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What Kind of Research and Development is Needed for Natural Resource Management?

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Abstract: *This paper presents a set of principles and operational guidelines for research and development (R&D) to better address natural resource management problems distilled in a series of workshops with more than 150 experts and practitioners. The principles and guidelines, a number of which relate to scaling issues, are illustrated with case studies from Zimbabwe and Indonesia. The former included research on watershed management for improved small-scale irrigation, while the latter focused on work with communities that had confronted logging companies, partly because of the negative impact of logging on water quality. The principles are grouped as follows: (a) learning approaches; (b) systems approaches, and (c) organisational models. Eleven operational guidelines for implementing the approach are suggested, arranged in three clusters: (a) working together; (b) establishing the institutional and organisational framework; and (c) improving the approaches to suit the task. The elements and strategies for two of these cornerstones (collaborative partnerships and scaling-up and scaling-out) are illustrated to indicate the quality needed to achieve appropriate implementation of the R&D approach.*

Key words: *social learning, participatory action research, adaptive management, innovative organisations, operational guidelines, research and development, partnerships, integration, scale, systems approaches.*

Introduction

Natural resources research in developing countries has not brought the benefits its proponents had hoped for, especially in benefiting the poor (Anderson, 1998; Barrett, 2002; Röling and Jiggins, 1998; Sayer and Campbell, 2004). Instead, the major impacts in natural resources research have come from approaches conventionally viewed as less scientific in terms of researcher objectivity, the type of data collected, and the methods employed. Greatest impacts tend to occur where actors become researchers and visa versa; where researchers investigate the 'softer' social systems, that are more difficult to observe, as well as the 'harder' environmental factors; and where facilitators create learning processes among stakeholders at different

scales, not just among scientists (Lee, 1993; Hagmann, 1999; Sayer and Campbell, 2004). A 'third generation' research and development (R&D) is needed (Roussel et al., 1991), in which researchers and other stakeholders work together to improvise and integrate R&D. As they do so, the distinction between research and development will become less clear (Chambers and Jiggins, 1986; Douthwaite et al., 2001).

Research on natural resources with real impacts for the poor is urgently needed. Billions of poor people depend on natural resources for the range of goods and services upon which their livelihoods are based (e.g. Byron and Arnold, 1999), yet inadequate management of these resources has led to their degradation and declining supply (e.g. Cleaver and Schreiber, 1994). The initial gains of agricultural research, largely confined to areas of high agricultural potential, often benefited more prosperous farmers, missing the poorest of the poor (Conway, 1997). In many cases agricultural research yielded short-term gains at the expense of long-term degradation of soils, water, biodiversity and forests (e.g. Angelsen and Kaimowitz, 2001; Gonsalves, 2000). In the meantime, population density increase and global climate change renders partly irrelevant the accumulated local and scientific knowledge upon which agricultural improvements are based. As water becomes scarcer and supplies less predictable, a number of human and social stresses jeopardize the ability to improve agricultural production. HIV/AIDS, malaria, tuberculosis and emergent diseases undermine the social structures of rural people. Increasing commercialisation and globalisation of production tends to foster economies of scale where larger companies, not smallholder farmers, realize economic advantages (Williams, in press). As a result of these trends, it is likely that poverty will worsen, particularly in Africa, where all these problems are especially acute.

Major questions remain as to how poverty alleviation goals match longer-term conservation interests. Countless studies have documented the deficiencies of previous efforts to conserve landscapes and improve livelihoods (McShane and Wells, 2003), and many agree on the need to adopt new approaches to natural resource problems (Binswanger, 1998; Sayer and Campbell, 2004). Recently, the World Bank, the United Nations Convention on Biological Diversity (UNCBD), the Global Environmental Facility (GEF), and the UN Convention to Combat Desertification (UNCCD) adopted policies committing to new integrated approaches to environmental problems. For example, the UNCBD has adopted the ecosystem approach as a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.

This paper present a set of principles and operational guidelines for improving R&D in order to better address the natural resource management problems of the rural poor, including those problems involving water. In the following section, these methods are described, along with an overview of workshops on which this paper is based. In the third section, two case studies (dryland Africa and humid Indonesia), both including water-related development components, are described. In the fourth section, the principles for NRM research are introduced. In the fifth section, the operational guidelines for implementing NRM research are highlighted. To show the level of detail required to achieve quality implementation of such research, two of the eleven guidelines (collaborative partnerships and scaling-up) are described in more detail. Finally, in the last section, some conclusions are drawn.

Methods

The principles presented here for NRM research are based on the presentations and discussions generated during two international workshops (in Penang and Cali). These were convened by the Integrated Natural Resource Management (INRM) task force of the Consultative Group for International Agricultural Research (CGIAR), which includes 15 research centers. At the workshops, facilitation techniques were used to analyse, group and re-group the principles until consensus was achieved. Different facets of INRM were documented in a special issue of Conservation Ecology (http://www.consecol.org/vol5/iss2), and synthesised by Sayer and Campbell (2004).

Although identification of the key principles is an important advance, there is inadequate experience to put them into effective operation. The third INRM workshop (in Aleppo) addressed issues surrounding effective practice and derived an operational framework

for managing NRM interventions (Turkelboom et al., 2002). This was based on the LearningWheel©, a methodology for systematising experiences of multiple stakeholders (Campbell et al., 2006). Workshop participants derived the operational framework from analyses of their experiences. In a stepwise process, participant's experiences, representing a variety of cases from around the world including many that focussed on water-related issues, were shared and then analysed systematically to identify factors leading to successful outcomes for people and the environment. The participants' experience was in a few disciplines or sectors, rarely addressing the whole social-ecological system (Walker et al., 2002); nevertheless, their combined experience provided a fairly complete picture. Building on that analysis, the success factors were clustered into a set of necessary "guidelines" to effectively manage NRM interventions. The guidelines were subsequently elaborated by Campbell et al. (2006). More than 150 persons – mostly from the CGIAR, but also including NGO staff and academic and government agency researchers – contributed to the above-mentioned workshops.

