Development in Practice, Volume 11, Number 4, August 2001

Realising the potential of agroforestry: integrating research and development to achieve greater impact

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Investments in process-oriented and farmer-participatory research have led to the emergence of sustainable agroforestry solutions to the problems of land degradation, poverty, and food insecurity in rural areas. Thousands of farmers in diverse ecoregions have taken up innovations that demonstrate the potential of agroforestry. This paper highlights the importance of institutional change through illustrating the approach taken by the International Centre for Research in Agroforestry to scale up adoption and impact of innovations. Eight focal areas of intervention constitute the key elements of a development strategy aimed at providing 80 million poor people in rural areas with better livelihood options by 2010.

Introduction

For more than two decades agroforestry has been heralded and actively promoted as a practical and beneficial land-use system for smallholders in developing countries. This promise led to the establishment of the International Centre for Research in Agroforestry (ICRAF) in 1978 and its support by the Consultative Group for International Agricultural Research (CGIAR) since 1991. Functioning initially as an information council during the 1980s, ICRAF in 1991 shifted its emphasis towards strategic research to strengthen the scientific basis for advocating agroforestry. This significant investment in process-oriented research greatly enhanced understanding of the opportunities and limitations of agroforestry and led to more critical assessments of its potential use (Sánchez 1995, 1999). As a result, agroforestry progressed from being an indigenous practice of great potential and romantic appeal to that of a science-based system for managing natural resources (Sánchez 1995; Izac and Sánchez in press).

By the mid-1990s, the farm-level impact of agroforestry research was beginning to be observed in Africa and Asia. Much of this impact was a direct consequence of farmer-participatory research undertaken by ICRAF and its partners. Between 1992 and 1997, the number of farmers participating in on-farm research increased from 700 to more than 7000 (ICRAF 1998). Through such research, farmers acquired experience with the innovations, and this experience laid the foundation for pilot dissemination projects, and increased exposure to other farmers who did not directly participate in the research phase.

By 2000, several thousand smallholders in western Kenya were using short-term leguminous fallows and biomass transfer[1] to improve the fertility of depleted yet high-potential soils. In Embu District of eastern Kenya, more than 3000 farmers were planting tree

ISSN 0961-4524 print/ISSN 1364-9213 online 040407-10 © 2001 Oxfam GB
Carfax Publishing DOI: 10.1080/09614520120066693

legumes in fodder banks for use as an inexpensive protein supplement for their dairy cows. In Zambia, more than 10,000 farmers were using short-rotation improved fallows to restore soil fertility and raise maize crop yields. In the semi-arid Sahel region of West Africa, hundreds of farmers were adopting live hedges to protect dry-season market gardens from livestock. And in Southeast Asia, similar success was being observed on degraded sloping lands where hundreds of farmers in the southern Philippines were adopting contour hedgerow systems based on natural vegetative strips.

These examples from diverse ecoregions illustrate the emergence of sustainable agroforestry solutions to problems of land degradation, poverty, and food security in rural areas. The long-awaited promise of agroforestry as a science and as a practice is beginning to be realised at farm level. But impact on such limited scales, while certainly encouraging, cannot alone justify the millions of dollars invested in agroforestry research at ICRAF and national institutions over the past 25 years. Research institutions cannot rest on their laurels, having merely demonstrated that agroforestry has real potential. Instead, they must develop and implement strategies to ensure that millions of low-income farm families worldwide can capture the benefits of agroforestry.

This paper describes the approach that ICRAF has taken since 1997 to address the challenge of scaling up the adoption and impact of agroforestry innovations. To provide a conceptual foundation for scaling up, the first section provides a short overview of the literature and field experience regarding the constraints to adoption and impact. The next section describes institutional changes in the late 1990s that have imbedded development within ICRAF's strategy, structure, and operations. These two sections form the basis of ICRAF's development strategy, which is outlined in eight focal areas of intervention and investment.

The fundamentals of adoption and impact

To increase the scale of adoption and the impact of innovations, action must be based on an understanding of the dynamics of adoption and the critical factors that determine whether farmers accept, do not accept, or partially accept innovations. Adoption of agricultural innovations has been intensively researched since the seminal work of Grilliches (1957) on hybrid corn in the USA. Rogers and Shoemaker (1971) described adoption by individuals as an 'innovation-decision process', consisting of four stages as follows:

- *Knowledge*. The individual is exposed to the existence of the innovation and gains some understanding of how it functions.
- *Persuasion*. The individual forms a favourable or unfavourable attitude towards the innovation.
- *Decision*. The individual engages in activities that lead to a choice to adopt or reject an innovation.
- *Confirmation*. The individual seeks reinforcement for the innovation decision with the option of reversing that decision based on increased experience with the innovation.

