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Enhancing sloping land management technology adoption and dissemination

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Contour hedgerows of pruned leguminous trees have been promoted for almost two decades as a solution to the problem of sustainable crop production in the uplands. Despite the effort, adoption of the technology has not been widespread, due to various factors. Natural vegetative strips are a better alternative. Different extension models are described as a means to introduce the alternative to farmers in Claveria.

Introduction

The indiscriminate extension of supposedly superior soil-conservation techniques for the degraded acid upland areas of Southeast Asia has sometimes led to frustration among farmers and the R&D community alike. There are only few cases, for example, of wide-scale adoption of multi-purpose tree hedgerows that sustain permanent cropping on the slope, a system commonly known as "contour hedgerow farming" or "alley cropping on the slope". Technologies that are not based on site-specific biophysical and socioeconomic circumstances cannot be expected to maintain agricultural production and sustain natural resources because they will not be accepted by local farmers. The International Center for Research in Agroforestry (ICRAF) has been emphasizing a farmer-led approach to research and development. It has experienced an unexpected boost in the dissemination of soil-conservation technologies at its Outreach Site in Northern Mindanao due to its innovations: A low-labour, low cost technology based on natural vegetative strips (NVS) and an unconventional dissemination approach based on farmer clubs (Land Care Centers) supplemented by a local government unit driven extension effort.

Among farmers in Claveria, the perception that soil erosion is a serious problem is widespread. Most are clearly aware of the reasons for declining crop yields and possible strategies to combat the soil degradation process. Sloping fields in Claveria experience up

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to 200 t ha^{-1} of soil loss (rainfall 2200 mm $year^{-1}$). About 59% of the cropping (mostly corn and some vegetable farming) occurs on lands of more than 15% slope (Garrity and Agustin 1995; Fujisaka *et al.*, 1994). As is typical for the majority of cultivated upland areas in Southeast Asia, soils in Claveria are degraded and acidic (pH 4.5 - 5.2) with low available P.

Contour hedgerow systems using nitrogen-fixing trees have been viewed widely and promoted as important components of soil conservation in Southeast Asia to minimize soil erosion, restore soil fertility, and subsequently improve crop productivity. Although positive results have been observed and reported in a number of experimental and demonstration sites, farmer adoption is low. This low adoption is associated with constraints of high labour requirements in establishing and managing hedgerows, adaptation of leguminous trees in acid upland soils is poor, sources of planting materials are not readily available, and above- and belowground competition favours the hedgerows and may reduce crop yields.

The SALT (Sloping Agricultural Land Technology) technology is based on the conventional contour hedgerow or alley-cropping concept. It has been husbanded for the last two decades to sustain crop production while maintaining the ecological integrity of the uplands. The SALT syndrome has created the impression among upland farmers that soil and water conservation is a labour-intensive management system only intended for small-sized farms (<1.0 ha), absorbing family labour when off-farm employment is not feasible in densely populated rural areas. However, in the frontier areas, like most areas in the tropics, farmers do not face severe land scarcity. Soil- and water-conservation technology that requires intensive labour and capital (planting materials) is often ignored by the farmers because it is unsuitable to their land-labour circumstances.

ICRAF has been conducting research on contour hedgerow technologies for the past decade in Claveria. Intensive examination of many facets of contour hedgerow systems has led to the following conclusion: Hedgerow systems of leguminous trees consistently increase maize yield by 20-30%, but reasonable yield cannot be maintained without external nutrient supply (particularly P) in addition to the tree pruning. However, the increased labour required in establishing and managing the tree hedgerows is not compensated sufficiently by the yield increase observed. Thus, marginal returns to the management are usually low. The result is that tree hedgerow systems are usually abandoned after several years of trial.

This does not imply that farmers are not concerned about soil erosion. In fact, soil erosion was one of the top concerns among farmers in our surveys. What it does imply is that any adaptable technology must have minimal cost to the farmers as well as to the public institutions supporting the programme.

This paper will describe the evolution of these two sets of innovations and draw some tentative conclusions on their applicability on a wider scale.

