Chapter 11

Four Obstacles to Taking Integrated Soil Fertility Management Research to Higher Scales

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Introduction

Much of the literature on issues of scale in natural resource management (NRM) addresses the nature of the relationships between information and data collected at different scales (Lovell et al., 2001). For example, both theoretical and methodological problems are inherent in extrapolating data from plot to landscape scale because of the increasing number of interactions between plots nested within wider spatial areas. Factors that must be treated as externalities at a lower scale become internalized by the system at higher scales, and the actions of decision makers become increasingly interconnected (Röling, 2002). There are also "emergent properties" of systems, such as resilience, that only become apparent or important above certain scale thresholds (van Noordwijk, 2000).

Beyond the purely theoretical or methodological issues of dealing with multiple scales, natural resource managers are often concerned with two other aspects of scale. The first is ensuring that technologies and innovations developed at a local scale can be scaled out (or reproduced at comparable sites). The second is ensuring that lessons learned at the farm or household level can be scaled up to inform policy and land-use decisions made at the landscape, national, or international levels.

Until recently[1], less explicit attention has been paid to these latter two aspects of scaling up and out, partly because they appear to be more managerial and not immediately obvious as topics of theoretical or researchable interest. Land-use management and geographic information

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1. For example, two workshops held in 2000: "Going to scale" workshop hosted by the International Institute for Rural Reconstruction (IIRR) and the UK Department for International Development (DFID), and the Consultative Group on International Agricultural Research (CGIAR) workshop "Integrated natural resource management in the CGIAR: Approaches and lessons".

systems (GIS) offer ways of characterizing landscapes and communities for the purposes of identifying comparable niches or opportunities for interventions based on local successes, but the processes and challenges of scaling knowledge out and up have largely been neglected.

This chapter takes integrated soil fertility management (ISFM) as an example of a knowledge-intensive system of technologies and innovations for managing natural resources. While researchers, farmers, and policymakers alike may express an interest in taking ISFM to "higher scales", the processes for achieving this scaling out or up are neither straightforward nor uncomplicated. It is argued here, using examples from the African experience of the Tropical Soils Biology and Fertility Program (TSBF) of the International Center for Tropical Agriculture (CIAT, the Spanish acronym), that taking ISFM to higher scales must contend with at least four potential obstacles. First, because ISFM addresses ecosystem properties and involves multiple stakeholders, transferring knowledge between scales must contend with and resolve the many potential clashes of expectations. Second, problems are inherent in the fact that the broader use of ISFM concepts requires a scaling up of knowledge itself, which is not the case with the spread of more simple technologies or goods. Third, the development of ISFM principles relies heavily on innovation and experimentation—indeed on creating opportunities and nurturing the good fortune of serendipity—to tailor generic management principles to diverse local conditions. Finally, there are obstacles related to managing the complexity of ISFM systems, from merely knowing what innovations have occurred and are worth reproducing to understanding and targeting interventions to different parts of the systems.

Clashes of Expectations

Is there really an interest in scaling up?

At the most basic level, ISFM is about managing interactions between plot-level soil phenomena such as water, soil nutrients, and organic matter. When interventions, such as new cropping combinations of legumes and cereals or the complementary uses of organic and inorganic inputs, have proven themselves successful in a given context, it might seem natural to wish to see that success reproduced elsewhere.

And yet, consider for a moment the various stakeholders in a piece of successful research, even in a plot-level context. While the farmer, whose plot it is, may see the successful resolution of one of her NRM problems and now express a desire to conduct "more work on my other problems" using similar principles, the researcher involved in the experimentation might be enthusiastic about seeing this same experimentation process or intervention "used by more farmers". Thus the single moment of "success", however defined, produces two reactions facing in opposite directions: The land-users themselves seeing an opportunity for deepening their use of new knowledge (introversion), while outsiders are thinking of broadening the knowledge's use to include others (extroversion).

This suggests that, unless these obviously complementary outlooks are acknowledged and reconciled, there is the potential for much broader clashes of expectations about research and research outputs within the scaling up discussion. The project example cited in Box 1 shows how failure to explicitly discuss the different objectives of stakeholders in a project's Phase Two led to radically different impressions of what scaling up would mean.

Box 1

Negative comments about scaling up from a project feedback meeting

In early 2001, community discussions were held on the proposed next phases of an integrated soil fertility management (ISFM) project in western Kenya as the intensive, community-based experimentation phase was coming to an end. The new activities included leaving the original community to continue experimenting and adapting the technologies with minimal project oversight, and disseminating the research findings to other communities. However, clear differences of opinion regarding the merits of these new activities became evident, partly because project implementation had not explicitly involved all the participants in deciding the course and the justifications of the research. The following are extracts from the negative comments only made by various stakeholders, which were collected from the public (and private) discussions during and after the meeting.

Researchers (national and international)

- The only way we can carry out research these days is to persuade the donors that there will be an impact beyond just a single village, or a group of 30 or 40 farmers.
- Dissemination is not our job, it is extension's.
- If the technology is good, it will sell itself. All this [time and effort] here today is just a distraction.

Extension agents

- If the project is not even going to stay here, then it seems that all this attention to the "on-farm" research was just for the researchers' curiosity and nothing more.
- There is no enduring interest by the outsiders in this community. We [the national ministry personnel] were just used and are now being dropped.

Farmers

- [This particular] research [project] is just a passing cloud. It will go and something else will come to take its place.
- The researchers have learned what they needed to, and now they will forget us farmers and our problems.

These negative comments suggest that even the researchers felt that scaling up was not something for which they had a comparative advantage, to the point of cynically thinking that achieving and demonstrating impact only served a purpose of satisfying donors. The negative perceptions of the extension agents reflect the fact that they had not been involved in planning the second phase activities, obscuring any links between the initial stages and the scaling up. Finally, the farmers themselves were also ambivalent about a scaling-up phase, seeing the project as something transient and distant from their daily priorities, apparently responding to its own (mysterious) internal agendas.