The innovation-to-decision period is the length of time taken to go through this process, and it varies among individuals. Rogers and Shoemaker (1971) classified individuals by the length of their innovation-to-decision periods, categorising them as 'innovators', 'early adopters', 'early majority', 'late majority', and 'laggards'. This gave rise to the characteristic 'S' curve of cumulative adoption over time.

Schutjer and Van Der Veen (1977) noted that it is vital to consider the characteristics of alternative agricultural innovations when attempting to understand the importance of various

constraints to adoption. One such characteristic is divisibility of technology. A divisible technology can be adopted to varying degrees. For example, innovations such as seed or fertiliser can be used across any proportion of a farm depending on the farmer's choice and resource limitations.

Low-income farmers are more likely to experiment with a divisible innovation because it can be initially tested on a small scale. Many agroforestry innovations are divisible and can be readily tested and evaluated by farmers in relatively small portions of the farm, such as along boundaries and in home gardens. Others, such as agroforestry for soil and water conservation, require an approach involving a whole farm, community, and watershed. This differentiation has important implications for scaling-up strategies.

Relatively few studies have explicitly examined the adoption of agroforestry innovations. Scherr and Hazell (1994) proposed a framework for analysing adoption from the perspective of a farming household. They divide the process into six sequential stages: (1) knowledge of the resource problem, (2) economic importance of the resource, (3) willingness to invest long term, (4) capacity to mobilise resources, (5) economic incentive, (6) institutional support. Using this framework, Place and Dewees (1999) examined the effect of policy on the adoption of improved fallows, highlighting the importance of mineral fertiliser policy, production, and distribution of planting material, and property rights. Franzel (1999) identified a number of factors that affect the adoptability of improved tree fallows. These were broadly grouped as factors affecting feasibility (such as the availability of labour, institutional support), profitability, and acceptability (perceptions of the soil fertility problem, past investments in soil fertility, wealth level, access to off-farm income). Franzel concluded that it is important to offer farmers different options to test, and to encourage them to experiment with and modify practices. The importance of farmer adaptation of innovations was also highlighted in a recent study on the adoption of alley farming in Cameroon (Adesina et al. 2000).

On the basis of relatively few empirical studies directly related to agroforestry, it is difficult to draw definitive conclusions about what are the most important factors affecting adoption and their implications for scaling up. However, drawing on the available literature, in particular the recent reviews of Franzel (1999) and Place and Dewees (1999), several factors are most likely to affect adoption of agroforestry innovations:

- biophysical adaptation of the innovation—the ability of the innovation to adapt and be adapted successfully to the farm environment;
- profitability of the innovation—in a broad sense to include consideration of returns to labour and land as well as financial profitability;
- farmer's awareness of the innovation;
- access to land, labour, and water;
- access to social capital, particularly where group action is needed;
- availability of essential inputs, particularly seed;
- access to financial capital;
- degree of risk and uncertainty.

Over the past decade, on-farm participatory research has played a crucial role in understanding and addressing the factors listed above. This approach has led to an increased role of farmers in diagnosing problems and in identifying and evaluating possible solutions. The result is better appreciation of farmers' perspectives and constraints, a more focused, farmer-centred research agenda—and, ultimately, higher levels of adoption (Franzel et al. 2001).

Promoting and facilitating farmers to adopt innovations are aimed at achieving positive impact. Yet the complexities of impact and the means to assess it are not well understood. The

types of impact that result from adopting innovations can be broadly classified as economic, social, biophysical, and ecological—and are generally a combination of all four. To be more fully understood, impact has to be viewed from different spatial and temporal scales, as well as from the perspective of different stakeholders (Izac and Sánchez 2001).

Impact assessment is best undertaken through a framework that explicitly recognises the existence of trade-offs. For example, studies undertaken by the Alternatives to Slash-and-Burn Consortium in southern Cameroon demonstrated a clear trade-off between the global environmental benefits (carbon sequestration and biodiversity) and local profitability to farmers across a range of alternative land uses (Ericksen and Fernandes 1998). The research and development challenge is to understand the impact of adoption at these different scales (in this case, local versus global) and by different stakeholders (farmers versus the global community), and to optimise the trade-offs across a range of assumptions. Policy makers can then use this information to apply various policy instruments (for example, market intervention, land reform, infrastructure investments) that can affect the rate of adoption (Izac and Sánchez 2001).

