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Managing Natural Resources for Sustainable Livelihoods

Uniting Science and Participation

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Chapter 4

Scaling Up and Out

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Introduction

Natural resource management (NRM) is necessarily situated within a landscape and human context. Engaging in participatory research and management with rural families requires an understanding of 'at what scale?', as well as 'who' and 'what'. In this chapter we discuss working across scales, and scaling up and out to reach a larger audience. The primary focus is researchers, farmers and change agents, working together in the southern hemisphere for more sustainable, productive agriculture. The chapter is grounded in case studies, where different approaches to scaling up and out are presented. This includes examples of learning together at a community level and synthesizing the knowledge gained to reach thousands of rural families with improved, integrated crop and soil management practices. Different means of sparking farmer innovation on a large scale are also explored.

'Scaling up' can be defined in diverse ways that are not necessarily mutually exclusive. One definition involves enhanced geographic cover – the scaling up of an intervention or technology to serve a wide area. Another spatially-based view involves extrapolating from a small, field or plot-sized, experiment to estimate the impact on a larger area, such as a region. Nutrient budget estimates, for example, can be conducted at local or larger scales (Brown et al, 1999; Smaling et al, 1993). Statistical or simulation modelling approaches are frequently used to evaluate uncertainty associated with scaling up spatially, or temporally. A third definition focuses on the growth of a small sized organization to a large sized organization. Projects or initiatives can be 'grown' to a large scale – such as a small-scale and short-lived project that becomes a large-scale endeavour with some permanence (Braun et al, 2000), or a large number of new initiatives that may be scaled up through a multiplier effect (Gündel, 1998). A fourth definition involves expanding impact from a small number of beneficiaries to a large number.

The scaling-up process required to reach large numbers of clients is one of the main challenges that face researchers and farm advisors who are publicly supported (eg, government ministries, universities, non-governmental organizations (NGOs), regional networks and international research institutions such as the Consultative Group for International Agricultural Research (CGIAR)). Government extension systems were set up to reach rural populations; that is their mandate. They are charged with extending technologies and working with less-advantaged members of rural communities. Yet, in general, resource-poor farmers reap few benefits from public services (Chambers et al, 1989). One growing problem is that extension systems suffer from declining numbers of extension personnel, and farmers' access to new information is often very limited. Furthermore, the relevance of extension messages to the most resource-poor households and female-headed households may not be clear (Fujisaka, 1993; Snapp and Silim, 2001).

The primary focus of this chapter is on scaling up participatory research, in terms of it being a process of reaching out and engaging with many stakeholders. A conundrum in participatory research is that improving local resource management requires tremendous investment in human resource development, in local education and in building quality partnerships for learning and action research. This requirement for quality interaction and considerable investment at a local level poses barriers to scaling up and out. Financial and human resource support requirements would have to be massive to engage many people in participatory action research (PAR). One approach to overcoming this investment barrier is to engage farmers through mass media 'research challenges'. Another is to improve farmer-led experimentation through facilitating community research groups or working with extension farm advisors in government and non-government organizations. Other approaches discussed here include PAR that uses information tools such as meta-analysis of watershed, geographic information systems (GIS) and regional researcher–farmer partnerships. These are just a few of the many approaches possible for scaling up and out.

To understand how scale interacts with participatory approaches we combine the classic continuum of participatory research typology and a spatial scale. That is, the continuum from researcher-led (farmers as contractors) initiatives to collaborative arrangements that are client-driven (farmer-led) (Chambers et al, 1989). We explore this relationship as a matrix, with 'scale of operation' on one axis and 'farmer/researcher partnership typology' on the other axis (Figure 4.1). We present case studies documenting examples of researchers and change agents working with people to improve experimentation, technology adaptation and collective management of resources, at different spatial scales.

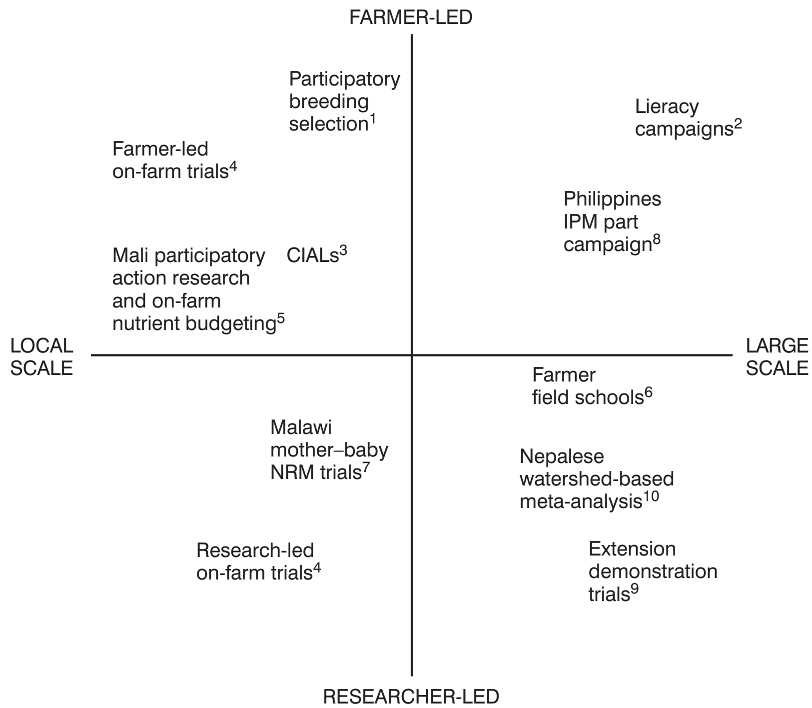

Figure 4.1 *A comparison of participatory learning and research approaches in terms of scale of operation, and degree of farmer versus researcher involvement*