The two case studies used herein, from dryland Africa and humid Indonesia, have been the subject of intensive R&D by teams of researchers for a decade

Table 1 Comparison of the two case studies: Zimbabwean drylands and Indonesian rainforests

	Dryland Zimbabwe	**Indonesian Rainforests**
Location	Chivi District, southern Zimbabwe	Malinau District, Kalimantan
Climate	Seasonal climate, ca. 600 mm rainfall	Equatorial climate, > 3000 mm rainfall
Vegetation	Dry deciduous savannas	Evergreen rainforests
Local land uses	Mixed farming including rainfed agriculture, smallholder irrigation, livestock production and woodland product use	Shifting agriculture, fishing, hunting and gathering
Pressures from external actors	Minimal	Mining and logging interests; rent-seeking behaviour by local officials
Water-related issues	Severe droughts affecting agriculture, household water availability; watershed management to maintain above- or below-ground water resources; open access fishing problems on small dams	Poor water quality as a result of land cover change; high quality water for fish farming
Primary aims of the work	Achieving management of the common pool resources in the watersheds for improved local livelihoods	Sustainable forest management integrating social, economic and silvicultural issues
Water-related aims	Watershed management, expanded smallholder irrigation (to give all rural producers the option of irrigated production)	Maintenance of water quality in the face of land-cover change; expanding fish farming
Scale-related issues	Analysis and interventions planned at local and district scales, scaling-out through links with an NGO, scaling-up planned (but not possible) via the national water reform process	Analysis and interventions planned at local, district, provincial and national levels; scaling-out through cross-village visits; scaling-up through national policy influences and links to the ecosystem approach of the UN Convention for Biodiversity (CBD)
Periods of engagement	3-year project, with much lower levels of engagement after project completion	Nearly a decade of R&D, with multiple projects
Types of partners	Government researchers, development NGOs, district officials	Government researchers, conservation and development NGOs, district officials

(Campbell et al., 2002; CIFOR 2002). They are used here to illustrate aspects of the principles and guidelines.

The Realities: Complexities faced by researchers in Zimbabwean drylands and Indonesian rainforests

Drylands of southern Zimbabwe

One of the greatest challenges in this area is the lack of water for household and farming activities (Table 1). Water specialists need to examine resources and use at different scales, and the multiple interactions across different scales. Key questions include: How does surface water interact with ground water? How does land and vegetation management influence water resources? How can water storage be increased for small-scale irrigation without severely impacting downstream storage needs? How can the effects of frequent droughts be ameliorated? These are only a subset of issues that need addressing in the larger social-ecological system. Local organizations (e.g. irrigation and water point committees, district government) perform poorly. In addition, local rules and regulations have numerous problems as illustrated by the inoperative district by-laws. Although a water reform process is occurring, it remains top-down, unlikely to mesh well with local institutions, practices and projects. To solve water-related and other problems, R&D agents need to engage multiple local and external players, including local committees, the national extension service, NGOs and policy makers (Hagmann et al., 2002). R&D agents need to recognise that NRM organizations have different perspectives, and that the boundaries of administrative units and different natural resources do not match. Unfortunately the organizational mandates and agendas of R&D agents are not set up to embrace the complexities.

In these drylands, local livelihoods involve a diverse portfolio of activities, so narrow crop- or animal-specific approaches are unlikely to make a large difference to the overall household economy. For example, the international research agencies CIMMYT (International Maize and Wheat Improvement Centre) and ICRISAT (International Crop Research Institute for the Semi-Arid Tropics) focus their activities on dryland crops such as maize and sorghum, but dryland crops comprise less than 20% of total household income. Thus, even if there was a major technological breakthrough in dryland crops, the impact on overall income is likely to be limited. Livestock research by ILRI (International Livestock Research Institute), and forest and agroforestry research by ICRAF and CIFOR would also be needed. Furthermore, at least a quarter of total income is derived from non-farm activities, so poverty reduction must also be addressed through efforts to improve small business opportunities, and remittances from urban employment.

While there are a multitude of poverty and natural resource problems at the research site, the main R&D thrust was centred on improving access to water for households, largely for small-scale irrigation. The research incorporated participatory action research (PAR) that involved changing the by-law system (so that, e.g., watersheds could be better managed), improving and expanding small-scale irrigation based on both ground and surface water, and examining better ways to do watershed management.

Rainforests in north-eastern Indonesia

In Indonesia, the second case study site (Table 1), the local government, large and small timber companies, and the national forest department have sought to extract timber through concessions, small-scale timber cutting licenses, and illegal activities, often in overlapping and unclear arrangements. Local people, meanwhile, relyon the forest for subsistence and cash income (Levang et al., 2005). The local villages, comprised of 18 distinct ethnic groups with their own historical alliances and conflicts, want to secure the boundaries of their territories to control use within them and claim compensation (Andersen and Kamelarczyk, 2004). However, forests are only one aspect of local people's lives. All villagers want better agricultural productivity, and improved market, transport, education and health infrastructure. They also want improved access to good-quality water for drinking, bathing and fishing. Logging negatively influences water quality; at least one village has made a stand against a logging company (Iwan, 2003). Close to the district capital there has been a rise in fish farming that depends on reliable access to high quality water. While rural population

densities are only about 1 person/km^2, conflicts over natural resources have increased dramatically since decentralization and democracy reforms began in 1998. The changes occurring are exceptionally rapid.