Overcoming constraints to the adoption of contour hedgerow systems

Contour hedgerows of pruned leguminous trees have been promoted for almost two decades in several countries in Southeast Asia as a solution to the problems of sustainable crop production in the uplands. This farming system aimed to provide effective soil-erosion control, organic fertilizer to the companion annual food crops, fodder for the ruminant animals, fuelwood for the farm families, and restore water quality and quantity in watersheds and others. Despite these benefits, farmers' adoption has not been widespread. After years of on-farm research and working closely with farmers we identified some key constraints and their solutions.

The constraints include:

- high labour requirements to establish and maintain the hedgerows,
- limited added value to the farm income,
- unanticipated problems in soil fertility due to hedgerow competition,
- irregular width of the alley,
- too dense hedgerows in moderately to steeply sloping farms,
- poor species adaptation and lack of planting materials, and
- insecure land tenure.

The following sections discuss solutions to these problems.

A minimalist approach to establish and maintain contour hedgerow systems: Natural vegetative strips (NVS)

The labour requirement to establish a hectare of tree-based contour hedgerow is approximately 58 man days (Fujisaka *et al.*, 1995; ICRAF, 1996). This is however influenced by the density of the hedgerows in a given sloping farm. The main portion of this labour (about 60%) is for shoveling the earth to form a bund and riser to establish the hedges. The rest of the labour is needed for the collection of planting materials and planting them on the riser. Pruning requires about 124 man days per hectare per year in hedgerows spaced 6 m apart (ICRAF, 1996). This amount of labour dramatically increased the crop production inputs from 64% to 90% in upland rice - maize crop sequence, respectively. Pruning is not only time-consuming but it is also hard work. The major issue, however, is not the amount of labour involved but the economic return of this labour and its opportunity costs. The investment in labour is not commensurate with the output, and the opportunity cost of labour is higher due to available off-farm employment opportunities.

After several years of research and extension on contour hedgerows it was clear that neither of the conventional recommendations were suitable for most farmers. Pruned tree hedgerows were too labour intensive, and productive forage grass hedgerows were too competitive with the associated crops. Adoption of both technologies was fading.

We observed, however, that the concept of contour hedgerows was a popular idea. Increasingly, farmers placed their crop residues in lines on the contour to form 'trash bunds'. These would revegetate rapidly with native grasses and weeds and soon form stable hedgerows. Other farmers laid out contour lines but did not plant anything in them. These lines evolved into natural vegetative strips, which we later observed were superb for soil-erosion control and reduced maintenance labour to a minimum.

These latter innovations caught the imagination of many farmers. By about 1994 it was estimated that over 250 farmers had adopted contour hedgerow systems. These were predominantly natural vegetative strips. The number of pruned tree hedgerow fields had been decreasing since before 1990. When research first began in Claveria in 1985 farmers ploughed up and down the slopes. Contour ploughing was unheard of. By 1995 it was evident that nearly all farmers had converted to the idea of contour ploughing, or at least attempted to do so, however off contour their attempts were to be.

Interest in NVS continued to increase. Since it is rare for an effective soil-conservation structure to be adopted by large numbers of farmers spontaneously and without public subsidies, we noted that perhaps we were witnessing the kind of low-labour, zero-cash-cost alternative that might have widespread applicability.

Our surveys of farmers who had not yet installed contour hedgerow systems but desired to do so indicated that their overriding reason for not contouring was that they lacked the technical expertise to do it right. We had uncovered recently an extremely simple and practical means of laying out contours without equipment even as sophisticated as an A-frame; the cow's back method.

We began to consider how we might experiment with techniques to diffuse NVS technology as rapidly and effectively as possible. We began examining lower labour alternatives. The establishment of NVS requires only a fraction of the needed labour compared to the conventional contour hedgerow of tree legumes. The only labour required is the laying out of contour lines (about 2 person-days per hectare). NVS are narrow contour strips of field area left unploughed and allowed to vegetate naturally. The total amount of time required to plough is reduced accordingly to the proportion of the unploughed strips thus offsetting the labour spent for laying out these contour strips. The amount of labour required to prune or maintain the NVS is proportionate to the densities. Mercado *et al.* (1997) found that NVS spaced at 6 m apart dominated by *Chromolaena odorata* required 15 person-days per cropping per hectare or 30 person-days per year, which is less than a quarter compared to a conventional tree-legume based contour hedgerow system of 124 person-days per hectare (ICRAF, 1996). But for low stature NVS like *Paspallum* spp, *Digitaria* spp, etc., only 3 to 10 days per cropping season are required (Mercado *et al.*, 1997; Stark, 1997, unpublished data).