Such an example highlights the need to generate realistic expectations collectively. Because NRM projects often begin with quite comprehensive benchmark surveys and community-based discussions, participants also tend to believe such energy levels will be sustained throughout the life of the project and beyond. While this is usually not the case, a fuller stakeholder involvement at strategic moments throughout the project cycle can both minimize the generation of false expectations, and ensure agreement on more realistic objectives.

Often, taking a given project's lessons to broader communities or policymakers is given relatively low priority at inception (see the researcher comments about "distraction" in Box 1). As the end of a project approaches, issues of scaling up or out then risk being blurred into plans for either renewal or the development of new projects, and may even fail to properly materialize if additional funds do not arrive (again, see the researcher comments about donors). While such thinking may appear pragmatic, it is more effective to view "scale" issues as inherent to all project processes and of interest to more than just the project "managers". Indeed, starting the discussion of scaling up and out activities **early** in the project cycle ensures that other participants, such as farmers and locally based institutions, can also recognize their own interests in seeing lessons applied more broadly.

Experience of the Tropical Soils Biology and Fertility Institute

As a small institute, focussed on soil biological processes, TSBF has developed most of its competence in small-scale, plot-level research. The emphasis on soil processes has also encouraged or facilitated a small-scale focus. A prevailing image from the earlier history of TSBF was that the institution itself had "no particular comparative advantage" in scaling up or out (Ramisch et al., 2002). As a result, all of its work has been done through partnerships, with national agricultural research and extension services (NARES) and various nongovernmental organizations (NGOs). Scaling up the general principles and understanding of soil functions has been achieved by linking multiple, local sites and experiments through the African Network of Soil Biology and Fertility (AFNET). Within sites, scaling out has been based on community-based experimentation and farmer-to-farmer dissemination strategies.

Having taken a conservative view of its own ability to widen the impact of its research, TSBF has therefore been surprised to observe examples of spontaneous scaling out activities. Farmer field school (FFS) groups to address ISFM topics have formed in both western Kenya and eastern Uganda purely on the initiative of farmers themselves (Delve and Ramisch, 2002). Certain green manure and improved fallow technologies, such as the use of *Canavalia ensiformis* (L.) DC and *Mucuna pruriens* (L.) DC, have also spread well on their own with relatively little input from TSBF or its partners (Figure 1). As will be discussed below, a common feedback from the community-based experimentation process is that more farmers want greater ownership of the learning process. Where this has been the case, more appropriate technologies have been developed and spread, and fewer clashes of expectations between farmers and researchers have emerged (Delve and Ramisch, 2002).

Scaling Up Knowledge

Although new varieties and cultural techniques are often a part of improved soil fertility management technologies, ISFM will not necessarily be promoted simply by spreading new germplasm, inputs, or agronomic advice. Its dissemination involves the spread of both intangible (knowledge-based) and tangible (resource-based) assets, which will be used in concert. However, since ISFM is essentially a set of management tools, its application is contingent on changing environmental conditions, and its expression may not even be apparent in a given context.

Different types of knowledge

The participatory technology design (PTD) methodology involves farmers directly in the problem-solving process needed to adapt nascent technologies into ones adapted to real-world conditions and constraints (Figure 2). As an iterative process, it is therefore both a knowledge-generation and knowledge-refining activity. Of course, the knowledge needed to conduct agricultural research can range from relatively simple concepts to highly complex understanding of systems. The more complicated the knowledge, the harder it is to present to others, and therefore the harder it is to transfer or to share.

For example, PTD relating to selecting or improving germplasm is at the simpler end of the continuum. It uses tangible, familiar materials (i.e., seeds, seedlings, or rootstock) and can exploit existing networks of local seed systems for sharing lessons and products. Adding an additional layer of knowledge, such as pest management, means that PTD on crop ecology becomes more complicated. For example, integrated pest management (IPM) research also addresses tangible, familiar entities (i.e., crops *in situ*, local pests), but typically demands continuous monitoring and evaluation by participants over full growing seasons to observe pest dynamics and the effects of interventions. More complicated

