

Economic Growth and Watershed Management: Drivers of Research and Development Innovations

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Abstract

The Municipality of Lantapan is wholly contained in the Manupali watershed, Bukidnon Province, in the southern Philippines. Lantapan's economy, landscape, and political environment exemplify tensions between rapid population growth, economic changes and environmental stress. Recent growth in agribusiness has spurred changes in land use and economic and social structures. This paper discusses the research innovations and lessons learnt from the World Agroforestry Centre's (ICRAF) work in the Manupali watershed. Initially, the centre's study focused on assembling the elements of realistic buffer zone management in Mount Kitanglad Range Natural Park on the northern border of Lantapan. Agroforestry intensification and community-endorsed social contract were important elements of effective buffer zone management. The Landcare approach, which centres on formation of Landcare groups, was used to rapidly disseminate agroforestry and conservation farming technologies, with apparent success. Thirteen percent of farming households adopted conservation technologies, covering 17% of cultivated land and 23% of critical areas in the watershed. However, the Landcare groups began to backslide a year after they started, due to availability of off-farm employment in the agribusiness sector and the ambivalent support of the municipal government, which encouraged the proliferation of agribusinesses to boost the rural economy. To address this dramatic change in farmer decisions and local government priorities, ICRAF refocused its research activities on the multiple functions of trees, environmental services, and policy innovations. The lesson learnt is that economic growth and watershed management goals are key drivers to research and development innovations. Research and development organisations need to be adaptive in their management, learning to alter their programmes to make them relevant to local needs. Salience and legitimacy are thus essential ingredients in research and development innovations.

Keywords: Landcare, agroforestry, adaptive management.

1. Introduction

The watersheds of the Philippines comprise more than half of the country's total land area, providing vital economic and environmental services and livelihood support to more than 20 million Filipinos living within these watersheds. In the Philippines 'watersheds' are generally characterised as 'uplands'

and both terms are often used interchangeably¹. Population growth and the lack of ability of the urban economy to absorb excess labour prompted lowlanders to migrate to the uplands. As a result, upland migration continues, exerting more pressure on land and forest resources. Hence, 80% of watersheds have been declared “critical” by the Philippines Department of Environment and Natural Resources (DENR). The availability of cheap labour and land resources has also made the uplands ideal for investments in corporate farming and agribusiness. This has encouraged rapid urbanisation and changes in economic and social structures (Catacutan, 2005). While there is scope for economic growth in the uplands, there is more pressure on the natural capital, as a result of competition in the use of natural resources by smallholders and the agribusiness sector. Upland dwellers therefore face dramatic changes as they explore new economic opportunities brought about by the agribusiness sector (Catacutan and Mercado, 2003). Forest encroachment, expansion of intensive agriculture and unsustainable farming practices are just some examples of the many complex issues confronting the uplands (Garritty et al, 2002). Biophysical conditions in the uplands vary within small areas and short distances according to soil type, fertility, climate, topography and vegetation. Hence diversity, complexity and change characterise watersheds in the Philippines (Catacutan and Mercado, 2003).

The issues surrounding watershed management are ecologically, socially, economically, and politically complex. This complexity combines with limited understanding of watershed management issues, and the unpredictable nature of many natural (Taylor et al, 2006) and human-induced events, including land-use change and development trends, to contribute to the uncertainty of management decisions and research and development (R&D) outcomes. Changing local priorities further increase uncertainty and contribute to the controversy in the way watershed resources are managed. Increasingly, adaptive management is suggested as a strategy for addressing rapid environmental and social change (Taylor et al, 2006). Adaptive management was first introduced for use in natural resource management by Holling (1978). It is a systematic process of continuous improvement of practices by learning from the outcomes of operational programmes and responding to changing demands of the environment in which the programme operates. Feedback and adjustments are key elements of adaptive management. The implication is that R&D organisations must learn to adjust their programmes to address dynamic changes in social, economic and environmental settings.

This paper is based on a decade of ICRAF work in the Manupali watershed in the southern Philippines and discusses how economic growth and watershed management issues influence or drive the R&D innovations of assisting organisations in rapidly growing economies. Although ICRAF was not

¹The Department of Environment of Environment and Natural Resources has defined upland areas in the Philippines as landscapes of slopes equal to or greater than 18%, including the table land and plateaux at higher elevations, which are not normally suited to wet rice (Stark, 2000). However, according to Sajise and Ganapin (1990), there is inconsistency on what constitutes an upland area, depending on the agency or kind of project involved.

