trapping, Kenya).

7. Information on costs, manpower deployment and socio-economic characteristics of the participants are hardly available.

All the projects reviewed emphasise the benefits of farmer participation in research (though the levels and modes vary) and call for greater participation of farmers in research.

Scope

It is generally accepted that the role of farmer participation is more in adaptive research, less in applied research and very limited in basic research. In agreement with this, some hold the view that basic, strategic and applied research are best done on the research station (or under controlled conditions) while on-farm participatory research is more appropriate to the adaptive phase, where technology is adjusted to the specific needs under a particular set of conditions. Though the scope of farmer participation in basic or applied research is seemingly less, the fact is that observations on farmers' indigenous practices can provide definite directions for basic research (e.g. analysing) traditional practices and improving it for wider applicability.). Sikana (1994) regarded the indigenous knowledge of farmers as entry points for future scientific work.

Reportedly, PTD has greater potential in varietal selection, working out beneficial rotations and other agronomic practices, developing soil and water conservation techniques, watershed management, disease recognition and assessment of susceptibility, biological control, integrated pest management, etc. "However, attempts to define specific problem areas or types of technologies which are more or less appropriate for farmer participatory research have been inconclusive" (Martin and Sherington, 1996).

Why PTD?

Our contention is that institutionalising farmer participation in research could be of much relevance to Indian Agriculture on the following grounds :

Inadequate focus on Farmers' problems

The major problem areas that "threaten the very concept of evolving improved technologies" in agricultural research system, as identified by the G.V.K. Rao Committee are (1) an inadequate focus on local problems in research programmes and (2) an excessive emphasis on uniformity of experiments and a straight jacket approach in research (ICAR, 1988). The National Agricultural Research Project (NARP) initiated in 1978 strengthened research infrastructure in the Zonal Research Stations of SAUs substantially. However, the research programme planning process at many ZRS were neither relevant to the farmer's needs nor have the researchers been able to embrace problem solving adaptive research mode (MANAGE, 1993). The Johl committee of ICAR in its report observed that the need and scope for substantial farmer participation through farmers' associations in developing appropriate research programmes in order to account for complexities of required knowledge involved and the ecology as well as the social environment in which farmer's work (ICAR, 1995).

Experience from Farming Systems Research (FSR)

The FSR methodologies meant to overcome many of the above said problems didn't make much headway. "Institutional inflexibility, lack of farmer organisations to represent their needs, poor research-extension linkages, poor research systems set up along strict commodity and disciplinary lines and constraints on personal policies all worked against implementing effective FSR programmes in the NARS" (DeBoer and Singh, 1995). One important component of FSR is its multi-disciplinary perspective. However, research projects continue to remain mostly uni-disciplinary and crop specific. Inter - disciplinary team building by involving scientists with conviction, commitment and mutual respect was indeed a difficult task to accomplish in reality. As Simmonds (1991) quipped, "Interdisciplinary teams are bureaucratically very O.K. but interdisciplinary thinking remains scarce."

Declining local capabilities

PTD may acquire greater significance in the face of the sweeping changes taking place in the economy. Scientific and technological advances have not yet penetrated to the lower strata of the society comprising of peasants, small producers, artisans and landless labourers. In order to bring them into the mainstream of economy, their existing capabilities have to be enhanced. This could be possible only by providing them with appropriate technologies and by pooling their resources and efforts. The existing technologies have to be made area specific and manageable at the level of small producers. Moreover, many of the technologies for sustainable agriculture are knowledge based and needs group action (integrated pest management, integrated plant and soil nutrient management, soil and water conservation and management, agroforestry etc.). PTD provides ample opportunities to make them active participants in technology development and thereby revivify local economies.