In the midst of these changes, external assistance committed to specific geographic areas or populations has had the most impact, in contrast to interventions built on specific technical and institutional arrangements, which have been short lived. The World Wide Fund for Nature has been active in managing the 1.3 million ha Kayan Mentarang National Park and promoting biodiversity conservation and community development since 1990, and a missionary of the Catholic church has worked with ethnic Punan groups for three decades.

Technical research on large-scale logging, conducted by CIFOR in 1996-1999 (Sist et al., 2003), demonstrated the value of reduced-impact logging. However, the work became suddenly obsolete when the new district government introduced small-scale timber cutting licenses in 2000, and the new logging companies had no interest in sustainable logging. Other researchers focused on improving management of watersheds. They purposely engaged different players at national, district and local level, who were often ill at ease with one another (Campbell et al., 2003). Local-level research on community boundary demarcation brought distrust at the district level and national level. Research on logging methods preformed with the logging companies was frowned upon by local communities because they felt cheated by the companies. Action research with communities on protecting the watershed functions of their forestland was not favourably received by the companies who wanted to log the forests. The research has sought to bolster the influence and capacities of weaker groups, and build communication and cooperation among all groups through a learning process approach using participatory mapping, multi-stakeholder dialogues, field visits, inter-community workshops, collaborative monitoring, training in facilitation and conflict management, and joint economic development activities (Wollenberg et al., in prep.). The main R&D problem is how poor people could better benefit from the districts' high-value resources (especially timber), and how exploitation of those resources could be managed to lessen negative impacts on local people and their resources (e.g.

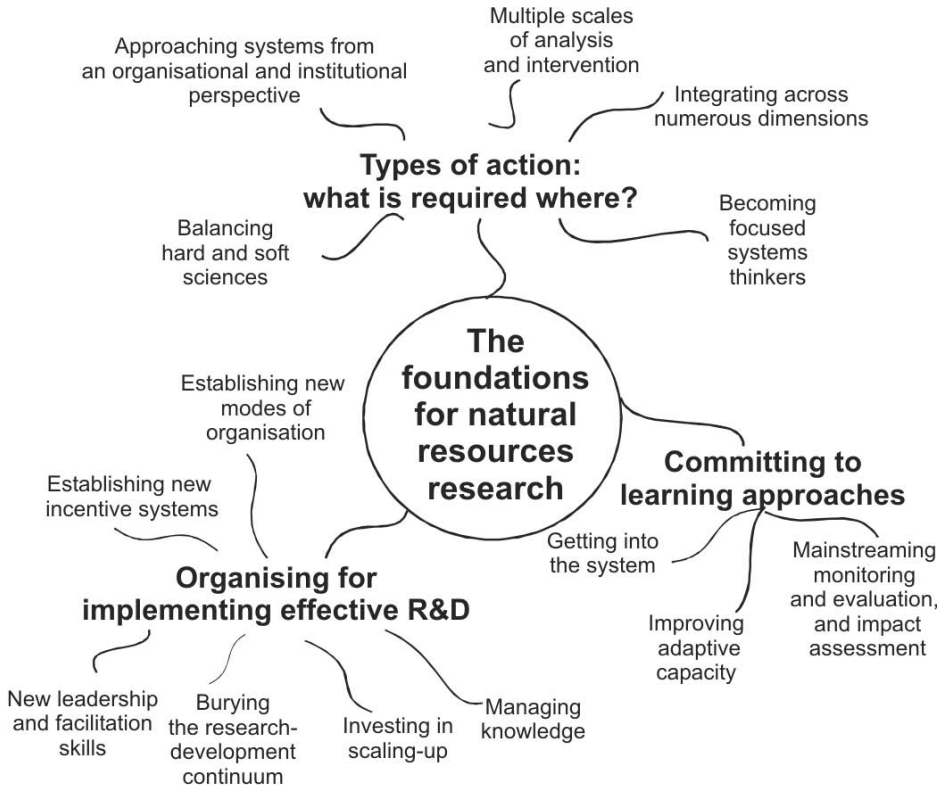


Figure 1. The foundations for natural resources research

water).

Foundations for improving natural resources research

A set of principles was derived for undertaking NRM research (Section 2 describes the approach used to identify the principles). The principles are grouped into three categories (Figure 1): (a) learning approaches; (b) systems approaches; and (c) organisational models.

Learning approaches

Ideas established in three different traditions – adaptive management, social learning and action research (Holling et al., 1998; Hagmann, 1999; Maarleveld and Dangbegnon, 1999; Daniels and Walker, 1999) suggest that when dealing with multiple stakeholders, management must be organised in a way that promotes active, conscious individual and social learning. Resource management should be based upon continuous dialogue, deliberation, planning, action, reflection and re-planning based on the insights amongst the stakeholders. In Indonesia, the value of research with an adaptive approach was demonstrated during Indonesia's violent period of policy change and uncertainty. The strategy shifted from seeking national policy changes that accommodate community claims to forest, to a strategy of district government capacity development and co-learning with communities about forest-based income opportunities. These rapid changes left little room for meaningful influence on national policy so national agencies were greatly disempowered. When opportunities were opened up by a community that confronted a logging company to protect its water resources, researchers stepped in to help the community achieve its aspirations. In Zimbabwe, constant dialogue with villagers and district officials allowed for flexibility of action and analysis. The work on by-laws with a focus on small-dam resources was not planned in the project proposal but emerged as the project unfolded.

