Success Factors in Integrated Natural Resource Management R&D: Lessons from Practice

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ABSTRACT

This paper analyzes integrated natural resource management (INRM) lessons and success factors based on a practical case study over more than 10 years in Zimbabwe. The work was geared toward enhancing the adaptive management capacity of the stakeholders in their resource-use systems. One main result was the development and institutionalization of an approach for participatory and integrated NRM research and extension. The INRM approach described is grounded in a learning paradigm and a combination of theories: the constructivist perspective to development, systemic intervention, and learning process approaches. Participatory action research and experiential learning, in which researchers engage themselves as actors rather than neutral analysts in an R&D process to explore the livelihood system and develop appropriate solutions together with the resource users, has shown high potential. However, this should be guided by a clear strategy, impact orientation, and high-quality process facilitation at different levels. The case study revealed the importance of a "reflective practitioner" approach by all actors. More effective response to the challenges of increasing complexity in NRM requires a shift in thinking from the linearity of research–extension–farmer to alternative, multiple-actor institutional arrangements and innovation systems. To overcome the weak attribution of research outcomes to actual impact, it also suggests an alternative to conventional impact assessment in INRM R&D interventions.

KEY WORDS: change management, facilitation, impact assessment, institutionalization, learning processes, local organizational development, natural resource management, participatory approaches, systemic intervention.

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INTRODUCTION AND BACKGROUND

The term "integrated natural resource management" has no universally accepted definition. It is an emerging concept, understood as "the responsible and broad-based management of the land, water, forest, and biological resources base (including genes) needed to sustain agricultural productivity and avert degradation of potential productivity" (CGIAR-INRM-Group 1999). This definition allows a wide-spectrum interpretation. Many conceptual, methodological, and institutional questions need to be clarified and answered to reach a common understanding of the role and contribution of INRM research. What products and results should research deliver, what should be the role of extension, and how can the efforts of all actors be integrated in an effective, institutional arrangement to bring about the desired impact? This complexity and integration at different levels pose serious conceptual and organizational challenges where roles and mandates between the actors are based on a component technology focus. Conventional linear models, methodologies, and tools do not fit an INRM framework that tries to take a more holistic perspective to deal with dynamic complexity of resource-use systems. Various alternative approaches and methods are being developed, rediscovered from other scientific fields and adapted to INRM (e.g., action learning; Lewin [1946]; and process approaches Corten [1980]).

We analyze practical experiences in participatory, integrated research and extension in NRM in rural livelihood systems in Zimbabwe since 1990 and South Africa since 1998. We discuss conceptual, methodological, and institutional lessons and draw conclusions on future challenges in INRM. We review development of the approach in Zimbabwe, discuss specific building blocks in INRM, and present an emerging conceptual framework. The main elements considered are conceptual underpinnings, complexity, integration of components, scaling up and out, modeling, and impact assessment in INRM.

THE LEARNING CASE: APPROACH DEVELOPMENT IN INRM R&D IN ZIMBABWE

Evolution of the INRM approach

INRM work began in Zimbabwe in 1988 as part of a collaborative program between the National agricultural extension service (AGRITEX), German development co-operation (GTZ), and later the strategic ally, the Food Security Project of Intermediate Technology Zimbabwe (ITZ). The program started off with a technical research focus on soil and water conservation in the semiarid areas of southern Zimbabwe (Chivi, Zaka, and Gutu districts in Masvingo province). Over time, it iteratively integrated more technical and social elements of the rural livelihood systems into the original INRM framework. The ability of rural people to develop and optimally use their own potential, together with the goal of making a real impact at the farmers' level, guided the project's evolution.

Once success at the farmer level was evidenced through NRM innovations developed jointly with farmers, with broader adoption of social and technical innovations, scaling-up considerations led to institutionalization of the approach within the extension service. The extension service was to provide the facilitation to trigger large-scale implementation of the INRM process. The focus on developing institutional capacities to scale-up the process turned the program into an institutional experiment that became a more self-conscious intervention through ongoing monitoring, analysis, and conceptualization of the experiences.

From more than a decade of work at institutional, conceptual, and field levels, six major learning cycles of action and reflection in development of the approach can be distinguished. They reveal technical and institutional insights at farmer and service provider levels that propel continual readjustments and reorientation of the focus. The main stages of this INRM action–learning process are summarized as:

- Phase 1 (1988–1990): on-station research on conservation tillage;
- Phase 2 (end of 1990–1992): adaptive on-farm trials on conservation tillage with individual farmers and farmer groups;

- Phase 3 (1992–1994): opening up: farmer participatory research and participatory technology development with individual farmers and farmer groups on broader natural resource management technologies;
- Phase 4 (1994–1995): refining the concept and approach for collective innovation processes (local organizational development) in INRM;
- Phase 5: (1996–1997): conceptualization of experiences and scaling up: piloting a competency development approach at institutional level to the extension service as facilitators of such processes at large scales;
- Phase 6 (since 1998): institutionalization, scaling up and out: organizational change program within extension service to adapt the organization service delivery approach. Large-scale competence development and networking at NGO level were other focal areas during this phase, with field activities expanded.

Since 1998, the lessons learned in Zimbabwe have been used to expand and further develop the approach in the northern province of South Africa as a second major learning case. Greater details of the evolution of this INRM approach are documented in Hagmann (1999) and Hagmann et al. (1997, 1998, 1999).

Main elements of the approach to INRM

The INRM approach, as it emerged from experiences in southern Zimbabwe, is a value-driven, community-based learning process in which local people and external service providers share ideas and learn together. Outsiders and/or insiders facilitate this process. The basic strategy to strengthen the adaptive capacity of the natural resource management system at the local level is:

1. To strengthen the collective capacity of local groups, institutions, and organizations for self-organization, collective action, negotiation of their interests, and conflict management, as well as their articulation and bargaining power vis-à-vis authorities, service providers, and policy makers ("local organizational development").

2. To enhance farmers' capacity to adapt and develop new and appropriate innovations by encouraging them to learn through experimentation, building on their own knowledge and practices and blending them with new ideas in an action learning mode. Usually these are agricultural technologies and practices, but they also address social, organizational, and economical innovations.

3. To enhance collective learning through action and social learning, facilitation of self-reflection, sharing knowledge, and networking.