Situating natural resource management

Attention to spatial scale is implicit in research on NRM. The endowment of resources is tremendously variable from place to place, and the goals of local managers are diverse as well. It is necessary to be situated in a locale to understand the soil, water, flora and fauna present and human interactions with the ecology. The scales at which resources are managed vary from a field, to a whole farm, to a community level, to a regional watershed or agroecosystems and even to the continent level. It is not enough to engage individuals in NRM. Collective action and community participation may be required to protect a watershed, to rehabilitate soil or manage a pest. Natural resource management issues frequently involve many communities and policy level engagement.

Heterogeneity is a reoccurring motif in NRM. It has both a physical and cultural basis. It occurs across the biophysical landscape, and among stakeholders with their diverse agendas. Biophysical heterogeneity includes the environmental extremes of human habitat, from dry desert to humid tropics, from low altitude shores to mountain tops. Temporal heterogeneity must be considered as well. Risk management in the face of extreme climate variability is a crucial concern of smallholders, one that can mean the difference between food deficit and security (Rohrbach and Okwach, 1999).

Smallholder farmers are often located in the most marginal environments. Not only are these environments highly variable, they are also rarely enhanced by inputs such as irrigation or fertilizer. A limited resource base impedes the ability to reduce heterogeneity. Extremes in topography and a wide range of locally specific conditions are difficult to characterize and to synthesize (Defoer et al, 2000; Lightfoot and Noble, 1999). Efforts to use information technologies to characterize biophysical heterogeneity include remote sensing and GIS-informed mapping. We will discuss some examples using these approaches later in the chapter (see the case studies in this volume by Williams from India, Peters from Central America and Schreier and Brown from Nepal). As discussed in these case studies, access to knowledge generated using information technologies requires commitment on the part of all stakeholders. Attention must be paid to the generation of figures with indicators that have local relevance as well as indicators that are of interest for research, meta-analysis and an international audience.

Socioeconomic diversity cannot be underestimated either. Different objectives and agendas will occur, particularly when working at watershed or regional scales. Stakeholders of the rural landscape may include nomadic peoples engaged with livestock and farmers active in cropping or integrated cropping–livestock systems. This is explored in a case study from India, where investment in water storage and forage management was evaluated from different perspectives (Conroy and Rangnekar case study from India, this volume). Water requirements for livestock often compete with that needed to irrigate vegetables and demands for household needs, which is frequently a gender equity issue as well (Snapp, 1989). The entrepreneurial elite who have access to capital and local officials or finance institutions are frequently in a position to monopolize irrigation or other water management technologies, as discussed in a case study from South Africa (van Koppen case study, this volume). Soil fertility enhancement through improved residue and manure management to reduce nutrient losses has been explored through field, farm and village level participatory nutrient budgeting in West Africa. In this study, different perspectives and objectives were articulated by nomadic and settled peoples, at the regional, community and household levels (Defoer et al, 1998).

Cultural heterogeneity is a major factor at relatively local scales of operation, where farmers, researchers and external facilitators and advisors interact with a range of organizations. These include governmental ministries, universities, non-governmental development agencies and private industry. Interested participants may include traders, shop owners, fabricators and artisans, financiers, buyers and sellers of produce, all from different resource bases, and linked to local or multinational bodies. Local institutions and the community fabric frequently involve religious groups, social and kin networks, health and educational or community development groups, worker or farmer organizations. Ethnic and cultural differences may be reinforced and overstated by political and hegemonic interests, but they also may inspire fundamentally different viewpoints. Action-oriented approaches that prioritize collaboration across diverse stakeholders and empowerment that addresses local objectives as well as a wider impact may be a way forward out of the challenging complexity of different agendas (Cramb, 2000).

Dynamics within and across families must be considered. Gender and cross-generational issues can provide quite different points of views, and priorities (Hirschmann, 1995). Female-headed families frequently have unique concerns in farm system management, as suggested by experiences in south eastern Africa (Snapp and Silim, 2001). Empowerment issues are complex and the agendas of stakeholders may differ enormously. Chapter 3 provides an in-depth exploration of these issues, including the challenging questions of 'whose agenda?' and 'whose research?' is being pursued.

Heterogeneity is a major barrier that constrains efforts to reach a wide audience. Over the last few decades the farming systems approach addressed heterogeneity by a reductionist process of documenting different agroecological zones and socioeconomic groups, and then developing recommendation domains (Fernandez, 1988). These domains were to encompass relatively homogenous groups within a complex environment. Participatory action research has evolved towards a more inclusive partnership process among researchers, change agents and farmers (Defoer et al, 2000; Fernandez, 1994). We explore, in this chapter, how some participatory research approaches are enriched by diversity and attempt to reach many different audiences, engaging with communities rather than defining recommendation domains.