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Maintaining soil fertility

Although the contour hedgerow system is effective in controlling soil erosion, it is not sufficient to dramatically increase crop production in acid uplands where P is the most limiting nutrient (ICRAF 1996; Garrity, 1996). Phosphorus is the most limiting nutrient in the acid upland areas in Southeast Asia, and responses to inorganic P application are always dramatic. Phosphorus contribution from the pruning of leguminous hedgerows is very limited due to the low P content in its biomass (0.2%) (Mercado and Garrity, 1994). To sustain crop production in this kind of environment, inorganic P application is very necessary despite the high biomass application from the hedgerows. Phosphorus competition is apparent in most places (Garrity *et al.*, 1995). The pruning biomass provides high N to the companion crops (>120 kg ha^{-1}) but this does not the eliminate the response of the inorganic N in both the annual crop (ICRAF, 1996) and the hedgerow itself (Mercado and Garrity, 1994). They both respond to the inorganic N application, which suggests that the timing of the organic N (constrained by pruning schedules to avoid canopy shading) is inappropriate to crop phenology, or the plant uptake is poor, or both. NVS are no worse because P is the real problem.

The NVS provide a distinct advantage because they utilize the existing natural vegetation thus eliminating the establishment cost. These species are already adapted to the area and they are effective in controlling soil erosion (Agus, 1993) but they do not compete with companion annual crops (Ramiaramanana, 1993). However, they do not have a distinct advantage on nutrient pumping and nutrient cycling, but leguminous-based hedgerow systems do not provide a comparative advantage either.

Obtaining uniform alley widths

The widths of the alleys are usually irregular especially when laying out the contour lines using an A-frame and starting at the topmost part of the slope. This is also due to the heterogeneity of the slope in a given length parallel to the contour. The extremities in width vary from 3 to 10 m. This irregularity of width affects the efficiency of land preparation in an animal-based tillage system. But the biggest problem is during interrow cultivation e.g. hilling-up because plants are trampled by animals or accidentally ploughed. This problem discourages other farmers from adopting.

It can be overcome by starting to lay out the contour lines at the middle of the slope, and the subsequent contour lines are laid out by measuring uniformly above and below the first contour line. The widths of the alleys are uniform from top to bottom, and from end to end parallel to the contour.

Both tenants and owner-operators adopt NVS

Lack of secure land tenure discourages farmers from adopting soil-conservation measures and tree planting. Tenants or land-lessees mine available nutrients in the soil, and abandon a farm once it is no longer productive and then move to another place. This is due to uncertainty of land tenure. With increasing population pressure in the uplands, tenants no longer have the luxury to move wherever or whenever they want. Tenant farmers who have established their households on tenanted land intend to stay longer and tend to apply fertilizers to enhance crop production; they are likely to adopt NVS. Tenants in Claveria are now using NVS on their farms because of the simplicity of establishment and maintenance. Their main reason is to reduce any loss of fertilizer they apply to the crops.

The Philippine Government is also fast tracking the agrarian reform programme to enable farmers to own the land they till. The government is asking large landowners to voluntarily offer their land for sale (VOS), as a soft step. The hard step is a compulsory offer for sale (COS). Farmers who are becoming owners are likely to adopt soil conservation. The Comprehensive Agrarian Reform Program (CARP) beneficiaries are at the top of the list of adopters.

Towards effective technology dissemination: The evolution of an innovative extension strategy

In addition to conducting applied research resulting in the development of appropriate technologies for the area and for sites of similar biophysical and socioeconomic conditions, ICRAF has initiated recently a technology dissemination programme to assure that derived innovations will reach the user group. Although not its explicit mandate, ICRAF has undertaken the commitment to develop an effective extension programme to strengthen existing government programmes and to help technology dissemination develop into a self-perpetuating farmer movement in the area towards highly-productive, resource-conserving agroforestry-based farming systems.