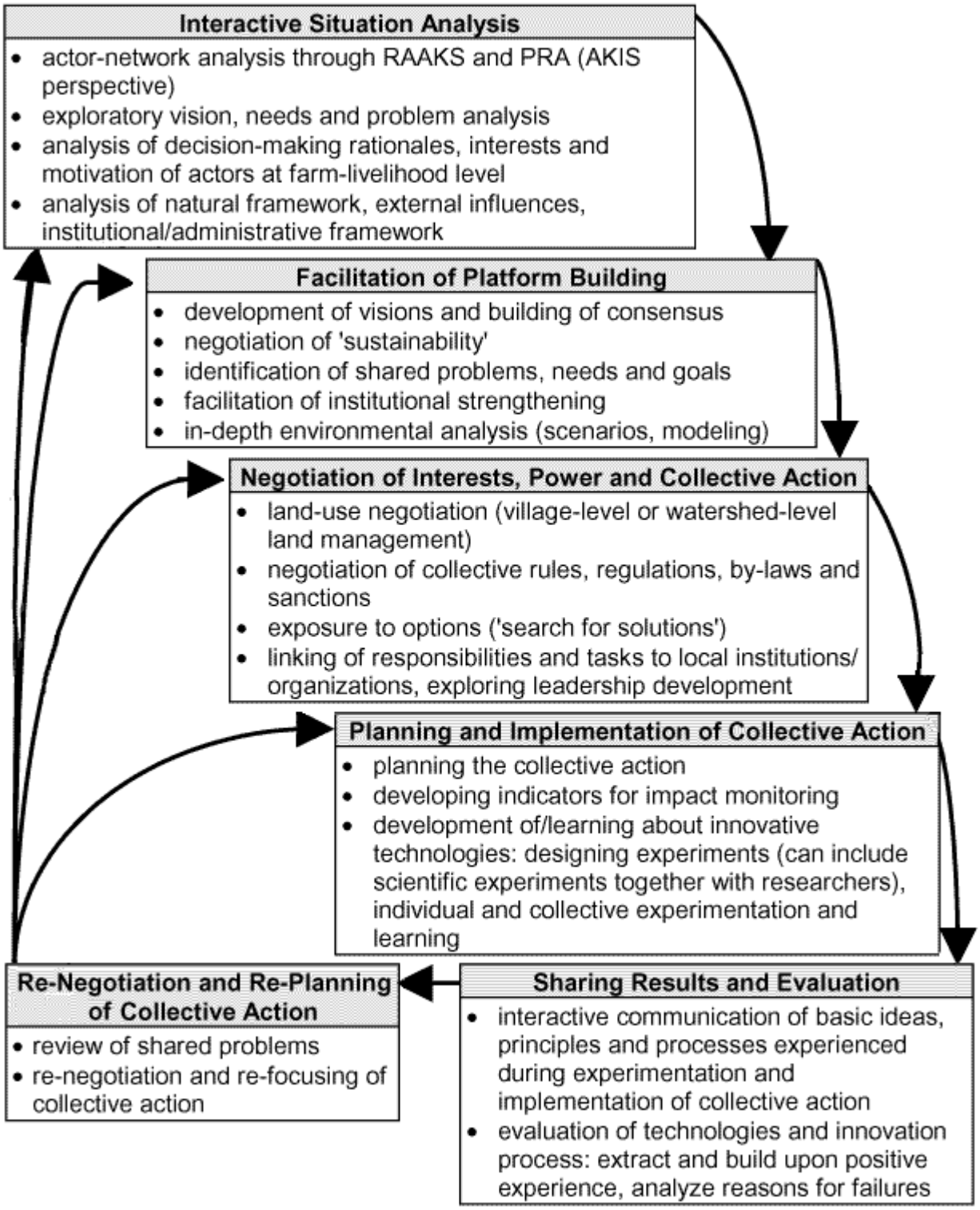
4. To negotiate the management of natural resources and related services, policies, etc., through stakeholder platforms of communities, service providers, and other key players.

This core strategy is implemented through a variety of concepts, methodologies, and supporting strategies. The INRM process is mainly guided by the vision and values to which the intervening and facilitating agents, as well as the communities, agree and subscribe. These core values are:

- full ownership of the process by the community and control over their own resources;
- self-reliance of local communities;
- self-organization, sharing, and cooperation;
- inclusivity of all stakeholders and groups;
- equal partnership among farmers, researchers, and extension agents, who can all learn from each other and contribute their knowledge and skills;
- equitable and sustainable development through negotiation of interests among these groups and by providing space for the poor and marginalized in collective decision making; and
- natural resource conservation as part of the generation contract.

The implementation process follows a sequence of flexible steps that are initially facilitated through outsiders (seeFig. 1; Hagmann 1999:65).

Fig. 1. Sequence of process steps of the INRM R&D process at the community level.



The methodological sequence can be viewed as a cyclical spiral of collective action, reflection, and self-evaluation (Fig. 1). Each cycle brings new learning experiences on which the next cycle can build. Not even the situation analysis is static; it will provide more insights during implementation that might require new actions. This action learning is an iterative process, aimed at full engagement and ownership of the process by local people with their own goals, values, and needs.

Results and impacts of INRM R&D

The INRM process concentrated on local impact, while analyzing and conceptualizing the lessons for scaling up and creating broader strategic research results. Long-term impacts of the participatory innovation development and extension approach in INRM cannot yet be fully quantified because large-scale assessment has not been finalized. However, the impacts up to 1996 have been qualitatively assessed and described (Hagmann et al. 1997, Murwira et al. 2000). We will present some of the key impacts.

Some local impacts (farmers' level)

More than 20 innovations in the field of land husbandry were developed in cooperation with farmers. These ranged from agricultural implements and tillage techniques to soil fertility techniques (a range of different manures, fertilizers, and organic matter management), soil and water conservation technologies (physical, biological, and agronomic measures), crop husbandry (natural pesticides, inter/relay cropping), rangeland improvement, fencing techniques, etc. (Fig. 2).

Fig. 2. Technical innovations developed and tested based on farmers' and researchers' ideas
(Hagmann et al. 1997).

Soil and water conservation techniques:

- tied ridges/furrows
- basin tillage (widely spaced ridges/semi-circular bunds)
- creative vetiver applications
- methods for rill reclamation
- the modified " *fanja-juu*"
- infiltration pits
- stone bunds
- subsurface irrigation for gardens
- inverted bottles for irrigation in gardens
- plastic sheet to prevent rapid drainage (gardens)
- mulching in gardens
- mulching in fields

Other agronomic and biological soil management methods

- innovative planting techniques
- various planting dates (various crops)
- various methods of making compost
- spreading of termitaria as fertilizer
- various manure and fertilizer applications
- green manure with crotalaria species
- planting and use of hedgerows
- a relay cropping system
- various intercropping combinations
- natural pesticides
- raising of indigenous trees
- chicken manure as topdressing

Implements:

- animal-drawn disc ridger
- donkey-drawn toolbar (multiple purpose)
- a knife-ripper tine mounted on the plough beam
- a planting device mounted on the plough beam
- animal drawn weed roller

There was a large-scale spread of a spirit of experimentation: up to 80% of the households in the intervention areas experimented with soil and water management and other NRM technologies, continually improving their effectiveness and management. The most successful technologies were related to soil fertility and water conservation (Fig. 2).

Capacity has increased for adaptive management, self-organization, problem-solving, and collective management of natural resources, e.g., conflicts, by-laws, local organization, and articulation vis-à-vis outsiders, policy makers, and service providers. For example, in one ward of approximately 1000 households, leadership changes induced through a local organizational development process enabled a rise in membership of farmer and other local organizations from 120 to 800 members within two years. Social capital became strong enough to challenge service providers (e.g., turning down extension agents who were not considered useful) and to deal with development and NRM issues confidently by themselves. Through solving leadership problems between modern and traditional institutions, rules and by-laws for common property resources, such as grazing schemes, were set up. Diversification of land use and crops, as well as a more site- specific utilization of spatial variability, have had an impact on the adaptive capacity of the resource-use system. Male-headed and female-headed households were assessed as equally active. Articulation of women in general, from both female- and male-headed households, increased to the extent that women often challenged men openly in discussions.