Blending formal and informal research systems

Many consider that participatory approaches could enable rapid and effective extension, besides a reliable feedback for refining the technologies to suit variety of real farming situations. Additional advantage of participatory approaches is the integration of indigenous technical knowledge of farmers to the formal research system. For this to happen, a proper understanding of what farmers know and do not know is equally important. Unlimited reliance on farmers' indigenous practices would not help solve the problems every time. For example, in Uganda, with the out break of African Cassava Mosaic, some farmers thinking that the disease was seed born, changed fields, but did not know the importance of selecting clean planting material. Haverkort *et al* (1991) observed that a weakness of farm experiments by farmers themselves is that the search for improved technologies may be based on limited scientific understanding of the process involved and may lead to wrong attribution of performance.

All these point towards the need for an appropriate institutional structure for facilitating farmer participation. A proper understanding and acceptance of the concept of farmer participation in research and technology development by the formal research system and formulation and implementation of appropriate policies in that line could make farm research more relevant.

Who initiates ?

Given the fact that farmers, especially the poor peasants and marginal land holders have less acquaintance with the formal scientific institutions and the methodologies followed by them in technology development, the initiative in propagating participatory approaches of experimentation and technology development should be taken up by the formal research system. This requires a reorientation of the present system enabling it to integrate the perspectives of PTD / FPR. Greater opportunities for meaningful scientists - farmer interaction with the help of extension agencies, farmers' groups and voluntary organisations need to be created.

Key issues in implementation

Implementation of PTD approach, in the existing research setup is not easy considering the organisational inadequacies and lack of receptivity of scientists to such ideas. While some of them are conceptual, some are optional. A brief account of these issues is given below.

Methodological challenges

PTD / FPR has to face some methodological challenges raised by the issue of diversity and differences among farmers and the anthropological characteristics of farmers' knowledge. (Fairhead, 1990; Van der Ploeg, 1993). First, farmers and research scientists do not share the same notion of what constitutes an experiment or innovation. Richards (1989) suggests that agricultural production more or less resembles a 'performance' of complex, situation specific adjustments, rather than a planned sequence of events and hence the boundary becomes blurred. This raises the question of whether farmers regard changes in practices as 'innovations' at all. A second set of difficulties arises while establishing a basis for collegiate dialogue between researchers and farmers. Van der Ploeg (1989) observes that this difficulty is due to the fact that farmer's understandings of agricultural process are a complex of personal metaphorical and contextual knowledge which becomes almost impenetrable when subjected to scientific enquiry. A third challenge for Research and Extension which is based on facilitating dialogue and mutual learning is the issue of power and control over knowledge. It is said that farmers' knowledge can not simply be aggregated as if it were the property of farmers in general, and making an innovation common property has social and political consequences.

Organisational support and commitment

In order to assimilate the philosophy of PTD, a different kind of institutional mechanism has to be created which has the capacity to retain its abilities to facilitate as well as to respond to change. It should be "able to evolve in its relationship with the dynamic and complex environment in which it exists" (Richards, 1994).

Many agriculture institutions, whether universities, research organisations, or extension agencies are characterised by restrictive bureaucracy. They have centralised hierarchical authority, specialised disciplinary departments and standardised procedures. Many formal research organisations at present do not provide enough space to accommodate these approaches in their research mode. Thrust areas identified at the headquarters level, and mandates of the organisations need not necessarily coincide with the real research needs of the farmer. The problems to be researched and the ways to go about are more or less fixed by the research councils who approve the projects. Often the researchers have to adjust their work according to the limited manpower available and depleting contingency support. As PTD believe in location specificity, on-farm experimentation, constant and meaningful interaction with farmers and presence of scientists in the farmers' fields are required too often. Other than the ongoing projects, the system should also have enough flexibility to quickly respond to unanticipated field level problems. All these require more manpower, adequate field staff and support for travel and stay. Obviously, monetary allocations should be adequate to meet these expenses.

Problems with 'mind set'

In addition to organisational changes, scientists should have an open mind and right attitude to work with farmers. This may require some sort of 'de-learning'. Scientists should descend from the hierarchical and conventional mode to a participative and mundane plane. Scientists and extension professionals are assigned with newer roles such as catalysts, consultants, advisors, facilitators of farmers own analysis, searcher and supplier for materials and practices for farmers to try. etc.

