

# 12. DESIGNING INTERVENTION STRATEGIES FOR FORESTRY SEEDLING PRODUCTION IN THE PHILIPPINES

Nestor Gregorio, Carl Smith, John Herbohn and Steve Harrison

---

The forest nursery sector in the Philippines is not delivering high quality planting stock of a wide species base for tree farming and reforestation programs. The ACIAR Seedling Enhancement Project, funded by ACIAR, has been implemented to address this problem. The project uses a systems approach and has developed a Bayesian Belief Network (BBN) to analyse the forest nursery system and investigate the relationship between factors affecting seedling quality and the operational effectiveness of the forest nursery sector. A workshop with various stakeholders was held to demonstrate the interactions among nursery system components using the BBN and to identify potential policy interventions. Stakeholders revealed three main themes, namely *Market for seedling and timber* (i.e. poor market of timber and seedlings), *Funding of nurseries* (i.e. budget) and *Seedling quality* (i.e. low quality of forest reproductive material) as potential leverage areas for improving the operational effectiveness of the forest nursery sector. Nursery accreditation, capacity building, increased seedling sales and an improved pathway of high quality germplasm were identified as major interventions. Further, policy reform was deemed necessary to create market-driven incentives for accredited nurseries and for government nursery operation to support the existence of private nurseries. The Seedling Enhancement Project has commenced pilot testing specific policy interventions.

---

## INTRODUCTION

The scaling up of smallholder forestry in many tropical countries is hampered by several constraints including the problems on the forest nursery sector (Aalbaek 2001; Noordwijk et al. 2003). For example, in Nepal, the problems of the unavailability of species preferred by farmers, low quality of planting stock and difficulty of smallholders in accessing seedlings from nurseries have been identified as reasons for most smallholders not planting trees and the apparent failure of established plantations (Robinson and Thompson 1997). Aalbaek (2001) reported that most of the farmers in Tanzania face great difficulties in reaching their planting targets because of the shortage of planting materials. In the Philippines, the promotion of smallholder forestry is hampered by the limited availability of seedlings (Herbohn et al. 2001), a narrow species range resulting in site-species mismatch (Koffa and Roshetko 1999) and the use of low quality planting stock (Tolentino et al. 2002; Gregorio 2006).

The forest nursery sector in the Philippines is largely comprised of nurseries established and managed by private farmers, community organizations and government agencies including the Department of Environment and Natural Resources (DENR), Department of Agriculture (DA) and academic institutions (Gregorio 2006). However, results of the survey carried out by Harrison et al. (2001) argued that the forest nursery industry in the Philippines is not well organized. Further, the research of Gregorio (2006) indicated that the current organization of the private and government forest nursery groups is not delivering high quality planting stock to smallholder tree farmers. The germplasm pathway of various species is not well established and access to high quality seeds is difficult. The DENR has institutionalised a

policy regulating the germplasm quality of forest trees through the approval of DENR Administrative Order 2010-11 '*Revised Regulation Governing Forest Tree Seed and Seedling Production, Collection and Disposition*' on 5 May 2010. This policy is still at the incipient stage of implementation and the current seedling production system is still largely quantity oriented, leaving seedling quality compromised.

The recently implemented DAO 2010-11 includes nursery accreditation as part of the policy to regulate the quality of forest reproductive materials. A major offshoot of this policy would be the development of a database of accredited forest nurseries, which currently is not available from the DENR. The absence of nursery accreditation leaves most nurseries to operate with their existence unknown to many buyers. There was an attempt to inventory tree nurseries in many parts of the country during the implementation of the Green Philippines Program of the previous Pres. Arroyo administration to obtain baseline information regarding the volume of seedlings that are readily available in every region of the Philippines (Gregorio et al. 2008). However, this has not led to the provision of support to private nurseries, especially for the advertisement and marketing of seedlings. Government nurseries are still producing the bulk of the seedlings for government planting and free distribution to various stakeholders. This effort is crowding out the operation of private nurseries because the species distributed by government are those that are commonly raised in private nurseries.

With the aim of improving the operational effectiveness of the Philippine tree nursery sector, a project funded by the Australian Centre for International Agricultural Research (ACIAR) entitled ASEM/2006/091 – *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector* (referred to as the ACIAR Q-Seedling Project) is currently being implemented in the Philippines, specifically on Leyte Island and in Northern Mindanao. The objectives of this project are to:

1. examine the respective roles and operational effectiveness of the private and public nursery groups;
2. develop a policy assessment model and identify policy intervention points at both the national and the local level; and
3. implement local-level policy changes in conjunction with DENR and local government units and pilot test strategies to increase the economic viability of the nursery sector.