Conventional extension methods

Many definitions of extension exist. Tengnas (1994) describes extension as "a non-formal educational system aimed at improving the livelihood of people ... not necessarily involving heavy subsidies or material support". He points out that it is a two-way educational process where local people and extension workers learn from each other. A comprehensive definition is given by Sim and Hilmi (1987): "Extension should be regarded as a process of integrating indigenous and derived knowledge, attitudes and skills to determine what is needed, how it can be done, what local co-operation and resources can be mobilized

and what additional assistance is available and may be necessary to overcome particular obstacles". A recent definition is given by Gross (1996), based on the review of relevant extension literature: "Extension is a professional policy supporting intervention which uses communication as an instrument to induce voluntary change with a presumed public or collective utility." Most definitions of extension agree that it is basically an educational process aiming at voluntary change, even though the immediate success of an extension activity is measured usually by the number of farmers adopting an innovation or making the change, regardless of whether the adopters are convinced of the technology's / change's benefits or accepted it indiscriminately out of politeness or external (short-term) incentives provided by the change agent.

The role of the rural development extensionist is stated below, and reflects ICRAF's extension attitude in its technology dissemination programme at its outreach site in Claveria. The role of the extensionist in the context of rural development is (adapted from Chavangi and Zimmermann [1987]):

- helping people identify and communicate their own problems and assisting them in identifying their own solutions, thus avoiding a top-down attitude in technology transfer,
- assembling and transmitting existing (indigenous) knowledge and adding new ideas to provide innovative solutions to existing problems,
- providing not only technical advice but also individual and/or group encouragement,
- creating a forum for exchange of ideas and experiences among farmers as well as among farmers and outsiders (members of research and rural development organizations),
- developing relationships with other organizations involved in rural development, and
- improving the exchange of information between researcher and farmer.

Only a few of the many different extension approaches shall be described to show where ICRAF's technology dissemination programme fits in with existing classifications. It should be pointed out, however, that ICRAF never followed standard recipes for effective technology dissemination in its initial extension programme, but rather intuitively applied seemingly best strategies for the site-specific conditions and with the limited available resources.

Extension methods can be classified basically as either the individual/household approach or the group approach. The individual approach is most effective for activities to be undertaken within the full control of the individual farmer or household (e.g. establishing contour hedges), while working with groups or the community at large is more suitable concerning matters related to the whole community (e.g. postharvest public grazing) or if activities will be undertaken (more cheaply) by a group (e.g. group nursery). The group approach is particularly suitable where group work is common, like the Philippine Bayanihan, the farmer work groups based on voluntary work contribution for the common benefit. The pros and cons of these two extension approaches are presented in Tables 1 and 2 in relation to the extension activities led by ICRAF in Claveria. Tengnas (1994) further defines the school approach (aiming at changing the behaviour and attitudes of the new generation) and mass extension methods (making use of mass media to create awareness), and stresses that in most cases the combination of all available extension methods is more effective than just one method.

Cow's back method simplifies contouring

Some farmers use the so-called cow's back method after the first contour line has been laid out to hasten the laying out of the subsequent contour lines. The cow's back method is ploughing across the slope and watching the angle of the cow's back on the level. When the animal is heading upslope its head is higher; when it is off course downslope, the rear part of the cow is higher. Stark (1997, unpublished data) found that this cow's back method was on the average about 2% off the real contour compared to either the A-frame method or the hose level method but it seems to be good for practical purposes, particularly in light of the fact that most farmers do not bother with A-frames at all, but simply estimate their contours visually, which is much worse.