PTD has not been viewed in its proper perspective by many in the scientific community. This has led to several unwarranted criticisms against this concept. One such criticism is about the validity of the data generated through participatory research. Many have termed the qualitative data as subjective and non-applicable in a wider scale. This argument can not stand any longer, since in recent years a number of useful statistical advances have been made in the techniques for analysing categorical (qualitative) data. Additionally, statistically valid experimental design and sample selections can be created to cater for qualitative data. (Martin and Sherrington, 1996).

Misconceiving PTD/FPR as On-farm trials

It is often generalised that PTD / FPR is nothing but on-farm trials done by the scientists. This is not fully true. The differences between on-farm trials and participatory technology development have to be clearly identified. In on-farm trials, the results are analysed by the scientists themselves and farmers are rarely consulted. This is used for "validating their own perspectives or actions" and is often described as "extractive and disempowering" (Chambers, 1992) However, in PTD there is joint implementation and evaluation of experiments at all stages. Here, professionals enable and empower in close dialogue and they attempt to build trust through joint analysis and negotiations. Thus in PTD, it is not monitoring the performance of a technology developed elsewhere, but evolving sound and appropriate ways of farming. But unfortunately, the difference is not properly understood.

Selection of participants

Studies have shown that one factor that led to limited success of Training and Visit (T&V) system of extension was the faulty selection of contact farmers (Ray, 1991). Selection of participants should be done democratically so as to reflect the genuine interests of the majority. It would be better to work with the existing farmer groups, wherever such groups exists. As mentioned earlier, farmers' groups or organizations can play important roles in carrying out participatory research and technology development. Farmers' groups can be instrumental in supporting farmers' experimental ventures. Organizing farmers into groups for collective bargaining and lobbying to make suitable changes in the research agenda can also be thought of.

Socio-Political issues in "People's participation"

Several socio-political issues affect peoples' participation. People's participation is also entangled in a host of associated problems such as caste, gender, tenure, settlement pattern, market proximity, health status of the population, etc.... All these can make differences to people's ability to participate.

Undoubtedly, these factors would reflect in the selection of farmers and deciding the research agenda. Thus this methodology is to be viewed and understood in a different perspective, a perspective of empowering the poor. How the formal research system can do this is a big question yet to be answered. PTD / FPR has to be understood as a part of a major development agenda, which dreams of empowerment of the deprived sections of the society.

The undue projection of participatory methodologies as a panacea to social problems is to be critically viewed. The tendency to view it as the lone solution to the problems in agricultural development may result in faulty diagnosis and action, as the ability of participatory approaches to resolve grave social realities depend on various factors operating in the society. Participation becomes meaningful only if it raises its mandate to a wide spectrum of activities, especially the social and political.

Implications for Research and Extension

Adoption of participatory approaches in the formal Research and Extension system would necessitate some changes in the present modes of operation.

Sensitizing research and extension

Formal research and extension systems have to be sensitized in a larger way, to assimilate the philosophies and principles of PTD approaches. Exposure to participatory approaches could be provided through systematic orientation / training programmes and also by making available relevant literature on these aspects.

Shift in Research agenda

In PTD approach, the research priorities of the research organization have to be decided on the basis of feed back from clients. The researchers then explore the concepts and procedures used by farmers in their experiments and apply the positivist assumptions of technical science, without neglecting its social and cultural aspect. The research agenda by all means would then address the problems of the locality.

Opetational support

The financial crunch being experienced at present by almost all the public funded organisations involved in research and extension have already adversely affected the availability of operational funds. Employing participatory approaches demand much higher deployment of scientists and extensionists at the field level, which would incur higher operational expenses. This calls for an enhancement in the allocations of operational funds.

Re-orienting Agricultural Education

Agricultural Education has to be reoriented in a way that the young graduates get ample opportunities to mix up with the rural masses and explore their problems through participatory approaches. Conventional classroom-lecture method needs to be supplemented by participatory learning methods.

Training to field level workers

Training has to be imparted to field level extension workers and agricultural officers on participatory methodologies such as PRA and methods of designing and monitoring experiments. They should also be given training to initiate group action through organising village groups and farmers' associations, which could facilitate farmers' own experiments. Extension staff should be provided training in planning and managing field experiments and on methods of facilitation and negotiation between different interest groups.