Impact over different temporal scales is an issue that is especially relevant to agroforestry in the developing world. Low-income farmers tend to discount heavily the potential long-term benefits of trees, opting instead for short-term practices that maximise food production and income. This slows the spread of soil conservation practices that have long-term benefits when the short-term effect on food production and income is negative (Fujisaka 1991). In contrast, farmers readily adopt agroforestry practices with short-term benefits such as short-term improved fallows (Kwesiga et al. 1999). The challenge for agroforestry research and development is to develop and introduce a range of options that provide an optimal trade-off between the long- and short-term expectations of farmers.

Institutional change: towards a research and development continuum

Now, after three decades of strong support to both international and national agricultural research, there are signs that growth has stagnated. Increasingly the call is for researchers to demonstrate the impact of past investments. This call is echoed at national levels where, in a climate of right-sizing in the public sector, ministries responsible for national budgets are starting to view public research as an extravagance. But the case for publicly funded research to address the challenges of food insecurity, poverty, and environmental degradation remains as compelling as it was in the 1960s. Research institutions must reinvent themselves to demonstrate that they are valuable and competitive investments of public resources. To this end, in the late 1990s, ICRAF embarked on institutional changes to foster and support greater impact of its research investments.

ICRAF's medium-term plan for 1998–2000 documented for the first time a clear institutional commitment to development impact (ICRAF 1997). The plan articulated three pillars of research—tree domestication, soil fertility replenishment, and policy—and two pillars of development—acceleration of impact, and capacity and institutional strengthening. In a departure from traditional CGIAR approaches to disseminating knowledge and technologies—that is, a reliance on networks, publications, and training as the principal vehicles of technology transfer—ICRAF and its partners adopted a more comprehensive and iterative functional model based on a continuum, from strategic research to applied research to adaptive research to adoption by farmers: a research and development continuum.

With this new approach, ICRAF and its partners accepted joint responsibility and accountability for ensuring the greater adoption and impact of agroforestry innovations. By proactively engaging in the development process, ICRAF could see four distinct benefits in institutional effectiveness:

- *Faster and greater impact*—by adopting a proactive rather than a passive approach to knowledge and technology dissemination, agroforestry innovations would reach more farmers, more quickly.
- *Innovation and learning*—by working directly and collaboratively with development partners in the field with farmers, opportunities would be greater for innovation and learning that would strengthen the knowledge and experience base of ICRAF and its scientists and thus share that asset with others.
- *A more relevant, demand-driven research agenda*—the innovation and learning associated with direct engagement in development would provide feedback to research on how innovations performed and generate hypotheses for future research.
- *Institutional credibility*—by demonstrating a clear commitment to greater impact of development, ICRAF would become a more credible partner in development and therefore could attract support from a broader group of stakeholders than would be the case if it assumed a strict 'research only' mandate.

In January 1998, ICRAF created a development division—the first of its type in the CGIAR system. The new division was established to complement the existing research division, which was responsible for planning and implementing an integrated natural resources management agenda related to agroforestry (ICRAF 2000; Izac and Sánchez 2001). The development division brought together the existing development-oriented programmes and units of the centre: systems evaluation and dissemination, capacity building and institutional strengthening, and information. Both regionally and globally, the development division took on a more explicit, hands-on role in identifying, catalysing, and facilitating agroforestry-based opportunities for greater adoption and impact.

Integrating research and development activities at ICRAF takes place principally in the field in each of the centre's five operational regions: east and central Africa, southern Africa, the Sahel, Southeast Asia, and Latin America. Strong regional leadership with an understanding and appreciation of the research and development continuum has been a major element of success thus far.

A second success factor has been the high level of 'buy-in' from the ICRAF board of trustees and from senior and middle management, including those individuals whose background and principal interest is research. After some initial concerns expressed about dilution of focus, lack of comparative advantage, and potential competition for limited resources, support and commitment have been strong. The understanding is clear that functioning through a research and development continuum actually strengthens support for research, and that greater field impact enhances the quality of scientific achievement. Both factors have been shown at ICRAF to have strong motivational effects on research scientists.

A third critical factor has been on-the-ground partnership with development organisations. ICRAF's comparative advantage has been and remains in applying science to development through agroforestry. Rather than try to substitute for specialised institutions that have experience and expertise in development, ICRAF has sought to add value to their efforts through strategically focused interventions in development efforts in a partnership mode. From being a scientific leader in agroforestry with unique global knowledge and experience in integrating trees into farming systems and rural landscapes, ICRAF is now contributing importantly to the work of its development partners by providing technical support, training, and information, and by supplying seed.