To address heterogeneity, we contend that participatory research and technology development needs to address two issues simultaneously:

1 empowerment and investment in human resource capacity to enhance local experimentation and adaptation efforts;
2 knowledge construction based on indigenous and scientific sources, to understand locally-specific agroecosystems, and conduct 'meta-analysis' of universal aspects.

Meta-analysis to extrapolate and predict how technologies will perform within bio-physical contexts can help to extend results from localized areas (Conway, 1985; Lightfoot and Noble, 1999 and Schreier and Brown's case study in this volume).

The challenge of synthesizing NRM knowledge

Local resource knowledge and innovative capacity is intrinsic to soil fertility and resource management. It is difficult to embody knowledge or develop synthesized forms of information about how to improve resource management. Integrated decision-making that takes into account the entire system and sustainability of resources is difficult to codify or to distil into small bits of information , in contrast to genetic information (Figure 4.2). Synthesis is challenging due to the locally specific nature of NRM decision-making, and the complex, dynamic relationships involved. Technologies to protect, conserve

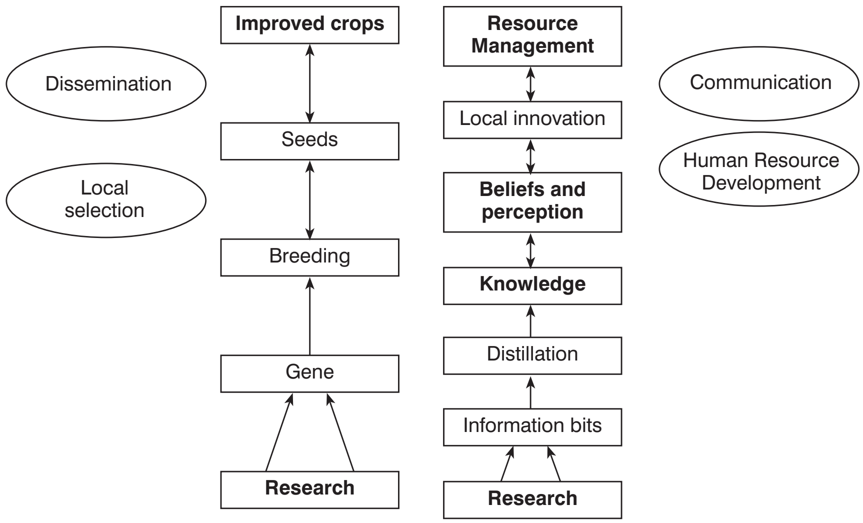

Figure 4.2 *Alternative pathways for enhancing knowledge distillation, testing and dissemination in genetic improvement and natural resource management research*

and regenerate resources require an understanding of agroecosystem relationships, and application to local environments (Lightfoot and Noble, 1999). This is a keystone of the non-formal education approach known as farmer field schools: training farmers and farm advisors in general ecological principles. The idea is to replace recommendations with education, to promote local understanding and adaptation of ecological principles and the development of specific management practices that improve a local system (Braun et al, 2000).

Research information on resource management, though abundant, seems to lack a process that can effectively integrate the various 'information bits' into usable entities (Figure 4.2). This contrasts with genetic technologies, where information is physically embodied in seeds and planting material. The 'information' is encoded within the seed, which can be tried out in many different environments by numerous participants. Locally specific information, generated from participatory breeding research is integrated into new seeds by the breeding and selection process (Figure 4.2). New seeds can be disseminated throughout rural areas through traditional and non-traditional seed distribution channels (Sperling et al, 1993). We suggest a need for processes that distil bits of information and develop them into usable entities or knowledge that can be communicated and used by farmers to make resource management decisions. The research distillation process is rarely used to integrate and simplify volumes of information into decision rules or heuristics (Heong and Escalada, 1999). If more attention was paid to this process, the information could be presented to farmers in an appropriate frame to motivate adoption. One such approach is described in Heong and Escalada's case study in this volume.

Steps to scaling up: enhancing relevance and accountability

Researchers and extension workers have the explicit goal of reaching many clients. Yet farmers are rarely involved in a meaningful way in the assessment of technology development services (Ashby and Sperling, 1995). Thus, accountability is limited. Institutions must address how to involve clients in research priority setting, decision-making about funding and performance assessment (see Chapter 6). In this context, scientists and farm advisors do not necessarily ask relevant questions, or work in partnership with farmers. Researchers may fail to understand farmer priorities (Chambers et al, 1989; Defoer et al., 1998; Sperling et al., 1993). Given the lack of accountability mechanisms, it is not surprising that researchers at times neglect to document the extent of local knowledge and client priorities, and relegate such studies to ex ante analysis and isolated research on indigenous knowledge.

The case studies documented in this book present many examples of researchers making a commitment to understanding local priorities and taking them into account in the research and development process. For example, a participatory research project working with two villages in India shifted from a focus on forage to broadening access to water (Conroy and Rangnekar's case study in this volume). To revisit this conundrum of scaling up participatory research, we note that most examples of accountability in the research and development process occur at a local scale, they are not multinational or regional in scope (Snapp's Malawi case study in this volume).