Improving adaptive capacity

In mainstream R&D the prime objective is often to introduce improved technologies, however, in a multi-stakeholder situation, it is unlikely that any single technological objective will suit all stakeholders. Standardised technologies that work in many contexts will only be part of the solution. Given heterogeneity, complexity and dynamism in system components, such as dryland cropping areas, irrigated gardens, livestock production etc., one of the prime objectives will be to improve the adaptive capacity of the actors; that is, improve their ability to sustain a flow of the diverse products and services under constantly changing conditions (Gunderson and Holling, 2002; Lynam et al., 2002). Tools to improve adaptive capacity include a variety of modelling approaches (e.g. Failing et al., 2004); for instance, the one adopted at the Zimbabwe site places great weight on the perspectives of different stakeholders (Campbell et al., 2002; Lynam et al., 2002).

Social learning

In comparison to farming systems research (Collinson, 2000) or the ecosystem approach of the UNCBD, the approach described here involves 'getting into the system'. There has been an evolution 'from understanding the system' to 'making the system understand itself better'. It is no longer research on systems but research within systems, combining understanding and change at the same time (Hagmann et al., 2002; Douthwaite et al., 2001; Sayer and Campbell, 2004). These and other authors build the case for researchers needing to recognise themselves as being an integrated part of the system, one of the many actors, with the research process driven by the users of the research results. Thus rural people will be partners, not passive beneficiaries. Empowerment from outside and emancipation from inside the system are central thrusts In this way behavioural changes can be facilitated, and capacities and capabilities developed (Leeuwis and Pyburn, 2002). Being part of the system should result in better understanding of traditional knowledge, more humility as to what can be achieved and greater recognition of the aspirations of local actors.

Adaptive management – mainstreaming monitoring and evaluation

The use of participatory action research (PAR)

entwines research with development so as to gain understanding within a particular social-institutional context, while influencing change at the same time (Scoones and Thompson, 1994). At the Zimbabwe site, for example, PAR was used at the village level to implement expanded smallholder irrigation, while at the district level it was used to negotiate a new governance arrangement for common pool resources, including the use of dams for fishing. In Indonesia, PAR involved a multitude of stakeholders with varying interests and perspectives, facilitating institutional change, and reflecting on the effectiveness of progress (Wollenberg et al., in prep.).

Although there is considerable experience of PAR at the farm level, much remains to be learned about its application at the level of social-ecological systems (German et al., in press). To accomplish this goal, additional efforts are required to reflect the larger scale and multiple interactions among numerous stakeholders. Management of these systems will be experimental in terms of (a) technical solutions for farms and other landscape units; (b) collective action or other institutions required; and (c) service and policy support. Natural resource agencies will no longer be able to project their own vision of a single best way of managing the landscape.

Information management is crucial to the learning process. Mainstream monitoring and evaluation, and impact assessment is essential for adaptation, learning and performance enhancement, along with providing data for further negotiation amongst stakeholders and for resource-allocation decisions (Guijt, 1998; Gottret and White, 2001). The key issue is not monitoring and evaluating by outsiders, but self-monitoring and evaluation by all the actors with their different realities and perspectives (Guijt, 1998).

In the research context high-technology research on system components is still vital but must be embedded in a context of specific biophysical and socio-economic situations. Moreover, research needs to recognise stakeholders' multiple, and sometimes competing, goals. Identification of, and dialogue regarding, different stakeholder goals are key components of the PAR approach. For instance in the Indonesian case, competing goals are clear and district authorities and local communities have very different perspectives on development needs.

Systems approaches

Balancing 'soft' and 'hard' approaches

Many scientists adopt a 'hard' science approach with only one correct answer to be discovered using formal (conventional) research methods under controlled conditions. Nevertheless, some scientists working alongside local resource managers understand and use constructivism (Douthwaite et al., 2001). They observe the multiple realities of the different stakeholders and understand that constructing new ones requires full participation, ownership and empowerment of local stakeholders.

As PAR approaches become more mainstream, development practitioners are increasingly taking a 'soft' science or more constructivist approach. Therefore, getting the balance right between 'soft' and 'hard' approaches will be a key challenge (Douthwaite 2002). In Indonesia the two approaches were not integrated until after a number of years of interaction when better balance was achieved.

Approaching systems from an organisational and institutional perspective

This perspective is essential because organisations greatly influence the 'hard' (ecological) system and its performance. Many organisations aimed at balancing different stakeholders' interests (i.e. through norms, rules and regulations) have limited effectiveness. Issues of property rights, access to resources, and decentralisation of decision making are central to research on social-ecological systems. In Indonesia, for example, researchers examined who controlled decisions at each scale, who was really involved, and what benefits were received. With respect to land use planning initiatives, district officials' own visions and interests guided the plans, and consultants who barely knew the area, other than from satellite imagery and maps, conducted the analysis. The plans turned out to be irrelevant to how communities and companies eventually used their forests. Researchers need to understand the political landscape and be adept at navigating it (Berkes and Folke 1998, Berkes et.

al. 2003). At one point it became possible to host the district-level GIS laboratory at the CIFOR offices, and this proved the major impetus for researchers to engage with district planners. In Zimbabwe, the bottlenecks to expanding the irrigated gardens mostly related to institutional problems. By working with the irrigation committee and having community members undergo "Training for Transformation" (which emphasises empowerment), the community irrigation area was finally doubled in size.