The nursery sector in the Philippines is comprised of three interacting groups of nurseries – namely the private, community and government nurseries – which are operating within a policy environment largely administered by the DENR. The issues associated with improving the operational effectiveness, economic efficiency and policy environment of the Philippine tree nursery sector have been conceptualized as being so interrelated that they cannot be addressed in isolation, thus the ACIAR project has adopted the systems approach to analyse the problems of the nursery sector. The project uses the Bayesian Belief Network (BBN), a conditional probability model presented in a graphical form that represents cause and effect within systems (Jensen 1996). It consists of nodes that represent system variables, links that represent causal relationships between nodes, and probability tables that quantify these relationships using conditional probabilities. BBNs can be applied for predictive, diagnostic and sensitivity analysis, and because they use probabilities to relate variables, they explicitly allow uncertainty to be accommodated in predictions.

A policy assessment model of the nursery sector is being used to help identify options for policy interventions and to predict the likely impacts these options would have if implemented. This paper outlines a method for identifying the key leverage points for improving the operational effectiveness of the Philippine forest nursery sector. The results of the application of this method are presented and the key policy interventions that are piloted as part of the implementation of the Q-Seedling project are discussed.

## RESEARCH METHOD

A BBN that had been developed for the Philippine forestry nursery sector, as in Gregorio (2006), has been used as the basis for the development of a policy assessment model to identify key leverage points for potential intervention (Figure 1). This model was developed using data from a survey of 74 nursery operators (37 individual, 22 communal and 15 government) on Leyte Island as well as information from literature and the experience of nursery experts. To ensure its validity and reliability, the model was refined in a workshop attended by selected respondents of the survey and stakeholder representatives held at Visayas State University in November 2005. The details of the development of the model are not covered in this paper; however, these are discussed in detail by Gregorio (2006) and Gregorio et al. (under review).

As part of the steps of refining the model and in order to identify potential policy interventions for improving the forest nursery industry, the model was used to simulate the nursery industry system and demonstrate the interactions among various components of the nursery system during a *Seedling Sector Policy Modelling and Analysis Workshop* held in Ormoc City, Leyte, on 12 February 2008. This workshop was held as part of the implementation of the ACIAR Q-Seedling Project. Key stakeholder group representatives at the workshop included senior staff from the DENR in Regions 8 and 10, extension staff and researchers from DENR and DA, private and community nursery operators, local government unit staff, and researchers from Visayas State University with expertise in forestry and agricultural extension. Various members of the ACIAR project team also participated, including those from the Visayas State University, The University of Queensland, and Southern Cross University.

During the presentation and discussions associated with the BBN to identify possible pilot schemes to be implemented under the Q-Seedling Project, participants were asked to identify major issues within the forest nursery sector to serve as a basis for possible policy intervention points for the improvement of the overall nursery industry. A team member recorded all the major issues that were identified on a whiteboard (Figure 2). Each participant was then asked to place dots against the identified issues according to their degree of importance, with three dots against the issues they thought were the most important, two dots for moderately important and one dot for the least important. The participants were allowed to place one or more dots on any issue.