The result of limited accountability in research and development services has been the development of single, generalized recommendations, which assume that the main underlying priority is maximization of yields. For example, in Malawi, decades of soil fertility research resulted in a single, blanket recommendation for fertilizer rates applied to maize (Kumwenda et al, 1997). Farmers have a wide range of goals, and many are interested in risk aversion or maximizing return to minimal inputs (Rohrbach and Okwach, 1999). Market linkages and specific local quality traits also need to be addressed – yet technology development rarely includes surveying client or market preferences (Kitch et al, 1998; Snapp and Silim, 2001). A step forward in building more appropriate recommendations would be to consider market conditions and agroecozone influences on crop responses to inputs (Benson, 1997). Yet, participatory approaches require further steps: farmers are best served by providing a wide range of flexible, promising technology options, and farmers need to be involvedearly and often (Okali et al, 1994). It has been almost impossible to address these complex goals while remaining within narrow, commodity structured organizations.

A closely related problem is that recommendations are not disseminated in ways that facilitate farmer's own experimentation. Demonstrations are frequently not understood by local clients, and they are carried out by extension staff, or by farmers who have been hired specially (Kanyama-Phiri et al, 2000). The purpose of participatory, client-driven research and technology development, by contrast, is to support local experimentation and decision-making in resource management (Ashby et al, 2000; Braun et al, 2000).

Is participation possible on a large scale?

There is widespread interest in PAR approaches as a way to improve research relevance. Yet, as discussed in the Malawi case study (Snapp's case study in this volume), there are also valid concerns about the costs involved and the feasibility of working intensely over a large area. On the one hand, participatory approaches were seen by participants in this case study as the only way to change farmer decision-making. On the other hand, it was not perceived as a cost-effective method for reaching clients, beyond the few in the project villages. This was a reoccurring theme in the Malawi-based case study, which involves a comparison of on-going technology development approaches in parallel villages. One survey documented that the NGO staff, farm advisors and researchers involved felt that partnering with farmers was only possible on a micro-scale (Johnson et al, 2001). Human resources and capital constraints present significant barriers to farmer empowerment or to partnering with farmers on a significant scale, beyond small, localized case study areas. Surprisingly, extension staff from the government and from NGOs considered conventional trial and demonstration approaches to be the only cost-effect way forward (Johnson et al, 2001 and see Snapp's case study on Malawi in this volume). The same NGO workers who conducted empowerment exercises and helped local farmers conduct their own research were worried about the expense of participatory approaches and felt that they were not a practical way to reach large numbers of clients. In this chapter we explore a range of scaling up and partnership approaches, and discuss ways forward out of this conundrum.

Participatory action approaches explicitly attempt to improve the relevance of NRM research. See, for example, the PAR approaches illustrated by McDougall and colleagues' multinational community forestry case study, and the Dey and Prein case study, in this volume, involving aquaculture systems in Bangladesh and Vietnam. Frequently these efforts involve strong partnerships with NGO staff and community organizers. Academics are often collaborators in transforming research for development, struggling with issues of making feminist and activist agendas work within this development paradigm (Cottrell, 1999). Different types of partnerships among academics, scientists and NGO development workers can all be effective. This is illustrated by experiences with soil conserving contour hedgerow systems in the Phillipines (Cramb, 2000). At each location the action research partnerships varied, depending on local organizations, history, land tenure and farmer priorities. Adoption of soil conserving technologies occurred widely, although it varied in degree and form at different sites (Cramb, 2000; Fujisaka, 1993).

Participatory approaches that involve farmers, change agents and researchers working closely and intensely together allows the articulation of different agendas. Groups that have been neglected by conventional research and extension may gain a voice within organizations. Ideally, scientists and farmers learn from each other, strengthening traditional knowledge through participatory research. However, the ability of a project to reach beyond the scope of the original locale where scientists and farmers worked together is frequently not addressed. It is becoming widely acknowledged that attention to the scope of a project, and how it might expand out, must be integral, from inception (Braun and Hocdé, 2000).

Some of the case studies presented in this book paid attention to scaling up from project inception, indeed they were central to the conception of the project. For example, the watershed mapping and participatory nutrient budgeting endeavors in Nepal (Schreier and Brown in this volume). New information technologies were used to involve more participants in documentation, monitoring and evaluation, over a larger area. This is also illustrated by the India case study by Williams, in this volume, where GIS is used to guide communities in developing indicators and monitoring progress. However, to ensure the relevance of outputs, the use of information technologies must be negotiated by all partners, as discussed in Chapter 5.

To revisit the conundrum of scaling up participatory research: many of the case studies in this book focus on a few key locales, with limited scope beyond the project scale. On the plus side, human capital is generally built through the empowerment and training that are an integral part of action research projects – as capacity building is an explicit goal. Yet, it is challenging to develop a sustainable approach that lives beyond the project, once funding and technological or human resource support are withdrawn from an area. In three Phillipine examples described by Cramb (2000), the adoption of soil conserving technologies did not spread effectively beyond a few, local success stories. In some cases, technologies such as contour plantings were not maintained after initial investments. Malawi soil conservation efforts also suffered from limited uptake, over both time and area (Sutherland's case study in this volume). Empowering farmers and stakeholders to conduct more effective research in partnership with researchers and change agents may be a necessary but not sufficient step towards improving NRM over the long-term (Braun et al, 2000).