Some impacts in relation to scaling up of the process of INRM (institutional level)

More than 300 extension agents have developed the facilitation competence for INRM and have facilitated INRM processes in Zimbabwe. So far, quantitative impact assessment beyond the pilot areas is not yet available, but each extension agent is actively practicing this approach. In some areas, they apply it to their whole area (about 1000 farmers); in other areas, selected communities are being facilitated to use this approach. Gradually, a scaling-up to watershed or district level might be reached. Cross-village sharing and cooperation and supra-village organization and representation are growing.

There are increasing requests for training from other actors (NGOs, consulting firms, etc.,). This enhances harmonized approaches and a more homogeneous scaling-up. Institutionalization and active promotion of such approaches in the extension department through organizational development matched the participatory approach. Changes in organizational culture, structure, and procedures developed from this effort enhanced the participatory extension in INRM.

Some strategic research/public good outputs (conceptual levels)

Numerous international publications have been generated from this project(see *Literature Cited* and Hagmann 1999, Murwira et al. 2000). Other outputs include:

- process analysis, approaches, and methodologies for innovation in NRM (e.g., approach for participatory extension, a model for linking research and extension, methodologies for learning process implementation);
- technologies and technological research (e.g., publications on soil and water management);and

- process analysis, approaches, and methodologies for competency development in facilitating action learning (Moyo and Hagmann 2000), design of process for institutionalization of participatory approaches and organizational change in national agricultural research system institutions (Hagmann et al. 1998).

FUNDAMENTAL CONCEPTUAL AND METHODOLOGICAL LESSONS AND SUCCESS FACTORS

The INRM approach developed in Zimbabwe is composed of various concepts and approaches drawn from different scientific disciplines. The synthesis of lessons learned and conclusions about success factors are based on our long-term practical experience. The vast majority of cases in agricultural research focus on linear technology development in NRM. Participatory research and stakeholder involvement are applied to improve the relevance of the work within a linear, positivist paradigm (Scoones and Thompson 1994) in which ownership of the process remains generally with the researchers. Other cases working toward integrated natural resource management (e.g., Murphree 1993, Uphoff 1996, Farrington and Lobo 1997, Ashby et al. 2000) have taken a more holistic perspective. Particular features that distinguish our work from most of these cases can be categorized as:

- process-based action research in which ownership of the process is with the local people/resource users;
- application of "systems thinking" in the sense of "systemic intervention," combined with learning process approaches, which allows exploration of the system from within; and
- systematic application of action learning for "experiential approach and concept development" in INRM interventions, which includes a more strategic perspective on impact assessment.

This paper focuses on the most innovative parts of our INRM work in Zimbabwe and South Africa, which are structured along the key elements of INRM approaches: underlying concepts, dealing with complexity, scaling-up, modeling, and impact issues.

Foundation for INRM interventions: different perspectives, concepts, approaches, and methodologies

In this framework, the key points relate to constructivism, sustainability and adaptive capacity, research vs. innovation, experiential learning, facilitation, and interdisciplinarity.

Constructivist perspective and social learning

There is a need to clearly differentiate between the roles of the resource managers in INRM ("insiders") and the roles of research/extension outsiders in support interventions for INRM. Natural resource management by local resource users is always "integrated" as they deal with resource management from their own complex livelihood perspectives. This does not mean that the integrated perspective leads to sustainable resource use, but based on our experience in Zimbabwe at micro and meso levels, the degree of sustainability in resource use is largely a result of rural people's knowledge, culture, values, norms, and capacity to act and organize themselves. Any managed change depends on conscious decisions of the actors to change their behavior. Decisions, however, are always based on the actors' existing perceptions and construction of reality, not on externally perceived realities. Therefore, if external agents intend to influence peoples' decisions, they are most likely to be successful if they have inputs into people's reality construction process (e.g., through raising awareness and through facilitation of decision-making processes).

This simple, but fundamental, fact calls for a constructivist perspective (Berger and Luckmann 1967, Röling 1996) in INRM R&D interventions, where negotiation of perspectives and interests is central. In practice, this implies that outsiders can be most effective if they have a truly facilitative role in a social learning process among the actors and stakeholders. The goal of social learning in collective action should be the creation of an environment in which the multiple, complex objectives of individuals are articulated and recognized, and where freedom for diversity and situation-specific solutions is inherent. Collective accountability for natural resources is built through generating a common vision. Experiences from

Zimbabwe highlight environmental learning and analysis that builds from stakeholders' values, together with the creation of new social norms, generating common vision and values. Existing local institutions and organizations should ideally be the basis for building this process.

Successful interventions in INRM thus need to be facilitative, based on a constructivist epistemology (see Douthwaite et al. 2001) and soft-systems methodologies (Checkland and Scholes 1990). There are two different schools of systemics, which are often termed "hard" and "soft" (Bawden 1995:8). Hard-systems approaches attempt to understand entire systems, e.g., cropping enterprises, whole farms, groups of farms, or even communities, by looking at them from the outside, assuming that the system variables under study are measurable, that the relationships between cause and effect are consistent, and that they may be discovered by empirical, analytical, and experimental methods. Soft-systems thinkers look at "human activity systems" arguing that systems are creations of the mind or theoretical constructs to understand and make sense of the world. Hence, soft-systems methods aim to generate knowledge about processes within systems by stimulating self-reflection, discourse, and learning (Hamilton 1995:35-36).

This does not mean that positivist, hard approaches have no place and are being replaced. Both hard and soft research methods are needed: soft participatory action research on processes of NRM (e.g., organization, collective management, competence development, conflict management) and conventional hard research on technological and social issues (e.g., soil conservation, agronomic practices, socioeconomic studies). The use of hard approaches within a constructivist framework differs substantially from conventional approaches.

Sustainability and adaptive capacity

Experience within complex, dynamic livelihood systems in Zimbabwe and South Africa led us to conclude that the only thing that is sustainable is change itself. Sustainability in development and in NRM is a continual value-dependent, political and social negotiation process that cannot be determined by outsiders for the insiders. Sustainable NRM, and even development in general, can be seen as a social learning process in which the goal is to increase human capacity to solve problems and adapt to changing conditions: "adaptive capacity" (Holling et al. 1998, de Boef 2000). In this framework, sustainable NRM is decided less by technical expertise than by learning and negotiation among stakeholders. Collective, active adaptive capacity is the key determinant for sustainability.

From linear research to innovation as a complex social process

Recognition of innovation as a socio-technical and collective process (Latour 1993, Richards and Diemer 1996, Kuby 1999) was central to the intervention. The spread of innovations and impact failed when working with individual farmers, be it with collectively managed resources, individual plots, or innovations. Societal norms in the communities meant that "natural-born" innovators were often avoided and victimized (out ofjealousy) rather than imitated. Thus, the social environment needs to be highly conducive if innovations (social and technical) are to spread, be it in NRM or any other part of the livelihood system. Thus, the NRM learning process was never separated from the complex livelihood context. This implies that the external intervention facilitated platforms for negotiation and participatory action learning at the community level and enhanced the communities' exposure to ideas and technologies. Farmer experimentation and sharing among community members enabled rural people to increase awareness of their reality construction, negotiate changes, and come to a commonly shared perception.