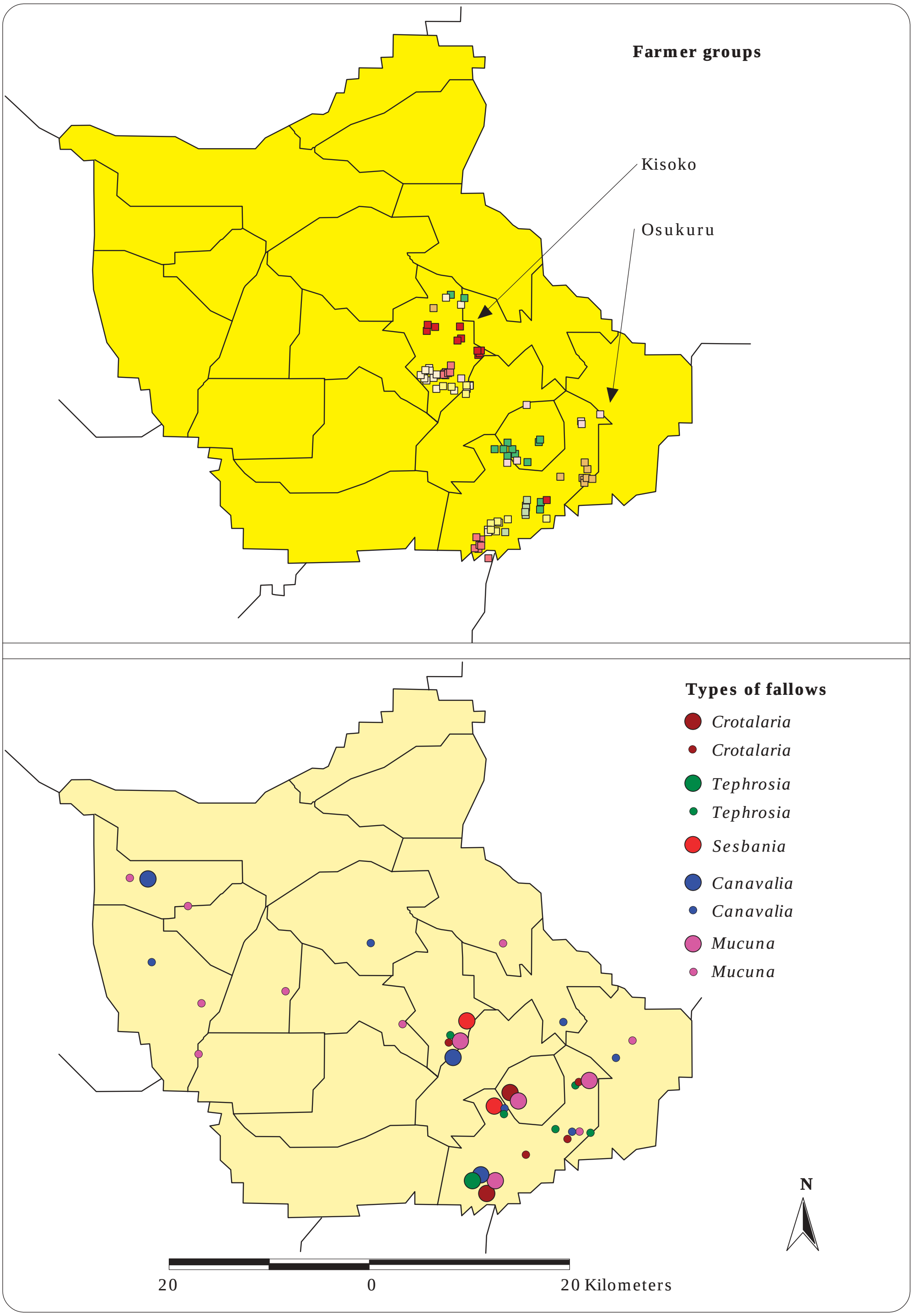

Figure 1. Spread of seeds for improved fallow species over five seasons (1999-2001) related to initial farmer groups in eastern Uganda.

still is PTD that addresses system ecology, such as ISFM, integrating choices about germplasm, and decisions about soil, pest, and water management. Such experimentation typically involves multiple seasons and reference to multiple sites to draw meaningful lessons. Indeed, the very process of learning about these system properties is stimulating the evolution of new ways of thinking, such as distributed cognition, based on the sheer interdependence of the processes involved (Röling, 2002).

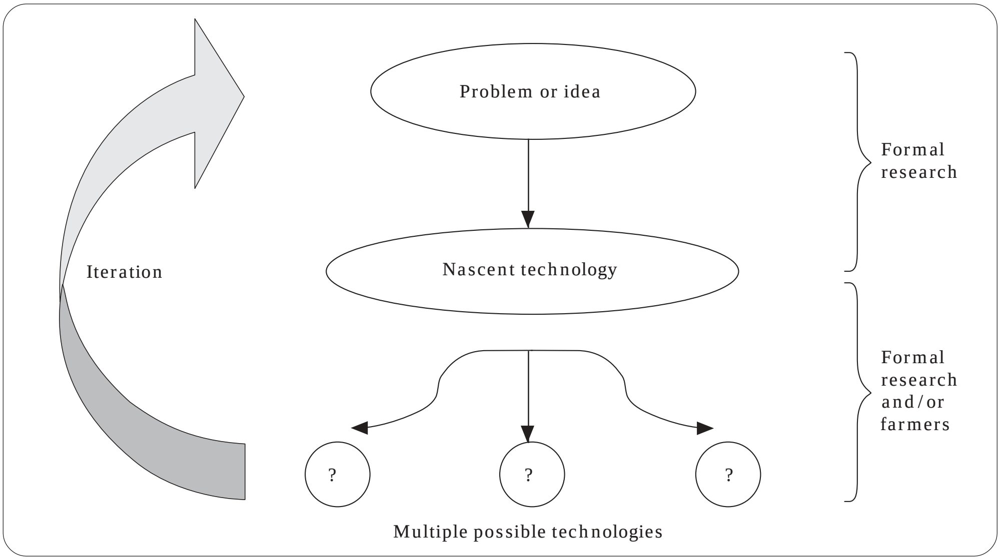

Figure 2. The participatory technology design process.

When addressing complicated, systems ecology problems, it is easy and tempting (and indeed often necessary) to extract individual components for analysis and evaluation. As such, ISFM is itself made up of several layers of knowledge and decision making: About technology decisions, about species, about relationships of those species to systems, and of ways of thinking or experimentation itself. While "solutions" to site-specific problems will be identified in the course of PTD, the principles of ISFM extend beyond them. The advantage of taking a systems ecology approach is that knowledge about more general principles uniting diverse, individual "solutions" will also be gained by referring to the knowledge generated under different sites and conditions. However, when it comes to sharing or scaling ISFM knowledge up and out, it is all too easy for more complex "general" principles to be overshadowed or forgotten once the "solutions" to local problems have been identified.

Knowing that knowledge is being used

The difficulty in tracking the spread of knowledge-based systems lies in having to observe the effects of knowledge indirectly. There are three potential problems here: Knowing that knowledge is being used, knowing where to look for the knowledge, and knowing who will be using it.

Knowledge is contingent. The first problem relates to the fact that most soil fertility management decisions are ad hoc and contingent. In the words of one farmer in Kenya, the use of soil inputs is “like medicine… you take it when you are sick and you stop when the sickness is gone.” Tracking the use of concepts (such as decisions about crop rotation or input combination in responses to changing soil fertility status) is therefore not as straightforward as tracking the use of components, such as the presence or absence of a given input (i.e., manure or inorganic fertilizer use). For example, the cover crop *Mucuna* is frequently used by farmers as much for suppressing weeds (such as *Imperata cylindrical* [L.] Palisot) as for soil fertility improvement (see Houndékon et al., 1998). If planting *Mucuna* leads to a suppression of the *Imperata* within 2 or 3 years, it is therefore logical to see the use of *Mucuna* then also trailing off (Galiba et al., 1998).