Steps to scaling up: building quality partnerships

Cooperation is key to building participatory team approaches. It arises from a recognition of the need to view resource management issues as a complex human activity system (Wilson, 1992). Research, development and extension are interactive as well as iterative. The main emphasis of this approach is to involve key stakeholders in a cooperative and flexible process that facilitates discussion and implementation of activities to achieve improvements. Building social capital, including empowerment of partners to participate provides a foundation for PAR. A cycle of monitoring, reflection and evaluation that involves all partners is key to furthering this process (Braun and Hocdé, 2000). Many participatory techniques are available, including rapid rural appraisal (RRA) techniques, participatory rural appraisal (PRA), focus group discussions and structured workshops (Carmen and Keith, 1994). The common themes across these techniques are qualitative appraisals and joint participation by stakeholders, fostering common understanding of the problems. However, often it is not how thoroughly analyses have been done but the partnership that will determine success or failure of a project (Norton et al, 1999). As discussed in the van Koppen and Sutherland case studies in this volume from southern Africa, partnerships tend to last when benefits accrue widely, not just to local elites or project administrative elites.

In order to enhance partnership quality, facilitating communication between stakeholders and joint planning, the participatory workshop approach is one way forward. This approach is iterative and interrelated. It frequently involves the following stages, many of which overlap.

Stage 1: Empower stakeholders

Use 'training for transformation' and related approaches to empower partners (Freire, 1970). This is particularly important for farmers and community members who may feel they are uneducated and powerless compared to participants who are perceived as outside experts, thus critical consciousness is a first step in building social capital. Braun and Hocdé (2000) provide concrete examples of local empowerment efforts. It is critical that local knowledge and priorities are articulated and put at the centre stage from the beginning of the participatory workshop (Norton et al, 1999).

Stage 2: Specify problems and opportunities

Use a range of techniques that will facilitate communication between stakeholders. Identify root causes and cause–effect relationships. Use baseline data whenever available. Some of these techniques are described in Norton and Mumford (1993), and texts on quality control circles (QCC) used in management (see for example Karatsu and Ikeda, 1987; Crocker et al, 1984). This can be seen, alternatively, as an opportunity to discuss with partners where opportunities lie and what inquiry or area of research is of interest to the group (See McDougall et al's case study in this volume).

Stage 3: Identify constraints

Brainstorm for opportunities to make improvements and to find ways to remove constraints. The key issues to be addressed include research, extension, training and policy aspects.

Stage 4: Analyse needs and design action plans

Engage participants in determining what actions need to be taken and in outlining action plans to achieve expected outcomes. Egan's (1988) model for change can be usefully employed at this stage.

Stage 5: Evaluate progress and review from different partner's perspectives to redesign action plans

One way to conduct this iterative approach is through a series of workshops, where the review stage is initiated approximately a year or two into the process as an all-stakeholder's review workshop, to ensure the quality of the activities as well as the partnerships (Escalada and Heong, 2003). Action and reflection cycles are integral to this process.

It can be challenging to build quality partnerships on a large scale. A participatory project-based approach, as described above, is generally carried out at the community or watershed scale. However, the information generated can be codified and disseminated through different means, such as farmer field school educational materials (Thalbitzer, 1996; van de Fliert and Braun, 2000), through the mass media (Huan et al, 1999) or via local agricultural research committees (Ashby et al, 2000; Braun et al, 2000, and see Braun's case study in this volume).

Scaling up participatory NRM to the watershed level

An example from India of emerging capacity at the watershed level involves the balancing of different group priorities through participatory watershed development (Turton and Farrington, 1998). Local control of resources by community organizations has been partnered with technical assistance from government organizations to serve local watershed development and conservation oriented groups. A key component of this approach has been developing human resource capacity and community experience in dispute mediation.

Watershed management has been approached through a wide range of projects that partner technical and academic advisors with community-based organizations that initiate their collaboration through community visioning exercises. In Malawi, this has involved resource and priority setting workshops, integrated with jointly-planned research along transects (Kanyama-Phiri et al, 2000). In Nicaragua, community watershed visioning was catalyzed through participatory mapping and local training in monitoring tools. Combined with community-led research groups and landscape level experiments, this has led to local empowerment to address larger-scale questions (see Vernooy's case study on Nicaragua in this volume). Schreier and Brown's case study in this volume presents a watershed-based approach that uses spatial tools, such as GIS, to document landscape ecological parameters in the service of local research endeavors. Long-term sustainability, and replication of these efforts – scaling out – may require a close connection of technical support and watershed tools to priorities and indicators that have meaning for local communities.

An exciting example of the collaborative management of community forests is presented in McDougall et al's case study in this volume. As shown by the experience of McDougall and colleages, developing sustainability indicators owned by the communities involved is key to adaptive management. Indeed, monitoring and evaluation that involves all stakeholders is the foundation of community-based participatory research. Indicators of sustainability may emerge that focus on economic returns to communities, at least initially (Turton and Farrington, 1998). Long-term, ecologically-based indicators frequently emerge over time as technical advisors and communities expand partnerships and extend the scope of their collective visioning, see, for example, the Nicaragua case study by Vernooy.

Beyond the watershed: the continuum of scaling up and out

At the Chatham meeting, we found it useful to discuss the case studies in terms of a continuum, from researcher-led, to farmer-led. Another step further is to consider where participatory natural resource management (PNRM) approaches are situated in a matrix, with 'scale' on one axis and 'type of participatory involvement' on the other axis (Figure 4.1).