Organizing farmers and involving them

To facilitate PTD, farmers groups have to be formed at the field level. Organising farmers on commodity / crop / enterprise basis seems to be a better approach for PTD than general farmer's organisations. Representation of farmer's groups in local and national research planning would certainly enable them to articulate their concerns and aspirations effectively.

Research Extension Linkage

Success of PTD approach would essentially depend on the strength of linkage between research, extension and farmers. Several studies have highlighted the poor linkages existing at present.

For a finer degree of farmer participation in technology development, new skills are to be acquired by the researchers as well as extension personnel. They are not only scientific and technical, but also interpretative of local knowledge and culture in which it is embedded. Skills of facilitation, conflict management and negotiation are also important.

Research - Extension - Farmer linkage has to be strengthened on the basis of the requirement of participatory methodologies. Extension system would have to take up the following roles and duties in this regard.

1. Help the research agencies formulate sound PTD projects by providing them with concrete and analytical information about the socio-economic and political characteristics of the locality.

2. Extension agency in the initial periods can facilitate the involvement of village institutions or farmers' organization in deciding and prioritizing the research agenda. Later on, these trained para professional groups can develop relationship with research stations and form collaborative partners to carry out PTD projects.

3. Extension wings of the research institutions should play the role of information providers and should help in facilitating proper interactions of their research wings with the village institutions.

4. Training is one of the most critical inputs for improving the research and management capabilities of farming community. Extension agencies should organise trainings to the farmers with a view to improve their experimental and observational skills. New training modules are to be designed on the basis of the principles of participation.

5. Properly trained field level workers, can assist farmers in conducting their own experiments and recording their observations scientifically. They can also give clarification to farmers during the course of experimentation. In addition to this, extension workers can monitor and evaluate the progress of farmers'

experimental ventures.

6. Capacities of farmers in information gathering, preparation of proposals, analysis and documentation are to be built up through meaningful interactions and demonstrations.

7. Local farming techniques could be documented so that they can turn to entry points in basic research.

Conclusions

Participatory approaches in research and technology development focus on the value and development potential of farmers' own research process. Integration of these methodologies in the existing modes of formal research and extension organizations needs substantial changes in their structure and function. Moreover, the stark social realities of power imbalances and exploitation and so many related issues are not addressed in the debates on empowerment and participation. Undoubtedly, this neglect would render even the genuine attempts vague and futile. Proponents of these methodologies should be aware of the contradictions within the body of literature and activities related to farmers' participatory research and technology development. Euphoria over these approaches should not be allowed to mask the realities associated with them.

At this juncture, theoreticians and practitioners of PTD / FPR should try to develop pragmatic solutions to address the theoretical and methodological challenges in these approaches. FSR implementation provide several lessons for research and extension systems. Key issues in implementation needs to be analysed and addressed. Above all, deliberate attempts to change the mind set and organizational rigours are to be initiated to accomplish the goals envisaged in the participatory paradigm of development.

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Participatory Technology Development - Some Policy Issues

Though the concept of Participatory Technology Development (PTD) is gaining much popularity in the present scenario of agricultural development, the concept is neither fully understood nor appreciated by the scientists in its proper perspective. Thus it is the question of proper perception and associated role performance by the scientists that is very important and deciding. With this in view, the present paper approaches the concept with the three-fold objectives as under:

a) to rationalise the technology development process in the farm sector,

b) to identify and clarify the systems involved in technology development process and define the roles of each system, and

c) to analyse the misconceptions about PTD and identify the relative advantages

A) Rationalising the Technology development Process

At present, what we observe is the passive approach by the research system in technology development, according to their own priorities, needs and interests without taking into account the views and critical needs of either the farmer (user) system or extension system. The lack of involvement and co-operation of the three system has led to the present desperate state of infidelity in the three systems, with each system blaming one another for the lapses or deficiencies in the evolved technologies. It is more or less true that the selection of research problem and design of experiments are often left entirely to the hunches, imaginations and guesses of individual scientists and committees. R & D institutions have to accept that research output of their faculties are limited by the constraints of their environment and they have to operate within the rigid rules and regulations of the organisations.