The passing on of contingent knowledge can therefore become problematic. Certainly in informal farmer-to-farmer dissemination activities, TSBF has observed that the results of experimentation with technologies are typically distilled as “lessons” to be passed to others. The process that generated those lessons is usually not emphasized. As a farmer in Uganda put it, “now that we know that green manures work (*Mucuna* and *Canavalia*), we have finished with experimentation… we would like to promote this now so that others can also know the goodness of green manures”.

Potential can be niche or universal. A second, related problem is that depending on whether a technology has universal or only niche potential, it is difficult to know whether a given level of adoption within an agro-ecosystem is high or low. African farmers’ intercropping of cereals with legumes reflects a long history of trade-off decision making about meeting nutritional needs while using scarce soil resources (particularly soil phosphorus). The niches occupied by food legumes such as bean (*Phaseolus vulgaris* L.), cowpea (*Vigna unguiculata* [L.] Walp.), or soybean (*Glycine max* [L.] Merr.) are therefore important to both food security and soil fertility, even if they can rarely account for more than 5% to 10% of food production on a dry matter basis (Bremen and van Reuler, 2002).

The potential of non-food legumes must therefore be considered in a similar light. For example, improved fallows using leguminous cover crops are typically most attractive to households with abundant land, or that can meet their food security needs with alternate sources of (off-farm) income (Franzel, 1999). However, the trade-offs between these factors can be complicated, because the perception of soil fertility decline is itself linked to decreasing land availability. In extensive systems, where land is plentiful and existing fallows with natural regeneration of vegetation restore soil fertility, farmers have little incentive to invest labor in improved fallows. These are more likely to be attractive options where population density is higher, fallow periods are decreasing, and farmers perceive a soil fertility decline. However, in intensive systems where additional land is unavailable and cropping nearly continuous, access to off-farm income can serve as the stimulus to invest in soil fertility management. Thus, although non-food legumes have shown themselves beneficial to such farmers, it is unrealistic to expect their potential to be universal or widespread.

Even the way that adoption "potential" is presented can be misleading if the relevance of the technology is not known. It is relatively common, for example, to report baseline studies that show that a given percentage of farms in a community have soil conservation structures such as terraces. On its own, such a statistic is meaningless, since we have no way of knowing what proportion of the land is actually at risk of soil erosion and therefore warranting the massive investment that terraces incur. A more relevant index, although much harder to measure, would be assessing the declining rate of soil loss or sedimentation lower in the catchment as a function of increased awareness and use of soil conserving techniques. Developing similar indices for ISFM technologies would likely show that many of the actual interventions, from improved composting to legume rotations to cover crops, would qualify more as "niche" rather than "universal" options within the landscape.

Knowledge's value depends on who is using it. The third problem, beyond knowing the conditions under which knowledge might be used and its potential agro-ecological boundaries, is that the same knowledge will be of different relevance to different people. For example, in many African settings, women often make the decisions about seed supply and variety selection for food crops, while decisions about land allocation are more often under men's control. This means that when it comes to ISFM within a given farm, different members of the household manage different plots differently for different ends. Because of intra-household dynamics, such as access to land, labor, and external inputs, the rationality of ISFM decision making will be different depending on who controls which plots (Box 2). Each decision is rational within its own context, but reflects the fact that even within a single farm there are multiple management domains.

The implication, therefore, is that taking knowledge to higher scales holds many risks. The contingent (and often site- or niche-specific) nature of ISFM knowledge means that any communication or transfer may inadvertently "prune" or reduce the original knowledge down to only a few components, which may in turn prove irrelevant or inappropriate to many potential subsequent users. Much as many local plant breeders retain a diversity of genetic material as a precautionary principle, it is useful to keep a range of ISFM dissemination materials that reflect the full history of a technology's development and use.

Box 2

Different integrated soil fertility management (ISFM) domains for kales grown on farms of western Kenya

Farm 1. Male-headed household, small area (1.5 acres), some market orientation

The husband uses his access to outside information and resources to justify a decision to grow kales (*Brassica oleracea* L.) for market on a less fertile part of the farm as part of an ISFM "experiment" that combines organic and inorganic resources.

His wife, however, with only indirect access to these off-farm resources is also growing kales, but purely for home consumption. She uses the land close to the home that she controls and directs the richest sweepings of chicken droppings from the compound to this plot.

Farm 2. Male-headed household, small area (1.1 acres), little market orientation

The wife grows kales for household consumption in small garden areas near to the main family home. These gardens are interspersed with other vegetables for home use, and some areas are shaded by banana (*Musa* spp. L.) groves. Many of the gardens benefit from the sweepings and kitchen wastes, but no other inputs.

The son is also growing kales for household consumption, but on plots at some distance from the home compound. This land is also being used to grow sweet potatoes (*Ipomoea batatas* [L.] Lam.) along with his mother, and does not receive any organic or inorganic inputs.

The husband has not prioritized kales within the farm and allocates no inputs to them. He was even willing to offer to researchers as a demonstration plot, the plot of land used by his son and wife for sweet potatoes and kales, until they later convinced him that they needed it.

Farm 3. Female-headed household, large area (3.2 acres), off-farm income

The widow invests some of the monthly income from her husband's pension and son's remittances in inorganic fertilizers and pesticides for a market garden of kale on a large plot. She is also using her connections with researchers to experiment with improved fallows and various organic and inorganic combinations.

Her younger son has a small plot of kale for market as well, but is not actively interacting with the researchers for new ideas. Also, since he does not have access to the household compost or manure resources, the only inputs are occasional doses of inorganics.