Multiple levels of analysis and intervention

Actors involved in action on a limited spatial scale (e.g. NGOs working with one community, farmer PAR), need to use tools to achieve impact at multiple scales so that higher level constraints can be removed and costly local interventions can achieve wider impact. Approaches require multiple levels of analysis and intervention, not merely adding landscape level analysis and interventions to the farm level efforts. Specific issues may call for work at three or more levels. In Indonesia, for instance, district officials did not give much attention to the woes of Setulang, a village taking a stand against a logging company that wanted to log the watershed area of Setulang. As an illustration of the principle of working at multiple levels, the researchers worked at the international level, helping Setulang become one of the finalists in the World Water Prize, and the village went on to get the nation's premier environmental prize. This forced the district officials to engage with the village, given their 'global' and national recognition. The researchers also worked to secure a payment from a global player to the local village for their 'biodiversity services' (Wunder et al., in prep.). In Zimbabwe, an example of R&D at multiple scales is provided by Hagmann et al. (2002), who undertook research that spanned the plot to policy scale. Their local work resulted in successful interventions (soil-conservation methods) at the plot level, while their work at district and national levels resulted in an important reorientation of thinking within the national extension service (to a more participatory, demand-driven approach).

Integrating across dimensions

Reductionist research or research tackling single-sector issues is often inadequate as it fails to tackle real world situations in its attempt to reduce complexity (Sayer and Campbell, 2004). Having to cope with multiple problems and improving the ability to seize opportunities requires integrated approaches. Integrating across various dimensions will therefore be a key concept: across scales, across multiple stakeholders with divergent understanding of problems/opportunities, across different system components, and across research and development. A challenge for the research teams will be to strike the appropriate balance between reductionist research and a more synthetic approach.

Focussed systems thinkers

The problems posed by complex systems require researchers to become focused systems thinkers. Given the complexity of social-ecological systems, the main challenge is to identify the impacts being sought ('guiding stars') and not get lost in peripheral issues, although connecting interventions to impacts is a difficult task (Gottret and White, 2001; Douthwaite et al., 2001). A variety of tools to tackle complexity will be necessary (e.g. modelling, databases, geographical information systems, decision- and negotiation-support tools). Negative attitudes towards modelling abound given the heavy data requirements of large, complex simulation models. While such complex models undoubtedly have their place, the concept of 'throw-away' models is also attractive; i.e. working computer-implemented models built in a few days to explore a particular problem and then be discarded (Lynam et al., 2002). The same holds for 'fuzzy logic' models dealing with uncertainties and dynamics; or simple diagrammatic models to understand relationships and interactions. Some recent work has used participatory modelling, in which stakeholders assist in the development of models, and model results are fed back to communities using participatory techniques such as role plays (Lynam et al., 2002).

Members of the Resilience Alliance (http://www.resalliance.org/) contend that complexity is not boundless but has its own natural subdivisions and boundaries, and that three to five key variables often drive a particular system (Gunderson and Holling, 2002).

The trick will be to identify these variables, taking care that 'slow' variables are not forgotten. These are variables that change imperceptibly, but when they reach a threshold, the system may switch rapidly into a new state (Gunderson and Holling, 2002). In order not to get lost in complexity, it is key to have clear objectives, understand trade-offs and the consequences of alternative interventions, monitor outcomes and correct past courses of action.

Organisational principles

Implementing NRM effectively inevitably requires rethinking the culture, organisation and roles of NRM R&D agencies. These agencies are faced with highly dynamic changes and have to deal with non-equilibrium conditions, multiple aspirations and ambiguity (Ashby, 2001; Sayer and Campbell, 2004). During the reform years in Indonesia, researchers had to learn how to work with spontaneous forms of cooperation and adjust the strategy of project work-plans annually (Wollenberg et al., in prep.). Agencies involved in NRM will need to establish new modes of organisation, by becoming learning organisations, where top management promotes institutional flexibility, conditions favourable for complex learning, integration of scientists with other stakeholders, etc.

Innovative incentives

New incentives are required for those working in NRM agencies (Ashby 2001). Scientists, for example, should get more kudos for a publication with or by partners than for their own single-authored publications. They should also be rewarded for packaging results in different formats, each appropriate to different target groups such as donors, development practitioners and academics. Scientists with the capacity to build quality, collaborative partnerships should also be rewarded for such work

New leadership and facilitation skills

Leaders must develop new facilitation skills to ensure flexibility, teamwork and partnerships. They must also be able to review large bodies of information and simplify complexity. Only by doing so in a timely manner can better questions be asked, implementation strategies identified, and wise decision-making facilitated. Given multiple levels, stakeholders and experts, a key element in NRM research is likely to be project facilitation. Integrative work can generate high transactions costs; integrated rural development projects of the 1970s and 80s were prone to these problems (e.g. Binswanger, 1998). In a farmers' group, for example, one farmer may be nominated for training in facilitation. At the district level, a professional facilitator may be hired to orchestrate multi-stakeholder negotiations. Facilitators will need to ensure depth and quality of discussion as well as bring out and acknowledge different perspectives. Process management and facilitation also include good leadership with clear thinking, vision, foresight, ability to use intuition and common sense, flexibility and consistent application of operational principles.. Facilitators need to see the big picture, maintain focus and move the process forward rapidly. In Zimbabwe, a full-time facilitator was recruited locally, working and living in the village; and facilitators were routinely part of all major processes in research done at both district and national levels.

Multiple sources of innovation

Broader participation with a variety of stakeholders leads to wider-ranging development impacts. Ultimately, in the ideal scenario, all management is experimental and all research involves managers, with little distinction between management and research (Sayer and Campbell, 2004). Nevertheless, scientific principles are still likely to be applied with varying rigor and disciplinary orientation. The traditional research-development continuum has to be replaced by a model acknowledging that the innovation system is non-linear, with multiple sources of innovation and interaction (Röling and Jiggins, 1998; Douthwaite, 2002).

