The Consultative Group on International Agricultural Research (CGIAR) works to promote food security, poverty eradication, and sound management of natural resources throughout the developing world.

In recent years the CGIAR has embarked on a series of systemwide programs, each of which channels the energies of international centers and national agencies (including research institutes, NGOs, universities, and the private sector) into a global research endeavor on a particular theme that is central to sustainable agriculture, fisheries, and forestry.

The purpose of the CGIAR Program on Participatory Research and Gender Analysis for Technology Development and Institutional Innovation (PRGA Program) is to assess and develop methodologies and organizational innovations for gender-sensitive participatory research and to apply these in plant breeding and crop and natural resource management.

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Equity, Well-Being, and Ecosystem Health

Participatory Research for Natural Resource Management

CGIAR Program on Participatory
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Contents

1. Participatory Natural Resource Management

"To change the modality we must change the metaphor."
Jean Houston, Foundation for Mind Research

Toward an Ecological Worldview

A new vision of humanity's relationship to nature is gathering strength. We are beginning to see our world as a living system, in which we ourselves are embedded. And we are gaining a greater awareness of our dependence on nature's ecological services and on one other. Our emerging mental map of the world shows it as an integrated whole rather than a collection of parts.

Of course, much human behavior suggests otherwise. As a result of our activities, the earth's forests are receding, while its deserts are expanding. Topsoil is diminishing, and the ozone layer, which protects us from ultraviolet radiation, is being depleted. Concentrations of heat-trapping gases in the atmosphere are rising, while the numbers of plant and animal species are shrinking. The human population continues to expand, as the gap between rich and poor widens.

Nonetheless, people in all walks of life are realizing that the major problems of our time are interconnected and that the only viable solutions are those that satisfy today's needs without diminishing future prospects. We have made a start toward building sustainable communities, in which we can fulfil our own aspirations while leaving a healthy world for tomorrow's children. To make this vision a reality means creating equitable social and economic arrangements that protect and maintain the ecological services that earth provides--and learning to live within our ecological means.

This publication shows how scientists from centers supported by the Consultative Group on International Agricultural Research (CGIAR) are working with farmers, communities, and organizations to improve the health and well-being of people and our environment. Toward this end the various projects described here are developing and practicing innovative participatory approaches for research on natural resource management (NRM). This research deals with such issues as resource monitoring, policy and legal frameworks, participatory learning, collective resource management, and learning communities. The case studies presented in this publication demonstrate the critical role of participatory approaches in NRM research, highlighting the roles of different stakeholders, the significance of scales and time dimensions, the inevitability of tradeoffs, and the challenges of dealing with complexity.

Ecological Literacy

"The survival of humanity will depend on our ecological literacy, on our ability to understand the principles of ecology and live accordingly."
Fritjof Capra, Physicist

The magnitude and urgency of the sustainability challenge are unprecedented. Calculations of humanity's "ecological footprint"[1] show that we may already be using 30 percent more ecological capacity than nature can provide. Our appetite for resources has become so voracious that it is affecting the integrity of our planet's land, water, atmosphere, and biological diversity. Our impact on the biosphere has become so large that we are now directly responsible for its condition.

Traditionally, we have managed ecosystems for the extraction of goods and services, such as fish, timber, livestock, crops, fiber, or hydropower, without fully realizing the tradeoffs involved or understanding the consequences for other people, places, or forms of life. By perceiving and managing our world in a fragmented way--with material acquisition and financial gain as the central objectives--we have sacrificed the ecological services provided by biodiversity--including soil generation, flood control, pollination, waste detoxification, nutrient cycling, climate buffering, and the evolution of new forms of life. These natural processes are ultimately more valuable than all the material goods we create.

The challenge then is to alter our perception of ecosystems, so that we see the whole rather than just the parts, and to replace our objective of acquiring more things and earning more money with the broader one of improving our social, economic, and ecosystem well-being.

"A significant fraction of the world has advanced technologically to the point where economic production of all the goods and services that society can imagine needing or desiring can be provided using only a small fraction of the population. It no longer makes sense for the 'central project' of society to be economic production and consumption."
Willis Harmann and John Hormann, World Business Academy

[1] The ecological footprint is a measure of the area of productive land and water we occupy to produce all the goods and services we consume and to dispose of all the waste we produce.

These are critical first steps towards healing the injuries we have caused. John Elkington of SustainAbility has called this broader collective mission for humanity “the triple bottom line.”

To understand the earth as a complex and self-organizing living system offers new possibilities for implementing the new vision and for managing the web of problems facing humanity. To realize the futility of controlling or dominating nature liberates us from looking for technical or economic “fixes.” Instead, we can aspire to mimic the patterns and process of nature itself.

Like life itself, ecosystems are characterised by self-organizing cycles. Nobel Prize winner Ilya Prigogine called these “dissipative structures,” because their self-organization requires a continuous flow of energy that dissipates as it moves through the system. The components of the system are connected in networks, which generate self-regulating feedback cycles. The systems are cognitive--that is, new structures and behaviors arise as a result of development, learning, and evolutionary processes.

Cyclical processes are a repeating theme in nature. Likewise, our management of the earth’s natural and human resources and life support systems can be cyclical and evolutionary. Management based on ecological design and on the metaphor of evolution implies an unending cycle of probing and experimenting, establishing indicators, monitoring feedback, adapting practices, and continually refining all of these processes as we learn from them.

“Sustainability is the outcome of learning and negotiation among resource users grounded in institutions, policies, communities, culture and power. Sustainability is the interface between our human ability to learn and our biosphere.”

Niels Röling, Wageningen Agricultural University

Research aimed at safeguarding natural resources can be designed around ecosystem ideas. Such research is a vital part of NRM, which in turn is critical for the overall management of ecosystems. Ecosystems are structured around a few key processes. Quantitative approaches, including controlled experimentation, are used to study their components, while patterns and processes are studied qualitatively, making it possible to map their interrelationships. Research on ecosystems thus integrates quantitative and qualitative tools and methods.

The management of resources and ecosystems affects many users and stakeholders. Unlike the nonhuman members of natural systems (e.g., plants), human stakeholders are guided by reasons, not driven by causes. Their reasoning leads to multiple and often conflicting goals. Given the diversity of human intentions, the only realistic way to achieve equitable and sustainable results is for users and stakeholders to participate in resource management. By taking part in research, learning, and negotiation, they become collectively responsible for decisions and for the resulting outcomes. They become the owners of their choices, and the entire process is democratized.

While evolution provides a new metaphor for resource management, the life cycle provides a new metaphor for technology development. In the past system linkages within the whole impact cycle of a product or technology were rarely considered. Hence the history of modern agricultural technology has included an era focused largely on improving productivity. With the globalization of trade, the links between production and processing and between marketing and consumption are receiving more attention. But only recently have we begun to integrate linkages to livelihoods, natural resources, and human and ecosystem well-being into technological innovation.

Principles of Natural Resource Management

To achieve holistic, adaptive management of our ecological heritage requires major changes in the way we think and work. It demands that we develop a broad understanding of patterns, processes, and structural relationships and develop broad knowledge and experience. Here are some fundamental principles of this emerging approach, derived from a variety of sources:

- Define success as preserving or increasing ecosystem capacity to produce desired benefits in the future.
- Reorient the boundaries of initiatives and integrate efforts across sectors in recognition that ecosystems function as wholes and need to be managed as such.
- Take a long view, working across various scales and time dimensions.
- View the production of material goods and services as outputs of a healthy ecosystem; and assign explicit values to the earth's ecological services, so these are no longer treated as externalities that are beyond planning and management.
- Involve users and stakeholders in the creation of learning communities that can engage in participatory research, learning, and collaborative management.
- Create mechanisms for channeling into the research and learning process environmental feedback on the interventions being tested.
- Measure progress toward goals against environmental indicators that are continually updated and refined.
- Employ conflict management tools with stakeholders to weigh the tradeoffs and off-site effects of specific interventions and to examine policy issues.
- Engage stakeholders in collective action aimed at negotiating rules and sanctions.
- Identify the conditions under which stakeholders are willing to make choices that benefit entire communities.

The Role of Participation

"Power is nothing if it is not the power to choose."
Joseph Weizenbaum, Massachusetts Institute of Technology

Participation is intrinsic to the new worldview and to the principles of an ecosystem approach for managing natural resources. The role of participation in society has profound roots in science and philosophy. In the 20th century, modern physics added its voice to ancient wisdom with the discovery that descriptions of reality depend on the observer. But it was Princeton physicist John Wheeler who realized that "observer" is an inadequate word for describing the implications of quantum theory. Wheeler wrote:

> May the universe in some strange sense be "brought into being by the participation of those who participate? The vital act is the act of participation." **Participator** is the incontrovertible new concept given by quantum mechanics. It strikes down the term "observer."

Put simply, the universe is participatory. We influence and create our reality through the choices we make, and participation is fundamentally the exercise of choice.

In ecological or holistic management of natural resources, true participation goes beyond merely consulting stakeholders to sharing with them responsibility for and ownership of the outcomes resulting from the choices and decisions they make.

The Contribution of the CGIAR

The mission of the CGIAR is to promote food security, poverty eradication, and sound management of the natural resource base of agriculture, forestry, and fisheries throughout the developing world. As forms of natural resource use, agriculture, forestry, and fishing have a major impact on global ecosystems:

- Agroeccosystems occupy more than a quarter of the earth's total land area, but two-thirds of this area has been degraded in the past 50 years through erosion, salinization, compaction, nutrient depletion, and pollution. Nearly 40 percent of the world's agricultural land has been seriously degraded.
- Less than 40 percent of the world's forests are relatively undisturbed by human activity. The greatest threats to forest area and condition are conversion to other forms of land use and fragmentation by agriculture, logging, and road construction.
- The impact of human activity on coastal, freshwater, groundwater, and ocean ecosystems is more difficult to assess. Nonetheless, we do know that people are taking about half of the readily available water in rivers and that almost 40 percent of the world's population suffers serious water shortages.

Broadening the mission

In recognition of these impacts, the CGIAR has altered its mission from a primary focus on productivity to include concerns about the environment and poverty. CGIAR scientists understand that securing food, eradicating poverty, and protecting natural resources are inseparable goals. And their efforts to help achieve these goals reach beyond research on varieties and soil as factors in crop production to encompass broader issues, such as social and natural capital, gender and intergenerational equity, tradeoffs, off-site environmental impacts, and the role of participatory approaches.

The CGIAR's broader research agenda also reflects a more holistic understanding of poverty as a process. For that reason much of the centers' research is now aimed at helping the poor build different kinds of assets, including natural resources and human capital. In this work rehabilitating, conserving, and improving natural resources (like soil, water, woodlands, and catchment areas) are seen as important means of building assets, especially for women, who make up a growing majority of the poor.

One outcome of the CGIAR's new mission is a new image of itself as one of many contributors to building a sustainable world. To work together all stakeholders in this common project, including the CGIAR, must improve their capacity to involve others in projects, harmonize diverse priorities, and engage in adaptive management of whole systems. Since participatory research and learning are essential for achieving these ends, the CGIAR is seeking new instruments for a more participatory role that is better suited to its more complex mission.

One of these instruments consists of systemwide programs, which create partnerships among CGIAR centers and national agencies, including research and extension institutions, NGOs, universities, and the private sector. The central purpose of these programs is to channel the energies of all partners into global research endeavors on themes that are central to sustainable agriculture, forestry, and fisheries. The systemwide programs thus pool resources and knowledge to accomplish what no single institution could do alone, and they add value to current work through collaboration.

The role of the PRGA Program

The Systemwide Participatory Research and Gender Analysis (PRGA) Program was formed in 1997 to improve user-sensitive participatory research approaches within the CGIAR and among its partners. Stakeholder and gender analysis addresses the key issue of who should participate, and it enables us to determine how different users are affected by change resulting from innovations in technology, institutional arrangements, management practices, and information.

Participatory research is highly relevant to natural resource management, because it addresses the limitations of conducting controlled experiments at the landscape scale. An alternative to such experimentation is continuous process monitoring against environmental, social, and economic indicators. Participatory research can contribute through the creation of stakeholder groups, or learning communities, that engage in adaptive management, monitoring, and assessment.