The hired (female) labourer maintains and harvests all of the widow's kale, and is able to retain a small share of the produce for her own use. She has not adopted any of the organic or inorganic practices on the kale she grows for home consumption on her own farm, saying she lacks the time and money required to use them properly.

Nurturing Serendipity

The PTD process relies heavily on the input of local knowledge into the generation and adaptation of prototype technologies to suit local conditions. To some researchers, this may mean little more than ensuring that farmers are winnowing out options that demand inappropriate inputs or are not suited to local tastes. However, many of the successes of integrated management approaches stem from the outcomes of local experimentation, innovation, and serendipity, which the Oxford English Dictionary defines as "the faculty of making happy and unexpected discoveries by accident".

For example, the identification of *Tithonia diversifolia* (Hemsl.) A. Gray as an effective "scavenger" of soil nutrients was serendipitous, given *Tithonia*'s abundance as a hedgerow and wildly occurring species in many rural landscapes. So too was the later discovery that farmers in western Kenya were using *Tithonia* as an amendment to compost systems, rather than applying it directly as a mulch or top-dressing, as was initially promoted.

All innovations in agricultural systems rely to some degree or other on serendipity. However, it is harder to obtain serendipitous outcomes if the technology is already "over-designed", with highly specified parameters and inputs. In such cases, the farmers' potential input is reduced to the rather dis-empowering binary decision of whether to "accept" or "reject".

Matching the precision of technologies to the precision of farming systems

When considering the "appropriateness" of a given technology, it is useful to think of its input requirements (natural, financial, labor, or managerial capital) in terms of its "precision" (Reece and Sumberg, 2003). A high-precision technology is one that yields favorable responses only when specific conditions are met, while a low-precision technology responds favourably over a wider range of conditions (Figure 3). While the best outcomes of a low-precision technology usually will not be as high as the best outcomes of a higher precision technology, the total benefits to users who do not muster the optimal resource combinations will be far greater for low- than for high-precision options.

In this context, it is worth analyzing whether many of the technologies in the so-called "ISFM basket of options" are not themselves over-precise. Work in Zimbabwe on manure management found that the initial scientific models made excessive demands on farmers' managerial and resource-mobilization abilities (Box 3). The farmers' management maximized the "quantity" of manure produced—maximizing the amounts of material included in the manure pile while also minimizing labor costs (such as digging pits, and covering or turning the piles). This management was well

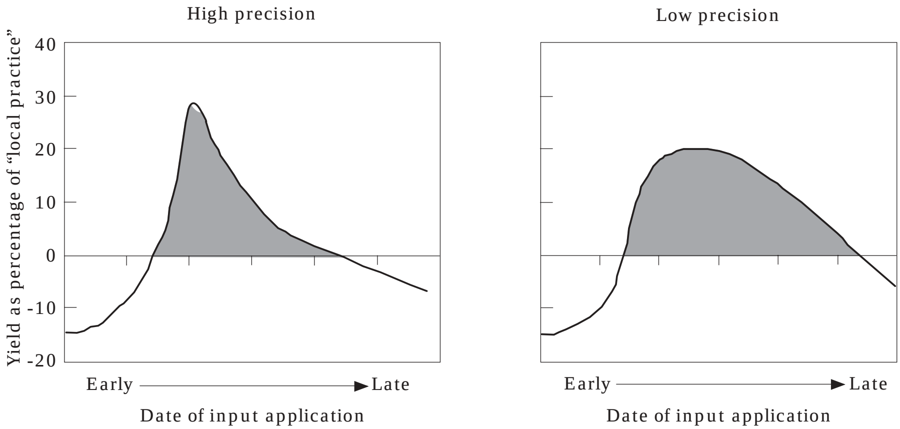

Figure 3. Comparing the "precision" and response of two different technologies.

suited to a low-precision system, where supplies of manure and other organic materials would be highly variable, and where opportunity costs of labor would be high. In contrast, researchers' management relied on much

Box 3

Integrating higher-precision scientist practice and lower-precision farmer practice in manure management in Zimbabwe

Farmer practice

- Managed for manure QUANTITY.
- Multiple materials were added to the manure regardless of quality (anthills, kraal sand, crop residues, sweepings).
- Local indicators of quality then determined how to use the resulting manure (broadcasting/banding, supplementation with top-dressing, used in gardens or field crops).

Scientist practice

- Managed for manure QUALITY.
- Selectively excluded low-quality (high C:N ratio) materials and covered pits to minimize N losses.
- Supplementation with inorganic inputs was inversely related to the quantity of high-quality manure produced.

Consultation between farmers and researchers showed that the many local criteria that farmers used to identify manure quality (which then guided manure use) could be matched with their earlier management practices. The addition of anthills and the feeding of supplements to animals, for example, corresponded with indicators that showed higher quality manure, which would be used in gardens or on field crops without top-dressing.

higher precision inputs, and was more concerned with generating high-"quality" manure (high nutrient content).

Engaging farmers and researchers in a participatory consultation process revealed the substantial differences in their priorities for manure management, and the different criteria they used to decide on its proper use. Combining the two sets of indicators for manure quality resulted in a set of testable recommendations for optimal uses that both farmers and researchers could then evaluate. This has since fed back into the research process as further management improvements. Farmers now make use of the resource quality criteria to manage and improve the manure while they are bulking it, and have broadened their repertoire of application techniques.

Formalizing the successes of participatory technology design

The participation process is not a recipe for success, but more of a checklist of issues that need to be considered when farmers and researchers collaborate. The experiences of TSBF in using increasingly participatory technology development processes have illustrated that certain concerns repeat themselves, and indeed must be addressed in a systematic manner.

The first is that serendipity has its limits. If the innovativeness of communities and individuals is to be nurtured, it is essential to foster the ability to recognize useful knowledge and patterns. This ability is self-reinforcing, but needs the support of farmers and researchers both collecting the right kinds of data and sharing that data amongst themselves.