Furthermore, the watershed has a unique ecological diversity characterised by a combination and interplay of connected landscapes with high natural biodiversity, intensive agricultural practices, economic and developmental impacts across the landscape, resource-poor upland communities, and various interest groups (Bellows et al, 1995). Communities living within the watershed depend mainly on agriculture and are cultivating small land holdings, averaging about 2 ha in size, for subsistence and commercial purposes. Major agricultural products include temperate vegetables, rice, maize, sugarcane and banana.

Lantapan has a total land area of 35,465 ha, of which 21,215 ha is classified as 'alienable and disposable land', while 14,250 ha is public land. The municipality is divided into 14 barangay (the local government administrative unit). Lantapan has an average elevation of 600 m, which increases to a maximum of 2,938 m as one proceeds northwest to the MKNRP. About 70% of the area is sloping with an incline of greater than 10%. Soil types are generally classified as Adtuyon and Kidapawan clays, which are mostly well drained, with clayey surfaces and subsoil horizons. They are slightly to moderately acidic, with a low organic matter content and high P fixation capacity, and a low capacity to retain nutrients (Coxhead and Buenavista, 2001). The average annual rainfall is 2,470 mm and air temperature and solar radiation decrease with elevation (Laurente and Maribojoc, 1997).

Lantapan's population has increased rapidly since the 1970 census. Until 1980, the annual average growth rate was 4.6%, much higher than the national average of 2.4% (Paunlagui and Sumingit, 2001). In 1995, the National Statistics Office recorded a total population of 36,943, which had increased to 42,383 by 2000. Given this rate, it was projected that the present population would triple in the next 15 to 20 years. Paunlagui and Sumingit (2001), who computed the man-land ratio in Lantapan, suggested an increasing scarcity of agricultural land for production at 0.15 ha per person, given the projected population of 114,198 in 2030. The ethnic composition is 25% indigenous Talaandig, 14% Bukidnon, 51% Dumagat (lowland migrants), and 10% Ifugao from Benguet Province in northern Luzon. Since the Dumagat migrants are the majority, the dominant language is Cebuano or Visayan. As of 1995, the literacy rate was recorded at 92% for those aged 5 to 35 and over.

Lantapan has an economy based on agriculture and until recently, 90% of households were dependent on smallholder farming. However, this has changed since Mt Kitanglad Agriventures and Dole Skyland Philippines, two large highland banana production corporations, started operations in the late 1990s. In 2003 officials from the Local Government Unit (LGU) estimated that about 60% of the total labour force of Lantapan was employed by these companies or by commercial swine and poultry farms, while others had seasonal employment on large maize and vegetable farms and sugarcane plantations. The on-going shift to large-scale commercial agriculture by large corporations and rich farmers has pushed smallholders to ever smaller plots in less productive and more environmentally fragile areas.

Table 1 shows the different crops planted in Lantapan. Maize is grown everywhere, but with corporate banana farms on prime land have pushed maize and vegetable production towards the lower footslopes of the MKNRP. The lower eastern boundary, irrigated by MANRIS, used to be planted exclusively with rice, but due to low prices farmers are shifting to maize and sugarcane.

Table 1: Crops and area planted in Lantapan

Crops planted	Area (ha)
Maize (HYV, OPV white & traditional variety)	4,081
Irrigated rice	698
Vegetables	
Tomato	58
Broccoli	27
Ampalaya (<i>Momordica charantia</i> L.)	1
Cabbage	104
Carrot	13
Cauliflower	22
Sweet pepper	21
Sweet pea	16
Squash	27
Bean	17
Chayote (<i>Sechium edule</i>)	19
White bean	6
White potato	51
String bean	1
Chinese cabbage	73
Singkamas (<i>Pachyizus erosus</i>)	3
Sub-total	459
Coffee	396
Fruit trees (lanzones & mango)	45
Rubber	42
Banana	2,000
Sugarcane	3,046
Cassava	2
Abaca	27
Total	10,796

Source: Municipal Agriculture Office, 2003.

Two sugar milling companies about 30 km southeast of Lantapan encourage sugarcane production even in areas of higher elevation. At middle altitudes (500-800 masl), maize is grown with coffee as a secondary crop along with banana, root crops, and fruit and timber trees, while in higher elevation areas maize is planted alongside temperate vegetable crops such as potato, cabbage, cauliflower,

lettuce, bean and tomato. While the Philippines' primary vegetable production area is northern Luzon, Lantapan is considered the vegetable basket of the south. Lantapan's pattern of agricultural expansion involved the replacement of forest and permanent crops by annual crops, and the spread of annual cropping to high altitude and steep sloping areas, pushing back the forest frontier. According to Lal (1990), this type of agricultural expansion and the intensification of cultivation in sloping lands causes dramatic increases in soil erosion rates in humid tropical areas, causing further land degradation.