Fewer hedgerows

One of the factors that inhibit adoption is the crop area loss. The rule of thumb is to space the hedgerows at 1-m vertical intervals i.e. the steeper the slopes the denser the hedgerows. Mercado *et al.* (1997) found that wider spaced hedgerows at a 4-m vertical drop are still effective in reducing soil loss. They also found that a single NVS strip on a 60-m long slope could reduce soil loss to 40%. Thus, farmers can now space their hedgerows wider, at 8- to 12-m intervals. This wider spacing is particularly appropriate when the NVS evolve into fruit or timber tree hedgerows. There is now much interest in Claveria regarding the establishment of fruit and timber trees on NVS. With our current extension activities, there are now 20 village nurseries producing timber and fruit tree seedlings for their NVS. Wider spacing of hedgerows will give farmers marginal crop area loss and allow them to grow fruit and timber trees while growing their food crops. NVS can be a foundation for the upland farmers to evolve to more sustainable timber- or fruit tree-based agroforestry systems.

NVS can evolve into many forms of agroforestry systems. Farmers in Claveria plant fodder grasses and legumes, timber trees and fruit trees, and other cash perennials on their NVS farms. Fodder grasses include *Setaria* spp, *Penisetum purpureum*, and *Panicum maximum*. Forage legumes include *Flemingia congesta* and *Desmodium rinzonii*. Timber trees used are *Gmelina arborea*, *Eucalyptus* spp, *Sweitienia* spp, *Ptericarpus indicus*, etc. Fruit trees include mangoes, rambutan, durian, etc. Perennial crops used are pineapple, bananas, coffee, etc.

Wider spacing of NVS is suitable for fruit and timber trees in which farmers can still grow food crops. However, farmers with larger farms opted to have closer spacing, and move to other parcels once the tree canopies shade the annual crops. These fast growing timber tree systems have a 6-8 year cycle. But farmers who opted for cash perennial hedgerows (like pineapple) wanted to have closer hedgerows to have more rows of cash crops. A farmer who adopted pineapple commented that he earned more money from the hedgerow itself than from the alley planted to either maize or peanut.

Table 2. cont'd.

Weaknesses	Threats
• People who are not group members will not be reached. • Individual problems cannot be addressed well. • It takes a long time to reach a decision (slow decision-making process). • It can be difficult to get people to agree and to make them work together. • Extensionists are agricultural experts, i.e. lack special skills in community organizing.	• Influential people in the community can dominate the discussions. • Technology delivery style and content might be biased to most innovative and outspoken farmers. • This technology dissemination strategy might not be used to its full potential if no (outside) expertise on community organizing.

(With additions from Tengnas, 1994 [adapted].)

In the Philippines, traditional conservation farming technology transfer has been done by extension workers with specific technical expertise, transferring innovations directly to farmer individuals or groups (transfer of technology). The Philippine Department of Agriculture (DA) and other public agencies, have applied this cost-effective top-down approach for many years, for example in the conventional training-and-visit manner whereby the field extensionists train selected "contact farmers" who are expected to pass on their knowledge to other farmers and the introduced technologies are thus thought to trickle down to every farmer. The irrelevance of the extended technologies regarding farmers' real needs, the slow pace of farmer adoption, and the bias towards better-off (more educated and wealthier) farmers have been common criticisms. A variant of technology transfer is the farmer-to-farmer method: usually a farmer or a small group of interested farmers are trained on one or a few new technologies and formally extend newly-gained knowledge to fellow farmers in the area. The farmer trainers can be either financially compensated for their time inputs or expected to willingly share their knowledge voluntarily with their fellow farmers. Depending on how participatory this approach is being implemented, the approach can improve the two-way flow of information and better ensure that taught technologies are relevant to the needs of farmers because the farmer-extensionists are in many cases users of the technologies themselves and have modified them to fit local circumstances. However, farmer-to-farmer methods of technology transfer also have limitations. It has been difficult to institutionalize this approach, i.e. to incorporate it into the national extension systems to reach a wider impact, and it has been particularly difficult to operationalize ways of effective collaboration and information-flow between extensionists, researchers, and farmer trainers, i.e. to ensure more effective participation. In many cases the lack of thorough technical training for farmer trainers to be able to understand and explain technical details of innovations has resulted in their myopic recommendations. Farmers lack dynamism and the time necessary

Table 1. Individual or household approach: The CHET model.