A second issue that arises in PTD is that it is frequently driven by a relatively small core group of charismatic or dedicated individuals. Although such strongly motivated actors are essential to stimulating interest and mobilizing resources, the project or activity can ultimately be stifled if it remains centered on them for too long. One-on-one interactions cease to be effective after a critical mass of involvement is reached, and it becomes necessary to decentralize the decision making and leadership. The key challenge is to make a graceful transition from charisma-driven activities to institutionalizing bottom-up processes of leadership.

A final concern is that ISFM on its own rarely provides a compelling entry-point for research or development. While local communities eventually acknowledge soil fertility decline as a problem, it is not typically at the top of most lists of agricultural constraints until the soil has badly deteriorated. As a result, it is increasingly recognized that long-term soil fertility benefits can be better realized if they are generated by technologies that also provide more immediate impacts that farmers can readily appreciate, such as a readily marketable commodity.

To build confidence in the PTD process, it is important that the initial steps use relatively simpler technologies as entry points. The more that these are compatible with existing practices, beliefs, and needs, the more likely that farmers themselves will gain confidence in their ability to test hypotheses and learn from their experiments. Motivation and interest in the process are sustained if there are benefits that can be tested and observed in the short term, particularly ones that are economically profitable. Other useful benefits include technologies that have low initial start-up costs, reduce discomfort or save time and effort, or provide social prestige.

Managing Complexity

The fourth and final obstacle to taking ISFM to higher scales lies in the rapid increase in complexity inherent in moving to include multiple scales of action. On the one hand, this makes the task of monitoring and evaluating the spread of knowledge and practices, innovations, and adaptations difficult. On the other hand, it also increases the number and complexity of the actors involved. The targeting of future interventions therefore becomes complicated, with the increasing importance of gendered and other intra-group dynamics, and the political differences in resource control use and decision making.

Tracking innovations and adaptations

To paraphrase Marshall McLuhan's aphorism, in most cases of ISFM technology development, "the innovations are themselves the message". However, while farmers are adapting and modifying technologies, the beneficial outcomes of these innovations are "lost" if their findings are not fed back into the research and experimentation process of others, including formal research.

If cut-and-carry systems using *Tithonia*, for example, are being modified so that material is used in composting rather than for direct application on fields, the assumptions about material selection will also have changed. In the original cut-and-carry scenario, the "high"-quality material for direct application would be rapidly decomposing, low lignin, high nitrogen species such as *Tithonia*. In a composting scenario, material that breaks down rapidly might no longer be the optimal choice if the compost heap is built up over the course of 6 to 12 months or more, and new criteria will need to be developed based on the new assumptions.

A similar problem is arising in the use of legume cover crops, where users frequently mention "low palatability to animals" or "inedibility" (by people) as constraints to wider adoption. While it might be possible to find or produce varieties of *Mucuna* or *Canavalia* with greater food or fodder value, farmers who have seen the benefits of non-palatable legumes for soil fertility are more likely to be receptive to the introduction of other, dual-purpose species such as cowpea or soybean. Indeed, these farmers are the ones now demanding and experimenting with multiple-purpose species.

In both cases, the innovations have emerged from follow-up discussions held with farmers. It is important therefore to follow both the germplasm as it is spread to other households, and the knowledge being generated on its use. Ideally, farmers would themselves be keeping data as part of a participatory monitoring and evaluation network. This would also increase the perceived ownership of the technologies and ensure the collection of data relevant to local concerns. However, since outsiders are likely to be more interested in knowing how the knowledge and technologies are evolving, it seems only reasonable that a large part of the responsibility for tracking innovations should fall to them.

Targeting interventions

All of the preceding examples have demonstrated the complex, site- or actor-specific nature of many ISFM innovations. A given technology's potential will therefore vary greatly between different actors, and will not necessarily be appropriate to all socioeconomic, cultural, or agro-ecological conditions.

For example, the needs of marginalized groups, such as women farmers or the very poor, are different from those of more mainstream groups in kind and not just in degree. Technologies that are not directly developed by them, or targeted to address their needs explicitly, are not likely to meet those needs merely by coincidence. Appropriate and empowering strategies need to be followed, such as creating research groups for women only, or centered specifically around a given (marginalized) livelihood, such as households that sell much of their labor.

In general, community-based learning techniques have shown themselves particularly effective for ISFM research (Defoer et al., 2000). They accelerate the prioritization of local topics of interest, and situate ISFM within a much broader productive or livelihood context. The learning and research is therefore demand driven and problem oriented, and occurs in a setting that favours peer support and encouragement.

However, problems with community-based techniques remain numerous. Perhaps the most important is that most groups (either already existing or created specifically for the research tasks) tend to favor group stability over more dynamic aspects. This is fully understandable—groups exist in large part to share risks and enlarge individuals' capacities to access resources (Misiko, 2001). However, it is also true that when farmers' groups present themselves to others, much more emphasis is inevitably placed on the history, structure, constitution, and rules for inclusion or exclusion of participants than on experimentation per se, the actual generation of knowledge or presentation of accomplishments (Muruli et al., 1999). Table 1 shows that while many farmers ranked “access to new ideas” as the greatest benefit from their involvement in research groups, “experimentation” was not seen as a good in itself. Even though experimentation had been suggested as a benefit in the discussion preceding the ranking, it was clearly not given prominence. When asked to elaborate on their answers, most farmers defined “new ideas” as “technologies that work”, again highlighting the tendency to understand “solutions” as the product of the research rather than conceiving of research as a process.

Table 1. Ranking of selected benefits perceived to result from participating in farmer research groups in western Kenya (four communities, 85 respondents).