The PRGA Program is particularly interested in reaching rural women, who make up a growing proportion of the very poor--a trend referred to as the "feminization of poverty." Women are especially vulnerable to the downward spiral of poverty because of their limited access to natural resources and other assets and because of the degraded condition of these resources.

The aims of the PRGA are to:

- Move the participation of farmers, especially women, "upstream" in research by involving them in decision making at earlier stages of technology design.
- Incorporate the decisions and choices of farmers and other stakeholders into the research and learning processes that are central to holistic, adaptive management of natural resources.
- Change institutional attitudes towards gender and stakeholder analysis as well as user participation in technology development and research for sustainable management of natural resources.
- Amplify scientists' roles to include supporting, strengthening, and complementing farmers' own research and learning processes.

Changing attitudes about participatory approaches is a vital first step toward achieving other PRGA Program objectives. The Program works to accomplish this by bringing together scientifically credible evidence concerning state-of-the-art approaches to user-sensitive participatory research and their outcomes. Researchers, decision makers, and development practitioners can then judge for themselves the merits of these approaches. In keeping with that strategy, this publication presents a cross section of cases involving participatory research on natural resource management in the CGIAR.

Cases Studies and Current Practice

Most of the cases presented here were contributed by CGIAR scientists nominated by the PRGA's Resource Group, a pool of highly experienced practitioners of participatory research as well as gender and stakeholder analysis. In September 1999 the case study contributors met in Chatham, England, at a workshop hosted by the PRGA Program and the UK's Natural Resources Institute (NRI). The group analyzed the case studies with a view to:

- Defining principles of participatory NRM research at the landscape scale
- Identifying common strengths, weaknesses, and gaps in the practice of participatory research on NRM
- Documenting successful methods for user-sensitive participatory NRM research; for improving the involvement of specific groups in this research; and for planning, monitoring, and evaluation

To enrich and broaden the overview provided by this group, the PRGA Program circulated a general call for case studies to all CGIAR centers in April 2000, and several additional cases were received. This expanded set includes material from 13 CGIAR centers and the CGIAR-sponsored African Highlands Initiative.

Through a recent survey of participatory NRM research projects (see Further Reading), the PRGA Program found that soil was receiving the most attention, followed by water, forests, and biodiversity. The survey also found that participatory NRM projects are likely to work with multiple resources and innovations.

In the overview that follows, examples focusing on one or two natural resources are presented first, followed by a section on those encompassing multiple resource and common property resources.

Cases dealing dealing with methodological innovations and learning communities of stakeholders in NRM are presented last.

The cases studies illustrate the diversity of participatory research approaches. These encompass a broad spectrum of modes for sharing control of the research process with farmers (See Further Reading). Some practitioners distinguish participatory research approaches according to two key criteria. The first is the identity of the decision makers, and the second is whether or not mechanisms for organized communication exist between farmers and scientists.

In the *on-farm* mode, scientists alone set the research agenda, decide how research will be conducted and determine when, to whom, and how the results will be disseminated. In the *consultative mode*, scientists make the decisions, though they take into account farmers' views by establishing mechanisms for organized communication. In the *collaborative* mode, organized communication between farmers and scientists leads to joint decision making. In the *collegial* mode, farmers make the decisions but draw on the experience of scientists through organized communication. Finally, in *farmer experimentation* there is no organized communication between farmers and scientists, and farmers alone make the decisions.

Each of the case studies presented here focuses on various dimensions of the participatory and ecosystems approaches highlighted in this publication. But like the agroecosystems these studies address, each should be viewed as an unbroken whole, with many inseparable dimensions, including resources, processes, and concepts.

The natural resource focus and other noteworthy dimensions of the cases are indicated in a box at the beginning of each case study presentation. The box also lists the main tools and methods used as well as the mode of participation for cases that provided this analysis.

2. Managing Natural Resources

Biodiversity, the Crucible of Life

Case 1: In situ conservation

Key Dimensions	Tools and Methods
Biodiversity Gender and user sensitivity Institutional innovations Partnerships Poverty alleviation	Case studies Cultural events Individual and group interviews Participatory plant breeding Surveys

"In our project on in situ conservation of agrobiodiversity, we acknowledge that only farmers can carry out on-farm conservation. National and international institutions can only support farmers in this process. Participatory research and management are important for linking institutes, disciplines, and stakeholders; understanding farmers' maintenance of local cultivars; and using our understanding to create social, economic, and ecological benefits for farmers and society."
Devra Jarvis and Heather Klemick, IPGRI

Biodiversity is a fundamental natural resource for agriculture. Until recently, most efforts to conserve plant genetic resources have centered on *ex situ* options, such as gene banks and botanical gardens. The main drawback to this approach is that it does not treat crop germplasm as an evolutionary product of farmers' interaction with the environment. As farmers plant, harvest, select, and store seed, they create plant genetic resources. These are lost when farmers cease to use them in the surrounding environment. Given the central role of farmers' seed management, participatory approaches are vital for conserving crop genetic resources

In 1995 partners in Burkina Faso, Ethiopia, Hungary, Mexico, Morocco, Nepal, Peru, Turkey, and Vietnam, together with the International Plant Genetic Resources Institute (IPGRI), initiated a global project called "Strengthening the Scientific Basis of *in Situ* Conservation of Agricultural Biodiversity." Its goal is, first, to understand the conditions under which farmers maintain and develop local crop varieties and, second, to add value to local plant genetic resources, thus making conservation more attractive to farmers.

Through this project national plant genetic resource programs forge links with farmers, community-based organizations, and other partners, such as universities, national institutes, extension agencies, and NGOs. The resulting networks (Box 1) create channels by which farmers can influence the agenda of national agricultural research.

Multidisciplinary teams from participating countries are building a global data set that links natural and human factors to crop genetic diversity over space and time. The data set is a valuable tool for exploring:

- Social, economic, cultural, and biological factors in farmers' decision making
- Crop population structures and breeding systems
- Natural and human selection factors
- Agromorphological characters, description, and selection criteria
- Seed/germplasm exchange and storage systems
- Value added to local crop systems through participatory plant breeding and policy recommendations
- The effects of all these on crop genetic diversity.

The scales of data collection are based on farmers' own units of genetic resource management, including the plot, household, named varieties, and seed samples. These can be aggregated into larger units for examining trends at the community and market levels, at the landscape scale, and in populations of named varieties or seed samples from multiple communities.

An understanding of the characteristics that farmers value in their varieties is crucial for promoting conservation of plant genetic resources (Box 2). To grasp farmer knowledge in turn requires innovative participatory methods and collection of data that are disaggregated by gender, ethnicity, and other socioeconomic factors (Box 3).

In seeking strategies for adding value to local plant genetic resources, the project relies on participatory plant breeding, or PPB (see Further Reading). Other mechanisms include strengthening both market-based incentives and others that draw on cultural and social traditions (Box 4).

Box 1: A national framework for conserving agrobiodiversity

Nepal’s experience illustrates the kind of institutional innovations required to create a national program for conserving plant genetic resources on farms.

The Nepal project commenced with the signing of a memorandum of understanding between the Nepal Agricultural Research Council (NARC) and IPGRI. The agreement called for the formation of a technical coordination committee to ensure close links between institutions of different types (government, nongovernment, community-based, and farmer-led) and with different areas of influence (local, national, and international). The committee is chaired by the director of NARC and includes representatives from the Nepal Ministry of Agriculture, the Department of Agriculture, and a local NGO. This was NARC’s first partnership with an NGO--Local Initiatives for Biodiversity, Research, and Development (LI-BIRD)--which has experience with biodiversity issues and farmer participation.

The project has also established multidisciplinary teams to work on crop biology, social science, community participation, gender, and participatory plant breeding. A national multidisciplinary group was created that consists of experts in these areas from NARC, LI-BIRD, the Ministry of Agriculture, and the Department of Agriculture. Local multidisciplinary groups for each study site were composed of representatives from District Agricultural Development Offices, local scientists, locally recruited LI-BIRD staff, and representatives from the Agricultural Service Centre (an extension agency). To reach farm households, local multidisciplinary groups networked with farmer groups and community-based organizations and supported the formation of such groups in communities where none existed.

Box 2: Understanding farmers’ preferences

All of the *in situ* project's partners acknowledge the importance of integrating social and economic elements into data collection at all stages--beginning with site selection.

With this aim in mind, Morocco’s *in situ* project is working to identify farmer partners in target communities, characterize farmers' environments, and understand farmers' knowledge and perceptions of local varieties. The project team has consulted farmers about the data needed to explore relationships between household characteristics, cropping systems, and measurable crop biodiversity. Information on farmers' knowledge of crops, management practices, and preferred variety characteristics was also gathered to identify farmers' priorities in managing plant genetic resources and to determine how conservation of plant genetic resources can best be fostered. In the course of this work, the Morocco project has consulted with both women and men farmers on preferred characteristics and management practices in the household and in the field.

Box 3: Gender and *in situ* conservation

In the Mayan *milpa* farming system of Mexico's Yucatan peninsula, household responsibilities influence the conservation of local landraces. Home gardens are women's domain, There they cultivate a diverse array of nonstaple crops, including vegetables, fruits, and herbs, primarily to meet household food needs. Women are particularly concerned about consumption characteristics, such as taste and cooking quality, and this shapes the choice of varieties planted in the household. Through their decisions women thus promote the maintenance of landraces that are particularly suited for ceremonial or everyday dishes.

The *in situ* project in Mexico has proposed that women's role in agrobiodiversity management be further investigated through case studies and group interviews as well as participatory interventions. It has also proposed that local recipes be compiled to stimulate conservation of landraces, based on women's expertise, cultural values, and pride in local cuisine.

Box 4: Adding value to agrobiodiversity

Farmers will maintain local plant genetic resources only as long as these remain competitive. The *in situ* project uses technical, market-based, and other strategies to make landraces a more attractive option that improves farmers' livelihoods. The Nepal project, for example, employs PPB and other participatory approaches to increase the value of landraces. The project also seeks to raise public awareness, create market and social incentives, and mobilize community support for *in situ* conservation.

Market-based incentives have been increased through the formation of farmer cooperatives that network with regional food businesses. To raise community awareness about the ecological and cultural value of biodiversity, the project has organized programs such as Diversity Fairs and the Rural Poetry Journey. In the former, samples of agrobiodiversity are exhibited; landraces are judged on the basis of rarity; and farmers who maintain agrobiodiversity are publicly recognized. The Rural Poetry Journey program invites local talent to compose poems and music about biodiversity, which are shared through performances and publication in local newspapers.

Water, the Essence of Life

Case 2: Irrigation assets and entitlements

"The establishment of close partnerships with a range of users and change agents, and not only farmers, is a key ingredient of our research. Embedding research in networks of water users, governments, policy makers, NGOs, and other key actors is vital for promoting ownership of the output and adoption of recommendations."
Barbara van Koppen, IWMI

Key Dimensions	Tools and Methods
Assets and entitlements Gender sensitivity Institutional innovations Legal frameworks Policy Poverty alleviation Water	Scenario building Stakeholder analysis

In arid and semiarid regions of South Africa, irrigation is a key to increasing farmers' agricultural productivity and incomes. Most of the country's irrigation water is used by large-scale white farmers on private holdings. The former Homelands, where most black farmers live, have only limited access to irrigation. In the few irrigation projects developed under the apartheid policy, such as the Arabie/Olifants Scheme in the former Lebowa Homeland, parastatal agencies and private companies derived income from these schemes and dominated agricultural operations and water management. Poor black farmers received few benefits and were excluded from decision making.

Since 1994 the new government has reversed the Apartheid policy, including support for schemes like Arabie/Olifants. Black farmers, who are mostly women, are now expected to "stand on their own feet." This sudden change has led most households in the Arabie/Olifants Scheme to abandon agriculture altogether, with negative impacts on their income and well-being. Few households have found alternatives to previous sources of credit, plowing services, and access to markets. And those who take up agriculture again have often been frustrated by breakdowns in the irrigation infrastructure.

The government has organized Irrigation management transfer schemes that give ownership of the infrastructure in irrigation schemes, as well as all rights and responsibilities for water management, to the users. In addition, the South African Water Act of 1998 has enabled smallholders to organize Water Users Associations (WUA). Membership is based, not on land ownership, but on water use in a specific portion of land. Almost everywhere else in the world, water rights belong to landowners rather than water users, effectively excluding women, who tend to farm rented land or land owned by relatives.