Intensive PAR approaches are frequently situated at locally specific sites, involving individual farm families and village community levels of the matrix. For example, PAR on nutrient budgeting to improve community resources in Mali (Defoer et al, 1998; Figure 4.1) requires intensive interaction with a community. Thus it is carried out locally. A major investment of researcher time and funds is necessary for this approach, focused primarily at one location. Advocates say this improves our understanding of nutrient cycling complexity and empowers local change agents to improve nutrient efficiency (Defoer et al, 2000). However, the sustainability of this effort over time, and the ability to reach many beneficiaries needs to be addressed. Farmer-to-farmer training can be a key component of scaling up from local, intensive efforts in PNRM. This could extend the ability to conduct nutrient budgeting to a large number of farmers. Possibly, a farmer field school approach to training would be effective, to educate on integrated crop management, basic nutrient cycling principles, and farm budgeting methodology to improve nutrient cycling efficiency (Braun and van de Fliert, 1997; Braun et al, 2000).

A community-based approach to micro-watershed rehabilitation is situated in the matrix in an intermediate position (Figure 4.1). For example, in India, a participatory watershed development approach has used guidelines that prioritize local autonomy, a decentralization of decision-making and funding, and partnership among NGO and government institutions (Turton and Farrington, 1998). Another type of watershed PAR, involving community visioning, mapping and monitoring is illustrated in Vernooy's case study in this volume. A critical early step in this approach is the group identification of problems early in the analysis. After initial training in interdependence of resources, local decision-makers led efforts to map the consequences of alternative resource utilization strategies.

A regional scale is illustrated by GIS-based landscape analysis and country-wide extension demonstration trials (Figure 4.1). The challenge in these cases is to enhance the quality of participation. Participation is frequently limited to initial consultations or surveys of communities. Documentation of local priorities are – in some cases – integrated to improve the relevance of NRM research (see Schreier and Brown's case study in Nepal; Vernooy's case study in Nicaragua both in this volume). Researchers are generally the lead designers in this approach, and work is implemented by extension and field staff. There may be little or no systematically designed role for farmers and communities as the project is implemented (Benson, 1997). These efforts, frequently involving hundreds of trials carried out throughout a region or agroecozone, and thousands of measurements and site monitoring, are conducted over several years (Hildebrand and Russell, 1996 in Figure 4.1). Final results are often communicated to communities or a region in the form of recommendations. For example, two major soil fertility endeavours in Malawi were conducted at separate times: each involved hundreds of maize fertilizer demonstration trials (Benson, 1997; Hildebrand and Russell, 1996).

One challenge is that farmers frequently perceive demonstration trials conducted across a region, or landscape monitoring with GIS-based tools, as having limited relevance. Indicators of agronomic performance or watershed sustainability may be quite different from sustainability indicators chosen by farm communities, such as increased market access, employment options or control of water management. It is a challenge to fully understand farmer resource levels and priorities. This is discussed in more detail in Snapp's Malawi case study in this volume, which compares different approaches and how these constrain or enhance partnerships among farmers, researchers and extension (Johnson et al, 2001). A range of indicators and technology trial designs that rigorously link farmer assessment with researcher assessment may need to be carried out, to insure relevance to diverse stakeholders.

Approaches to scaling up and out include using mass media campaigns to spread information in a way that challenges the listening audience, and builds local capacity. Mass media vehicles have been used too often for uni-directional dissemination of recommendations. Yet media can be used to catalyse experimentation on-farm. An example from Vietnam shows that research and extension staff can use leaflets, posters and radio to engage tens of thousands of farmers in experimenting on their own. Farmers were motivated to test the need for pesticides early in the rice growing season. Pesticides were being over used; after testing this idea for themselves, the majority of farmers involved reduced use of insecticide sprays (Escalada et al, 1999, and see Box 4.1)[*!box 4.1 near here!*]. Local governments extended the approach further and in 1999, 15 other provincial governments multiplied the media materials and launched their own campaigns reaching about 90 per cent of the 2.3 million households in the Mekong Delta (Huan et al, 1999).

The potential use of the media to complement face-to-face participatory approaches has not been well exploited. It is evident from this case study that when systematically planned and implemented, a media campaign can initiate and help sustain changes in farmers' beliefs and practices. A number of

BOX 4.1 FARMERS TESTING RULES OF THUMB IN INTEGRATED PEST MANAGEMENT

Farm surveys show that a large proportion of Asian rice farmers' insecticide sprays, especially in the early crop stages, were targeted at leaf feeding insects, commonly known as 'worms' (Heong and Escalada, 1997a). During the early crop stages, highly visible leaf damage by rice leaf folders, whorl maggots, grasshoppers and beetles, are common. Entomologists, on the other hand, found that initial leaf damage is not usually related to yield loss and insecticide sprays applied early in the season can harm the ecosystem, causing secondary pest problems (Heong and Schoenly, 1998). In making the decision to spray early, farmers rely on heuristics, such as the rule of thumb that equates visible insect damage with a serious problem. To facilitate farmer testing of this erroneous heuristic, a farmer participatory experiment was conducted utilizing the concept of cognitive dissonance (Festinger, 1957). The heuristic tested was 'Spraying for leaf feeder control in the first 30 days after transplanting (or 40 days after sowing) is not necessary'. Farmers were encouraged to try this on about 500 sq. m of their rice fields that would not receive any insecticide treatment in the first 30 days after transplanting. The rest of the field would receive normal treatments. The results were discussed in workshops where farmers shared their experiences with the entire community. Most farmers (88 per cent) who participated found that yields of the two plots, whether sprayed in the first 30 days or not showed no yield difference. The experiment helped farmers to resolve the conflicting information and beliefs changed. Before participating in the experiment, 68 per cent of the farmers applied insecticides in the first 30 days. This was reduced to 20 per cent after a year and to 11 per cent after 2 years.