Perceived benefit	Frequency benefit was ranked (%)	
	Highest	Lowest
Access to new ideas	46	0
Links to outsiders	15	18
Access to new materials	11	6
Experimentation	6	21

The very principle of exclusive membership, defining an “in” versus an “out” group, also works against an interest in scaling out findings indiscriminately. It is therefore important to understand a group’s composition, history, and motivations before we can anticipate to whom and under what conditions learning will be disseminated (Misiko, 2001). The knowledge generated by the group can quickly become a valuable secret to be used for one’s own advantage, and not to be shared. In such cases, groups tend to reinforce existing power and gender relations, and participation in the research group is often motivated by potential access to outside resources that have little to do with interest in ISFM. If research or development projects arrive only rarely in a given community, it is hardly surprising that the initial volunteers are not always the best contacts (see the prominence given to “links to outsiders” as a benefit in Table 1).

Sharing Responsibility

Despite their complexity, these four obstacles to scaling ISFM up and out can be overcome provided that they are acknowledged, and partners take responsibility for overcoming them. This need not be a complicated process—consider that building shared expectations and assigning responsibilities are fundamental to most initial stakeholder meetings—but the barriers that partners themselves face in scaling ISFM out and up are still potentially great.

Formal sector

In the formal sector of government research or policymaking throughout the developing world, retrenchment and funding crises are the norm. Job insecurity is further coupled with a seemingly “fickle” climate of ever-changing donor priorities and obligations. As a result, “package solutions” are often still considered relatively attractive, because they are essentially self-contained or freestanding solutions that minimize the need for inputs or connections with other organizations or departments. Within agricultural ministries, the emphasis on food self-sufficiency and export priorities also are more likely to favor increased production objectives over more holistic strategies, such as ISFM. Finally, prevailing top-down information flows make it difficult for formal policy to receive or internalize bottom-up contributions, such as the views of farmers or field staff.

Professional insecurity, the competitive nature of inter-departmental or ministerial relations, and the enduring appeal of simple policy options over complicated ones will undoubtedly remain inherent to the formal sector. However, stakeholders in ISFM research should see the advantages of nurturing potentially sympathetic policymakers as advocates for ISFM strategies or components. At the same time, if the development of ISFM technologies is driven by the clients themselves, they will also be working to create and enlarge the livelihood opportunities those technologies will support.

Extension and nongovernmental organizations

Within state extension services, funding crises are even more acute, especially in sub-Saharan Africa where formal extension has been nearly paralyzed since the early 1990s. Thus, even with well-trained or self-aware staff, the lack of tools and resources severely limits extension’s ability to feedback information between farmers and researchers. In many cases, extension agents are aware of farmers’ attitudes and needs because of their presence at the grass roots, but there are not necessarily channels to internalize these, especially if extension is simultaneously obliged to carry out and promote official state policy. Problems also occur where extension agents have not received training in new methods or approaches, which may make them resistant or suspicious of “participatory” methods that might challenge their positions of local influence or power.

Community-based organizations (CBOs) and NGOs might offer viable alternatives to the formal organizations by virtue of their intensive and client-focused working styles. However, small-scale, NGO-led projects themselves often lack clearly defined pathways to scale their successes up or out, and usually can be expanded only by repeating the same slow, costly, in-depth techniques in successive communities. Certain types of technology—largely those that can be implemented individually—can spread laterally by farmer-to-farmer extension, but lateral spread that requires joint action is far less likely (Lovell et al., 2001).

Community participation should have the goal of building farmers' confidence with experimenting using new and existing knowledge, gradually increasing the levels of complexity that feel "manageable". Entirely "bottom-up" proposals for improvements limited to the possibilities already known to rural people are clearly not sufficient. The process must be open to the wider possibilities known to outsiders, and in a procedure for planning, implementing, and monitoring that allows outside agencies to verify that public funds have been spent properly (Farrington and Boyd, 1997).

Involving rural change agents in the research process, and making its outputs more accessible to them, could help insert ISFM more firmly into the fabric of community development strategies. This is particularly relevant where NGO and CBO agendas and budgets separate "environmental" from "agricultural" concerns, or put greater priority on the former than on the latter. From TSBF's experience, ISFM will rarely top any community's list of problems or priorities. However, addressing soil fertility issues is usually fundamental to solving many of the problems that do lead the list (food security, pest or water problems, low income, etc.). Because of its knowledge-intensive nature, ISFM presents an ideal starting place for community-development strategies that build local mechanisms to learn about learning (Maarleveld and Dangbégnon, 2002).

Conclusions

To see ISFM principles applied by a wide variety of actors at scales ranging from the farm level to the national or continental levels means addressing the problems of how to use knowledge gained at one scale to interpolate or extrapolate knowledge for decision making at another scale. To confront the four obstacles outlined in this paper, the experience of TSBF suggests the following resolutions.

Clashing expectations

The more client-driven the technology, the more likely the users will themselves have an interest in seeing the innovations scaled up and out. Farmer research groups typically share the researcher's desire to see successful outcomes replicated elsewhere (extroversion), as long as such scaling out is not at the expense of further and continuing problem solving (introversion) in the initial groups. It is never too early to introduce the ideas and the relationships that will be needed for future scaling up and out activities. Such discussions should be a part of initial stakeholder meetings, which already typically have the objective of establishing shared expectations and responsibilities.

Scaling up knowledge

ISFM will always be knowledge-intensive, and by its nature many of its management and decision-making processes will be highly interdependent. As such, facilitating the spread of knowledge requires clarity about which knowledge is needed in a given context. Identifying where this knowledge needs to be used, and by whom, facilitates the development of appropriate ways to enrich or supplement the existing knowledge and practices. The information needs of farmers require relatively detailed, practical, and accessible materials that are easily shared with others, while local officials or policymakers are more interested in syntheses and overviews of technologies, and the way that concepts fit together with other concerns.

Nurturing serendipity

In general, the greatest successes have come from matching the precision of technologies with that of the farming system. Lower precision technologies—for example, those using generalizable principles (such as resource quality) rather than emphasizing a particular species—are more amenable to further refinement by the users themselves. The innovation process inherent in PTD is iterative, such that the confidence inspired by mastering initial problems or technologies builds the innovators' ability and confidence to address greater complexity. Collectively developed successes are also more likely to endure longer than those that were the achievements, or "pet projects" of single, charismatic leaders or "model farmers".