The South African government has gone further than most governments in actually transferring *ownership* of infrastructure to farmers. Under these schemes there is thus great potential for strengthening the rights of women smallholders. Nevertheless, ownership of infrastructure that has become a liability for the government does not help women in the Arabie/Olifants Scheme. They still lack access to other inputs and markets, which are indispensable for making productive use of irrigation water. In some parts of the Arabie/Olifants Scheme, traditional male chiefs have established contacts with LONRHO, a commercial cotton enterprise, for contract farming on their own plots and those of neighboring farmers.

The International Water Management Institute (IWMI) analyzes current and potential forms of natural resource management, designs policies, and determines the possible impact of different policy options and interventions on poor women and men. The institute mediates information exchange and analysis and provides access to water management solutions. IWMI engages in a continuous dialog with government officials as well as other actors influencing policy, and it thus facilitates communication among organizations. The institute also develops comprehensive irrigation management transfer scenarios, which outline desirable and undesirable paths of agricultural growth and NRM.

Following are two such scenarios for the Arabie/Olifants Scheme (Boxes 5 and 6). Under the first, which seems most consistent with current events, irrigation management transfer takes place in isolation and exclusively through a male elite. The second scenario envisions an inclusive path of natural resource management that is more consistent with the goal of eradicating poverty.

Scenario building involves participatory analysis of problems that poor farmers themselves have identified and of the measures they are developing to overcome these problems. This provides a sound basis for planning local action. In the Arabie/Oliphants scheme, bottom-up organization and transparent election of WUA committee members should contribute to the development of local leadership and have positive impacts beyond the management of water resources.

Box 5: Exclusive resource management

Under one scenario for the Arabie/Olifants Scheme, agricultural production and water management become "exclusive." Irrigated farming is confined to a small entrepreneurial "elite," whose members are relatively well-off, literate, mobile, male, and well connected to policy networks. These characteristics enable the elite to overcome constraints in the provision of capital and inputs and in access to land, water, and markets. As a result, they expand the scale and increase the productivity of irrigated agriculture.

The emergence of an elite may have a substantial impact on the productivity and well-being of the poor. This could come about through trickledown effects, including opportunities for wage labor or for employment created by spinoff economic developments, such as increased trade and demand for services. On the other hand, further concentration of land to increase the farm size of the elite and displacement of labor by mechanization may harm the poor farmers who cultivated the Arabie/Oliphants plots before the government withdrew its services.

This development path is most likely irreversible, since competition for water is growing strongly. Even though the South African Water Act is intended to reduce inequities based on gender and race, it will be difficult to implement. New participants in the scheme will find it difficult to obtain licenses for installing or rehabilitating irrigation infrastructure, thus further reinforcing the elite.

Box 6: Inclusive resource management

Under inclusive NRM the majority of current smallholders, who have limited access to land, would be included as new owners of the irrigation infrastructure and would gain access to loans, inputs, and marketing channels. Local leaders or entrepreneurs would play an important role in driving these changes. But rather than monopolizing access to resources and entitlements, they would be accountable to other farmers for ensuring wider access within the community.

An inclusive development path is not only consistent with the government's policy of alleviating poverty but would probably result in higher land productivity. This is consistent with evidence from around the world that shows a negative relationship between holding size and productivity per unit of land.

Case 3: Fish in deepwater ricelands:

Key Dimensions	Tools and Methods
Agroecosystem health Fish Institutional innovations Partnerships Poverty alleviation Technological innovations User sensitivity Wetlands	Farmer-designed experiments Group interviews Participatory rural appraisal Researcher-designed experiments Wealth ranking

In Asia over 10 million hectares of rice land (10 percent of the region's total rice area) are affected by uncontrollable seasonal flooding. During the dry season, ownership of land is fixed according to tenure arrangements. But during the rainy season, when farmers grow deepwater rice and fish in flooded areas, fish are treated as a common resource, and community members are traditionally granted access to private property for fishing.

With a view to increasing and sustaining the productivity of rice and fish in such areas, the International Center for Living Aquatic Resources Management (ICLARM) and the International Rice Research Institute (IRRI) are collaborating with local communities, government organizations, and NGOs in a participatory action research project. Begun in 1997, the project seeks to improve household incomes in the seasonally flooded agroecosystems of Bangladesh and Vietnam. The project's strategy combines indigenous approaches to resource management with semi-intensive fish culture and management technologies.

The project's unit of analysis is the resource management domain (RMD) at the landscape level. The RMD encompasses the environmental, social, and economic characteristics of a recognizable unit of land and takes into account its inherent natural variability. Project clients include landowners and other local residents who rely on fishing during the rainy season. To identify its clients, the project convened meetings with farmers from different wealth groups as well as with landless laborers and members of local organizations. A team of researchers and representatives from local organizations conducted diagnostic surveys to identify the needs of each group. The results were presented and discussed during group meetings. The survey data provide a baseline for analyzing project impact over time.

A project implementation committee was established at each project site, with representatives from each user group. The committee oversees implementation of the project, prepares budgets, manages project accounts, negotiates sharing agreements, settles conflicts, supervises fish sales, and distributes the proceeds from experiments. With support from researchers and NGO staff, different user groups have designed their own organizational arrangements for testing technical innovations in fish culture.

The concept of managed fish culture in deepwater rice fields is new. So, researchers designed technical options in close consultation with users and based on information about their needs, knowledge, and current practice. Technical options were tested locally in small-scale experiments, and the options were fine-tuned on the basis of feedback from users. Currently, users are testing options themselves, with minimum support from researchers. Users provide labor, manage experiments, and collect data. During its first 2 years, the project provided seed money to cover the costs of materials. Users deposit a part of the proceeds from the sale of fish produced in experiments to cover future project expenditures.

Researchers are monitoring water and soil quality, profitability, input use, fish consumption, group performance, and sharing arrangements. Based on this information, the project will analyze the impact of technological innovations and project processes.

Soil, the Living Matrix

Case 4: Slash-and-burn agriculture and the soil

Key Dimensions	Tools and Methods
Agroecosystem health Biodiversity Gender sensitivity Savannas Soil Technological innovations Woodlands	Geographic information systems modeling Individual and group interviews Researcher-designed experiments Wealth ranking

Most upland rice in West Africa (covering a total area of about 2.5 million hectares) is produced for subsistence by smallholder farm families in the savannas and forests. These farmers generally practice slash-and-burn agriculture in bush-fallow systems. In recent decades population pressure has forced them to drastically reduce fallow periods or expand cultivation onto marginal soils. This has increased erosion, mined soil fertility, led to the buildup of weeds and other pests, denuded large areas of natural vegetation, and reduced production potential.

Improved fallow technologies have been developed that could stabilize upland rice systems and thus reduce clearing of new land. In addition, legume-based technologies show potential for conserving the natural resource base, while maintaining or increasing rice yields. But despite many attempts to change upland rice production systems, most farmers continue to use traditional methods. They have not widely adopted practices such as the use of cover legumes, because these have not taken into account farmers' diverse production systems, needs, and resource endowments.

In search of a more effective approach, scientists from the West Africa Rice Development Association (WARDA) organized participatory diagnosis trials in Côte d’Ivoire. These involved more than 500 farmers in four villages across the country, representing different rice-growing environments. The trials compared soil properties, weed infestation, crop yields, labor productivity, and farmers’ perceptions of problems related to more intensive production.

In the same four environments, researchers compared 50 annual legume species with the traditional weedy fallow on the basis of weed suppression, nitrogen accumulation, biological nitrogen fixation, and rice yields. Next, 20 women and 10 to 20 men farmers evaluated the agronomic and economic performance of the best legume selections through periodic visits to an experimental field established on one of their farms. Farmers gave additional feedback during group and individual interviews held at fallow clearing, first weeding, and harvest.

Trial results showed that, as land use was intensified and fallow length reduced, yields dropped by 20 to 30 percent. In forest agroecosystems this was mainly the result of weed growth, whereas in the savanna reduction in soil organic matter and nitrogen supply were the main culprits.

In both savanna and forest environments, increased demand for hand-weeding reduced labor productivity, and farmers cited this as their prime production constraint. Poor farm households are unable to purchase the inputs necessary to reverse productivity declines related to land-use intensification.

Legume-based fallows produced more biomass than natural vegetation, and several legume species suppressed weed growth. Rice preceded by a legume fallow yielded about 30 percent more than rice preceded by the natural weedy fallow. Some legume fallows dramatically reduced the time required for land clearing, but most legume species did not lower labor requirements for weeding. Overall, labor productivity improved over the traditional fallow, mostly due to increased yields.

Over 60 percent of the 129 farmers involved in participatory technology evaluation expressed interest in using fallow legumes in their upland rice systems. Farmers perceived vine-like species as weeds and generally rejected them. Their choice of fallow legumes was based largely on labor considerations. Men gave priority to ease of land clearing, while women were interested in weed suppression. And the effect on yield was important to both. Farmer preferences were also influenced by highly site- and system-specific considerations, such as provision of stakes for fencing and food for ruminants.

Follow-up research done since 1999 has shown that farmers continue to grow several of the legume species selected during the project. Geographic information systems have been used to define agroecological and farming systems niches for this technology and to extrapolate the results. This provides a basis for further development of alternative production systems and for designing strategies to scale up participatory research.

At two sites manuals are being developed jointly with farmers, an extension service, and an NGO. At the forest site, farmers' management of the legume species *Crotalaria micans* has increased agroecosystem performance, while decreasing labor requirements in comparison with a 3-year natural fallow. For every well-managed hectare of improved fallow, several hectares of land can be taken out of slash-and-burn production, with obvious benefits for natural vegetation, biodiversity, and the environment.

Case 5: From vertisols to highlands

"Resource degradation is both a cause and an effect of poverty. Technologies that address the problem of poverty through improved productivity and have resource conservation potential are more likely to be adopted than technologies that address conservation alone. Participatory research for NRM is more complex than for crop improvement, and taking the long view is essential."
Mohammad Jabbar, ILRI

Key Dimensions	Tools and Methods
Agroecosystem health Biodiversity Collective action Highlands On-farm research, consultative and collaborative participation Poverty alleviation Soil Technological innovation Watersheds	Individual and group interviews Farmer-designed experiments Participatory rural appraisal Researcher-designed experiments Surveys

Poverty, malnutrition, low crop and livestock productivity, and resource degradation are major problems in the Ethiopian highlands. Population pressure has pushed cultivation and livestock grazing onto steep slopes and fragile lands, causing serious loss of vegetation and soil erosion. Yet ironically, about 12 million hectares of land with vertisol soils remain underutilized because of poor drainage, which leads to flooding and waterlogging during the rainy season. With a view to lessening pressure on the highlands, a consortium of national and international research centers, coordinated by the International Livestock Research Institute (ILRI), has undertaken a major effort to reduce crop production constraints in vertisol areas.

Toward this end researchers developed a technology package consisting of 1) an animal-drawn implement, called the broadbed maker, to drain excess water during heavy rains, 2) higher yielding wheat varieties for early planting to take advantage of a longer growing season, and 3) appropriate input and agronomic practices.

Indigenous knowledge and farmer preferences were taken into account in designing the broadbed maker. It was tested on-farm at selected sites before development agencies introduced it in other areas.

Improved wheat--which yields 2-3 tons per hectare, compared to less than 1 ton with traditional technology--was expected to address poor farmers' food deficits. Economic analysis suggested that this would also significantly raise profits and employment. In some cases, though, the new technology had negative off-site effects, such as waterlogging of plots downstream as a result of draining water from plots on upper slopes.

To solve these off-site problems, the project involved local communities in watershed management. For this purpose a pilot research project was undertaken, for which common main and subsidiary drains were constructed with voluntary farmer participation. Research focused on water management, drainage technology, and organizational innovations.

Poor-quality feed was identified as a major reason for low livestock productivity. Since land is scarce in the project area, strategies were sought for increasing both food and feed production by integrating food and forage crops with multipurpose trees as well as through better feed use and nutrient cycling. With a view to improving feed production, new forages were selected for adaptation to the environment, feed quality, resource requirements, and potential for use as inter-, relay, or alley crops.

In some cases yields of cereal grains have increased in association with forages. But greater impact came from higher amounts of feed produced per hectare. Studies also showed more efficient use of water and better nutrient cycling. Economic analysis found that, compared to pure cereal stands, crop-forage intercropping significantly increased gross margin and cash income. Combining the crop-forage system with crossbred cows for milk production further enhanced economic returns.