Strengths	Opportunities
• Individual needs and problems can be addressed. • Unclear messages can be clarified. • Cooperation with farmer can be secured easily and confidence with whole household established through personal contact.	• The extension focus can be directed easily towards farmers' needs and changing external situations. • Every person in the household can be reached and can participate.
Weaknesses	**Threats**
• Expensive in terms of time and transportation. • Only a small number of farmers can be visited • Area covered is small.	• Bias towards easily reachable and open-minded farmers in nearby villages. • More educated, outspoken or influential farmers can skew the extension activity towards their needs.

(With additions from Tengnas, 1994 [adapted].)

Table 2. Group approach: The people's organization model.

Strengths	Opportunities
• More people can be reached faster. • Usually cheaper than the individual/ household approach. • Rich information exchange (ideas and experiences) among group members. • People can express their needs more confidently. • Easy to monitor.	• Well-informed and motivated group members can act as multipliers of innovations, speeding up the dissemination process. • Local government support can be sought or other organizations (NGOs) requested for financial or technical help. • In combination with the organization development approach there can be a high degree of people's empowerment and programme sustainability.

in assisting the dissemination of appropriate technologies to the people for which and with whom they have been developing technology innovations.

Contour hedgerow extension team model – the individual or household approach

To try to overcome the constraints imposed by the traditional and farmer-to-farmer models of technology transfer we devised a somewhat different approach. We formulated a "CHET team" (Contour hedgerow extension team). This was composed of a Department of Agriculture-Local Government Unit (DA-LGU) technician, an ICRAF researcher with expertise on soil conservation and agroforestry, and a farmer adopter with skills in communicating his experience. The strength of the team was in combining the technical expertise, extension skills, practical indigenous experience, and the flexibility and capacity to address arising technological as well as institutional constraints. This new paradigm has been proven effective in transferring the technology to the farmers. However the capability of the conservation team to reach out to larger areas is a question. For example, in municipality-wide activities it is difficult for a single conservation team to reach out. Therefore it would require a number of teams to effectively cover the whole municipality. But what about provincewide or nationwide programmes? And what if resources to do extension work are very limited, and a large number of conservation teams are not feasible? This was the issue we encountered as we expanded our activities to the municipal level. In the beginning we split the team into individuals. The team met regularly to discuss the progress and issues raised in the field and come up with a common decision in a participatory manner. Splitting the group into three still could not cope with the farmers' request to assist them in NVS establishment. With such increasing pressure we opted to have group training to reach more people. We took 5-7 participants from each of the seven villages we were working on, and conducted a one-day training event. Half of the training was devoted to technical aspects and the rest was used in visiting farmers who had established NVS earlier. Before the participants went home they decided to organize themselves into the Claveria Land Care Association (CLCA), and they elected a set of officers among themselves as a municipal-wide association of farmers who are dedicated to soil and water conservation.

People's organization model – the group approach

The group approach model is presented in Figure 1. After the CLCA was formed, participants grouped themselves according to villages they represented. The individual village group formed chapters (subgroups of the CLCA), and elected a set of officers among themselves. There were seven chapters. The chapters expanded memberships in their respective villages. The chapter members spread the NVS technology to other farmers. The subsequent group training was organized upon requests from chapters, and they were conducted in the village where the requesting chapter was located. The newly trained farmers

joined the chapter in the village thus increasing the CLCA membership. The conservation team role shifted to assisting the chapters in disseminating NVS technology, training other farmers, and providing technical backstopping. With funds depleted, the support for the farmer trainers has stopped, and the DA technician was pulled out by his supervisor to fill in the activities vacated by another DA staff member who had left. With our commitment to pursue the programme we let the ICRAF researcher continue to assist the chapters and assist the formation of other chapters in villages who have strong interest to adopt NVS technology.