The linearity of research–extension–farmer as the conventional pathway for innovation and impact proved rather ineffective in Zimbabwe, even if improved through feedback loops from farmers to researchers through on-farm trials. Innovation was much more than research, involving a whole system that is creative, multi-actor, motivating, and inspirational. Research, extension, and farmers are just three actors in a nonlinear, dynamic system. The direct cause and effect of a certain activity is almost impossible to assess. This has important consequences for INRM research. In contrast to the linear model, research can no longer stay "outside" and investigate objective, transparent, and predictable elements of a system. Again, researchers need to understand themselves as part of an actor system contributing to innovation processes that are not controllable and predictable. The roles of different types of research (e.g., basic, applied, adaptive) can no longer be separated clearly because they are all part of a simultaneous

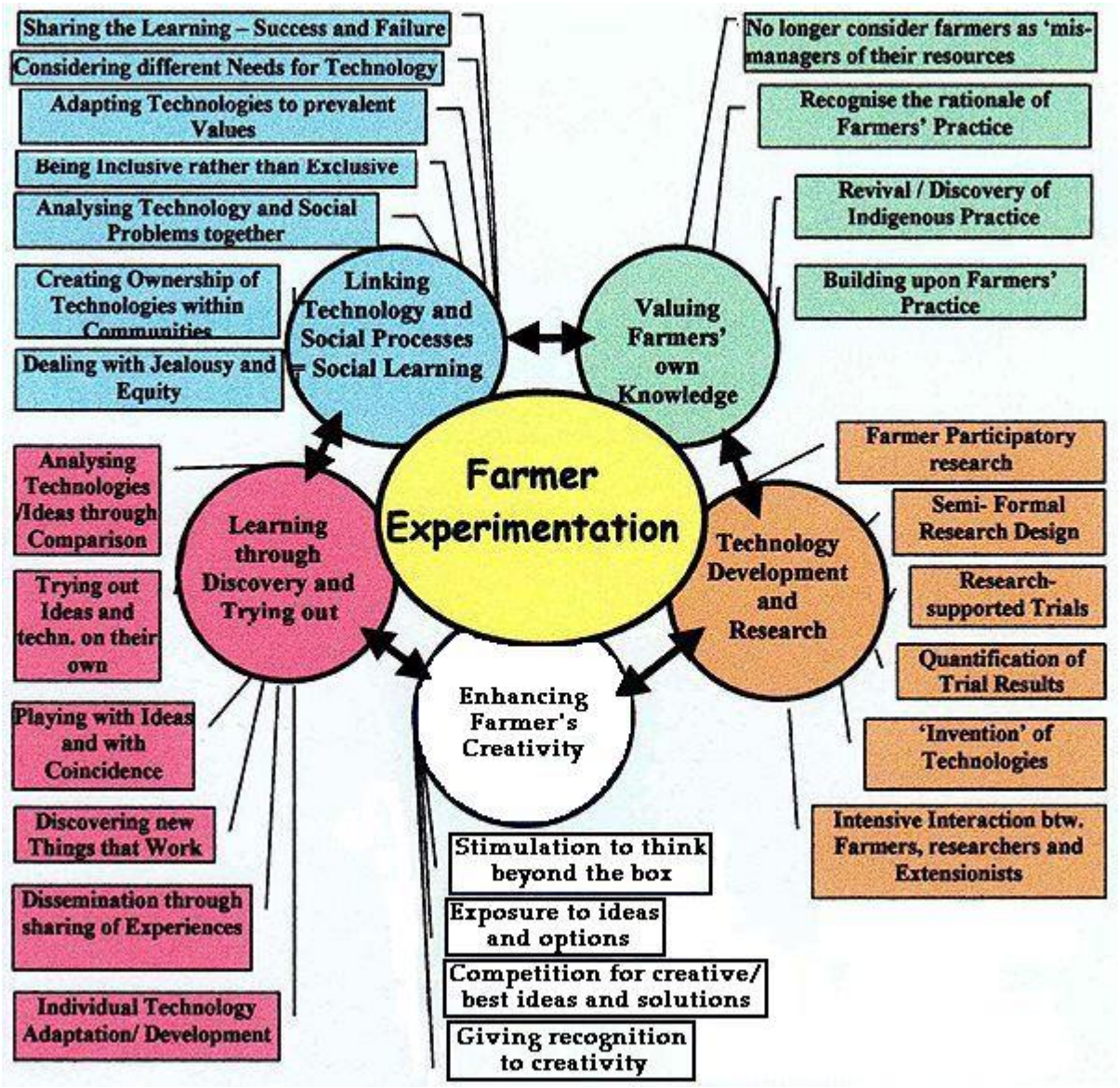
innovation process. Implications of this perspective are further described in the section on*Understanding complexity.*

In terms of intervention methodology, making INRM operational requires a "learning paradigm" (Röling and de Jong 1998) with a flexible combination of concepts and methodologies. Participatory action research (PAR; Lewin 1946, Selener 1997), experiential learning (Kolb 1984), systems thinking (Checkland 1985), chaos theory, and self-organization (Wheatley 1999) are implemented through facilitation of process interventions at all levels, and are guided by a clear vision and strategy to form the foundation for approaches geared toward collective action and human, as well as social, capital-building. Most important in designing and implementing such approaches are pragmatism, empathy, and common sense). It would be reductionist to consider any single concept, approach, or methodology (e.g., PAR) as the panacea methodology.

Experiential learning: from adoption to adaptation through farmer experimentation

Experiential and discovery learning (Kolb 1984, Hamilton 1995) played a key role in enhancing farmers' creativity and capacity to innovate in INRM. Farmer experimentation (Fig. 3) has been central to the operation of experiential learning processes. Often, it is simply seen as a tool in participatory research. However, we discovered several important side effects beyond the "tool" aspect, which were less visible, but played a central role in building the adaptive capacity of farmers. These include farmer experimentation as:

Fig. 3. Important components of farmer experimentation (Hagmann and Chuma 2001).



- A methodology for discovery and experiential learning. It creates curiosity and a spirit of trying and discovering.
- A way to value farmers' own knowledge. Farmer experimentation improves the understanding of biophysical processes by farmers (land literacy) and reveals the interrelationship between farmers' knowledge and scientific knowledge. This contributes to a better mutual understanding and raises the status of farmers' knowledge, in turn raising confidence in their own solutions.
- A way to enhance farmers' creativity. Curiosity and confidence encourage and trigger creativity in finding solutions. People develop their own solutions rather than waiting for answers from outside.
- A methodology that links technical and social processes and generates social learning. A collective experimentation process automatically raises technical and social issues. Any technology will be adapted to social conditions if farmers are trying them out and sharing their experiences with others.
- A methodology for research and technology development. It helps researchers and farmers to work effectively together and develop technologies. In this way, research has a major role to play.

Experience in training and scaling up shows that, in most cases, farmer experimentation is understood simply as a tool for research and technology development; its other strengths are overlooked. To demonstrate its wider value to people with no experience of this way of working, exposure visits to experimenting farmers proved very effective. These allowed people to see that, in terms of land literacy and NRM in general, farmer experimentation is the core methodology for enhancing their understanding of the resource system and for generating creative solutions to the challenges faced: in other words, their adaptive capacity. Putting farmer experimentation into action required a number of practical methods and tools to enhance farmers' understanding of their ecosystem. A range of different, easy-to-apply "learning tools" (simulation models) were developed to support the process.