In addition, several multipurpose trees were identified through participatory experiments. As a result of farmer-to-farmer sharing of seed, many more farmers around the original research sites have planted these trees.

The feed problem is aggravated by variability in quality and quantity across seasons and years. Studies were conducted on-station and on-farm, using crossbred cows for milk production and traction, to reduce the need for oxen and thus the demand for additional feed. The results showed that with adequate feed supplementation crossbred cows could be used for both milk production and traction. This was because the limited amount of traction needed to work small farms did not significantly reduce milk yield and livestock reproduction. Crossbred cows increased cash income and improved household nutrition, especially among pregnant women and children.

Soil fertility is declining in the project area, because manure is used principally as fuel and farmers cannot afford chemical fertilizers. Efforts to improve soil fertility have focused on livestock production, efficient use of crop residues and manure, and introduction of herbaceous and tree forage legumes that fix nitrogen. Trials have shown that, where manure is left on grazed plots, biomass production increases, and soil erosion diminishes. It also appears that farmers can avoid feed shortages by synchronizing grazing with seasonal availability of herbage at different slopes. In addition, strategic fertilizer application could improve biomass productivity and protect the soil.

Farmers participated in the development of some of the component technologies described above, and these were tested at the plot, animal, and farm levels. Their economic viability was assessed partially in terms of yield and income. But impact assessment should go beyond this to consider more explicitly the research consortium's ultimate goals of reducing poverty, strengthening food security, improving health and nutrition, and conserving natural resources.

Improving ecosystem health and human welfare requires that the biophysical and human dimensions of the research be integrated both spatially and temporally. And this means that the human, policy, and technical dimensions of the work must be integrated at the household and watershed or community levels. Toward this end the project is currently working within an agroecosystem health framework to assess the stability, resilience, and efficiency of the ecosystem in improving human and ecological welfare.

The project has used different methods at different stages and for different purposes. At the diagnostic stage, scientists took the lead, using a combination of rapid appraisal techniques and formal surveys. But they assigned much importance to farmer knowledge and perceptions about problems and possible solutions, and they took this into account in designing better interventions. During on-farm testing of component technologies, farmer participation was consultative at the beginning but later became more collaborative. At the technology diffusion stage, farmers conducted some experiments with the broadbed technology to make it better suited to their requirements.

When the project altered its research focus from the plot and farm to the watershed level, local communities became more deeply involved in decision making and collective action. Farmers, community groups, and other organizations were included as stakeholders in creating and managing common goods. Now that the project has adopted an agroecosystem health framework, the number and type of stakeholders has further increased.

Any complex problem can be viewed from a variety of perspectives. Within each perspective the problem can be studied at different spatial and temporal scales. Within each perspective and scale, the people involved may focus on different elements, use different indicators, and draw different conclusions. So, the choice as to whose perspectives are taken into account, how these are incorporated into the research, and at what scale the research is done will determine research outcomes.

3. Managing Multiple and Common-Property Resources

Case 6: The African Highlands agroecosystem

"Participatory research is central to our approach in the African Highlands Initiative. AHI focuses on improving natural resource management in highland systems that are stressed due to population pressure and limited economic development. Issues include declining soil fertility and erosion; an increase in pests and diseases associated with intensification and declining fertility; influx into forested areas; and management of wetland areas, commons grazing areas, and water sources. These are complex problems, requiring a longer term vision of repair and maintenance and the participation of the stakeholders."
Ann Stroud, AHI

Key Dimensions	Tools and Methods
Agroecosystem health	Community mapping
Collective action	Farmer-designed experiments
Gender and user sensitivity	Future visioning
Grazing lands	Niche analysis
Highlands	Organizational diagramming
Learning community	Solution inventories
Methodological innovations	Stakeholder analysis
Partnerships	User-sensitive resource mapping
Soil	Wealth ranking
Water	
Wetlands	
Woodlands	

The goal of the African Highlands Initiative (AHI) is to help improve land productivity and preserve the natural resource base by developing improved policies and technologies with farmers. Through an approach called Participatory Agroecosystem Management (PAM), AHI involves women and other stakeholders in maintaining agroecosystem health through collective learning.

PAM has four cornerstones:

- An agroecosystem focus that includes social, economic, and policy dimensions
- Multipartner and multidisciplinary team work
- Participatory methods
- Integrated community action plans that emphasize learning by doing

In participatory research farmers and other actors play significant roles at all stages in the process--identifying and prioritizing research topics; planning, implementing, monitoring, and assessing activities; and disseminating research results. AHI expects that the PAM approach will facilitate technology adoption, empower farmers to share in decision making, improve their problem-solving capacity, and build local knowledge, skills, and institutions.

PAM calls for major shifts in attitudes and ways of working--from closed to open, from individuals to groups, from collecting to sharing information, from verbal to visual communication, and from "researcher-to-village" to "village-to-village" information flow. Younger scientists in particular have shown much interest in this approach. So, AHI has embarked on a capacity-building program that includes training at the regional level and at research sites as well as follow-up with site teams.

The first stage of the PAM process--diagnosis--is critical for building relationships with farmers. The aims of the diagnosis are to:

- View issues from a historical perspective and thus gain a better understanding of the driving forces behind change.
- Develop a better understanding of traditional knowledge and improve links between different sources of knowledge.
- Determine the physical, ecological, social, and economic variations in a region, using gender analysis techniques, resource endowment mapping, and spatial analysis.
- Understand external factors, particularly public policy and services, that influence resource management.

In the course of the diagnosis:

- Secondary information, including maps, is collected and analyzed.
- Farmers and researchers jointly identify research issues and cause-effect scenarios.
- Other institutional partners are identified and their perceptions taken into account.

- Declines in land productivity are described, and the major contributing factors are identified, by wealth group.
- Researchers gain a grasp of the interactions between policy, gender aspects, market forces, and other factors.
- They also come to understand farmers' priorities and their perceptions of productivity declines and the principal production constraints.

AHI has found that it is sometimes difficult for researchers to learn participatory methods. The older ones tend to feel uncomfortable with the new style of making decisions, while younger scientists worry about lack of experience. Institutional support for participatory approaches is often limited. Scientists may therefore have little motivation to adopt these approaches, particularly when they are evaluated by colleagues who are unfamiliar with participatory research.

Largely for these reasons, AHI researchers reverted after the diagnosis to their original habits of deciding research topics, controlling the research process, ignoring differences among farmers, and working on isolated components of the production system. At that point the program decided to provide further training in participatory approaches. Decisions were made collectively to organize the research on a geographic basis, to work in multidisciplinary teams, and to use resource maps and “niche analysis” (Box 7) for orienting the research agenda to farmers' varying needs and resources. Using various tools, the program has formed a research agenda that is squarely based on issues selected and prioritized by farmers.

Box 7: Tools for participatory agroecosystem management

AHI has used various tools--resource endowment groups, resource maps, and niche analysis--to introduce the perspectives of different farmer groups into work on soil fertility.

Wealth, or resource endowment, groups are defined by community members. The names of village residents are written on cards, and local informants sort them into piles corresponding to people or households with “like” conditions. The informants then explain their criteria for defining the different groups.

The wealth groups and criteria provide a starting point for focus-group discussions, resource mapping, and niche analysis. Maps made by individuals show the variation within a given group; composite group maps enrich this information. Niches are areas in the landscape that offer opportunities for improvement. These are jointly identified and discussed by different socioeconomic groups. Identifying such niches and mapping resource flows help farmers decide where to intervene in the agroecosystem.

Resource mapping and niche analysis stimulate ideas for collective and individual action. The resulting diagrams provide a point of departure for discussion, a baseline for monitoring progress, and an aid to planning. Researchers and farmers must conduct a broad analysis of the agroecosystem, because soil fertility management is related to many aspects of land use, including social and economic factors, such as labor, land use rites, bylaws, markets, and off-farm aspects.

Case 7: Understanding the landscape

“The complexity of natural resource management problems has created a new awareness that the best of agronomy, ecology, policy, social, and economic research needs to be brought together with new insights and methodological tools from landscape ecology, systems theory, actor-oriented rural sociology, and learning theory to create a more integrated approach.”
Ronnie Vernooy, IDRC

Key Dimensions	Tools and Methods
Gender and user sensitivity Institutional innovations Learning community Methodological innovations Resource monitoring Soil Water Watersheds Woodlands	Community mapping Conflict resolution fora Future visioning Individual and group interviews Niche analysis Qualitative modelling Solution inventories Stakeholder analysis Surveys Transect walks User-sensitive resource mapping Wealth ranking

A watershed is a natural ecosystem in which the relationships between different resources influence land-use patterns at different scales--from the plot to the farm to the microwatershed and watershed level. Watersheds are drained by a single watercourse that encompasses water, soil, and vegetation and links uplands with downstream areas. These ecosystems are also an arena for conflicting interests.

Two features of watershed management make this a particularly complex task.

1. The interests of people inhabiting the watershed are interdependent but asymmetrical. Upstream use of land and water directly affects people downstream, and many resource management problems (such as deforestation, soil erosion, pests, and diseases) cross natural and human-made boundaries.

2. The interdependence of upstream and downstream interests creates uncertainty. Downstream users do not know how upstream users will behave or whether they will consider the downstream effects of their actions.

Under these circumstances collective action is vital for achieving sustainable resource management. And that in turn means involving local organizations in ways that allow less privileged people (such as women, ethnic minorities, and the landless) to gain greater control over resources and to influence policy making at the regional or national levels.

To create a collective vision for managing Nicaragua's Calico River watershed, a participatory workshop was held during September 1997 near the town of San Dionysio in Matagalpa Department. It brought together 30 men and women farmers as well as NGO staff, local government officials, and researchers from the International Center of Tropical Agriculture (CIAT). The group identified problems and conflicts affecting land management, and described livelihoods at the community, microwatershed, and watershed levels. Among the problems were land degradation (resulting in lower crop yields), deforestation (leading to soil erosion and loss of wildlife), and both water scarcity and pollution. These findings confirmed the results of a poverty assessment conducted previously in the watershed.

The main conflict identified by workshop participants is access to and use of drinking water. Tension is mounting between landowners and communities in the upper reaches of the river, on the one hand, and downstream users of water, on the other. The latter complain about negligence in maintaining water sources, deforestation in the surrounding areas, and upstream landowners' rejection of proposals to reforest lands that are well endowed with water sources.

Land use and access are another source of conflict. Uncertainty about the legality of agrarian land reform continues to create trouble, particularly for farmers belonging to cooperatives. Several of these have received expropriation notices from former landowners, who returned to Nicaragua after the 1996 elections. Landless farmers complain about large landowners' unwillingness to rent land. The Indigenous Association of Matagalpa is in conflict with local government about land claims and taxes.

A third area of conflict concerns woodlands. Municipal and other government authorities oppose illegal loggers and fuelwood collectors, while local communities criticize government authorities for granting logging permits to absentee businessmen.

In examining the list of problems and conflicts, workshop participants also sought opportunities for action. In the end they decided to broaden participation in decisions related to resource management, to improve coordination between local organizations and government, and to negotiate solutions to resource conflicts.

The 1997 workshop provided a general picture of conditions in the watershed as well as some insights into key issues. But more detailed information was needed to understand what was happening and to identify opportunities for research. CIAT's Hillsides Project began seeking methodological tools for answering questions about "resource and people" dynamics. Eventually, the project came up with a combination of tools for resource mapping, transect analysis, and indicator-based assessment.

By March 1998 small teams of local informants who know the area well had completed 15 participatory microwatershed studies. They made special efforts to capture the perspectives of men, women, and other user groups on land use and the state of forests, water resources, crops, wildlife, domesticated animals, pastures, and soils. The local research team identified limitations and opportunities for improving livelihoods and natural resource management in the area.

The results were presented to local decision makers, including the mayor, state agencies, NGOs operating in the watershed, and a recently created association of community organizations. The information provided decision makers with a better basis for taking action by pointing to areas where natural resources are highly degraded or under risk or where rapid improvement could be achieved.

Each study began with the development of a local resource map, whose boundaries were defined according to local criteria. The maps showed hills, roads and paths, springs and watercourses, reservoirs, drinking water pipelines, infrastructure, production systems, vegetation, and soil types. They were used to define transects across major agroecological zones, production systems, and other important resource features. During a transect walk of each microwatershed, informants analyzed resources, with assistance from the CIAT Hillsides Project team.