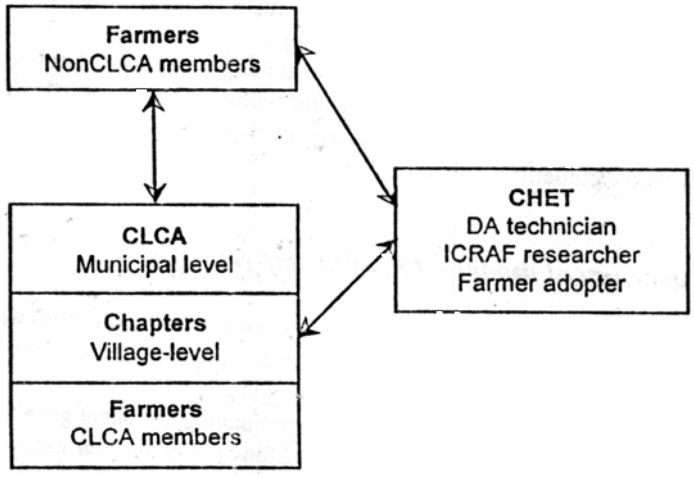

Figure 1. Initial structure of the extension system in Claveria: the individual or household approach was modified into a group approach to make technology dissemination more effective.

The CLCA has a monthly meeting attended by the chairmen from the different chapters. Chapter chairmen are encouraged to discuss issues and problems in their respective chapters thus giving regular feedback to the CLCA and the conservation team. The chapters have regular meetings also.

One of the key issues that emerged in various meetings was the establishment of cash perennials on the NVS. Although farmers appreciated the role of NVS in controlling soil erosion, most of them felt the hedgerows needed to be optimized. Farmers are interested in establishing timber and fruit trees on their NVS. *Gmelina arborea* has been planted widely in the area, and they are looking for other species. We scheduled a visit to a wood processor and tree plantations. After the visit farmers were interested in eucalyptus because of its better market potential for poles and lumber. The CLCA established a central nursery. It was agreed that each chapter would contribute to the labour required and costs of establishment and maintenance. ICRAF provided the seeds. Due to lack of technical expertise about

growing small seeded trees, and the distance of chapters from the centralized nursery, the survival of seedlings was low. The group evaluated the effort to be a failure. Training on nursery establishment and management is very necessary and the idea of having a central nursery was eliminated in favour of a chapter or decentralized nursery.

ICRAF conducted nursery establishment and management events attended by chapter chairmen, selected members, and barangay councils. The training included lectures and strategic planning.

Twenty-four village nurseries have been set up. The seedlings are *Eucalyptus* spp (*E. deglupta*, *E. robusta*, *E. camaldulensis*, and *E. torillana*). ICRAF provided the seeds for these species. The chapter members provided the nursery shed, fence, cellophane bags (potting material), and did all the activities in the nurseries. Members were rotated for maintaining the nurseries (watering and cleaning).

The nursery activities did not compete with hedgerow establishment. NVS are established during the land preparation period and therefore are seasonal. The demands for assisting NVS establishment are high during the months of February, March, April, May, September, and October.

Local government model – towards self-reliance

The barangay officials were already aware of the ongoing activities and were interested in participating in the programme. Together, we conceptualized the local government unit (LGU)-led technology dissemination model (Figure 2).

The decentralization programmes of the national government gave increased power to the LGUs to manage their natural resources. Many national government programmes have been devolved to the municipal level such as: Agriculture, health and nutrition, natural resources management, law and order etc. The barangays are given funds (called barangay internal revenue allotment [IRA]) to maintain administrative and infrastructure maintenance costs. One of the components of the IRA is the Human and Ecological Sustainability (HES) programme. The HES programmes are skewed towards environmental related projects such as: Soil and water conservation, tree planting, waste management, and others.

The conservation team at the municipal level trains or works with the barangay captains and barangay councilman designated as chairman of the committee on agriculture, and with the other members of the council (a municipality is composed of 15-30 barangays). The conservation team ensures that these core people understand about the technology and the need to implement it through official village meetings, slide shows, and subsequent small group training events on NVS establishment in farmers' fields. These core people in return will work with the sitio or zone leaders (a barangay is composed of 5-10 sitios [a sitio is a subvillage]), ensuring that these sitio leaders understand and appreciate the technology. These sitio leaders will disseminate it to the farm families within the sitio. A sitio is usually composed of 10-20 households. The sitio leaders ensure that farmers understand, appreciate, and implement the technology.