To motivate change and reach more farmers, a media campaign was launched with 21,000 farmer households in Long An province. Farmers were challenged to experiment with the idea that early pesticide use in rice was not necessary (Heong and Escalada, 1997b). The campaign reached 97 per cent of the households and 31 months after the introduction of media, farmers' insecticide use dropped by 53 per cent, from 3.4 sprays per season to 1.6 (Escalada et al, 1999).

components could have accounted for the large-scale adoption of the heuristic communicated in the campaign – detailed understanding of farmer decisions, simplicity of the message, educated farmers, benefits of the innovation, the media mix, the materials development process and delivery. In addition, an emphasis was placed on motivating farmers to test the heuristic. Researchers started with an understanding of current farmer knowledge and belief (see Box 4.1), to show how farmer's could test for themselves a new, more efficient pesticide use strategy. Economic, ecosystem and health benefits obtained from more targeted pesticide use were also emphasized (Escalada et al, 1999).

In the case of complex agricultural management issues, enhanced human resource development at the local level may be critical to helping communities ask the right questions, and design appropriate research. Soil and disease management issues may not be simple to understand, or straightforward for farmers to test on their own. An example of a methdology for facilitating local experimentation is the CIAL (Comité de Investigación Agrícola Local)or local agricultural research committee first developed in South America (Figure 4.1, Ashby et al, 2000; Braun et al, 2000, and see the Braun et al. case study in this volume). These act as a platform for improving local research capacity. They are locally situated, but CIALs interact at the regional level through second order organizations and national meetings.

Ways forward

Communication is the medium of participatory research. Technology development collaborative efforts need to be focused on strategic and priority questions. Thus the key role is listening to each other and paying attention to ensure communication among partners. The case study described in Malawi (Snapp in this volume) includes different types of participatory research trial designs. The goal is to assess the costs and benefits of a range of collaborative and communicative modes, from the perspectives of all involved. One promising trial design involves the linkage of simple 'one-farmer, one replica' trials – managed by farmers – so that they feed into central trials managed by academic researchers, extension and NGO farm advisors (Box 4.2). These trials were named 'mother–baby trials' by a participating farmer (Snapp, 1999). The goal is to facilitate communication and researcher attention to farmer input (quantitative and qualitative) in a relatively cost-effective, rigorous and practical manner (Kanyama-Phiri et al, 2000). This approach takes a conventional mode of research and stretches it. Communication is institutionalized early and often in the project, among scientists, extension staff, NGO workers and farmers. The mother–baby trial design can be carried out at the community scale (Box 4.2). To scale up further, effort must be invested initially in choosing representative communities that will allow meta-analysis and synthesis at the regional scale (Snapp and Silim, 2001).

Meta-scale analysis can also be conducted through watershed-based approaches, such as the case study presented in this volume for Nepal (Schreier and Brown). This illustrates how geographic information systems (GIS) and statistical meta-analysis can help to build on knowledge in an extremely complex environment (Schreier, 1999; Figure 4.1 and see the case study in this volume). Issues raised by the communities in two Nepalese watersheds were addressed using a GIS approach that included overlay stratification, modelling, statistics and socioeconomic surveys. The key factors indicative of climatic conditions (elevation and aspect), the major soil types, and dominant land uses were used to define categories and conduct meta-analysis. Communities were surveyed through rapid rural appraisal (RRA) methods and participated in on-farm research to assess sustainability of nutrient management practices. The case studies by Williams and Peters in this volume illustrate the use of GIS-based information tools to help synthesize lessons from local NRM experience.

Performance of technologies over the long-term, and how risky they are in different agroecosystems and climates, can be addressed by nutrient budgeting and modelling (Lightfoot and Noble, 1999). Linkages of models to on-farm experimentation, to explicitly evaluate risk and farmer perceptions is an approach developed in Zimbabwe. These experiences are reported by Rohrbach and Okwach (1999) and closely related work by Snapp and colleagues (1999);

BOX 4.2 FARMERS AND RESEARCHERS PARTNERING IN MALAWI THROUGH MOTHER–BABY TRIALS

Researchers and extension workers are reaching out in Malawi to maintain constant communication with their clients, farmers. In the new mother–baby trials, researchers establish one benchmark on-farm trial in a village, which they manage, in order to gain replicated data for analysis. This is called the mother trial (a metaphor that connects especially well with the highly enthusiastic women farmers). Associated with the mother trial are about 20 baby trials, each managed by a farmer herself, using treatments she has expressed a particular interest in – not just the ones the researchers may want to promote. A baby trial may have as few as four plots, easing the workload while focusing on the 'best-bet' treatments the farmer is most likely to adopt. Farmers manage their baby trials using their own inputs and equipment. They define their own control treatments for comparison to see if the new idea is really an improvement on their previous practices. Surveys are conducted to integrate farmer evaluation of best bet technologies with researcher judgements (Snapp, 1999). Where villages representative of different agroecozones are chosen for conducting mother–baby trials, meta-analysis of technology performance can be conducted over time and space.