# Identifying Leverage Points for Policy Reform in Seedling Production in Leyte, the Philippines

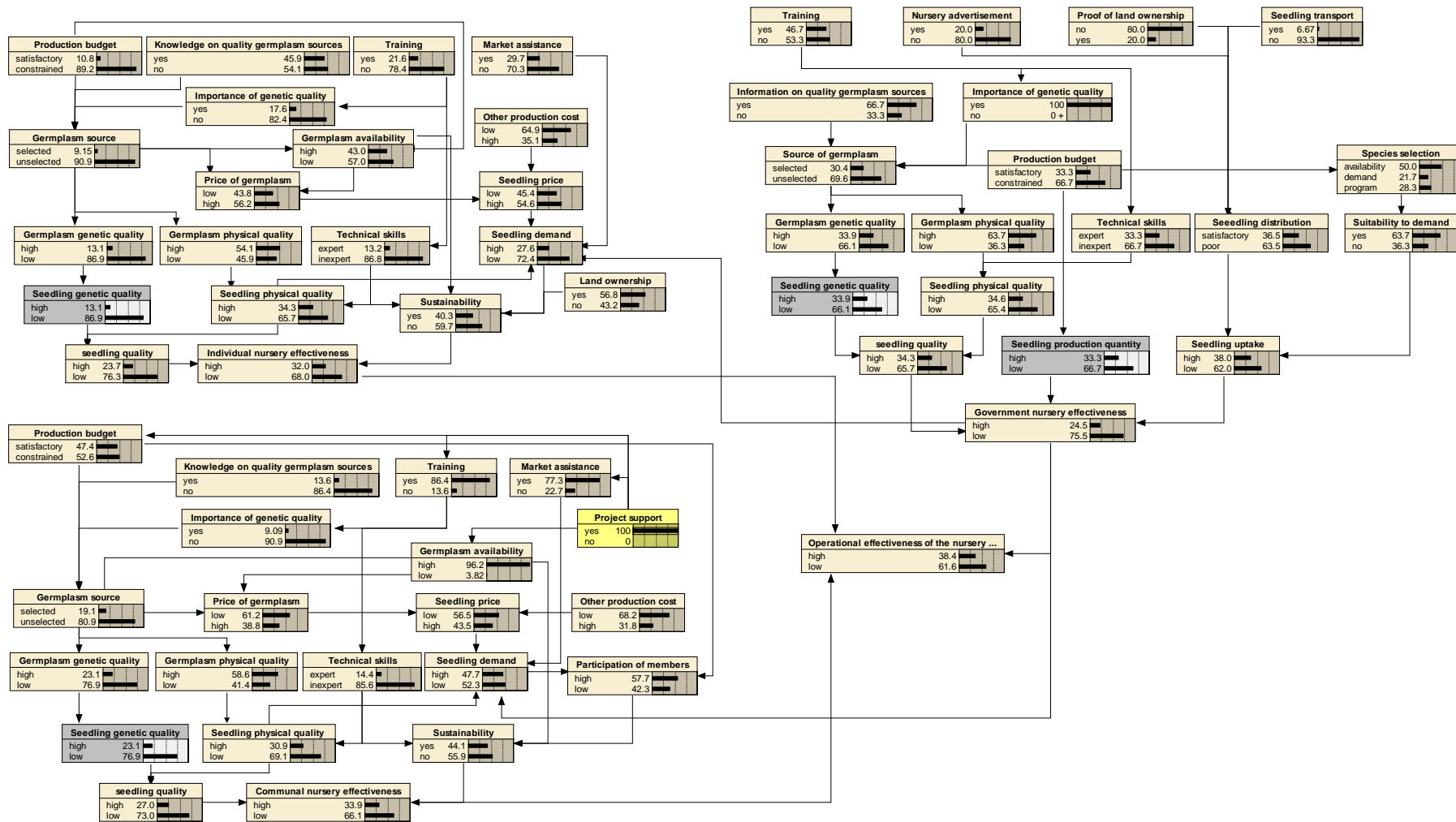
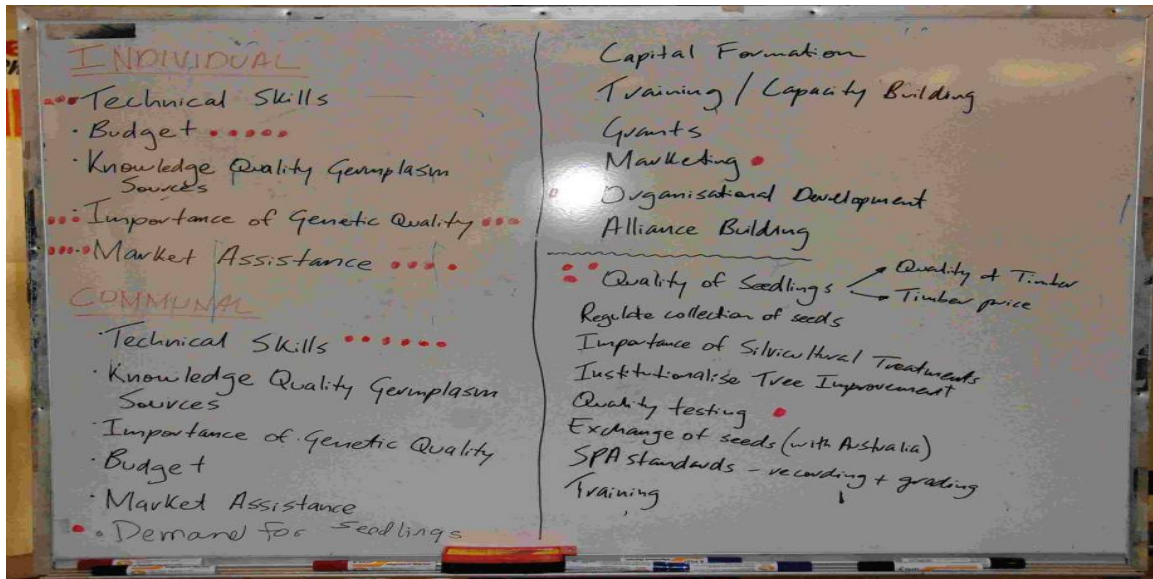


Figure 1. The BBN of the forest nursery industry in Leyte, the Philippines.