Rationality in technology development is likely to take place through reorganising the structure of the technology development. In practice, awareness and commitment are likely to be present when structural approach to technology development is based on the following assumptions :

Assumption 1 : All the three systems (research, extension and farmer systems) will be able to articulate their perception of problems provided that the farmer system and the extension system are involved in the identification and prioritisation of the research needs (agenda setting).

A meaningful linkage between farmers and scientists is required and this can only be achieved through a close relationship between the two categories. It is for example, not uncommon for scientists to appreciate the potential applications for their technologies, but fail to convince the users who may reject it on insufficient evidence or because it does not fit into their requirements.

Assumption 2 : Problem identification by the farmers leads to their personal involvement in the solution of the problem also.

The scientists, who are external to the farmer system, may not be fully familiar with the constraints of the operating environment or their limitations. The approach of the scientists is usually constrained by their past experience and training. Faced with a new problem, it is likely that the scientist will apply his own filter to the information he is supplied, selecting only those ideas which lies in his own field of competence. These will then be ordered and processed according to the tool of his specialisation. In this way, he applies a subjective distortion to his understanding of a problem which he proceeds to solve by extrapolation along a narrow path.

However, when farmers are also involved in the process of seeking solutions for the problem, the bias of the scientists will not occur normally. The concept of competence as introduced by Heiner (1983) is quite relevant in this context. According to him, competence can be either technical or economic. Technical competence is the competence for designing production process in terms of physical variables, which the scientists possess.

However, economic competence is quite different, which can be regarded as a mixture of three basic components- allocative competence, associative competence and learning competence which the farmers have. It is, therefore, better that scientists and farmers join hands so that there will be fusion of both technical and economic competence.

Assumption 3: The process of identifying the problems and solutions is in itself, a most important and relevant act of technology development, particularly when this involves implementation of solutions by the farmers.

It is wasteful to develop a technology for which there is no demand from farmers and yet it is seen that this happens not infrequently. As a result, there is more rejection of that technology by the farmers. As Illich (1990) had remarked, "The professionals have become colonials in the sense that they have taken possession of the knowledge of technology- a knowledge that all people should possess to be able to change their own lives". Such institutionalisation of knowledge makes farmers dependent on having their knowledge produced for them.

If productivity of research is to be increased, then the selection of the problem and design of experiments must be jointly planned and decided by the scientists and farmers, and not left entirely to the hunches, imaginations and guesses of the scientists. If we analyse the specific forms of user-producer (farmer-researcher in the present case) interaction in relation to the process of innovation, it could be seen that it is beneficial to both. The researcher will have a strong incentive to monitor what is going on in the farmers' fields. The bottlenecks and technological interdependence, observed within the user units form the potential problems for research for scientists. The farmers, on the other hand, will not only be benefited by the close monitoring by the scientists, but also will be compelled to involve in the analysis and solutions of the problems.

From the above, it could be concluded that whatever it be, PTD is based on the simple assumption that **farmers** are and remain the **main actors** in the process of technology development and that **outsiders** can at best play only a **supportive role.** This role can be translated into different functions, but in the main should aim at strengthening, the experimental capacity of farmers (Haverkort and Zeeuw, 1991).

B) Systems involved in Technology Development

All the above pinpoint the need for a participatory approach and action by the three systems in the three main stages in technology development process-viz; problem identification and prioritization, evolving appropriate technology and popularisation of the evolved technology. The roles of each system may vary in each stage. However, there has to be proper involvement of the three systems during these three stages.

In the problem identification and prioritization stage, farmers should be assigned a major role since they are the ultimate users of the technology. Moreover, they have a treasure of knowledge which they have gained directly from their field. Such traditional indigenous knowledge of the farmer can serve as a strong base for the sustainable agricultural technology development. In fact many have opined that indigenous knowledge of farmers could be regarded as entry point for future research works by the scientists. The crude local farm practices prevalent in each locality can pave way for th evolution of sustainable practices suitable to the locality. If such practices are considered for the refinement or modification on scientific lines, the chances for the acceptance of research results by the farmers will naturally be high.