Create an enabling environment for scaling-up and scaling-out

Organisations need to plan and invest to create an enabling environment for scaling-up and scaling-out (see Section 5.3 for more detail) as part of the research process rather than as a delivery mechanism for a finished product. Embedded in the concept of scaling-up and scaling-out is the idea that any change (technological, institutional and/or policy) is brought about by the formation and actions of networks of

stakeholders in a social process of communication and negotiation (Hagmann et al., 2002). This concept of scaling is an important departure from positivist science. In Indonesia for example, researchers not only worked intensely with four villages but also created communication networks of villages in the watershed and with NGOs of national influence. Work at both scales enabled the effective sharing of information across scales.

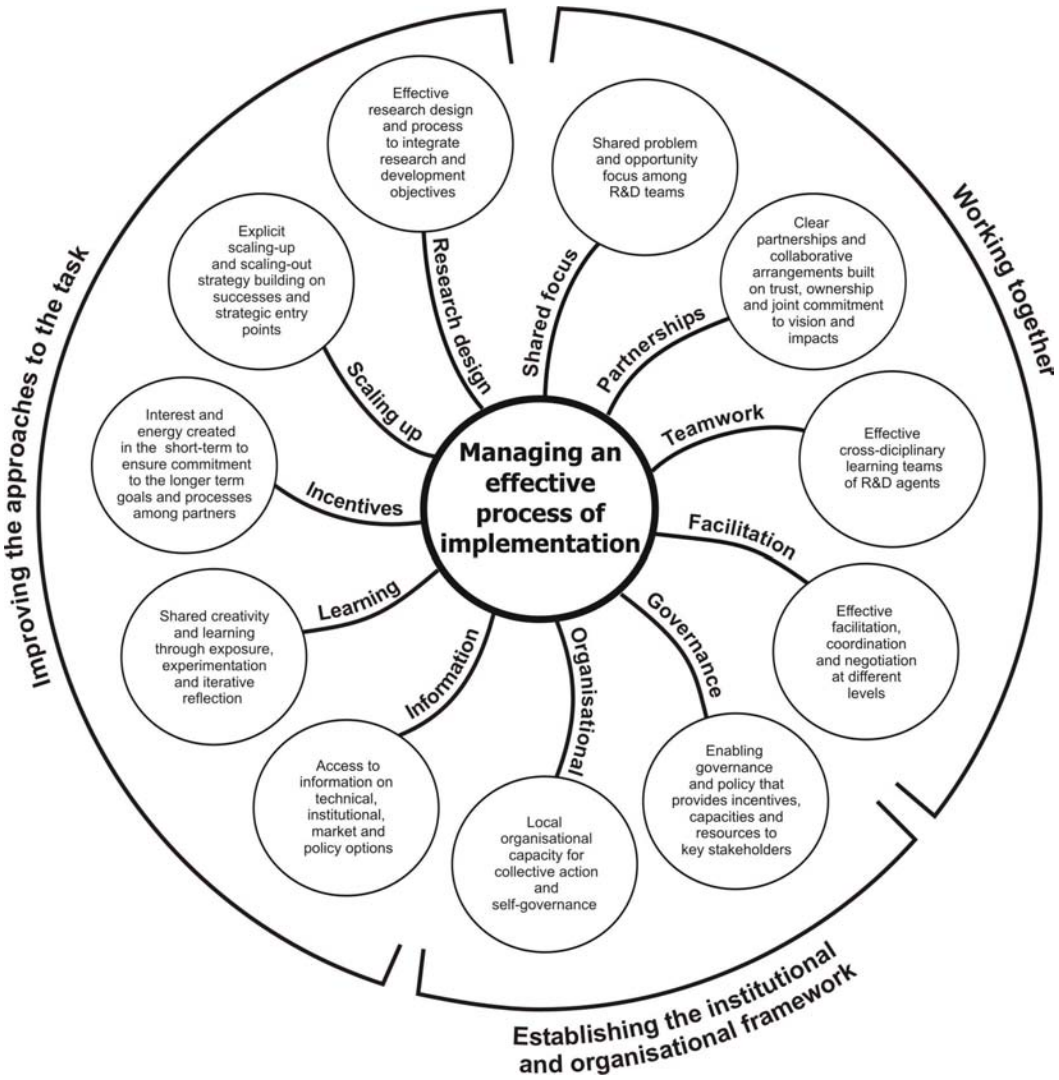
Knowledge management

In order to organize and share the diversity of information held by different actors and apply it at various scales, knowledge management is required. More weight will have to be given to the sharing of informal or tacit knowledge as it often drives decisions. Scientists need to learn humility and give credence to the fact that the lives of local resource users depend upon informal knowledge accumulated over generations (Berkes et al., 2000).

Summing up

There is widespread dissatisfaction with NRM research, usually from practitioners and policy makers. This dissatisfaction was best expressed by Andrew Campbell some time ago: the research establishment "is incapable of delivering social equity, economic efficiency and ecological integrity in response to the decline of rural society and deepening crises in the depletion and degradation of water, soils, flora and fauna" (quoted in Röling and Jiggins, 1998). A more recent example is the critical view of Barrett (2002)

Figure 2: NRM LearningWheel – conceptual framework to manage and implement research



in assessing the NRM research of the international research centres. It appears that something needs to change. In this section the principles for a new brand of NRM research, derived by about 100 participants in two international workshops, have been presented. Many of these are already being tried, though often with emphasis on only a few of the principles, resulting in less than satisfactory performance in other areas.