An important issue to consider is whether the need for a development division within ICRAF will continue. The division has drawn interest and support during its first three years.

In the longer term, however, it may be more appropriate that development becomes a mainstream way of doing business in much the same way that research on farming systems, environmental issues, and gender concerns have become mainstream in many research organisations after an initial period of special programme status.

Strategy for scaling up: crucial areas of investment and intervention

In September 1999, a two-day workshop at ICRAF brought together 23 national and international research and development specialists to discuss and identify the key elements of a successful scaling-up strategy (Cooper and Denning 2000). Drawing on seven case studies, participants identified ten essential and generic elements (Figure 1).

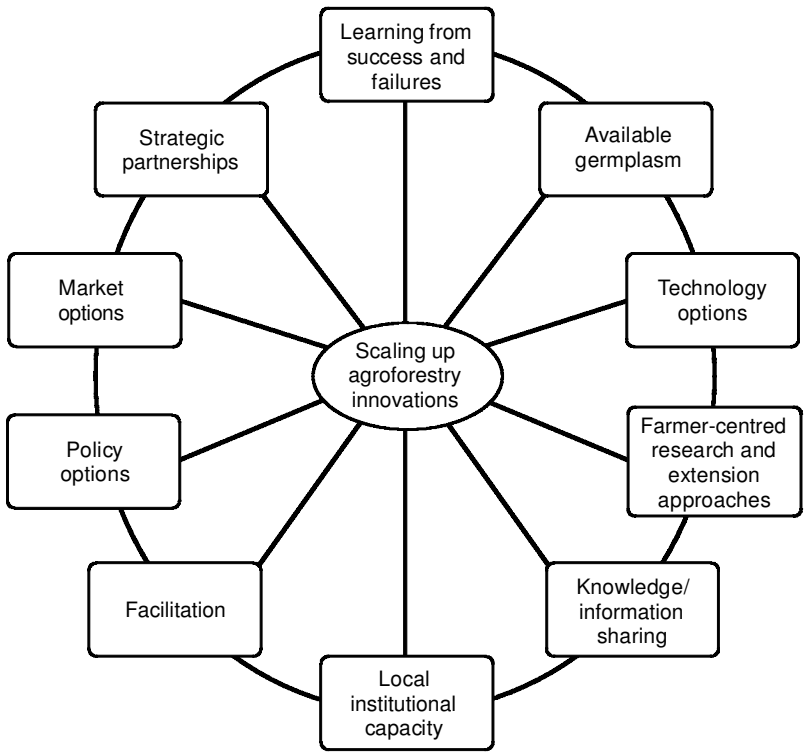

Figure 1: Essential elements for scaling up agroforestry innovations (from Cooper and Denning 2000)

Next, ICRAF sought to achieve greater adoption and impact by considering its institutional comparative advantage, using the outcome of this workshop, and referring to adoption literature. It devised a development strategy around eight areas of intervention and investment, as described below.

Policy makers

Public policy decisions can profoundly affect uptake and impact of innovations (Place and Dewees 1999). The 1998 CGIAR system review (Shah and Strong 1999) highlighted the

importance of policy research and dialogue in bringing about a better enabling environment. ICRAF is increasing efforts to facilitate and catalyse policy change through collaborative research and through formal dialogue with important policy- and decision makers.

Higher education institutions

ICRAF's success in both research and development critically depends on the capacity of partners: individuals and institutions. In 1993, ICRAF established the African Network for Agroforestry Education (ANAFE) as a collaborative mechanism for universities and colleges teaching agroforestry and related subjects. By 2000, ANAFE had 103 member institutions in 35 countries, becoming the largest network of education institutions in Africa (ANAFE 2000). The goal of ANAFE is to promote the institutionalisation of agroforestry in higher education institutions in order to produce graduates better equipped to develop, disseminate, and implement sustainable agroforestry and natural resource management practices. In 1998, a similar network was established in Southeast Asia with 35 collaborating institutions.

Basic education institutions

Basic education institutions have enormous potential to expand the reach of agroforestry information and technologies. Building on related investment and experience by other institutions in environmental and health education, ICRAF has initiated a Farmers of the Future programme that aims to reach the future generation of farmers and, through them, to influence the current generation. The main areas of intervention will be education policy change, improvement of curricula and teaching resources, awareness creation, pilot projects linking schools and communities, and education systems research.