**Figure 2.** Identification and rating of factors influencing the operational effectiveness of individual and communal nurseries

A group of participants allocated each of the identified issues on the list into themes, irrespective of whether the issues were related to the operation of communal, private or government nurseries. Three main groups of policy intervention points were identified and participants then self-selected into three groups to identify options to address each of the three problem areas. The participants were allowed to move between groups to share their ideas. A representative from each group presented the outcomes of the group discussions to all workshop participants for critical discussion. The general sessions were recorded and transcripts prepared as a permanent record. Based on the outcomes of the workshop, selected groups were asked to prepare more detailed proposals for pilot studies to be undertaken as part of the ACIAR Seedling Enhancement Project.

A modified version of the nursery BBN has been developed to include the policy interventions identified by the workshop participants. Most of the identified policy interventions are being pilot tested. The next step will be to assess the impact of each policy intervention. These data will then be used to refine the modified BBN model and evaluate the overall impact of each of the policy interventions, individually and in combination, on the effectiveness of all three tree nursery subsectors in Leyte.

### **General Intervention Points for Improving the Operational Effectiveness of the Nursery Industry**

The presentation of the original nursery sector model to stakeholders during the February 2008 workshop exposed them to the elements of the forest nursery system and the simulations helped them to understand the interactions among these elements. There was general agreement among the workshop participants that the model reflects the forest nursery industry and that the model simulation outputs are logical.

The simulations conducted using the original model revealed many intervention points for improving the forest nursery industry in Leyte. It is beyond the scope of this paper to discuss the

details of all policy interventions. These are discussed in Gregorio et al. (in review). However, some key aspects are highlighted. The current scenario as presented in Figure 12.1 shows that improving the operational effectiveness of the government nursery subsector creates a negative impact on the market for seedlings in the private and communal nursery subsectors. This is due to the competition that currently exists between the two subsectors caused by government nurseries distributing free seedlings of the same species sold in private nurseries.

For the private nursery subsector, the main intervention points for improving the operational effectiveness include *Technical skills*, *Production budget*, *Knowledge of quality germplasm sources*, awareness of the *Importance of genetic quality* and *Market assistance*. The availability of germplasm has the greatest impact on the sustainability of private nursery operations. Improving the availability of germplasm not only means increasing the supply quantity but also the quality. Providing information on sources of genetically superior germplasm potentially increases the production of high quality planting stock in the smallholder nursery sector, and providing marketing assistance is likely to have the largest influence on improving the seedling demand.

For the communal nursery sub-sector, *Technical skills*, *Knowledge of quality germplasm sources*, awareness of the *Importance of genetic quality*, *Production budget* and *Market assistance* were found to be the main intervention points for improving operational effectiveness. The sustainability of the operation of communal nurseries is greatly influenced by the presence of project support. The model simulations show that where funding from external agencies is absent, there is a slim chance that a communal nursery will sustain its operation because the participation of members of community organizations becomes minimal. Sustaining the operation of community nurseries therefore requires constant financial resources and this is where seedling sales can potentially serve as an alternative income source. Increasing the seedling sales for communal nurseries through marketing offers a buffer against the negative impact of the exhaustion of external project funds. Linking the nurseries to a wide population of potential seedling buyers is a vital part of the package of interventions for improving the effectiveness of communal nurseries.

For the government nursery sector, *Production budget*, *Species selection* and *Technical skills* are the main intervention points for improving effectiveness. Although managers of government nurseries generally have information on sources of high quality germplasm, their limited production budget prevents government nurseries from using genetically superior germplasm and therefore prevents them from producing genetically superior planting stock. Limited funding also results in government nurseries producing planting stock for only a few common exotic species with readily available and inexpensive germplasm. The lack of funds also prevents government nurseries from transporting seedlings to villages, which is an important factor for improving seedling distribution and uptake. While managers of government nurseries have mostly completed tertiary education and attended training classes on seedling production, the majority still lack the necessary skills to produce high quality planting materials.