The next step was to develop user-friendly indicators through a consultative process. The research team prepared a draft set of indicators based on the combined findings of 15 resource analyses. The informants reviewed and refined the indicators and then used these to assess the state of their own microwatersheds, assigning qualitative values for each indicator. The results were organized by different resource and landscape features and then presented in a second workshop.

To achieve better resource management through collective action, rules, and sanctions, local people and their cooperators need to start with a good understanding of resource dynamics. Resource assessment is key for improving management practices and regulatory arrangements. Monitoring also helps to raise awareness among local decision makers about the interdependence of resources. If monitoring is done collectively, it can also impart skills and create ownership and confidence.

A challenge for the future is to design and implement landscape-level experiments that address transboundary problems, such as soil erosion, pests, and water pollution. Experiments are now under way in the Calico watershed to apply the insights gained from the participatory mapping and resource analysis. A key actor in this research is the Calico Watershed's network of local agricultural research committees, or CIALs. These are community-based research services staffed and managed by farmers (see Further Reading).

Case 8: Governance of common-property resources

"One of our objectives was to develop institutions for common property resource management, but legislation does not support such management. Our experience has made a breakthrough--district councils in Zimbabwe are now receptive to providing the legal framework that is necessary for common property resource management."
Bruce Campbell, CIFOR

Key Dimensions	Tools and Methods
Collective management Gender and user sensitivity Grazing lands Institutional innovation Learning community Legal frameworks Methodological innovation Policy Water Watersheds Woodlands	Case studies Conflict resolution fora Future visioning Institutional analysis Role playing

In southern Africa and elsewhere, governments have not managed natural resources effectively in communal areas. They tend to impose legislation centrally, even where they have little capacity to enforce it. Local people are alienated from state regulations, and the costs of enforcing the rules are high. Traditional norms and conventions, in contrast, are recognized at the local level and are usually upheld by traditional authorities, operating parallel to state systems. In many countries, though, the traditional system receives scant support from state authorities.

In Zimbabwe district councils were made responsible for governance of natural resources in the 1980s. These councils regulate resource use through by-laws. But even though they are closer to the people than the central state, the councils have brought little change. Local people still have no say in the drafting of by-laws, and the enforcement mechanisms remain ineffective.

The Center for International Forestry Research (CIFOR), the University of Zimbabwe Institute of Environmental Studies, and the UK's Centre for Ecology and Hydrology are collaborating in a 3-year participatory research project in two microcatchments of Chivi District in southern Zimbabwe. The project is developing systems for managing natural resources, many of which are common pool resources. Much experience around the world suggests that the relationship between local communities and district councils is a key problem. The most effective local systems for natural resource management are based on traditional systems and focused user groups. District councils, with their legal mandate for resource management, by-laws, schedules of fines, and enforcement mechanisms, are relatively ineffective.

Project researchers organized a meeting of village representatives with the district council to examine the possibilities for reorienting resource management within the current legislative framework. They did so through scenario building, in which participants build visions of the future, as a first step toward redefining current development pathways. In this case the visions were developed around governance systems. Meetings were held in local communities, so people could express their views to district officials with greater confidence.

The district-level meeting generated enthusiasm, and participants hoped that other meetings would follow. Most village representatives had never discussed resource management issues with district authorities. In the final session, each of five subgroups presented their scenarios. Four of the groups were composed of village representatives, and each covered a different topic: water, woodlands, livestock and grazing, and enforcement mechanisms. The fifth group, consisting of officials from the Rural District Council (RDC) and some councilors, presented their vision of the roles to be played by the RDC and local communities.

This latter vision proved to be revolutionary, representing a radical shift away from the command-and-control mode. The council saw itself as facilitating and supporting community initiatives, providing arbitration when necessary and coordinating activities among villages.

The RDC subgroup suggested a pilot project on the governance issues involved in raising and using fish in dams, a particularly troublesome issue in local communities. Currently, communities exploit the fish as an open-access resource and have little incentive to manage this resource for the common good. In follow-up discussions, the RDC expressed interest in expanding the pilot project to other resources and communities. Researchers and facilitators are now developing the pilot study and organizing community meetings to establish rules for managing selected resources. Factors that contributed to the development of this progressive vision are summarized in Box 8.

Box 8: Progressive management of common-pool resources

- Long-term commitment by researchers

  The resource management vision proposed by the RDC emerged from a long series of interactions between researchers and key stakeholders. The project had been under way for 18 months before the meeting at which the vision was finally proposed, and the RDC's chief executive officer had been a member of the project steering committee. Partly as a result of positive exchanges with researchers, the RDC arrived at conclusions that could have been viewed as a threat to its power. Researchers also had a positive influence at the village level; two of them lived in each of the microcatchments for up to a year before the meeting.

- In-depth institutional analysis

  Many institutional studies were conducted before the district-level meeting, covering national legislation, decentralization, and the local organizations involved in management of woodlands and water. A literature review and experience in Zimbabwe cautioned against the current wave of enthusiasm for common property resource management. These studies provided insights on intervention points for institutional change and illustrated the ineffectiveness of current planning procedures.

- Preparing the community for the district meeting

  A series of meetings was held in each microcatchment before the district meeting. Preliminary community visions were developed at large all-day meetings. Three smaller, shorter meetings, facilitated by researchers, were then held to select community representatives, further develop community visions, and prepare presentations. At the initial all-day meeting in each catchment, the plenary group of about 100 villagers was divided into groups of older men, women, and younger men. Role playing was used to create a forum for discussion of sensitive issues. Matrix ranking was used to explore expected changes in variables.

- Careful orchestration of the meeting

  Organizers of the meeting paid close attention to the agenda and choice of language. Shona was used instead of English, so that everyone could follow the deliberations and engage in detailed discussion of the political undercurrents. The communities presented their visions first, and these stressed the importance of basing governance on the traditional system. Researchers then presented case studies on successful devolution of water and woodlands and pointed to key factors of success. Five subgroups were formed for discussing different themes. The groups of villagers then returned to the plenary and presented visions that further stressed the need to devolve power from the RDC to local communities and to base governance on traditional systems. But they also agreed that these systems should be transparent and representative. By the time the RDC subgroup presented its vision, much had already been said about new forms of governance.

4. Participatory Methods and Learning Communities

Case 9: Participatory research on heuristics in rice pest management

"While we may know a lot about the adoption of innovations embodied as physical technologies like seeds and machines, we have much less understanding of innovations embodied as information. We can add more value to our research through investing in decision research, an emerging field of applied social psychology."
K.L. Heong, IRRI

Key Dimensions	Tools and Methods
Agroecosystem health Consultative and collaborative participation Information innovations Methodological innovations Participatory learning	Heuristic experiments

Farmers decide when to spray pesticides based on their perceptions of crop losses caused by pests. They tend to overestimate the seriousness of highly visible pests or damage symptoms. In making decisions farmers often rely on heuristics, or rules of thumb, to simplify matters. Developed through experience and guesswork about possible outcomes, heuristics may have inherent faults and biases.

Farmers' decisions about leaf folder infestations in rice provide a case in point. Many farmers spray to control this pest, even though it does not cause yield losses, especially when it attacks in the early crop stages. Farmers' reactions to visible damage or insect presence may well be due to faults in their heuristics. One approach for solving this problem is to analyze farmers' heuristics, develop a corrective measure, frame it as a hypothesis, and motivate farmer participation in an experiment to test it.

Researchers at the International Rice Research Institute (IRRI) have initiated participatory research and learning on heuristics in collaboration with Department of Agriculture technicians and village leaders in Leyte, the Philippines. The process began with half-day meetings in each participating village, to which 10 to 25 farmers were invited. The meetings began with general discussions about rice growing and related problems. They then moved on to a more focused discussion of leaf folders, their damage, the resulting crop losses, methods of control, and their costs and effectiveness. Eventually, the researchers facilitating the meetings raised the issue of whether control is necessary and how not spraying might be beneficial.

Next, volunteers were invited to test the hypothesis that “insecticide application in the first 30 days after transplanting is not needed.” Each participant marked an area of about 100 square meters in his or her field that would receive no insecticide applications in the first 40 days of the crop cycle. In the rest of the field, farmers followed their usual practice. At the end of the season, participants reported their results in a workshop, and each participant received a certificate of participation. Farmers from the participating village and neighboring villages were invited to the workshop. Pre- and postexperiment surveys were conducted to monitor changes in farmers' beliefs and intentions; the frequency, timing, and targets of their insecticide spraying; and their crop yields, inputs, and management practices.

In about 80 percent of the farmers' experimental plots, rice yielded as much or more than in their main plots. The number of insecticide applications fell from three to two per season, and the percentage of farmers applying insecticides in the first 30 days of crop development dropped from 70 to 20 percent.

Case 10: Participatory methods and soil fertility research

“Every agricultural research institute should pursue participatory research, though the mode of participation may differ, depending on the problem pursued.”
Siegelinde Snapp and David Rohrbach, ICRISAT

Key Dimensions	Tools and Methods
Biodiversity Gender and user sensitivity Institutional innovations Learning community Methodological innovations On-farm research, consultative and collaborative participation, and farmer experimentation Partnerships Soil Technological innovations	Farmer-designed experiments Researcher-designed experiments Surveys

The International Crops Research for the Semi-Arid Tropics (ICRISAT) is developing new research methods in Malawi and Zimbabwe for improving soil fertility. It is also building partnerships among national scientists, extension advisors in NGOs and the public sector, and farmers. By obtaining input from farmers at earlier stages, the program aims to improve the ability of national research programs to develop “best-bet” NRM technologies for poor farmers.

New technologies are needed that improve human nutrition while enhancing soil management and enabling communities to rehabilitate degraded environments. The main innovations introduced so far are legume intensification and integrated use of organic and inorganic soil nutrient sources. In Malawi farmers are testing and adapting options such as doubling up of grain legumes and combining small amounts of fertilizer with manure and pigeonpea or maize residues.

One novel aspect of the program is its evaluation of several participatory approaches applied in parallel in different villages. The results are compared with baseline data from villages that have no known relationship with researchers or farm advisors from

NGOs or extension services. This approach enables researchers and farm advisors to address their concern that farmer adoption of fertilizer and integrated nutrient management has been practically nil, despite a decade of on-farm research and the recent focus on participatory research and extension as well as training-for-transformation empowerment approaches. Some researchers and senior extension staff are also concerned that extension rarely reaches female-headed households and women farmers, nor do their concerns enter into agronomic research.

The methods being compared include farmer empowerment approaches led by NGOs, extension-led demonstration and field visit methods, and farmer participatory research (Box 9). The project is assessing the cost and effectiveness of each approach for building institutional links and improving relationships among stakeholders. Researchers are also determining how well each approach addresses the needs of female-headed households. Project partners have conducted comprehensive surveys to provide a baseline for comparison, and they have developed methods of comparison. They agree that the comparison should indicate which methods are working best, as reflected in the satisfaction of researchers, extension advisors, and farmers; farmer adoption and adaptation of technologies; farmer empowerment; and improved soil management.

Box 9: Mother-baby trials, a participatory research method

Agronomists in southern Africa have positive views about farmer participation in research, and they often assess technologies through informal discussions with farmers. Moreover, in recent years agricultural professionals have used surveys to help prioritize research, and trials are often located in farmers' fields. In southern and eastern Africa, extensive on-farm research has dealt with variety adaptation, crop rotations, and agroforestry systems. But despite these advances, researchers lack methods for capturing farmers' perceptions of new technologies in quantitative as well as qualitative terms.

To make up for this shortcoming, ICRISAT is developing methods that allow farmers to provide input early and often. One promising method for improving communication between farmers and researchers is the "mother-baby" trial design.

This approach was originally created to facilitate farmer collaboration in testing soil fertility technologies. Researchers first design "best-bet" technologies, taking into account farmers' priorities and resources. Then mother-baby trials are planted in each participating village. The "mother" is a replicated experiment designed by a researcher. The baby trials, which are single replicates of the mother trial, are planted and managed by farmers. For this purpose each farmer selects a best-bet technology from the mother trial and adjusts the level of inputs and equipment according to his or her preferences. Each farmer also chooses a control against which to compare options in the baby trial.