The inhabitants of the Manupali watershed exert pressure on both the remaining protected forests and the managed ecosystems. Recent inventories by Heaney and other conservationists (cited in PENRO, 2002) revealed that the number of birds and mammals has decreased significantly. Amoroso (1997) also noted an alarming rate of habitat destruction due to human activities, including conversion of forestlands into agricultural production. Natural population growth and in-migration resulted in farmers cultivating steeper slopes and poorer soils, with shorter fallow periods. The growth of agribusiness also exacerbated the situation.

The conditions of the Manupali watershed are not unique among Philippines watersheds. The interplay of economic issues and watershed management problems lends itself to greater interest for scientific studies aimed at contributing to a body of knowledge that informs decision makers and guides the decision-making process of local communities.

3. Research and development framework

At the height of popularity of participatory watershed management approaches in 1993, the Sustainable Agriculture and Natural Resource Management (SANREM), a Collaborative Research Support Programme (CRSP), funded by the US Agency for International Development (USAID) embarked on its global effort to develop a new model for research on sustainable agriculture and natural resource management (Hargrove et al, 2000). The Manupali watershed was one of SANREM's three global sites. During the first phase of SANREM (1993-1998), R&D interventions were concentrated in Lantapan since it encompasses more than half of the Manupali watershed. Drawing on the Brundtland Commission report (Coxhead and Buenavista, 2001) and lessons learnt from the global experience with integrated conservation and development projects (Wells and Brandon, 1992; McNeely, 1995), SANREM's research approach was built on participation, interdisciplinary collaboration and multi-stakeholder cooperation at various social, economic, political and biophysical levels of the watershed, with ICRAF leading the Biodiversity Consortium of the Philippines under the SANREM project at that time.

The Participatory Learning/Lifescape Appraisal methodology and ICRAF's research during the initial years (1993-1996) documented the land use practices and interactions among community stakeholder across the landscape (COPARD, 1996; Banaynal, 1996). The research report revealed the need to develop an integrated and sustainable buffer zone management programme. The report stated that local communities in the Manupali watershed can become effective partners in watershed management activities as protection of the environment for spiritual, cultural and livelihood purposes is innate in indigenous peoples' cultures (Cairns, 1996). Environmental stress in the watershed was attributed to lack of appropriate technologies and inadequate institutional arrangements to provide a framework for the management of these systems.

3.1 ICRAF's R&D innovations

ICRAF's work in the Manupali watershed concentrated on espousing a more fundamental understanding of people-ecosystem interactions to guide the development of natural resource management processes (Garritty et al, 2002). Research activities were aimed at developing the elements of a workable framework for economic growth and watershed management between local communities and outside stakeholders. The research hypothesised that there are two aspects of sustainable buffer zone and management:

1. Agricultural intensification through a range of agroforestry systems in the watershed to enhance income growth, complemented by other forms of off-farm employment generation in the local and national economy.
2. Community-supported enforcement of the boundaries of the natural forest ecosystem.

ICRAF's research activities focused on both aspects, implemented in succeeding phases. The first phase focused on agricultural intensification through agroforestry and conservation farming, while the second phase emphasised inducing institutional innovations to improve natural resource management. This resulted in the development of grassroots organisations, namely the Agroforestry Tree Seed Association of Lantapan (ATSAL) and the Landcare associations. The current phase focuses on examining economic outcomes and ecosystem services in intensive agroforestry systems as well as institutional arrangements and mechanisms for rewarding ecosystem services. These R&D innovations are implemented progressively.

3.1.1 Phase I: agroforestry intensification

ICRAF researchers investigated appropriate technical options suited to the biophysical and socio-economic conditions of the watershed population, conducting researcher and farmer-managed on-farm experiments. These included tree farming practices and conservation farming with annual crops, both of which have been widely adopted. Component technologies in agroforestry