Improving *Technical skills* was consistently a highly important intervention for lifting the operational effectiveness of all nursery subsectors. This is directly related to the attendance of nursery operators and managers at training sessions. *Training*, however, was found to have little influence on *Technical skills* for private and communal nursery operators in the BBN simulations. This came as a surprise; however, detailed discussion at the workshop revealed that this was, in fact, logical. The nature of training provided to nursery operators is often a one-off event for just one or two days without any follow-up or checking that technologies covered in the training are applied by nursery operators. Also, stakeholders emphasized at the workshop

that the training provided by government agencies (e.g. DENR) and NGOs has not been effective because it was not suited to the learning styles of the operators. This leads to the conclusion that follow-up training is necessary.

### **Key Issues and Interventions**

The ratings of potential areas for intervention by stakeholders revealed three main themes, namely *Market for seedling and timber* (i.e. poor market of timber and seedlings), *Funding of nurseries* (i.e. budget) and *Seedling quality* (i.e. low quality of forest reproductive material). Workshop participants then grouped themselves around these key themes to discuss the key issues, and identify potential interventions. For example, the group discussing low quality of seedlings identified causal factors including low income (from seedling sales), low price (of seedlings), poor site-species matching, low quality of seeds, inappropriate scheduling of seedling production, low quality seed collected from poor seed sources, lack of infrastructure, and poor nursery cultural practices. Six interventions were suggested to overcome these problems, namely establishment of seed production areas, establishment of seed orchards, certification of seed sources, accreditation of nursery operators, provision of information about site species matching, and hands-on training on best nursery practices, nursery design and infrastructure. Table 1 summarizes the outcomes of these group sessions.

Identifying Leverage Points for Policy Reform in Seedling Production in Leyte, the Philippines

**Table 1.** Summary of the three key issues identified during stakeholder workshop and suggested intervention measures

<b>Issue</b>	<b>Details</b>	<b>Possible intervention</b>
<b>Marketing</b> Lack of market for timber products affects the demand for seedlings	Poor access to markets Lack of promotional activities Low quality seedlings Lack of government support of market information; lack of linkage to buyers Markets not clearly defined for smallholders, timber and seedlings (no clear vision of markets)	Standardising nursery operators through a simple/affordable registration scheme to ensure quality seedling production Support for marketing of seedlings of nursery operators to become part of DENR's IEC programs
<b>Limited budget</b>	Fund sourcing (program; private labouring; institutional borrowing; aid projects/government subsidy Establishment costs – capital outlays Operational costs – labour and supplies Free seedlings program – in competition with smallholder nurseries Evidence – need for evidence of profitable tree farming to see a way to make a future living	Fund sourcing – subcontract programs with technical assistance from DENR; smallholder grants; joint ventures Establishment and operating costs, good governance; skills training; management training; market research Free seedling program – subcontractors of free seedling program – portion of the seedlings needed will be produced by smallholders; working with DENR to manage seed production areas Markets – sustainable tree planting scheme; information data base of buyers/prices/sellers
<b>Seedling quality</b> i.e. low quality of forest reproductive material	Low income and low price Poor site species matching Low quality of seeds Raising seedlings outside the planting season Seed trees with low physical and genetic qualities Infrastructure Nursery cultural practices	Establishment of seed production areas and seed orchards Accreditation of seed sources Accreditation of nursery operators Proper site species matching Hands-on training on proper nursery practices, design, infrastructures



It appeared that some of the proposed interventions were not specific to a particular issue. Some interventions proposed by a group working on a particular theme overlapped with interventions proposed by other groups. For instance, the 'seedling quality group' proposed a nursery accreditation scheme as a way to improve the quality of seedlings. The 'marketing group' also proposed a nursery registration scheme to ensure the production of high quality seedlings, recognizing that seedling quality is important for increasing seedling sales and also for improving timber quality, which in turn will increase the market demand for timber. The 'budget group' proposed both management and skills training as a means to reduce nursery establishment and operating costs, while the 'seedling quality group' also proposed training in appropriate nursery practices and appropriate nursery design including the suitable design of infrastructure such as the germination shed, potting shed, transplant shed and elevated hardening beds. The 'budget group' and 'seedling quality group' both considered the establishment of seed production areas as important but for different reasons. The 'budget group' viewed this type of intervention as a means of reducing costs of seedling production, while the seedling quality group saw it as being a way of improving the genetic quality of seedlings. The 'marketing group' and 'budget group' both considered the advertisement of private nurseries to potential seedling buyers by support agencies including the DENR as a means of improving the market for seedlings and to help alleviate the problem of limited funds to operate nurseries.