As a result of the mother-baby trials, spontaneous experimentation among farmers has increased and improved. The baby trials also give researchers and extension advisors the opportunity to observe and learn from farmers.

In Malawi 400 farmers are assessing best-bet technologies at seven sites around the country through baby trials and their own experimentation. In the process they are satisfying researchers' need for sound quantitative experimental results.

Researchers from the International Maize and Wheat Improvement Center (CIMMYT) have also recently begun applying the mother-baby trial approach to participatory research in Zimbabwe. Farmers and CIMMYT researchers are together evaluating new maize varieties and hybrids from the public and private sectors.

Case 11: Long-term resource monitoring

Key Dimensions	Tools and Methods
Agroecosystem health Methodological innovations Partnerships Resource monitoring Soil Water	Participatory rural appraisal Researcher-designed experiments Surveys

Since 1994 the International Center for Agricultural Research in the Dry Areas (ICARDA) has been working with colleagues in several Egyptian research institutions to design and implement an NRM research program for the country's key agricultural environments. After carrying out literature reviews, rapid appraisals, formal farm surveys, and planning, researchers established long-term trials at four irrigated sites--one in the Nile Delta, another in Middle Egypt, and two in newly reclaimed desert lands, known as New Lands--plus one trial at a rainfed site.

At all sites water quality and quantity are the paramount concerns. Maintaining soil fertility is also important in the old lands of the Delta and Middle Egypt, but building up soil fertility is essential for sustained production in the New Lands and rainfed areas. A third issue addressed by the trials is the choice of sustainable crop sequences for rotational systems. The trials are being conducted at experiment stations by researchers and are designed to run for a minimum of 12 years.

At each site the long-term trial is integrated with participatory research in surrounding villages and on individual farms. Like the on-station trials, the participatory work, called long-term monitoring (LTM), is intended to have an extended life. Its purpose is to establish a continuing dialog with farmers concerning their farming practices, management decisions, and the condition of their natural resource base. The dialog centers on farmers' long- and short-term objectives, their perceptions of the qualitative aspects of the resource base, and their technical knowledge of resource management. The participatory research also involves a longitudinal study of farmers' management of natural resources in response to changing environmental, economic, and social circumstances.

As part of their exchange with farmers, researchers are also monitoring changes in the status of natural resources on representative farms through periodic biophysical measurements. They are combining farmer consultation with biophysical measurements to provide information about the interaction between natural resource conditions and farmers’ management practices.

Once the LTM system has been institutionalized, it will provide a mechanism by which researchers and farmers can exchange knowledge on improved management practices and their effects on natural resource health. A multidisciplinary research team is conducting the monitoring at each location. Each team includes members of local farmer associations, local extension staff, researchers from various institutes, and participating farmers.

These farmers were selected according to a carefully prepared list of environmental criteria for each location, including hydrological and soil factors and cropping patterns. Socioeconomic factors, such as farm size and type, natural resource endowment, social background, level of education, and household composition, were given equal weight. Farmers were selected at random from lists for each site. They received a thorough explanation of the purpose and activities of the LTM system and were asked if they wanted to participate. They were also informed about the amount of time and information required and were told that the work would involve a long-term commitment. The 85 farmers who agreed to take part in developing the system represent the whole range of social, economic, and natural resource conditions at each study location. The program made provisions for new participants to join without altering the research design. During the first year of research activities, only one farmer dropped out, and three new farmers asked to join the research team.

For each participating farmer, information on socioeconomic factors, farm management decisions, and perceptions of resource conditions and productivity are being collected every 6 months, after the main winter and summer cropping seasons. Natural resource conditions are measured on different schedules according to scientific requirements. In addition to basic information about crop sequences and rotations, management practices, input use, productivity, and economic returns, data are collected on labor use and sources, household composition, income sources, and household investment patterns. This information will explain why farmers make the decisions they do and should thus help develop profitable and sustainable production practices.

A review workshop is held once a year to bring together the research teams, including farmer members, for discussion of results and trends in the information collected. Through this work Egyptian farmers, researchers, and extension workers are building and testing a new holistic approach to studying agricultural production, including socioeconomic as well as biophysical factors and their effects on the natural resource base over time.

Case 12: Participatory modeling

"In the past we overemphasized technological fixes. Awareness is growing that technology alone cannot help resource poor stakeholders."
Kit Vaughan, CIMMYT

Key Dimensions	Tools and Methods
Agroecosystem health Consultative and collaborative participation Gender and user sensitivity Information innovations Learning community Methodological innovations Partnerships Soil Technological innovations	Farmer taxonomies Farmer-designed experiments Participatory simulation modelling Researcher-designed experiments Solution inventories Stakeholder analysis Wealth ranking

Small farms of less than 5 hectares account for about 70 percent of southern Africa's maize production. Though new technologies are available for improving production in smallholder maize systems, there are major constraints to widespread adoption--particularly the constant threat of drought and declining soil fertility. In Zimbabwe and Malawi, the soils in smallholder areas tend to be sandy, with limited organic matter, low nutrient content, and low water-holding capacity. Moreover, farmers have only limited access to organic manure and cannot generally afford inorganic fertilizers.

The threat of drought, combined with fluctuating market prices, mean that farmers are gambling on an uncertain yield and economic return. Therefore, to be attractive to farmers, new technologies for improving soil fertility must be able to reduce production risk. They must also be compatible with farmers' livelihood strategies. To support the development of such technologies, CIMMYT's Risk Management Project (RMP) evaluates their biophysical and socioeconomic performance through a combination of computer crop modeling and farmer participatory research in Malawi and Zimbabwe.

Past research on soil fertility has focused primarily on technology development. It has often ignored farmer's indigenous knowledge and the complex systems dynamics of declining soil fertility. These shortcomings have been compounded by the long time needed to evaluate technologies for improving soil fertility.

With computer models of crop growth, one can simulate soil fertility technologies across soils and seasons and over time. Models can drastically reduce the need for long-term trials by producing scenarios of crop performance and soil fertility that span 30 years. Participatory approaches introduce a systems perspective to the search for solutions to declining soil fertility. Farmers, researchers, and extension agents all play important roles in defining soil fertility problems, outlining possible solutions, and setting research priorities. By combining data generated through modeling with findings from participatory research, researchers can better assess the attractiveness of technologies for different users and farm environments.

The RMP employs both hard (quantitative) and soft (qualitative) approaches to explore the links between the agroecosystem and its socioeconomic environment (see accompanying figure). A participatory research subproject conducts systems diagnostics, identifies stakeholders, determines farmers' soil and climate taxonomies, describes farm families' livelihood strategies, and fosters farmer experimentation with soil fertility management practices. The modeling subproject collects data to validate the computer model and fosters use of the model to examine the biophysical performance of soil fertility management practices under specific soil and climate conditions. By integrating the two activities, RMP can use farmers' soil and climate taxonomies to develop soil and climate profiles for running the model. Moreover, the model can be used to evaluate technologies developed by farmers, and farmers can evaluate outputs of the model in the context of their livelihoods and risk management strategies.

RMP collaborates with focus groups from the Universities of Zimbabwe and Malawi, national agricultural research programs, and the Africa Centre for Fertiliser Development. Researchers and farmers evaluate soil fertility technologies being developed by the focus groups. Through this integrated approach, researchers can draw on the experience of one another and that of farmers.

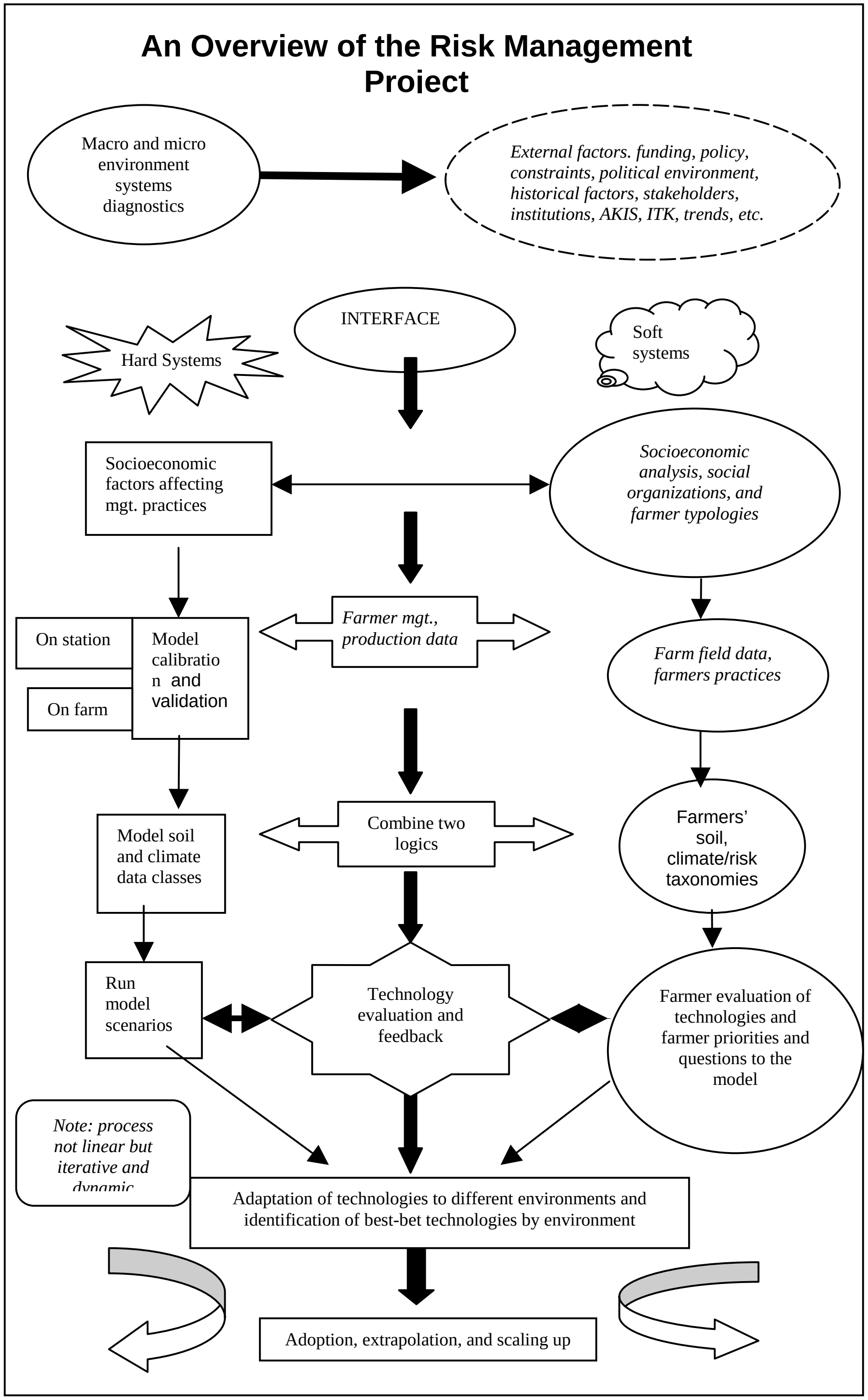
The project also has links with ICRISAT and CARE. CIMMYT and ICRISAT jointly fund researchers and field activities and share information. Farmer groups established by CARE link the RMP to communities and provide a social framework for broader dissemination of successful technologies.

One of the group's activities is to design a framework for running simulation models based on farmers' soil management practices. The goal is to develop an interface that permits discussion of outputs and key management variables, involves farmers in assessing scenarios developed by the model, and enables them in turn to pose questions to the model.

Focused planning meetings are conducted to enhance the team's organization. Participants develop common workplans and research frameworks for all project stakeholders. The RMP began with a macrosystems diagnostics approach, which enabled it to identify key stakeholders, secondary data, and partners for implementing project activities and identifying appropriate techniques for fieldwork. The RMP has thus created a strong network of research partners throughout the region.

In its fieldwork the project has concentrated on forming or strengthening farmer groups at two sites in Zimbabwe and one in Malawi. Farmers, extension staff, and researchers formed new groups for the 1999-2000 crop season. Their activities included participatory wealth ranking, development of farmer taxonomies of soils and climate, inventories of management options, and practices for different resource endowments and varying soil and climatic conditions.

The RMP's research agenda is highly creative and ambitious and holds great promise for effective evaluation of soil fertility management technologies under highly variable climate conditions.