systems such as soil conservation practices (Mercado et al, 1999) and tree domestication were the technological focus of ICRAF's scientific queries. ICRAF studies found that natural vegetative filter strips (NVS) are effective in controlling soil erosion and could provide a useful low-cost technology in the uplands. The NVS evolved as a variant of the sloping agricultural land technology system when farmers experimented with the hedgerow concept by placing crop residues along the contour lines and leaving the native weeds to re-vegetate in the unplanted strips, eventually forming stable natural barriers to erosion (Garrity and Mercado, 1994; Sabio, 2002; Stark, 2000; Catacutan, 2005). It was found that NVS provide minimal below and above ground competition, and are effective in filtering field runoff by more than 90% in a 40-60% slope (Garrity et al, 1998; 2002; Catacutan, 2005). The advantages of NVS were summarised as follows: 1) control of soil erosion by more than 90% and improved water infiltration during heavy rains; 2) low labour and cost requirements for establishment and maintenance; 3) minimal competition with adjacent field crops; 4) filtering of pesticides, nitrates and soluble phosphorus from water runoff; 5) facilitation of subsequent land preparation and crop management; and 6) creation of a good foundation for farmers to develop agroforestry farms and increase productivity.

Parallel to this, ICRAF researchers also experimented with various agroforestry tree species in the different landscape positions in the watershed. The aim was to provide best-bet tree species for farmers to select (table 2). Once the NVS were in place, many farmers enriched them by planting timber trees, annuals or perennials on or above the NVS to compensate for the lost crop area, and to improve total farm productivity. Timber trees including *Eucalyptus*, *Acacia* and *Gmelina arborea*, and fruit species such as mango, rambutan, durian, citrus and jackfruit were planted. Spacing of trees depended upon each farmer's future plans. With closer spacing, tree canopies closed between three to four years after planting, thus limiting the penetration of sunlight to the alley crops. Except when farmers opted for shade-tolerant plants or introduced ruminants under the trees, this system was not feasible for continuous cropping in the alleys. Wider alleys allowed farmers to plant annual food crops between the rows of the trees and grow fodder grasses between trees along the rows. A wider spacing of NVS was found to be very useful for farmers who wished to continue growing food crops as the fruit and timber trees matured. Farmers also experimented with cash perennial hedgerows, like pineapple, banana, guava and coffee, which were found to earn more than maize or annuals planted in the alleys. As a consequence, farmers progressively reduced the spacing of hedgerows in order to have more cash crop rows. Forage legumes like *Flemingia congesta* and *Desmodium rensoni* were also planted by farmers either along the contour lines as tree hedgerows, along farm boundaries, and in small woodlots. ICRAF described this process as the evolution of smallholder agroforestry.

Table 2: Tree species evaluated in Lantapan, 1998

Scientific name	Common name
<i>Acacia aulacocarpa</i>	Aulacocarpa
<i>Acacia auriculiformis</i>	Auriculiformis
<i>Acacia crassicarpa</i>	Crassicarpa
<i>Acacia mangium</i>	Mangium
<i>Albizia lebbbeckoides</i>	Black wattle
<i>Eucalyptus deglupta</i>	Bagras
<i>Eucalyptus pellita</i>	Pellita
<i>Eucalyptus robusta</i>	Robusta
<i>Eucalyptus torelliana</i>	Torelliana
<i>Eucalyptus urophylla</i>	Urophylla
<i>Gmelina arborea</i>	Gmelina
<i>Grevillea robusta</i>	Grevillea
<i>Mesopsis eminii</i>	Musizi

3.1.2 Phase 2: community-endorsed watershed management strategies

The municipal government natural resource management plan

In 1996 a local-level and demand-driven natural resource management planning process began in the municipality of Lantapan. At that time, the town mayor felt it would be beneficial to make use of the assembled scientific and research outputs of existing research institutions in the municipality by incorporating these in a comprehensive plan (Catacutan, 2005). The alarming condition of the locality's environment as well as the availability of information and technical assistance from various research institutions prompted the local government to prioritise natural resource management as a core programme in its agenda, and the Natural Resource Management and Development Plan (NRMDP) was developed. The research-based environmental information from SANREM provided much of the plan. While the planning process was designed by the local government, ICRAF's contribution stemmed mostly from its research work on soil and biodiversity conservation. One remarkable feature in the natural resource management process in Lantapan was the creation of a local multi-sectoral body, the Natural Resource Management Council (NRMC), constituted from representatives of community-sector groups, technicians and legislators. The local planning council was designated to develop the NRMDP as

“a stronger community partnership towards well managed natural resources and an ecologically balanced environment for sustainable development in Lantapan by the year 2002”.