Both researchers and farmers learn from this approach. In Malawi, for example where 300 farmers across five agroecosystems are conducting baby trials, one farmer exclaimed, 'Groundnuts doubled up with pigeonpea is my new basal fertilizer. I grow them before my maize crop and I get a strong crop: I only have to apply a small amount of urea as a side dress.'

The work has impressed upon researchers that any technology – such as legume intensified maize cropping systems – must have multiple benefits. Farmers are ready to invest in crops that help reduce labour requirements, and have marketing potential. Soil fertility enhancement is not enough on its own. This finding has spurred additional research on market access and legumes that have cash cropping potential, as well as nitrogen-fixation soil benefits.

see also the Zimbabwe case study by Vaughan in this volume. New methodology and knowledge has improved efforts to integrate on-farm evaluation of cropping system performance over time and space. These include multivariate statistical approaches to analysis of variance and nutrient balance methods to calculate nutrient in flows and out flows as sustainability indicators and guides (Brown et al, 1999; Defoer et al 2000; Mutsaers et al, 1997)

As spatial analysis and simulation prediction tools become more widely available, stronger linkages to PAR need to be developed. Empowering communities to improve natural resource decision-making across regions, and countries, is a process being explored by McDougall and colleagues where community forest management is challenged by conditions of rapid change, deforestation and involving multiple stakeholders in Indonesia and other countries (McDougall et al, this volume). CIFOR (the Center for International Forestry Research) has recently carried out initial research to develop and test suitable criteria and indicators to help assess the sustainability of community forest management.

Links to markets and access to inputs are also important components of scaling up, where demand and supply can help facilitate farmer experimentation.

An interesting example is provided by a recent uptake of pigeonpea in new regions of Malawi through a combination of events, including market liberalization and increased market access for smallholder farmers (Jones et al, 2000). This may have long-term positive consequences for soil fertility regeneration: pigeonpea is one of the most effective grain legumes in terms of fixing nitrogen and increasing phosphorus availability under on-farm conditions (Snapp, 1998). Thus, strategic partnerships among private and public organizations to facilitate market-demand and access to inputs may be necessary to scale up technology adoption.

Summary

A highly heterogeneous environment that requires locally-specific decision-making complicates efforts to improve NRM. Heterogeneity among stakeholders makes it difficult to craft cooperative agreements, and develop effective communication. Further, smallholder farmers and resource-poor rural people cannot always invest in experimentation, and they may not understand all of the interactions and the bio-physical principles involved (Bentley and Andrews, 1996). Researchers frequently have knowledge about agroecological principles, but do not know how to apply them to local circumstances or resource bases. A major stumbling block is that those charged with improving local decision-making are frequently unclear about indigenous knowledge or local priorities.

To scale up and move forward, a radical change in the research sequence is necessary. Participatory problem definition needs to start with the farmers' perspectives (Bentley and Andrews, 1996; Heong and Escalada, 1997a). Improved communication tools and PAR methods are becoming available to facilitate this process. Structured means of improving information flow among farmers, researchers, farm advisors and other stakeholders are discussed here. These include relatively practical and rigorous methods that can be adopted immediately by agronomists and soil scientists, such as community nutrient budgeting and mother–baby trials (Kanyama-Phiri et al, 2000). Key components include improving communication through participatory workshops and the linking of action research and synthesis of biological performance and farmer perceptions. Spatial analysis tools such as GIS can play a role in the synthesis of natural resource information and developing indicators at different scales, including those with local and multi-regional importance. Community participation and human resource development approaches may take longer to develop, but are essential to the sustainability of scaling up efforts. Community agricultural research groups, watershed management associations and farmer field schools provide examples of how to develop human capacity and improve NRM decision-making on a grand scale (Ashby et al, 2000).

Reaching many farmers may require learning from nationwide literacy campaigns (Freire, 1970), and understanding how market access and links can be developed. These require major investments in terms of time and resources, which may involve mobilizing the private and public sectors. At the same time, in cases where relatively simple relationships are apparent, we suggest that one way forward, with short-term impact potential, is for resource management scientists to distil research information into testable rules of thumb. Then clients throughout a country or region can be challenged to evaluate this hypothesis (Cooperrider et al, 2000). Management decision-making framed as heuristics has the opportunity to be disseminated widely by the mass media. Thus, thousands of farmers can become engaged in experimenting to evaluate rules of thumb, and determine validity for themselves (Escalada et al, 1999).

We attempt here to distil information about building quality partnerships, while expanding to reach many people. The case studies detailed here are rich sources of information about what worked and did not work. It is apparent that communication among farmers, researchers and change agents as well as community skills in building in NRM are essential ingredients to sustainability and scaling up; this holds for a range of different information tools and participatory approaches. Maintaining and expanding on these partnerships is part of the challenge of reaching the multitudes.

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