Operational guidelines to implementing R&D

The NRM LearningWheel is shown in Figure 2 (derived through the process described in Section 2). The major utility of the LearningWheel is its practical application to situations in NRM initiatives and programmes. The framework can be used as an analytical tool for: strategy development; planning, strategic monitoring and steering of NRM initiatives by the partners involved; and as a knowledge management system to re-integrate the lessons and experiences gained at different sites and actors. The framework facilitates gap analysis, as well as identification of critical entry points and priorities for intervention. NRM is a comprehensive process involving a number of key functions (guidelines) that need to be in place, or developed, if interventions are to be successful. All guidelines interact with one another. Overlaps between the guidelines are unavoidable and desired in this perspective. Not all guidelines have to be actively addressed at all times. Some might be in place in the NRM process at a given time, others may be weak and need to be actively addressed to support the process work.

Some of these guidelines are now well established in the development lexicon, but the tendency is to use the terms without considering what it takes to make them a reality. This limits the potential effectiveness of an effort; for example, collaborative partnerships may be high on the agenda, but while many individuals and organizations embrace their importance, little has actually changed in the way partners are selected and sustained. It is about more the meaning of these terms, it is the quality of implementation that is the most important. Here we describe all the guidelines in general terms (sections 5.1.1-5.1.3) and then use the collaborative partnership and scaling-up guidelines (sections 5.2 and 5.3) as examples to show the depth required to ensure quality implementation of NRM research. Campbell et al. (2006) provides more detail on each guideline.

Overview of guidelines

The eleven guidelines are clustered into three groups: (a) working together; (b) establishing the institutional and organisational framework; and (c) improving the approaches to the task.

Working together

A number of the guidelines relate to how different researchers and partners work together, with facilitation being an important part of this endeavour.

- *Shared focus*: Mutual agreement among R&D teams about problem and opportunity focus.
- *Partnership*: Clear partnerships and collaborative arrangements built on trust, ownership and joint commitment to vision and impacts.
- *Teamwork*: Effective cross-disciplinary learning teams of R&D agents, where team members share responsibility to a common vision but have clear and distinct roles.
- *Facilitation*: Effective facilitation, coordination and negotiation at different levels.

Establishing the institutional and organisational framework

Two guidelines are dedicated to governance and policy issues and to ensuring local organisational capacity:

- *Governance:* Enabling decision-making and policy that provides incentives, capacities and resources to key stakeholders.
- *Organisational*: Local organisational capacity for collective action and self-governance.

Improving the approaches to the task

A number of guidelines pay attention to the processes of engagement, covering information access, the learning process, incentives to engage, scaling-up and out, and research design and process.

• *Information*: Access to information on technical, institutional, market and policy options.
• *Learning*: Shared creativity and learning through exposure, experimentation and iterative reflection.
• *Incentives*: Interest and energy created in the short-term to ensure commitment to the longer term goals and processes among partners.
• *Scaling-up and out*: Explicit scaling-up and scaling-out strategy building on successes and strategic entry points.
• *Research design and process*: Effective research design and process to integrate R&D objectives.

Example of the collaborative partnership guideline

Collaborative partnerships enable the coordination of a project among diverse groups with a stake in, or capacity to improve, NRM. Partnerships occur in varying degrees of collaboration, with varying levels of commitment and investment. Partnerships are a basic 'ingredient' when trying to solve complex NRM problems because of the need to acknowledge different perspectives, disciplines and competencies that can have a bearing on the NRM problem (Hall et al., 2001; Smith 2005). Collaboration among stakeholders and resource people with different functions, skills and perspectives, if well facilitated, can generate an atmosphere that promotes sharing, idea exchange and creative problem solving (Leach and Pelkey, 2001). Collaborative arrangements should reflect a strategic mix of official institutions, influential institutions, organisations with capacity to mobilise resources, and service providers such as extension agents and technical specialists (Smith, 2005).

To achieve quality in implementing each guideline, its elements need to be outlined with detailed strategies to achieve them. Four elements of the collaborative partnership guideline are recognised, each with a series of strategies. The four collaborative partnership elements are:

- Assess need for partnership, then identify and assess potential partners.
- Maximize synergies and complementarities with clear roles and balanced competencies.
- Establish shared ownership and identify common values and principles.
- Establish and maintain conditions and processes for monitoring the partnership, decision-making and reaching agreements that are fair and equitable (e.g. Hall et al., 2001; Conley and Moote, 2003).

Each element has a number of specific strategies. As an example, the strategies for the last element are:

- Establish processes and mechanisms to ensure clear operational modalities with checks and balances to ensure accountability.
- Establish communication and feedback mechanisms; review these periodically.
- Ensure strong leadership that is inclusive, fair and accountable.
- Establish ways to deal with unequal partners and power relationships, as well as ways to negotiate and/or deal with differences (Conley and Moote, 2003). Have mechanisms to uncover differences so they do not fester.
- Ensure collaboration, not co-option; establish trust.
- Promote transparent information sharing and allow for divergence and convergence of opinions.
- Conduct partnership appraisals periodically to highlight the strengths and weaknesses and to highlight what needs improving in the partnership.