The NRMDP had three key pillars: 1) soil, 2) water and 3) biodiversity conservation. To support these, the NRMDP also identified and implemented capability-building programmes for the NRMC, LGU officials, and the community. ICRAF maintained a strong partnership with the local government to

help achieve mutual goals and benefits for the farmers of Lantapan. It worked with the LGU in institutional development and directly with the farmers in technology development, dissemination and adoption. Currently ICRAF is leading a major dissemination effort under the NRMDP's biodiversity and soil conservation components. It employs the Landcare approach as a people-centred movement for dissemination, promotion and adoption of conservation farming techniques such as NVS (an effective alternative to labour intensive soil conservation technologies), and entrepreneurial production of good quality planting materials for important tree species through nursery establishment and other improved agroforestry systems.

The Landcare approach

Landcare commenced in Lantapan in 1998, fostered by the activities of ICRAF, with support from a project funded by the Australian Centre for International Agricultural Research. Landcare is a farmer-centred programme involving farmer-to-farmer knowledge sharing, training, and capacity building. As conceived by ICRAF, the Landcare approach involves technical and institutional innovations with three cornerstones, 1) appropriate technologies, 2) institution building, and 3) partnerships. The Landcare programme in Lantapan built on ICRAF's earlier experience in Claveria, Misamis Oriental to the north (Arcenas, 2002; Sabio, 2002; Catacutan, 2005) and the prior interventions of an array of organisations under the SANREM programme. The ICRAF Landcare team comprised two experienced facilitators and four intern facilitators. The programme began with a broad information campaign on environmental issues and conservation technologies, especially NVS. The campaign was implemented in all 14 barangays of the municipality. A survey was conducted to determine the level of farmers' interest. As a result, seven barangays in the upper part of the municipality were given priority. Major activities in these barangays included slide shows, cross-farm visits, and training, often repeated at the level of the local community or 'sitio'. The training involved half-day or whole-day sessions that usually began with hands-on training in establishing NVS or with training in nursery management. The training was supported by visits to farms where the practices had already been adopted. The first Landcare group was formed six months after the information campaign, in May 1999.

The recorded rate of adoption of conservation farming during the implementation of the Landcare programme was impressive. By mid-2006 two of main conservation measures, contour barriers and agroforestry, had been adopted by 977 farmers, or about 18% of the total number of farm households in Lantapan (though not all households were potential adopters). Of these, 789 had adopted during the Landcare programme (figure 2). The total area under conservation measures was about 1,229 ha (43% under NVS and 57% under agroforestry). This represented 17% of cropped land, 14% of land under maize and vegetables, and 23% of 'environmentally critical' land, suggesting a significant impact at the landscape level. However, these figures do not account for any 'dis-adoption' (failure to maintain NVS or planted tree seedlings), the rate of which has not been measured.