Facilitation of participatory learning and action research

In Zimbabwe and South Africa, across a number of sites with different facilitators, process facilitation, as a non-instrumental form of intervention (Röling 1996), proved to be the foundation of the learning process in INRM. The quality of facilitation was more important than any particular tool or learning aid, and this skill proved to be more difficult for development agents and local people to learn than any other skill needed for implementing the learning process. The core of reflective facilitation (Groot and Marleveld 2000) is about asking the "right" questions at the "right" time in order to enhance people's self-reflection and self-discovery without pre-empting the responses or pushing in a preconceived direction. These questions should mirror to people the consequences of their present perceptions and behavior, and possible solutions in the long run, thus leading to a deep self-reflection and ownership of the problems that they express.

The values of ownership, participation/emancipation, and social learning were crucial in facilitating the construction of new realities. Local ownership was created by basing the interventions on local organizations that took full ownership and responsibility. Intervention was geared toward strengthening those organizations through enhancing accountability, improving leadership, and facilitating critical self-awareness and self-discovery of inherent local (human) values.

Values probably had the greatest influence in farmer decisions in INRM. Through skilled facilitation, these core values, such as social harmony, collectivity, inclusivity, and environmental values, surfaced and could be debated in relation to farmers' present situation and behavior. These facilitated debates often triggered deep self-reflection. Over a number of iterations, they brought about some new social norms, often expressed through slogans and songs (e.g., "nobody knows nothing, nobody knows everything").

The main difficulty is steering the facilitation process. Some supportive skills and conditions can be outlined as:

1. A clear vision and the values of the process goal. This vision needs to be built upon values such as development through participation, ownership, inclusiveness, people's self-development, openness, transparency, and accountability. With this vision, the facilitator can handle situations flexibly and can pose the right questions to enhance learning. The facilitator needs to lead the process, but not its outcome. Often, this can be enhanced through exposure to successful cases, which provide real, concrete examples of such a vision.

2. Empathy and the culture of inquiry. The facilitator must be able to empathize with group members in order to react appropriately. Empathy goes beyond knowledge about group dynamics; it is a skill that depends on personality and emotional intelligence (Goleman 1988). Another skill is the "culture of inquiry," the ability to question fundamental as well as apparently simple things and get down to details. Real problems often lie in the details, which need to be disclosed before a solution can be developed. People's mental models often need to be made apparent and deconstructed through their own reflection to generate new ways of thinking and acting.

3. A clear understanding of the process design and steps. Unless the design is clear, facilitators face problems guiding the process. Beginners to process facilitation need an "operational framework" as a handrail to guide them. Such a framework defines the objectives, key questions, issues, core methodologies, and partners for each process step. Only after thorough training and experience in these steps can facilitators understand and implement them confidently and modify them according to their own experience, empathy, and common sense. Understanding the process with its usual ups and downs also

helps to reduce the frustrations often experienced when things do not go in the desired direction. Having gone through a whole process cycle, facilitators know that these frustrations are part of any nonlinear learning process and can handle these situations by putting them in context.

Facilitating learning in INRM also requires knowledge about ecological principles and practices, where specific learning tools play a crucial role (Hamilton 1998, Loevinsohn et al. 2000, Hagmann and Chuma 2002).

Interdisciplinarity: a strategy toward integrating the disciplines

INRM, by its complex nature, is highly interdisciplinary. Accordingly, external research and extension interventions can contribute most effectively if they are also interdisciplinary. As experienced in Zimbabwe and South Africa, this poses a great challenge to linear, discipline-based support organizations and to individual scientists. Often, problems are compartmentalized and dealt with through a multidisciplinary team. Each member, with individual disciplines, works on one compartment, but because the different compartments are difficult to integrate, no higher level synthesis and synergy emerge. Based on our experiences, we drew several lessons. A truly interdisciplinary approach in INRM research requires a coherent strategy departing from the desired development impact of the intervention and the users to be addressed. Different research questions can be formulated based on this strategy, which provides a clear framework. It needs to be developed from the top or the whole, along the following questions:

- What do you want to achieve in INRM?
- If your INRM research is to be successful, who (e.g., farmers, farmer organizations, researchers, extensionists, policy makers, NGOs) would do what differently? Behavioral changes can be used as impact/performance criteria.
- What is required to support behavioral change?
- What are the products and the outputs of INRM research to enhance these factors?
- What is the role of other actors?
- What are the INRM research questions leading to these outputs?
- How can these INRM research questions be best dealt with (approaches and methodologies)?
- With whom and how does INRM research have to collaborate to be effective?

It is almost impossible to build such a strategy from single, disciplinary issues, or from problems that arise at the local level. In other words, one requires a solid framework, providing orientation and direction first. This impact-oriented thinking model provides the basis for integrating and determining priority issues. It also provides the space to experiment with innovative approaches without losing focus. The next step, once the strategy is clear and "owned" by research teams, is to build small interdisciplinary teams with a very good understanding of each other's disciplines and thought models. Building joint conceptual frameworks often occurs only after a team has "grown together" in joint work for at least six months. Core teams need to manage and steer the disciplinary scientists to make their contributions and create the feedback loops. Not everybody needs to be fully interdisciplinary.

Building interdisciplinary teams has two central elements: teamwork (which depends on personality factors, but can be enhanced through team building focused on behavioral issues) and the interdisciplinary science base (which needs to be learned and negotiated between the disciplines). The capacity to practice interdisciplinary research in INRM needs to be built up experientially. It is not a matter of qualifications in disciplines, but of expertise in practice. Scientists need to become reflective, analytical practitioners who are good at conceptualization. These components form a foundation for INRM interventions. Other components, equally necessary to make INRM interventions successful, e.g., systems thinking, will be discussed in the following section.

Understanding complexity: from systems analysis to exploring systems from within

Understanding complexity in action-oriented INRM means dealing with complexity. Trying to understand the livelihood system by becoming an actor (acting within the system instead of analyzing from outside) was the key factor in identifying the most effective intervention points and pathways to maximize impact.

It was important to start exploring these systems from the perspective of farmers' INRM, rather than from the top. Through this, a policy dialogue emanated and farmers' reality was recognized as a fact, rather than outsiders making assumptions about their reality (e.g., when policy makers were confronted by farmers about the implications of certain conservation laws). System boundaries had to be widened beyond the livelihood system to include the whole innovation system, with institutional support in INRM.

As a conceptual base for the iterative learning cycles, systems thinking, chaos theory, and self-organization provide useful elements for a framework. Although the behavior of social systems cannot be accurately predicted through external analysis, their reaction to changes, e.g., through intervention, is most revealing. Kurt Lewin (1946) described this: "If you want to know how things really work, just try to change them." Thus, external, "clinical" systems analysis and static intervention design, as practiced in farming systems research and in many research and development projects, have failed to address the real issues that make things work or fail (Bawden 1995). The Zimbabwe case fully confirms this, with unexpected revelations about social dynamics after five years of intervention when hidden conflicts between modern and traditional authorities surfaced and finally could be dealt with.