#### *Implementing and testing policy interventions*

With the interventions outlined in Table 1 as a basis, a modified version of the policy assessment model was developed by the project researchers (Figure 3). This model will be used in the future to explore the impact of specific policy interventions on the individual, communal and government forest nursery subsectors. Simulation tests using the model indicate that for private and communal nursery subsectors, *Tree planting programs* of the government utilizing seedlings from private and communal nurseries, *Database of buyers and sellers* and *Subcontracting of government seedling production* to private and communal nurseries are interventions that could increase *Seedling demand*, thereby addressing the issue of budget constraints. Having a *Smallholder grant scheme* for seedling producers is also an intervention that will address the issue of a limited budget. *Nursery training and certification* is an intervention that will address the issue of 'seedling quality' through improvement of the technical skills of nursery operators and use of germplasm from selected sources. Establishing a *Tree seed centre* is an intervention that will promote the availability of high quality germplasm of a wide species base.

# Identifying Leverage Points for Policy Reform in Seedling Production in Leyte, the Philippines

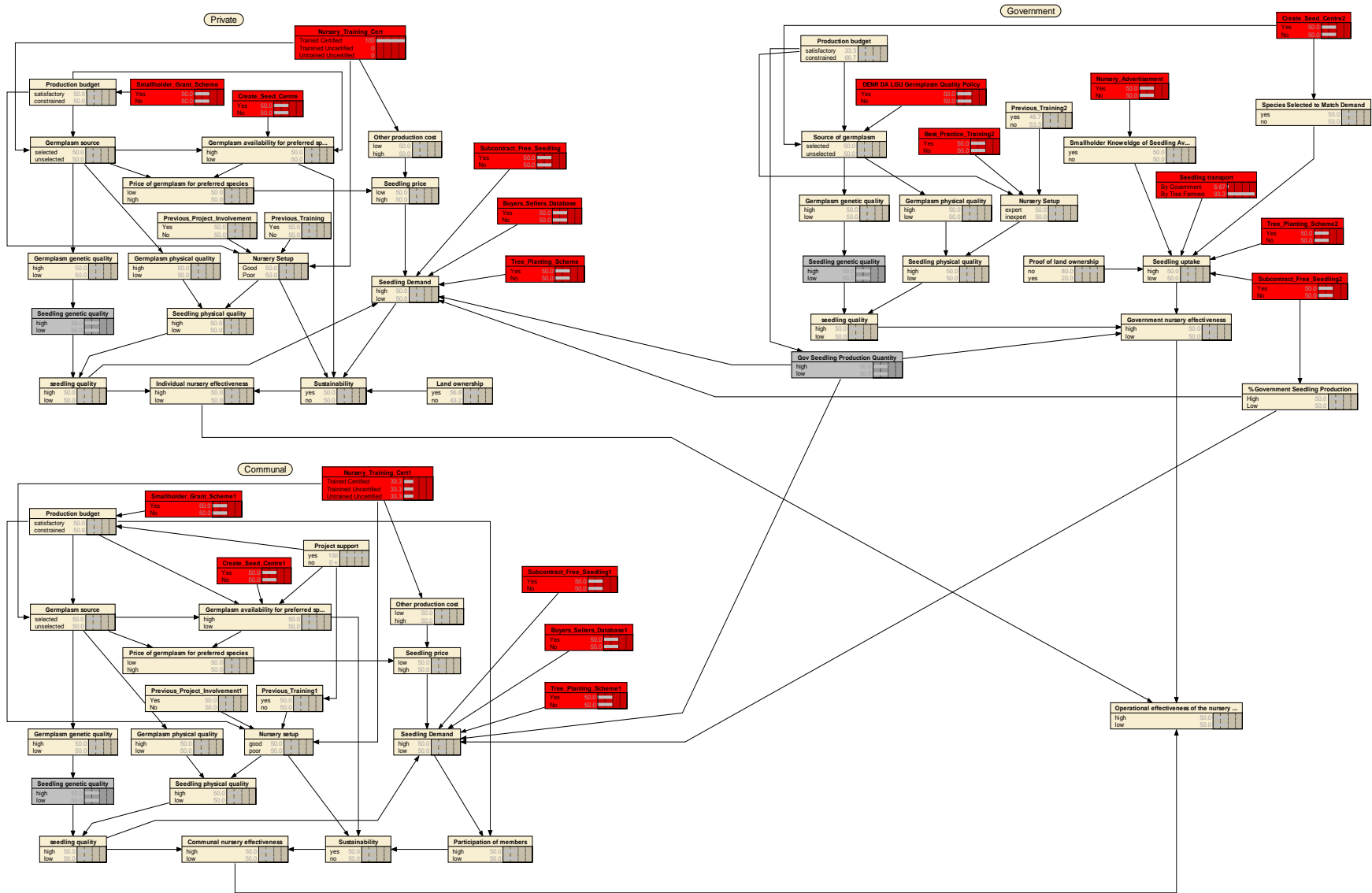


Figure 3. The modified forest nursery BBN containing nodes of potential interventions (shaded boxes)

For the government nursery subsector, the implementation of a *Germplasm Quality Policy* could ensure the use of high quality germplasm in government seedling production and *Advertisement of the government nurseries* could increase seedling demand. As with private and communal nurseries, the presence of a tree seed centre could diversify the species of seedlings in government nurseries to suit the demand of smallholders. The uptake of seedlings from government nurseries will be affected by the *Tree Planting Program* of the government and the *Contracting of seedling production* by the private forest nursery operators.

Some of the interventions outlined in the modified policy assessment model are being implemented by the seedling enhancement project. These include a trial of a nursery accreditation scheme, improvement of the germplasm pathway through the creation of a tree seed centre at VSU, capacity building of nursery operators and creation of database of seedling producers. A description of these initiatives is provided below. Data on the impact of these interventions will be collected through a nursery operator survey that will be undertaken as part of the implementation of the ACIAR Q-Seedling Project and these data will be used to populate the modified policy assessment model to review the impact of the interventions.

#### *Forest nursery accreditation*

Accreditation of private nurseries requires the nursery operators to adopt best management practice (which may include the use of genetically desirable germplasm, appropriate nursery design and structure, and the adoption of suitable nursery cultural practices), to ensure the production of high quality planting materials. Higher quality planting materials could be sold at a higher price and therefore improve the financial viability of the seedling nursery enterprise.