In the second stage of evolving suitable technologies for the farmers, naturally, the research system has a major role. But in this process, the other two systems should not be alienated. The involvement of the farmers and extension personnel in this stage add to the value of evolved technologies. Most farm research starts in a research station under carefully controlled conditions. It is seldom possible to apply such research station findings directly on the farms because of differences in circumstances and because capital and manpower are often assured and more readily available on research stations than they are on farms. So also, farm research is often conducted within a discipline. However, many farmers' problems have interdependent or overlapping components of several disciplines. Information from these disciplines must be integrated and combined with farmers' experiences and ideas, if the problems are to be solved effectively. Experimentation under PTD takes care of these salient and vital aspects. Unlike in the case of conventional research wherein experiments are conducted in the R & D institutions, where only the scientists are involved, in the participatory technology development process, farmers are the experimenters who are guided and supported by the scientists, and closely supervised by the extension personnel. Thus, here there is a true partnership between the three systems and each system earns the confidence, support and approval of the other systems.

During the stage of popularisation of the technology, though extension system has to take a lead role, this may not be much needed in the case of technologies evolved through PTD process. Unlike the present situation, where the farmers are quite passive in accepting the technology which is not relevant to them (in most cases), in the case of the technologies evolved through PTD process, the farmers will be quite ready to accept the technology without any persuasion by the extension personnel. Either the "individual- blame" hypothesis or the "system - blame" " hypothesis is relevant in this context. This becomes possible since the farmers value the technology as "their own" developed by them. Hence the responsibility and the burden of extension system gets greatly reduced. However, the extension system has to take a lead role in bringing the researchers and farmers together as partners in the research process by creating greater opportunities for scientist-farmer interaction.

C) Misconceptions about PTD

PTD has developed around it a set of images and myths. These are neither entirely true nor entirely false. However, these misconceptions have to be cleared and a proper perspective developed for the proper implementation of PTD. Some of the important misconceptions are:

a) PTD needs well educated farmers.

   PTD is possible even with farmers who are illiterates.

b) Research can be done only by scientists and not by farmers.

   Farmers can take up many small scale experiments in their own fields on a logical and scientific basis. There are many farmers who conduct small experiments in varietal selection, screening of plant protection chemicals, etc.

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C) **Farmer experiments will not be scientific**

Although the experiments may not be as scientific as carried out by scientists due to obvious reasons, they are also of good quality definitely which meet the requirements of the farming community.

d) Farmer experiments are vulnerable to situational factors.

This is also applicable to experiments done by scientists. (not pot culture experiments, but field experiments)

e) Farmer experiments are culturally unacceptable

It is presumptuous to assume in advance that farmers do not or will not appreciate experiments done by the fellow farmers.

f) Research results of farmers have no market value-.

It is true that research results may not find any academic value and place in research journals. However, the results will have definitely value in terms of application in farmers' situations.

D) **Advantages to Farmers from PTD**

There are many factors of PTD compared tc conventional research which are advantageous to the farmers. Some are as below:

a) Farmers produce their own technologies.

The most important tool of farmers is their own "skills". Farmers who produce their own technology have definitely control over it.

b) Farmer technology encourages community participation - The farmers show more interest in the technologies evolved by their colleagues and participate in adopting them in their fields.

c) Farmer technologies use local materials and local expertise.

This does not mean that resources must be found in the village itself. This means that the farmers have access to the materials and expertise without having to depend on external assistance or aid.

d) Farmer technology is non-hierarchial.

Because of its inherent simplicity and easy availability, other farmers can adopt the same technology without waiting for the extension system to intervene.

e) It is cheap and flexible.

The technology is less costly and affordable by the farmers, which also is amenable to slight modifications to suit differing farmer environments.

f) It is culturally supportive

The farmers have more faith and confidence in the experiments conducted by their fellow farmers in their local environment.

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