A rather similar mechanism also applies to complex ecosystems with slow-acting variables and rapid effects, which are very difficult to predict even if based on long-term observation. Because such systems can only be analyzed at the point 0 + *X* time, it is impossible to assess their dynamic complexity with a clear reference point. Analysis is always based on moving reference points and targets, a major problem for both systems analysis and impact assessment. It implies that we should give up the notion that we can ever analyze, understand, and control all the factors in complex, nonlinear systems like livelihoods and ecosystems from outside. Through interaction with the system in action research interventions and by analyzing and interpreting the system's reaction to changes, we are able to better understand characteristics of the whole system. Such research contrasts with the reductionist realist–positivist paradigm. Instead of analyzing as many separate components of a system as possible and how they interact, the action research intervention would induce change in certain components of the system. The reactions will reveal the interactions between the parts and which other parts of the system must be understood in depth and dealt with at the given time and situation. Process approaches are required in this exploration analysis, which aims to define an open-ended, flexible intervention strategy. Wheatley (1999) describes this insight from a historical perspective:

Johann von Goethe applied his genius to the problem of seeing the wholeness of nature. He was intrigued to understand any phenomenon not as an isolated event, but as a consequence of its relationship to other phenomena. In traditional science, the scientist invents the questions and then interrogates the object of study. But Goethe describes how we can move from interrogation to receptivity, being open to what is occurring, allowing ourselves to be influenced by a whole that we cannot see. We can dwell with the phenomenon and feel how it makes itself known to us.

In practice, this implies a focus on parts of the system and their interaction in order to study the dynamics of the whole system. The part is not the whole, but can lead to it. Bawden (1995) comes to similar conclusions in relation to "holism" and "reductionism." In essence, the interplay of systemic thinking and process approaches allows the methodological exploration of dynamic and complex systems. Exploration through action research requires the ability to facilitate and to understand that there are many other parts, problems, and issues that one does not know, but that play an important role. The drivers in systems exploration in Zimbabwe were the desired impact (which provided direction), together with farmers' problem perceptions of the system, with its unfolding, dynamic complexity. This approach required considerable flexibility in planning; activities had to be adapted after each cycle of learning and exploration when new, higher priority problems revealed themselves.

Central to systems exploration were learning process approaches and participatory action research (PAR) at the levels of both farmers and interventionists. Process approaches enabled exploration of the systems and optimization of outsider intervention. At the farmer level, they triggered a continual, iterative improvement of natural resource management. Cyclical self-reflection and self-evaluation through PAR created ownership and increased the local people's capacity to innovate.

In setting priorities for INRM interventions, "systemic intervention" was the main principle. The decision about which system components to research was based on the smallest possible intervention with the greatest possible effect. This is the main principle of systemic intervention (Königswieser and Exner

1998). If regularly monitored, it allows for dynamic adaptation of the intervention strategy, informed by iterative learning and insights gained through systems exploration.

Integration of diverse elements in INRM: not losing focus

Considering the complexity of INRM and livelihood systems, the main challenge is not to get lost in hundreds of research questions at the expense of impact. Keeping it all together with integration through the strategic focus on impact was central to the INRM research process in Zimbabwe. Design and management of the intervention process were the main drivers for integrating research. Based on the principle of systemic intervention, events and problems were dealt with as they occurred within farmers' reality, rather than being anticipated and prescribed. As a result, the technological focus and research broadened. To maintain focus and manage priority problems and issues, a strong strategic orientation at the outset guided the choice of priority research topics and the integration of different components. This "guiding star" was provided by the interventionists' vision and by the farmers' own goals. Review of successes and failures then determined the continual adaptation of the intervention design. Often, ongoing issues needed less attention, were outsourced through networks to other actors, or had to be neglected due to limited capacities and resources within the community. Strategic partnerships and networking were highly important.

In South Africa, the strategic orientation was complemented with sound conceptual and operational frameworks. Guiding principles for process facilitation and management were all developed and conceptualized from the Zimbabwean experience. These elements were essential tools in building the competency of facilitators. In particular, the guiding star, the value base, and guiding principles enabled facilitators to respond flexibly, as they were reference points to fall back on in case of insecurity.

Integration of NRM also touched other dimensions. Integrating hard and soft issues in research and extension was very important in effective support of farmers. In Zimbabwe, two different types of research were carried out and integrated through the process:

1. *Research on the process of INRM* (mainly soft, interdisciplinary, participatory action research, e.g., on local organizational development, communication interfaces, innovation, and knowledge development, and on institutional change and competence development). This action research, grounded in farmers' reality, integrated local and scientific knowledge. Farmer experimentation helped greatly to match internal and external ideas and knowledge. Research on process was actively supported by:

2. *Process-supporting research* on technological and social issues and problems (mainly more conventional hard research, e.g., on soils, land use, soil and water management technologies, and state of degradation, and also socioeconomic studies).

Both types of research were required to achieve impact at different levels. Hard studies were often used to demonstrate the need for soft approaches such as building capacity for adaptive management or for deepening the basis and outcomes of farmer experimentation and assessment The broader framework of soft action research allowed evaluation of hard research outputs. Questions for hard research emerged from the action research process; results were directly fed back to help stakeholders make informed decisions. Hard issues automatically come in as soon as technical innovations become central. The interdisciplinary research team and research managers play key roles in integration; they need to prioritize which trait to follow and how to bring the loose ends back together.

Scaling up the process through facilitating service providers: challenge of organizational change

Scaling up the INRM process in Zimbabwe was conducted through service provider agents and networking. It has been assumed that scaling up would build the adaptive capacity of people and develop technologies and models for INRM. This, in turn, would increase the adaptive capacity of the whole natural resource use system. This assumption was confirmed by successes in technology innovation and social organization. Scaling up has developed along social and political dimensions in Zimbabwe, from village to ward to district to province. The external facilitator was critical in triggering these learning processes, starting from the community level. The agricultural extension service, the main government institutional actor, seemed to be the most pragmatic solution for scaling up through service provider organizations,

which had been operational in all wards of the country. In terms of logical institutional arrangements, a farmer-based organization would have been more appropriate, but no effective group could be identified. Within the extension service, a vertical scaling up from ward-level extension agent to district to province to national levels seemed necessary. This strategy for scaling up in the extension service consists of four main steps, overlapping or in parallel (see Hagmann et al. 1998):

1. Development and implementation of case studies (pilot activities) of communities where participatory INRM approaches are practiced as learning cases for approach development and as show cases (from 1991).
2. Raising awareness for change and familiarization with alternatives through exposure of extension staff to the case studies (field visits and presentations in workshops, networking, and initial training activities; 1993 to 1995).
3. Initiation of institutional learning about implementing participatory extension through development of field-level capacities within extension (from 1994). This was to address a shift in attitudes, concept, and skills.
4. Organizational development and change management to transform the organizational culture, structure, and governance to match the new approaches.

A clear strategy for scaling up from the start of implementing case studies has proven to be the ultimate success factor in Zimbabwe and South Africa. It provided guidance for the direction of the case study and the research, for interaction with different levels of institution, and for approach development. The lesson through the drought in 1992, which suddenly shattered rigid thinking about interventions, is that situations that appear static and unchangeable can move unexpectedly. Steadiness and perseverance are useful in piloting innovative approaches.

The core element in scaling up through service providers was competency development. Enhancing adaptive capacity at the resource manager level requires support institutions with adaptive capacity to react flexibly to the needs and requirements of the process. The same principles apply to both institutions and farmers (Cooke 1997, de Boef 2000; B. Cooke, *unpublished manuscript*). Competency development in learning processes at the delivery level (field extension and research agents) has been demanding. People have to engage themselves in process-oriented research. Cognitive understanding and external analysis alone proved insufficient to build competence. The process must be experienced and understood emotionally and is critically linked to emotional intelligence (Goleman 1998). Without this experience, the learners were never able to understand what social learning processes mean in practice, and how to facilitate them. Our experiences in competence development demonstrated that training and coaching staff on the job over 1–2 years (several learning workshops and follow-up coaching) effectively address knowledge, attitudes, and skills (Moyo and Hagmann 2000).