Workshops with stakeholders including DENR, Local Government Units (LGUs), Department of Agriculture-Bureau of Plant Industries (DA-BPI), academe, nursery operators, tree farmers and timber processors and sellers were held in Leyte and Northern Mindanao to design the mechanisms for implementation of a forest nursery accreditation policy at the local level. The workshops resulted in the crafting of two nursery accreditation schemes – for LGUs and local DENR implementation.

The project has developed partnerships with the municipality of Palompon in Leyte Province to pilot test the implementation of forest nursery accreditation. Palompon is implementing a watershed development program through the auspices of the Development Bank of the Philippines (DBP). In line with the pilot testing of the forest nursery accreditation policy, the municipality has purchased seedlings from the nurseries accredited by the ACIAR Q-Seedling Project and the LGU of Palompon. A series of hands-on best management practice training events have been conducted with private nursery operators in Palompon. Extension materials including nursery quality seedling production leaflets and videos were developed and used during these training activities. A demonstration nursery managed by the LGU was established in the municipality to showcase best management practices to private nursery operators and to serve as distribution points of germplasm and extension materials to smallholders.

Pilot implementation of the nursery accreditation policy has also been undertaken by the DENR in Region 10, particularly within the jurisdiction of the Community Environment and Natural Resource Office in Bukidnon. Relevant staff of the DENR attended the hands-on training on high quality seedling production and nursery and seedling assessment for accreditation. Also, a demonstration nursery of smallholder-based best management practice has been established at the Ecosystems Research and Development Section of DENR 10 at Malaybalay, Bukidnon.

This nursery was constructed following the design provided in the nursery best management practice manual (Gregorio et al. 2009) developed as part of the ACIAR Q-Seedling Project.

*Establishing tree seed centres and conducting an inventory of superior mother trees*

A tree seed centre was developed at VSU and another seed centre has been established in Northern Mindanao. These centres are designed to serve as conduits for distributing selected seeds to various nurseries in Leyte and Mindanao. They also serve as distribution points for extension materials on the production of high quality seedlings and assist in advertising private nurseries to potential seedling buyers. The centres also play a crucial role in the accreditation of private nurseries by serving as facilitating offices, accepting applications for accreditation of private nursery operators and forwarding these applications to the accreditation team.