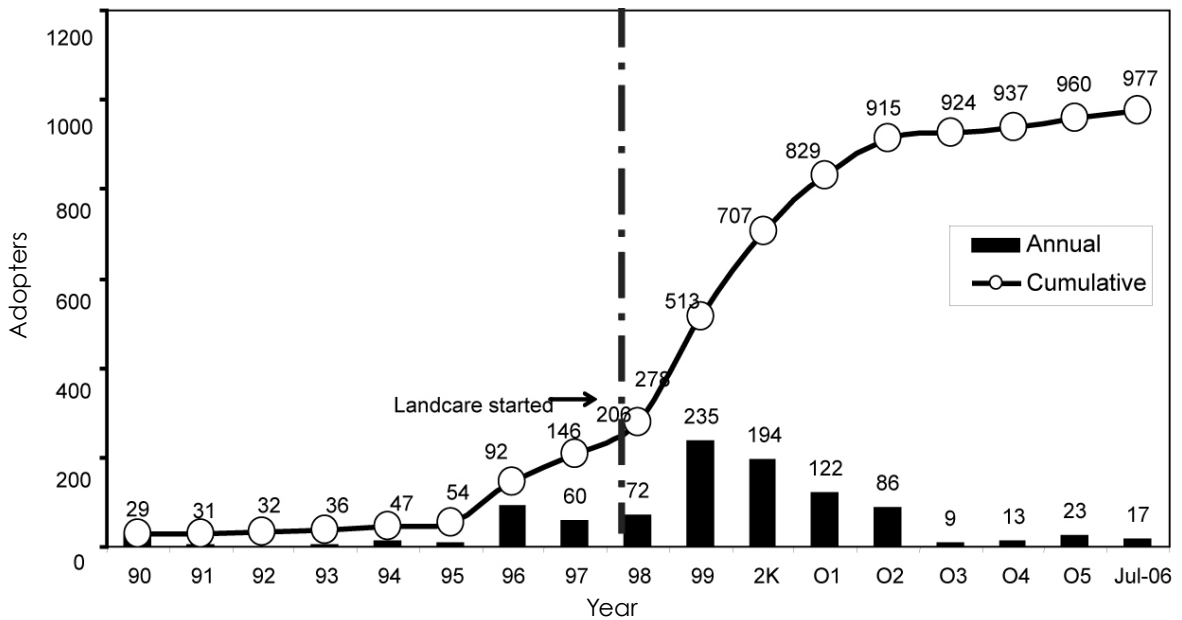


Figure 2: Adoption of natural vegetative filter strips (NVS) and agroforestry

There was a rapid formation of Landcare groups, usually at the sitio level, and soon a Landcare Association was established with 62 local groups and 840 registered members (though in practice membership was quite informal; Catacutan et al, 2006a). These groups were an important source of information on conservation practices for their local community and encouraged members and others to work together, especially in the establishment and maintenance of communal Landcare nurseries. Landcare groups manifest a social capital at the sitio and barangay levels. However, many groups became inactive once the initial adoption of NVS and/or tree planting had occurred, and especially in those locations where banana plantation development and other agribusiness ventures had led to the demise of smallholder farming (Catacutan et al, 2006a). The banana plantation companies started operations in Lantapan in 2000, and many Landcare farmer-members took employment with the companies or rented their land to these companies (table 3). The decline in Landcare activities was also aggravated by the inconsistent support of the municipal local government. Although local government officials were appreciative of the Landcare programme, they did not provide enough support to boost Landcare activities, expecting instead that the presence of plantation companies would accelerate economic growth in the locality. Overly rapid expansion early in the programme may also have been a factor in the decline of group activity, limiting facilitators' capacity to follow up on existing groups. By mid-2003 the number of active groups had dropped to 12, with 45 groups reported to have disbanded though individual members may still have participated in Landcare activities and some groups had the potential to re-form around new activities. Nevertheless, the Landcare Association remains reasonably active and has the potential to take on more aspects of the Landcare programme, especially the provision of training to outside groups. The Landcare Association represents a higher level of social capital that is linked to a network of other service providers, such as NGOs.

Table 3: Reasons for participation decline and group disintegration

Reasons	No. of informants	Rank
Employment in the corporate and private sector	48	1
Transfer of residence (due to unrest and security problems)	21	2
Lack of leadership	19	3
Out-migration in search of better future	8	4
Personal dissatisfaction & frustrations (e.g, unapproved livelihood proposals etc)	8	4
Other	2	5
TOTAL	106	

A recent evaluation of the impacts of Landcare concluded that its contributions to better lives for the rural poor included increased farm incomes, improved access to credit, reduced dependency on external farm inputs, diversification of farm operations and livelihood strategies, and enhanced access to efficiently functioning markets and market information; ecological impacts included maintenance of ecological integrity, protection and/or increase of biological diversity - particularly of indigenous species, prevention of land degradation, and protection of air and water quality.

The Agroforestry Tree Seeds Association of Lantapan

As mentioned above, on-farm trials were set up to evaluate the growth performance of various agroforestry tree species across different landscape positions in the watershed (table 2). As part of a participatory research strategy, farmer-cooperators were involved in the selection of tree species to be tested, and were trained on seed collection and processing, seedling production techniques and nursery establishment (Catacutan et al, 2006b).

After about a year of working with farmers in nurseries and on farms to enhance the diversity and management of tree-based production systems, it became obvious that there were limited seeds or planting materials available. Commonly, small quantities of seeds from locally-grown trees were collected by and exchanged among small networks of farmers, and few others purchased seed or seedlings within or outside Lantapan (Koffa and Garrity, 2001). A case study conducted by Koffa and Roshetko (1999) to assess the seed collection, processing and diffusion practices of Lantapan farmers investigated the major knowledge gaps in standardised methods of seed collection. The findings were presented in a workshop attended by 15 farmer-cooperators (from the on-farm trials) and local seed collectors interested in seed technologies. After the workshop the farmers decided, with facilitation from ICRAF, to organise themselves into the association of seed producers now known as ATSAL (Koffa and Garrity, 2001).

ATSAL was organised to serve as a unifying body that harnesses collective will, skills, talents and efforts in meeting five objectives: 1) to collect and process quality tree seeds to meet household requirements for tree farming and for the markets; 2) to establish, develop and manage tree nurseries and plantations efficiently and cost-effectively; 3) to harvest, process and market trees and tree products and to provide wood for home consumption; 4) to train other farmers in Lantapan and beyond in the proper collection and handling of tree seeds, and the establishment and management of tree nurseries and plantations and 5) to conserve steeply-sloping farmlands through the application of low-cost, efficient soil erosion control measures, employing the independent or combined effects of grasses, shrubs and trees.