These principles are by no means simple to implement. In the Indonesia case, researchers developed formal partnerships with local government and the national forest research agency while attempting to build local partnerships through district-level workshops to which different stakeholders were invited. To build these partnerships, trust had to be developed by not requiring the same types of accountability measures from national and local organizations as might have been requested from other partners. Similarly, while communities were initially suspicious of efforts to establish formal contracts, excellent partnerships were developed during the five-year collaboration. The high quality partnership resulted from sharing similar goals of empowering local villagers, as well as from

strong informal bonds developed by full-time resident field staff. The staff regularly received visitors, tried to answer villagers' questions about all matters of concern to them, and visited other villages and government officials. The researchers worked with existing leadership but firmly requested representation of marginalized groups such as women. Communities were given the political space to make their own decisions, with researchers largely having a facilitation role. Regular newsletters were developed to report activities, and evaluations of different kinds were conducted to get community feedback on the R&D activities. As expected, the good partnership with communities made it more difficult and more time consuming to cultivate good relations with other stakeholders who view community empowerment as a threat. When the Setulang village received the national environmental prize for its watershed management efforts, jealousies amongst communities were heightened.

Example of the scaling-up and out guideline

Deep involvement of R&D actors in specific pilot sites can yield valuable insights, but researchers need to consider how to "go to scale…to bring more quality benefits to more people over a wider geographical area more quickly, more equitably and more lastingly" (Gonsalves, 2000). Scaling-up is vertical – e.g. through institutions (e.g. rules, policies), and organisational-competence development and improvement at higher levels. Scaling-out is horizontal – e.g. from community to community, often involving service providers. It is the spatial extrapolation of successful approaches to other sites with similar circumstances.

There are four scaling-up and out elements:

- Identify promising options for scaling-up and out.
- Engage organizational partners for scaling-up and out.
- Identify and capacitate service providers and identify appropriate institutional arrangements.
- Share knowledge and information.

Each element has a number of strategies, but as an example, the strategies for the last element are:

- Develop a communication strategy to target products in various media for various 'users' and situations.
- Find appropriate actors and methods to collect and share information.
- Develop feedback mechanisms to find out how useful the information is and to identify if further information is necessary to better target 'client' information needs.

From the Zimbabwe case study, it was possible to identify good and bad practices. In the case of the water-related work, which involved trying to establish local institutions for water and watershed management, insufficient attention was paid to scaling-up. The national water reform process should have been engaged to foster a partnership that scaled up project efforts. In defence of the research team, the key players in the national process were invited to various meetings but never attended because of other commitments considered of higher priority. Other means of engagement should have been attempted. On the positive side, the research team worked with CARE, who had water projects in 55 sites, so opportunities for scaling-out were good. Also, Hagmann et al. (2002) provide an example of scaling-up through their work in engaging the provincial extension service while mainly focused at the farmer level.

In Indonesia, researchers tried to scale up and out by working with local government, involving influential NGO networks and individuals in the field activities (e.g. in training, facilitation of workshops, evaluations), sharing newsletters widely, facilitating national seminars, sharing donor reports, and facilitating regular cross-visits among villagers and local officials to other communities or districts in Indonesia. Managing activities at different scales and striking the balance between testing ideas on the ground and sharing information and experiences is a challenge. In one activity, researchers disengaged themselves from a national committee because of the large time required, maintaining instead less formal communication channels.

Conclusions – the way forward

NRM research has been criticised for its limited ability to deliver impacts and generate generalisations beyond case or pilot studies (e.g. Röling and Jiggins, 1998; Barrett, 2002). As a result, there has been reflection on how to achieve more successful NRM research (e.g. Alrøe and Kristensen, 2002; Harwood and Kassam, 2003; Leshner, 2002; Lincoln et al., 2003; Sayer and Campbell, 2004). These reflections have been focused on achieving greater poverty alleviation and/or improved environmental outcomes. In this paper we have outlined principles and operational guidelines for improved NRM research, derived from a series of workshops involving more that 150 participants with a wealth of experience largely from developing countries. Elements of the approach have been dealt with in detail by some authors (e.g. scaling up; collaborative partnerships; knowledge management) but seldom has there been an attempt to cover the full spectrum of principles and guidelines. Considerable effort is needed to redesign R&D. The principles and operational guidelines provide a comprehensive description of a new way of doing business. NRM research is much more than the integrated management of soils, water and other resources. It is also distinctly different from farming systems research approaches and farmer participatory research.

Fundamental concepts essential for effective NRM research include collaborative partnerships and scaling. Scaling is important from a number of different perspectives – multiple scales of analysis and intervention are needed and scaling-up and out from case studies or demonstration sites is necessary. Integration (across components, stakeholders, expertise, perspectives and entry points) was recorded as a key principle. It goes well beyond integration of physical entities and process, right down to inclusion and empowerment – ensuring that voices and choices at the lowest scale are heard and counted; addressing and subscribing to diversity.

So, how can effective NRM research become a reality? The operational guidelines provide a good starting point, as the elements and strategies are concrete ways in which process and practice can be improved. But, a cookbook approach is not needed as NRM research needs creativity to match particular contexts. One major problem will be ensuring that a range of appropriate strategies across the different guidelines are being tackled in a timely and integrated fashion. If the weakest operational guideline is not dealt with the entire implementation process could be at risk. Implementation teams can use the operational framework to reflect on their intervention and analyse the state of art for each guideline. Reflection must take into account the 'quality' aspect, where many research efforts fall down. This requires linking the LearningWheel to a clearly defined performance assessment framework based on observable indicators indicative of 'good' practice.

Although the operational guidelines do provide a means to establish better NRM research, and some of the principles will be readily accepted by researchers, reforming R&D can be a mammoth undertaking. For many researchers, a move away from the current incentive system is difficult in the short term. How many scientists in academic institutions, where the majority of researchers are trained, would be willing or able to shift their goals related to numbers of refereed publications to goals involving the quality of developing partnerships? Enlightened leadership from numerous actors is needed for the NRM research proposed in this paper to become a reality.

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