At organizational and management levels among service providers (in our case, extension organizations), genuine institutionalization of participatory approaches engages them fully in their own process of change. Planning procedures, priority setting, hierarchy, management styles, linearity, and discipline are some of the components that must be adapted through management change focusing on learning organizations (Senge 1990). Thus, scaling-up processes through support institutions are more than dissemination of approaches (Lovell et al. 2002).

Scaling out: from farmer to farmer

An active scaling-out process was facilitated through farmer learning tours and exchange visits across communities, wards, districts, provinces, and countries (e.g., Zimbabwe–South Africa) and between farmers and other sources of innovations (e.g., research stations, specific farmer innovators). These exchanges of knowledge and experiences have been highly effective when integrated with a larger, community-based innovation process. The choice of community representatives and the designing of their terms of reference by the community (e.g., reporting back) were central to triggering large-scale INRM activities. This decentralized, non-monopolist and non-hierarchical approach to rural knowledge management was very effective. It was backed up by production of farmer reference materials on technological options, which summarized farmers' own experiences with technologies. One major future thrust would be the development of farmer networks for sharing information and experience. Rural resource centers, farmer libraries, and, in the long run, Internet use will play important roles. However, it

is easier to replicate and adapt technologies than emancipatory processes supporting the adaptive capacity. For such processes, service providers are needed as facilitators, at least initially.

Modeling: Building bridges to communicate lessons learned

Modeling for the purposes of this research refers to the conceptualization of intervention processes and the simplification of biophysical processes through learning tools. Both types of model were tools to communicate and support the action-learning process at different levels. Conceptual models were developed and visualized to explain the major steps in INRM research and extension. Operational models made the implementation of INRM more transparent to research and extension agents. Without these models, it would have been extremely difficult to communicate the characteristics of INRM intervention processes for competency development. Thus we were "using new images and ideas as a means of creating shared understandings that will allow us to do new things in new ways" (Morgan 1997).

At the farmer level, a simple range of models as learning tools was developed, e.g., a simple rainfall simulator with farmers analyzing the effects of different soil management technologies on soil and water conservation (Hagmann and Chuma 2002). These models were highly effective in making biophysical processes visible and letting farmers discover for themselves and debate the implications and the systems interaction in their much more complex real world (e.g., fields, watershed). The understanding of complex ecological principles that farmers gained through this insight greatly motivated them to experiment and thus increase their adaptive management capacity. However, the models need to be simple and readily available at user level as a tool to support discovery and negotiation, rather than to predict detailed conditions or behavior of complex systems in the future.

Impact assessment: monitoring and improving strategy

The internalized impact orientation (guiding star) steered the Zimbabwe case to develop an initially implicit, later explicit, strategy on how to achieve broad impact. The strategy and approaches, methods, and activities were adapted regularly in response to the outcomes, both intended and unintended. Impact monitoring and assessment were internalized processes to learn, reflect, and then readjust to improve the performance of all actors involved. The focus was on learning; thus monitoring and self-evaluation were integral parts of the action research loop at different levels. The guiding question in designing impact monitoring was: "who wants to learn what and at what level?" For example, farmers may monitor their plans, activities and experiments, and any social implications; researchers/facilitators monitor the effectiveness of their interventions in enhancing these processes among farmers). For each of the superimposed learning loops of different actors and learning objectives, a clear set of performance criteria can be defined during the planning stage.

The impact monitoring and assessment consisted of three elements: process monitoring, outcome monitoring, and documentation of the process and outcome. This was carried out in the field mid-season and when farmers and researchers together evaluated activities and technologies in the field through annual reviews, self-evaluation in communities, and in the teams. This self-evaluation led to readjustments of the strategy and replanning of activities.

Process documentation ("writing the journal") was central for self learning; to demonstrate the quality of process implementation and impacts and/or outcomes; and to ensure that the rationale for adaptating the planning framework was transparent and understood by headquarters and evaluators. Without sound process documentation and analysis, external evaluators might have found it easy to criticize the "non-fulfillment of the logframe commitments," and eventually derail the direction of the program. The documentation also built confidence within branches of the partner organizations toward increasing autonomy in adapting the planning framework.

Lessons and insights from monitoring and evaluating the program in Zimbabwe and South Africa can be summarized as:

1. The need for a genuine impact orientation at the start of the project cycle, a strategy for impact being a first step. Often research projects that do not even have a clear impact strategy are evaluated on the basis of an impact they never set out to achieve, which in itself is not consistent. It often appears that

far too much time and energy are invested in impact assessment instead of developing and improving the strategy for making a real difference.

2. The need for monitoring and adaptation of the "plausible impact strategy" and the process. To reduce complexity of attribution of effects, Kuby (1999) constructs an "attribution gap" in impact assessment in R&D. Because innovation is a social process with many actors, it is practically impossible to assess effects of certain activities beyond a given level; too many factors beyond the control of a program dilute the attribution. Therefore, programs can be held responsible for their planned outputs and outcomes, but not for broad impact. To bridge the "attribution gap," Kuby pleads for a "plausibility bridge." In our experience, this plausibility bridge is the strategy developed in the interdisciplinary sequence that we have described and the process designed to get there, both of which need to be regularly monitored and readjusted to remain plausible.

This does not mean that R&D interventions would be released of their responsibility. They would have a much greater responsibility for their local process outcomes, strategy, and contribution to bringing other actors together. Intervention performance would be measured through quality criteria related to process implementation and strategic orientation/adaptation, in contrast to the present impact indicators. If the impact is difficult to attribute in more open-ended processes, more focus needs to be placed on quality process inputs. Quality criteria and standards for process implementation, as well as competency development, will have to be developed.

A true learning system in interventions would aim to become self-referenced. In other words, the capacity to learn, reflect, and readapt the strategy and action is the process to be achieved. Once self-referenced, the system will be able to reflect self-critically concerning the meaning of its actions, and will be less likely to make serious mistakes. External evaluation is still required and useful, but learning systems perpetuate their own performance improvement. These are the basic characteristics of adaptive management.