Managing complexity

Finally, effective monitoring and evaluation is essential to successfully take ISFM to more users and higher scales. Without accurate record-keeping, and balanced appraisals of different innovations' results, recommendations for future steps risk being made purely on the basis of "faith" or ideological commitment to a given technology. Similarly, without knowing how soil knowledge fits within wider priorities, or an understanding of community dynamics (how different types of information are generated, disseminated, or kept secret locally), finding the appropriate channels for propagating new ISFM knowledge will tend to be a hit-or-miss affair.

References

Bremen, H.; van Reuler, H. 2002. Legumes: When and where an option? (No panacea for poor tropical West African soils and expensive fertilizers). *In:* Vanlauwe, B.; Diels, J.; Sanginga, N.; Merckx, R. (eds.). Integrated plant nutrient management in sub-Saharan Africa: From concept to practice. CAB International, Wallingford, GB. p. 285-298.

Defoer, T.; Budelman, A.; Toulmin, C.; Carter, S.E. 2000. Building common knowledge. Participatory learning and action research (Part I). *In:* Defoer, T.; Budelman, A. (eds.). Managing soil fertility in the tropics. Book 1. A resource guide for participatory learning and action research (PLAR). Royal Tropical Institute (KIT), Amsterdam, NL. 208 p.

Delve, R.; Ramisch, J.J. 2002. Impacts of land management options in Eastern Uganda and Western Kenya. *In:* Benin, S.; Pender, J.; Ehui, S. (eds.). Policies for sustainable land management in the highlands of East Africa, International Food Policy Research Institute (IFPRI)-International Livestock Research Institute (ILRI) Conference, 24-26 April 2002, Addis Ababa, ET. p. 155-162.

Farrington, J.; Boyd, C. 1997. Scaling-up the participatory management of common pool resources. Dev. Policy Rev. 15:371-391.

Franzel, S. 1999. Socio-economic factors affecting the adoption potential of improved tree fallows in Africa. Agrofor. Syst. 47:305-321.

Galiba, M.; Vissoh, P.; Dagbenonbakin, G.; Fagbohoun, F. 1998. Réactions et craintes des paysans liées à l'utilisation du pois mascate (*Mucuna pruriens*). *In:* Buckles, D.; Etèka, A.; Osiname, O.; Galiba, M.; Galiano, G. (eds.). Cover crops in West Africa: Contributing to sustainable agriculture. International Development Research Centre (IDRC), Ottawa, CA. p. 55-65.

Houndékon, V.; Manyong, V.M.; Gogan, C.A.; Versteeg, M. 1998. Détérminants de l'adoption de *Mucuna* au Bénin. *In:* Buckles, D.; Etèka, A.; Osiname, O.; Galiba, M.; Galiano, G. (eds.). Cover crops in West Africa: Contributing to sustainable agriculture. International Development Research Centre (IDRC), Ottawa, CA. p. 45-54.

Lovell, C.; Mandondo, A.; Moriarty, P. 2001. Scaling issues in integrated natural resource management. *In:* Proceedings of the Consultative Group on International Agricultural Research (CGIAR) Workshop, Integrated Natural Resource Management in the CGIAR: Approaches and Lessons, 21-25 August 2000, Penang, MY. 28 p. Available in: http://www.inrm.cgiar.org/Workshop2000/docs/Lovell/lovell_main.pdf

Maarleveld, M.; Dangbégnon, C. 2002. Social learning: Major concepts and issues. Lessons from natural resource management in *terroirs* and *landelijke gebieden*. *In:* Leeuwis, C.; Pyburn, R. (eds.). Wheelbarrows full of frogs: Social learning in rural resource management. Koninklijke van Gorcum, Assen, NL. p. 67-84.

Misiko, M.T. 2001. The potential of community institutions in dissemination and adoption of agricultural technologies in Emuhaya, western Kenya. M.A. Thesis, Institute of African Studies, University of Nairobi. 92 p.

Muruli, L.A.; London, D.M.; Misiko, M.T.; Okusi, K.; Sikana, P.; Palm, C. 1999. Strengthening research and development linkages for soil fertility: Pathways of agricultural information dissemination. Unpublished Tropical Soil Biology and Fertility Institute (TSBF)/University of Nairobi project report to the International Development Research Centre (IDRC). 31 p.

Ramisch, J.; Misiko, M.; Carter, S. 2002. Finding common ground for social and natural sciences in an interdisciplinary research organisation—The Tropical Soils Biology and Fertility Program (TSBF) experience. Paper presented at Looking Back, Looking Forward: Social Research in the Consultative Group on International Agricultural Research (CGIAR) System, CGIAR Conference hosted by the Centro Internacional de Agricultura Tropical (CIAT), 11-13 September 2002, Cali, CO. Available in: http://www.ciat.cgiar.org/src/pdf/tsbf_jramisch.pdf

Reece, D.; Sumberg, J.E. 2003. More clients, less resources: A new conceptual framework for agricultural research in marginal areas. Technovation 23:409-421.

Röling, N. 2002. Beyond the aggregation of individual preferences: Moving from multiple to distributed cognition in resource dilemmas. *In:* Leeuwis, C.; Pyburn, R. (eds.). Wheelbarrows full of frogs: Social learning in rural resource management. Koninklijke van Gorcum, Assen, NL. p. 25-48.

van Noordwijk, M. 2000. Scaling, lateral flows, filters, sustainability and negotiation support models for natural resource management in landscapes with trees. *In:* Proceedings of the Consultative Group on International Agricultural Research (CGIAR) Workshop, Integrated Natural Resource Management in the CGIAR: Approaches and Lessons, 21-25 August 2000, Penang, MA. Available in: http://www.inrm.cgiar.org/Workshop2000/abstract/Maine/Fullmeine.htm