An Overview of the Risk Management Project
Macro and micro environment systems diagnostics
External factors. funding, policy, constraints, political environment, historical factors, stakeholders, institutions, AKIS, ITK, trends, etc.
INTERFACE
Hard Systems
Soft systems
Socioeconomic factors affecting mgt. practices
Socioeconomic analysis, social organizations, and farmer typologies
On station
On farm
Model calibratio n and validation
Farmer mgt., production data
Farm field data, farmers practices
Model soil and climate data classes
Combine two logics
Farmers' soil, climate/risk taxonomies
Run model scenarios
Technology evaluation and feedback
Farmer evaluation of technologies and farmer priorities and questions to the model
Note: process not linear but iterative and dynamic
Adaptation of technologies to different environments and identification of best-bet technologies by environment
Adoption, extrapolation, and scaling up

Case 13: Farmer field schools

"We need more support for efforts to link the research establishment with the extension establishment as a natural alliance for integrated and participatory research, learning, and development."

Rebecca Nelson, CIP

Key Dimensions	Tools and Methods
Agroecosystem health Biodiversity Consultative and collaborative participation Gender sensitivity Learning community Methodological innovations Participatory learning Partnerships	Agroecosystem analysis Farmer-designed experiments Heuristic experiments Participatory plant breeding

Potato late blight is a particularly devastating disease that often causes complete crop loss. As a result of recent worldwide migrations of more virulent and fungicide-resistant strains of the pathogen, potato farmers face a problem that behaves differently than it did before. Poor farmers have little knowledge of the disease, perhaps because the organism that causes it is invisible.

Fungicides are the primary means of managing late blight. In industrialized countries forecasting and advisory systems help farmers apply fungicides with ever greater precision. Current pathogen populations, however, are resistant to one of the most important fungicides, metalaxyl, and there are mounting concerns about the carcinogenic potential of these products.

In developing countries fungicides have always been a poor solution; because they are often unavailable or are used inefficiently and in ways that endanger human health. Late blight epidemiology and management are very different in temperate countries from that in the highland tropics. So, developing countries have little to gain from the vast literature on disease management in temperate zones. Effective disease management strategies are best devised locally, due to the tremendous variation in human, environmental, host, and pathogen factors among potato agroecosystems.

The options for managing late blight are few. Approaches that work well with other diseases (nutrient management, plant spacing, and intercropping) are not effective. Sanitation, which is extremely important under temperate conditions, is not effective in the tropical highlands because of the year-round presence of high levels of inoculum. Nevertheless, knowledgeable farmers can manage the disease well through the use of resistant varieties and careful fungicide application.

After decades of resistance breeding, potato varieties and breeding lines with promising levels of resistance are available. Though efforts are being made to breed for durable resistance, variety diversification is desirable to reduce the erosion and breakdown of resistance. Given the difficulties of multiplying new potato varieties, getting improved varieties to farmers is a significant challenge. Deployment of promising breeding lines in stressful and heterogeneous environments that lack formal seed systems is particularly difficult. Participatory approaches are therefore essential to breeding, implementing integrated disease and crop management strategies, and improving the efficiency of informal seed systems.

The Farmer Field School (FFS) approach offers a means of meeting these challenges by involving farmers in the use and improvement of technology. Since 1997 the International Potato Center (CIP) has been working with several research and extension institutions, primarily NGOs, to develop and implement farmer field schools with farmer groups in the Andean zone and elsewhere.

The FFS approach has been widely applied over the past decade, particularly for management of rice pests in Asia. In this work a group of about 25 farmers from a community meets once a week for a half day over the course of an entire cropping season (or longer). With the help of a trained facilitator, farmers conduct field experiments and engage in hands-on learning. In “agroecosystem analysis,” a central learning activity, farmers work in small groups to make detailed observations of the crop as an ecosystem, recording these in the form of a poster. The group depicts the status of soil and water, plants, and weather and gives special attention to the dynamics of pests and beneficial organisms. After presenting and discussing their observations, participants decide and implement crop management actions. The field school integrates discovery of ecosystem principles and processes with experimentation in an effort to improve farmers' knowledge and build their expertise in crop and pest management.

The rice IPM field school approach has been adapted for other crops and other agroecosystem management challenges, including soil fertility and disease management. The FFS approach to disease management improves farmers' knowledge of disease processes, gives them access to varietal diversity and resistance, and helps them reduce disease problems by modifying their agronomic practices.

To initiate the development of a field school for late blight, CIP convened a series of regional and national meetings and an international workshop to develop a strategy and to identify available materials. An FFS curriculum, embodied as a field guide for facilitators, was drafted and continues to be further elaborated.

In 1997, CIP and CARE-Peru initiated FFSs on a pilot scale in four communities. Simultaneously, a baseline study on late blight was conducted in Ecuador, Peru, Bolivia, and Uganda. This study confirmed that late blight is the most important problem for potato farmers and provided insight into farmers’ knowledge and practices. After the first season, two students resided in two of the communities for 2 months to conduct an assessment of the pilot FFS. Their analysis and insights provided valuable feedback on the experience.

In response to demands by farmers and FFS facilitators, the FFS field guide was revised and expanded to include material on management of insect pests. The program was redesigned to cover two seasons, so farmers could have more control over the research agenda during the second season and so the subject matter could be applied to other crops and agricultural problems. The redesign process has drawn heavily on experiences in participatory plant breeding and on the CIAL methodology (See Further Reading).

Another eight pilot FFSs were conducted in the 1998-1999 growing season. Two communities continued their work from the previous season, and six new communities initiated FFS activities. Pilot-scale FFSs have been established in Peru, Bolivia, Ecuador, China, Bangladesh, Uganda, and Ethiopia through the collaboration of researchers, extension organizations (mainly NGOs), and farmer groups. A 3-month intensive training-of-trainers course, implemented in collaboration with the Global IPM Facility of the UN's Food and Agriculture Organization (FAO), was attended by 35 extension workers from Bolivia, Ecuador, and Peru.

Many young men are excited by the discovery process built into FFS, but many women find sustained participation daunting. The project is experimenting with alternative strategies to reach women, including a focus on the health effects of pesticide exposure and the importance of understanding microbes in family, animal, and plant health.

Efforts to incorporate on-going assessment of impact are under way as part of FFS development. The FFS approach to managing late blight in potato has clearly increased farmers' knowledge and their adoption of resistant varieties.

In potato production farmers take many of their key decisions before the growing season begins. The variety they choose and their source of seed are key factors in managing late blight. CIP is developing ways to help farmers use experimental data to make better varietal choices. The FFS curriculum involves a season-long varietal evaluation, with a session on economic analysis. Testing and follow-up in subsequent seasons will allow farmers to confirm their results and explore the consequences of their decisions.

Case 14: The Landcare model

“Watershed degradation need not be an inevitable consequence of agriculture on sloping land. Smallholders can farm and manage natural resources in a productive and resource-conserving manner. Awareness of this has focused attention on evolving demand-driven, community-based approaches to watershed resource management, in which those who occupy the land actively participate in management and sustainable utilization of their local resources. Watershed farming systems are enormously variable, and their problems are not solved by simple recipes. Often, the issues need to be tackled cooperatively at a scale larger than the individual household.”
Dennis Garrity, ICRAF

Key Dimensions	Tools and Methods
Biodiversity Collaborative management Collective action Highlands Institutional innovations Learning community Policy Soil Technological innovations Water Watersheds Woodlands	Farmer-designed experiments

The role of local organizations in improving management of forests and other common property natural resources has received much attention in Asia. Joint forest management in India, forest users' groups in Nepal, and community-based forest management in the Philippines are notable examples.

Similarly, local organizations may apply knowledge to solve problems in agriculture through improved land husbandry. In countries where power and fiscal responsibility are being decentralized, democracy is reaching the village level, and rural people are acquiring new leadership skills. These skills provide a basis for the development of farmer-led organizations that can develop practical ways of achieving a more sustainable agriculture.

One particularly noteworthy model for strengthening local initiatives to reverse land degradation is called Landcare. Through this approach local communities organize efforts to tackle agricultural and environmental problems in partnership with public institutions. Landcare groups, which are voluntary and self-governing, engage local communities in a search for innovations that are suited to the diverse and complex environments of smallholder farming. They mobilize communities to address problems of water quality, forest and biodiversity protection, soil conservation, and others at the landscape level. Experience in the Philippines and Australia suggests that Landcare may provide an effective means of generating and sharing technical information, spreading the adoption of new practices, enhancing research, and fostering farm and watershed planning processes.

In the southern Philippines, Landcare groups are forming partnerships with local government and technical research and extension agencies. Local governments are actively assisting the movement through financial and political support. This has attracted the attention of national government, resulting in a national watershed management strategy based on Landcare that will spread its principles and experiences to other parts of the Philippines.

The Landcare movement in the Philippines began in Claveria, Mindanao, in 1996. There are now about 200 village-based Landcare groups in Claveria and in other municipalities of northern, central, southern, and eastern Mindanao, with a membership of several thousand households. The groups have established more than 1,500 conservation farms as well as more than 200 community and household nurseries that have produced hundreds of thousands of fruit and timber tree seedlings, all with local resources.

Conservation farming based on contour buffer strips has become popular as a result of collaboration between the International Centre for Research in Agroforestry (ICRAF) and Landcare groups in the Philippines. With a view to diversifying farm enterprises, Landcare groups have also established nurseries for fruit and timber trees. At the community level, Landcare has proven to be a powerful force for creating initiatives that protect the whole watershed. Since the agenda of these groups is determined by members, they have addressed a wide range of issues, including dairy and beef farming, cut-flower production, and vegetable crop farming.

Landcare provides important opportunities for improving the way farmer participatory research is done. Such research can be managed by Landcare groups, enabling them to diversify their experimentation, ensuring a better understanding of the performance and recommendation domains of technical innovations, and offering more effective and less expensive alternatives to technology-transfer approaches. The farmer field school approach for conservation farming is currently being explored as a means of initiating Landcare groups.

ICRAF is conducting surveys through the Landcare groups to obtain grassroots feedback on researcher priorities from the farmers' perspective. In Australia public research institutions, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), are adjusting to new realities through Landcare. Farmers sit on, and may even dominate, the boards that decide which research projects to fund. This is sharply focusing research on problems that farmers are concerned about.

There are three significant concerns about the Landcare movement. First, given its growing popularity, there is a risk of “projectizing” the movement, that is, attracting the support of projects that operate in a top-down mode, thus defeating the purpose of a farmer-led movement. A second concern has to do with the long-term sustainability of Landcare groups. Networking and outside contacts are considered to be crucial for long-term success. This can be achieved through Landcare Federations, as has happened in Claveria, and through provincial and national federations, which are currently being explored in the Philippines. Finally, group leadership is a time-consuming and exhausting task, particularly when undertaken on a voluntary basis. Though Landcare is still young in both the Philippines and Australia, leadership “burn-out” has already raised concerns.

ICRAF’s analysis suggests that several steps must be taken to further release the power of the Landcare concept. Public institutions and NGOs need to facilitate group formation and networking among groups, so they can grow and develop their management capacity and ability to capture information from outside local communities. Such organizations can also provide farmer leaders with leadership training, thus helping to ensure the sustainability of the Landcare groups. External financial assistance is also a must, with emphasis on trust funds that enable farmer groups to compete for small grants with which to implement their own local Landcare projects. This approach has been remarkably successful in the Australian Landcare movement.

5. New Directions

The case studies summarized in this publication were analyzed on the basis of the principles of holistic, adaptive NRM described on pages 00-00. The accompanying figure summarizes the application of these principles by the projects covered in the case studies.

Several patterns stand out:

- Only a minority of projects define success as preserving or increasing the capacity of the system being managed to produce desired benefits in the future. These programs generally claim to be pursuing an "agroecosystem health" approach. The majority of the projects, while lacking an explicit ecosystem approach, did link the goals of improved productivity and food security with others, such as enhanced soil fertility, increased income, and better nutrition.

- The majority of projects are expanding their boundaries to include the management of whole systems. They are also taking steps to build learning communities that involve stakeholders in research and management, and they are creating mechanisms for obtaining environmental feedback on changes introduced in the ecosystems they are managing. These projects employ indicators to measure progress toward ecosystem goals.