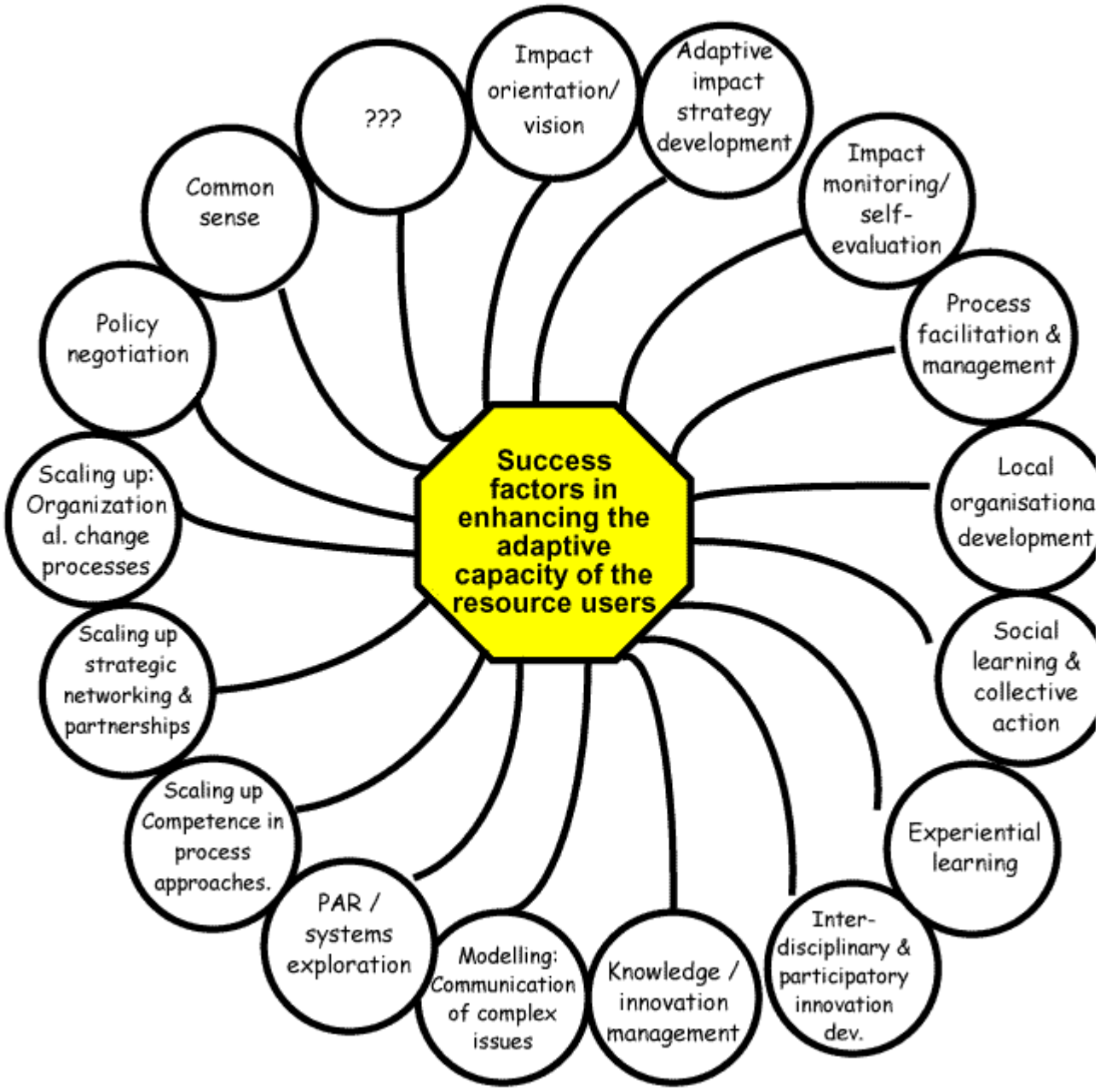
Performance indicators of such systems with high adaptive capacity need to broaden beyond technology to other dimensions such as enthusiasm, empathy, confidence, self-esteem, understanding, creativity, values, and the social energy (Soedjatmoko 1986) displayed by farmers when articulating and demonstrating the solutions they found to their problems. In Zimbabwe, these were indicators for an increased adaptive management capacity that were recognized and accepted easily by evaluators during visits because they reflect human- and value-based criteria. However, it was difficult to make them objectively verifiable and quantifiable, which might not be the appropriate approach to assess constructivist learning processes. Ultimately it is the management aspect in INRM (human dimension) that makes the wheels turn. INRM science needs to take this more into account.

There are still many open questions in this framework of assessing performance and quality of research. Core criteria would be quality of strategy, process implementation, and the research process, rather than the impact (e.g., attitude to scaling-up, a plausible strategy, an impact orientation, guiding principles, effectiveness of coordination and the convening role, clarity of the value system). All these performance criteria are derived from the process and learning paradigm in INRM and replace the conventional understanding of "impact." In brief, INRM might imply a shift in emphasis from impact assessment to performance, quality, and strategy monitoring and assessment.

Synthesis: a conceptual framework for INRM

The lessons and success factors described in this paper, together with other factors that were not treated in detail (e.g., policy negotiation, knowledge/innovation management), form a foundation for an emerging framework for designing INRM interventions. The framework, in the form of a "wheel" (Fig. 4), combines and links the critical conceptual and methodological success factors in a systemic way. This implies that none of the elements can be dealt with in isolation, but different elements might be relevant in different stages of the process. The implementation process design and management will define which element will be required, when, and how in developing the adaptive capacity of the main actors. One example of the design is Fig. 1, but different sequences might be developed for different contexts. This flexible framework is based on the understanding of innovation as a social process, applying the constructivist perspective as discussed. It operates on the principles of systems thinking in rural livelihoods and through participatory learning approaches.

Fig. 4. The main elements/success factors in INRM R&D interventions.



The core value of INRM interventions is local ownership where participation is understood as emancipation of rural resource users. Intervention aims to be inclusive, accountable, transparent, and to enhance openness from all actors to social learning and collective action.

CONCLUSIONS: FUTURE CHALLENGES

The INRM focus on enhancing the adaptive capacity of the resource user system changes the role not only of research, but also of the whole innovation system, including extension, rural knowledge management, and service delivery. Conventional divisions of linear institutional mandates do not appear effective to

address complex and diverse needs of INRM and other spheres of development. Within this broader framework, the roles of international vs. national research in INRM, research in general vs. extension and other development agencies, and other key players (e.g., private sector, farmer organizations) need to be revisited to build an effective, synergistic institutional arrangement for innovation and service delivery. If individual actors are linked in a broader network where interfaces between actors are well defined, their individual effectiveness can improve substantially. Our South African experience showed that platforms of service providers and stakeholders on which a joint vision, roles, relationships, and approaches are worked out, can contribute greatly to the development of functional innovation systems. R&D programs can work toward this in a persistent way and can achieve results step by step. Researchers can take a convening role, accompanying the process by action research to develop workable modalities and methodologies.

A core issue in INRM is the facilitation role, which is demanding and requires a high level of competency. It is unrealistic to think that every researcher can become a good facilitator. The individual who plays this role will need to be negotiated and agreed upon. Development agents who facilitate action learning processes at local levels and researchers who carry out studies on these processes must be fully engaged. Such situations leave the development agents as "guinea pigs" in an insecure position. Unless researchers engage themselves emotionally in participatory action research, they limit their ability to understand the dimension, and thus their ability to contribute effectively.

The implications for the structure and governance of international and national research organizations are also challenging. Moving from discipline-based "silos" to interdisciplinary teams, with sound competencies for process-oriented action and systems research is one challenge. Another task is to match flexible client needs with centralist, top-down planning procedures and their hierarchical and control-oriented management styles and organizational cultures. Without substantial organizational development over several years, involving structural and cultural/behavioral approaches and the development of strategic leadership (van Maurik 1999), these changes are not likely to come about fast enough. Ultimately, this might become a question of survival for many R&D organizations.

None of these challenges threatens preconditions for the operation of INRM R&D. Both INRM and the new institutional arrangements for innovation and service systems are conceptually and in practice still evolving through early stages. Considerable experiential learning is required to develop workable arrangements and approaches. If many R&D organizations would actively engage in this process, even through small steps, joint learning could promote rapid change. Better indicators, performance criteria, and standards for "adaptive capacity" and "process implementation" will help to move the approach forward for implementers and planners. Ultimately, the focus on competency in process approaches will make INRM interventions successful.

RESPONSES TO THIS ARTICLE

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