ATSAL performed quite smoothly during its first two years of operation, 1998-2000. The association specialised in production of quality seeds, mostly of exotic timber tree species, and was able to create a market niche primarily for NGOs, national government agencies and LGU customers. From 1998 to mid-2006, reported sales of various agroforestry seeds totalled more than 954,000 Philippine pesos or about US\$21,000 (figure 3), suggesting a significant increase in farmers' income. In the Philippines this record was unprecedented for a smallholder collective. The increased sales of seeds during the first two years was attributed to the 'prepared' market (buyers that had come to Lantapan). This meant transactions were locally negotiated, with almost no costs involved. The leadership skills of ATSAL's president and the experience of the marketing officer were seen to have contributed to the remarkable sales.

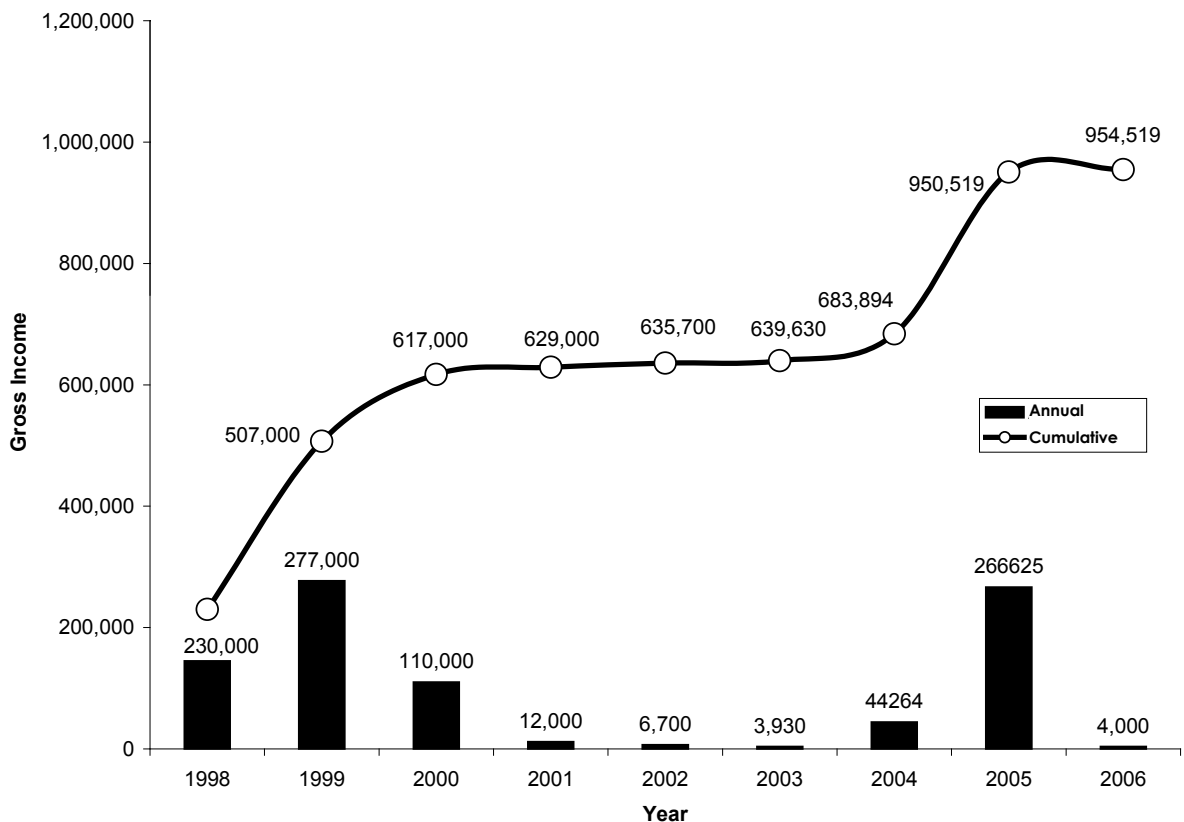


Figure 3: ATSAL gross income, 1998 to mid-2006

By 2000 ATSAL had started to expand its market outside Lantapan with initial success, particularly in the central Philippines. However, it failed to meet the demand for seeds and the logistical requirements for transporting seedlings to external customers became a burden. The sales of seeds followed a double 'S pattern', increasing in the first two years, declining in 2000 and rising again only in 2005 (figure 3). This pattern could be attributed to many factors, but the main issue confronting ATSAL was neither a lack of technical competence in producing quality seeds nor a lack of market *per se*, but rather its organisational weakness in dealing with internal conflict and marketing issues. For ATSAL, the timing of training and farm visits made by various groups in Lantapan was propitious, giving readily accessible customers and creating for a niche within this market segment. Its expansion into the central Philippines was more to do with increasing the number of customers within the same market segment (NGO, and local/national government buyers). Hence it can be said, that over the years, ATSAL has maintained its niche in this particular market segment, and despite its organisational limitations, has gained a stronghold in the local and regional markets, making it a renowned community-based seed and seedling producer. However, further expansion to bigger markets, e.g. national or international markets, would require more organisational stability and efficiency. For a smallholder collective like ATSAL, the odds for success at these scales of the market are low, considering the complex market forces over which they have little or no control. Even if smallholder collectives are strong, their long-term success and integration into bigger markets requires mediation and support from external organisations.

The growth and decline of both Landcare and ATSAL provide lessons for those involved in building social capital for effective natural resource management and watershed management. The crucial issue is the maintenance of established social capital: carrying on the twin goals of watershed protection and improving the livelihoods of impoverished watershed communities. Unlike natural capital, social capital is easily depleted without use. Maintaining group activities, communication and networking among farmers is important for bonding social capital. To harness the potential of Landcare groups and ATSAL to resolve many watershed management issues will thus require strategic investment for 'repair and maintenance' of social capital in the form of group facilitation and provision of livelihood support and incentives.

3.1.3 Phase 3: Incentive-based policies for agroforestry adoption and ecosystem services