  In several cases the "whole systems" targeted for management are watersheds or the common-pool resources supporting livelihoods in a particular geographic area. In other cases these whole systems are resource management domains within agroecosystems, such as seasonally flooded rice landscapes.

  Participatory research that engages farmers, researchers, and local organizations in the development of agricultural technology is the most common entry point for building learning communities. Other starting points include the involvement of stakeholders in exercises such as envisioning futures, scenario building, and modeling. Many of the projects described in this publication build on existing community-based organizations, sometimes stimulating these to form federations at larger geographical scales. Several projects led to the creation of completely new organizations. Many projects have brought stakeholders together for the first time.

- Nearly all of the projects have involved stakeholders, formed partnerships, and considered how priorities and impacts vary between women and men. Few projects, however, have conducted an explicit stakeholder analysis, and only a third have addressed the different needs and priorities of groups at different wealth, well-being, or resource endowment levels.

- Only a minority of projects have involved stakeholders in evaluating the trade-offs associated with decisions about resource management. Fewer than half have involved stakeholders in negotiating agreements for governing natural resource use for the common good.

- None of the projects have explicitly assigned values to ecological services.

These findings lead to the following conclusions:

- A clear strategy is needed for facilitating an ecosystem approach among CGIAR projects that links social, economic, and environmental goals.

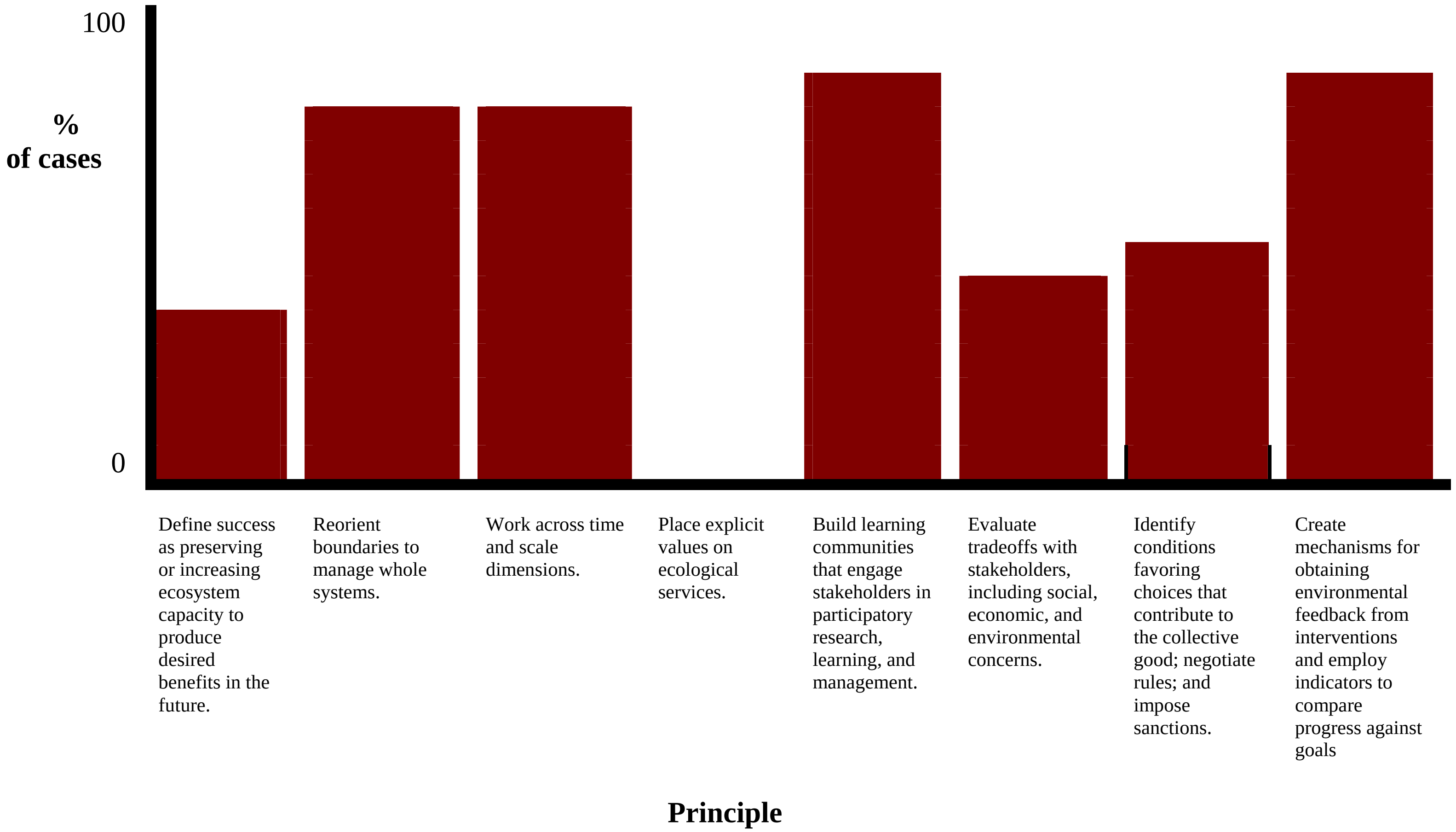
- The CGIAR's current efforts to mainstream the application of gender and stakeholder analysis in NRM projects should be continued, and efforts to increase sensitivity towards groups with different resource endowments should be strengthened.

- The CGIAR has little expertise in valuing ecological services and incorporating this issue into research, learning, and management. The CGIAR also has limited expertise with negotiation processes. These areas represent important opportunities for establishing partnerships that draw on the comparative advantages of other actors.

- In order for ecosystems approaches to succeed, the organizations that embark on these approaches must develop the capacity to manage complexity. The relationships between the level of complexity, management of complexity, and project outcomes are a researchable issue and should receive attention in monitoring and evaluation.

Application of principles of holistic adaptive NRM approaches by CGIAR Centers

The figure is based on fourteen case studies



6. Supporting Participatory NRM Research

The PRGA Program is working with stakeholders to develop diverse ways to support and add value to participatory NRM research. The goal of this work is to build a learning community involving CGIAR researchers and their partners.

Current forms of support include:

- Inventories and assessments of state-of the-art practices

  Recent examples of these include an inventory of approaches to user participation and gender analysis in NRM research and an analysis of key factors in developing technologies that benefit women (see Further Reading). Program inventories are available as a searchable database on the program's Website.

- Conceptual discussion papers.

  One recent example is a publication entitled *User participation and gender analysis in natural resource management research: An empirical analysis of the state of the art,* which describes different approaches to participatory research and the results that can be expected from these (see Further Reading). The PRGA Program also commissions papers to promote interaction with NRM actors worldwide.

- A "toolbox" of participatory research methods (available in the PRGA Program Web site as a searchable database) that stimulates the exchange of methods and makes these more accessible.

- Impact assessment studies

  In an initiative sponsored by Germany's Federal Ministry of Cooperation and Economic Development (BMZ), the PRGA Program is working with projects that pursue six contrasting approaches to participatory research, with a view to assessing the costs and benefits of these. The program will then develop guidelines for using these approaches, based on the benefits to different stakeholders and their overall impact on research priority setting, technology design, and adoption. It will also develop guidelines for helping decision makers, researchers, development practitioners, and community leaders assess the impact of participation.
- Research fellowships

  The above initiative also funds the involvement in the action research and capacity building of a number of research fellows associated with the prjects' field research in Honduras, Uganda, Nepal and Zimbabwe

- The NRM small-grants program

  The PRGA Program has complemented the above initiative with an NRM small-grants program funded by the Ford Foundation, focusing on farmer-led research to assess the implications for CG and NARS partners' adaptive research strategies. Small grants are made to initiatives that examine one or more methodologies for innovative division of labor between scientists and farmer-researchers in NRM, dealing with a farmer-identified problem or inventive solution related to farmers' current research practices and/or information.

- Capacity building

  The objectives of the program's capacity building program are to:

  ✓ Increase recognition by senior research managers in the cGIAR and NARS of the results obtained by researchers using gender-sensitive participatory research approaches to NRM research
  ✓ Provide easy access to knowledge, tools and skill training for these researchers
  ✓ Develop regional groups of trainers in Africa, Asia, and Latin America who can provide future training and mentoring in participatory research methods and gender/stakeholder analysis to CG centers and their partners
  ✓ Aid regional groups of trainers to develop, test and refine training guides appropriate for researchers engaged in participatory NRM research
  ✓ Develop, test and evaluate strategies by which learning experiences and materials can be used in different cultural and ecological conditions.

- Facilitation of a group of innovative scientists who are applying and developing participatory approaches to NRM research.

  The charter members of this group were nominated by the PRGA Resource Group and met for the first time in September 1999 at a workshop cosponsored by the UK's Natural Resources Institute (NRI). Through regular meetings, joint ventures, and e-mail networking, the group is pooling resources and expertise, increasing the visibility of their work, and adding value to it through collaboration.

- Dissemination of information

  The PRGA distributes information on participatory NRM research through its Web site, a working paper series, periodic special publications, and support for publication initiatives of the NRM Scientists Group. Currently, the group is developing a book based on the cases studies presented at the 1999 meeting.

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UNDP (United Nations Development Programme); UNEP (United Nations Environment Programme); World Bank; WRI (World Resources Institute). 2000. World Resources Report 2000-2001. People and ecosystems: the fraying web of life. Summary.

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Acronyms and Abbreviations

ACIAR	Australian Centre for International Agricultural Research
AHI	African Highlands Initiative
AUSaid	Australian Agency for International Development
BID	Banco Interamericano de Desarrollo (Inter-American Development Bank)
BMZ	Bundesministerium für Wirtschaftliche Zusammenarbeit und Entwicklung (Federal Ministry of Cooperation and Economic Development), Germany
CGIAR	Consultative Group for International Agricultural Research
CIAT	Centro Internacional de Agricultura Tropical (International Center for Tropical Agriculture), Cali, Colombia
CIFOR	Center for International Forestry Research, Bogor, Indonesia
CIMMYT	Centro Internacional de Mejoramiento de Maíz y Trigo (International Maize and Wheat Improvement Center), Mexico, D.F., Mexico
CIP	Centro Internacional de la Papa (International Potato Center), Lima, Peru
CSIRO	Commonwealth scientific and Industrial Research Organisation
DFID	Department for International Development, UK
FAO	Food and Agriculture Organization
FFS	Farmer Field School
GTZ	Deutsche Gesellschaft für Techniche Zusammenarbeit (German Agency for Technical Cooperation)
ICARDA	International Center for Agricultural Research in the Dry Areas, Aleppo, Syria
ICLARM	International Center for Living Aquatic Resources Management, Penang, Malaysia
ICRAF	International Centre for Research in Agroforestry, Nairobi, Kenya
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India
IFAD	International Fund for Agricultural Development
ILRI	International Livestock Research Institute, Nairobi, Kenya
IPGRI	International Plant Genetic Resources Institute, Rome, Italy
IPM	Integrated Pest Management
IRRI	International Rice Research Institute, Los Baños, Laguna, Philippines
IWMI	International Water Management Institute, Colombo, Sri Lanka
LI-BIRD	Local Initiatives for Biodiversity, Research, and Development
NARC	Nepal Agricultural Research Council
NRM	Natural Resource Management
OPEC	Organization of Petroleum Producing Countries
PAM	Participatory Agroecosystem Management
PPB	Participatory Plant Breeding
RDC	Rural District Council
RMD	Resource Management Domain
SDC	Swiss Agency for Development and Cooperation
WUA	Water Users Association

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AHI

A. Stroud 27, 28 (background), 29

CIAT

7 (background), 8, 31,32 (left and right), 55 (background)
L.E. Pino: ii, 1,4,11,54,56
N.Russell, inside front, 3,7 (left), 9, 42, 58
E. Salmerón: 2
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J.A. Llontop: 6, 47 (right), 48 (left and right), 49
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ICLARM

M. Dey: 20
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IWMI

B. von Koppen 16, 17, 18

For more information contact:

PRGA Program Coordination Office
International Center for Tropical Agriculture (CIAT)
Apartado Aereo 6713
Cali, Colombia

Phone:	57-2-4450000 or 1-650-833-6625 (via USA)
Fax:	57-2-4450073 or 1-650-833-6626 (via USA)
Email:	prga@cgiar.org
Website:	http://www.prgaprogram.org