Seed supply systems

The lack of seed, seedlings, and other planting material is frequently identified as the most important constraint to greater adoption of agroforestry (Simons 1997). This shortage often disappoints farmers who must depend on relatively ineffective public and private sectors. ICRAF's focus in this area is to develop and apply better methods of forecasting germplasm needs, and to help establish effective, low-cost, sustainable, community-based systems of producing and distributing germplasm.

Community organisations

It is increasingly recognised that empowering local communities to control their own decisions and resources is fundamental to any successful development strategy (Binswanger 2000). A trend is emerging in developing countries towards devolving power to local government and increasingly to local communities. This devolution is coupled with building capacity in the community. ICRAF's experience with introducing and adapting the Landcare movement in the Philippines demonstrates the key role of community organisations in helping to scale up the adoption and impact of agroforestry innovations (Mercado et al. this issue). ICRAF sees a continuing role in catalysing and documenting institutional innovation through action-research with development partners. There is also a continuing need to develop and share relevant agroforestry innovations as entry points for community action.

Product marketing systems

Better markets for agroforestry products provide a way for poor farming households to generate income (Dewees and Scherr 1996). The key challenge is to improve the structure, conduct, and performance of agroforestry tree product markets and to make those markets accessible to low-income producers. ICRAF plays a role in placing market research in the mainstream of agroforestry research and development programmes, in developing innovative marketing methods, and in building marketing capacity. Another key role is that of a knowledge broker on aspects of agroforestry marketing, including aspects of processing that add value to products.

Extension and development organisations

Mainstream extension organisations and development institutions are often in a position to expand the reach of innovations. Extension contacts are particularly important during the early stages of farmer experimentation with innovations (Adesina et al. 2000). ICRAF is working closely with government extension systems, NGOs, and development projects to catalyse greater adoption and impact. The major contributions are in providing research support and technical advice, studying approaches to dissemination, and helping organisations to share their experiences.

Research institutions

Demand-driven, impact-oriented research institutions are needed to ensure a flow of innovations to rural areas. Yet frequently we find that research agendas are unresponsive to field realities and poorly linked to extension. Through collaboration, training, workshops, and publications (such as this issue), ICRAF has actively promoted participatory on-farm research approaches and the research and development continuum as a potential operational model for national research institutions, for the reasons elaborated earlier in this paper.

Through these focal intervention areas, ICRAF aims to reach 80 million agricultural poor by 2010, providing them with access to agroforestry options that improve livelihoods and sustain the environment (ICRAF 2000). ICRAF's development strategy is founded on strong partnerships and strategic alliances with a diverse group of institutions that share the Centre's mission and complement its expertise and reach.

Conclusions

In 1997, ICRAF set forth on a new and less-travelled path for an international agricultural research centre. Recognising that agroforestry research had the potential to deliver new livelihood options for reducing poverty, improving food security, and sustaining environmental quality, the Centre unilaterally expanded its mandate to include a more proactive, hands-on approach to achieve greater impact.

ICRAF took this unconventional step, first, because the impact of natural resources management research (including agroforestry) had in the past been limited and sporadic, suggesting that the traditional Green Revolution approaches to research and development were not universally appropriate. As we move beyond the food bowls of Asia to meet the challenges of more complex, heterogeneous, and often marginal environments, more site-, farmer-, and community-specific solutions are required. To better understand these circumstances, researchers need to be closer to policy makers and the more direct clients—smallholder

farmers and the change agents who work with rural communities—to test, adapt, and share innovations. Because of this approach, ICRAF's research agenda has evolved in a way that is more relevant to the real needs of, and opportunities for, the agricultural poor.

By directly engaging in the development process through strategic partnerships with development institutions, the impact of research on food security, poverty reduction, and environmental sustainability will be realised more quickly and on a greater scale than with classic technology transfer approaches that use publications as the principal vehicle for disseminating research findings. Research institutions must therefore broaden their thinking and their mandates to the point where they can function as, and be seen as, credible development partners.

The developing world has no shortage of successful and well-publicised pilot projects. But these success stories have rarely been replicated on a scale that has made them cost effective. 'Like expensive boutiques, they are available to the lucky few' (Binswanger 2000). Thus a clear and demonstrated commitment of research institutions to development, and a willingness to be held accountable for broader-scale impact, appears not only logical but also a social and economic necessity for future investments in research.

Note

1 Leguminous fallows are natural fallows enriched with planted legumes to improve soil fertility. Biomass transfer is the application of leafy biomass from hedges to crop fields to improve soil fertility.

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