Despite the challenges encountered, farmers' responses to agroforestry were generally promising; hence, ICRAF's work currently focuses on deepening the knowledge base for fruit and timber tree-crop interactions in agroforestry systems. Farmers in the upper watershed are not likely to change their farming systems of vegetable production with tree integration as the demand for commercial high-value vegetables and tropical fruit trees continues to increase. In addition, the government is likely to designate the municipality as a vegetable production area. The vegetable agroforestry (VAF) system is seen to be the most viable farming system, particularly in the upper watershed, and provides

economic and environmental benefits. However, tree integration in vegetable production is technically complex, and many policy issues need to be addressed if it is to be promoted successfully. For instance, integrating timber trees requires farmers to register their planted trees with the local DENR, so that they will not have difficulties to secure the permission to cut and transport the timber at harvest time. Additionally, farmers also need to enjoy other economic benefits from integrating trees while waiting for the harvest. One possibility could be through having their efforts for their environmental services, for example water for irrigation and hydropower generation, recognised and rewarded by downstream users such as the national irrigation and electric power authorities. However, all these opportunities need to be explored more rigorously through policy action research and on-farm experimentation to further understand the technical complexity of the VAF system. In addition, there is a need for LGUs to vigorously promote the VAF system through incentive-based policies and programmes. Thus technical improvement and incentive-based policies to promote VAF and reward ecosystem service are the current focus of ICRAF's scientific inquiry in the Manupali watershed.

4. Concluding remarks

ICRAF's experience in the rise and fall of Landcare groups in Lantapan shows how the unavailability of financial capital or delay in economic outcomes can result in diminishing social capital and a decline in the adoption of conservation farming technologies. This suggests that watershed management should be viewed in the context of sustainable livelihoods, where the promotion of conservation farming technologies is clearly linked to people's livelihoods. There is also a need for continuous expenditure in the 'repair and maintenance' of social capital, for instance in the form of continuous training and the facilitation of farmers or producer groups. In addition, appropriate policy incentives may also be needed to promote conservation efforts. Where the watershed economy is highly dependent on the resource base, local government decisions and priorities and political considerations are important determinants of successful watershed management. Finally, watershed management can only be sustainable with a) effective local government support that is consistent with the intention of policies; b) community-initiated change, involving a broad range of stakeholders (e.g. the agribusiness sector); and c) broader support from outside communities.

The message behind this experience is that watershed management objectives and economic goals can be successfully addressed through adaptive R&D innovations. This means that adaptive management is needed, and R&D innovations should be based on salience and legitimacy if they are to effectively address the complex problems faced by poor watershed communities. R&D practices should be highly facilitative, and have the willingness not only to lead, but also to be part of a joint learning process. This requires the flexibility to continuously adapt project goals and on-ground management strategies.

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