To improve the supply of high quality germplasm especially for native timber species, a survey to identify the location and phenology and also assess the phenotypic quality of mother trees of native timber species on Leyte Island was carried out as part of the implementation of the ACIAR Q-Seedling Project. The locations of mother trees were recorded using a Global Positioning System device and phenology was determined through local knowledge of seed collectors and seedling producers as well as available literature. The phenotypic quality was assessed using the method developed by the DENR. A total of 502 mother trees belonging to 32 timber species were identified, and a database about the location and phenology of the mother trees has been developed. Figures 4a and 4b show the ACIAR Q-Seedling staff assessing the phenotypic quality of a mother tree from the natural forest, and the impressive form of one of the mother trees that were identified and marked.



**Figure 4.** The Q-Seedling Project staff assessing the phenotypic quality of a mother tree (a) and a mother tree of white lauan (*Shorea contorta*) assessed and marked during the inventory (b)

*Capacity building of nursery operators*

Nursery accreditation and seedling certification require the nursery operators to possess sufficient knowledge and necessary skills to adopt prescribed BMP. For this purpose, a series of lectures and hands-on training sessions were carried out with private nursery operators and managers of government nurseries in both Leyte and Mindanao. The training events were undertaken to convey the importance and benefits of using high quality planting materials and to demonstrate the technologies for producing seedlings of high physical and genetic quality (Figure 5). Training and extension materials including nursery best management practice

manual, high quality seedling production leaflets and posters were distributed to training participants. Also, training videos were provided to DENR and LGU staff to be used when they carry out training sessions with nursery seedling producers.



**Figure 5.** Training sessions with private nursery operators (a) and managers of government nurseries (b)

#### *Database of nursery operators*

To facilitate the advertising of private nurseries, a database of nursery operators has been developed by the project. The database contains names of nurseries and their operators, phone numbers, addresses, species produced and seedling sale prices. This information has been disseminated to prospective seedling customers through the tree seed centre and demonstration nurseries of the pilot municipality and the DENR.

### **CONCLUDING COMMENTS**

The operation of the forest nursery industry in Leyte is not effective in delivering high quality planting materials of a wide species variety to tree farmers. Seedling production enterprises are hampered by various constraints including limited funds and low quality planting stock, resulting in low financial viability. At present there is little coordination between the operation of government and private nurseries. The program of free seedling distribution of government nurseries crowds out the operation of private nurseries. The continued operation of private nurseries is important because most of the seedlings used in smallholder tree farming in the Philippines come from private nurseries. Also, the fund allocation for government seedling production is declining, thus the continued operation of private nurseries is imperative to supply in the seedling demands for both smallholder forestry and large-scale watershed rehabilitation programs.

The ACIAR Q-Seedling Project is being implemented to improve the operational effectiveness of the nursery sector by developing and implementing policy interventions in conjunction with relevant agencies including the DENR, DA and Local Government Units. A workshop with stakeholders has led to the identification of key problems in seedling production enterprises and possible interventions to address these. While the suggested interventions are general in nature, the Seedling Enhancement Project has identified specific interventions which are being tested in Leyte and Northern Mindanao and to be evaluated using the policy assessment model in late 2010. These interventions include the implementation of a forest nursery accreditation scheme to ensure the production of high quality planting stock, establishment of a tree seed centre to improve the pathway of high quality germplasm, and advertisement of private

nurseries through the development of a nursery database at the VSU tree seed centre. Additional pilot activities designed to support nursery accreditation include training sessions of nursery operators in best management practice, distribution of nursery manuals during training events, and establishment of demonstration nurseries in selected pilot municipalities.

## REFERENCES

- Aalbaek, A 2001, 'Farmers' tree planting and access to germplasm in the southern highlands of Tanzania', *Southern African Forestry Journal*, no. 191, pp. 75–88.
- Gregorio, NO 2006, Improving the effectiveness of the forest nursery industry in Leyte Province, the Philippines, PhD thesis, School of Integrative Systems, The University of Queensland, Brisbane.
- Gregorio, NO, Herbohn JL and Harrison SR and Smith CS (in review), 'A Bayesian Belief Model to improve the operational effectiveness of the forest nursery sector in Leyte, the Philippines', *Small-scale Forestry* (in process).
- Gregorio, NO, Herbohn, JL and Harrison, SR 2009, 'Guide To Quality Seedling Production In Smallholder Nurseries, Baybay, Leyte, the Philippines', p. 44.
- Harrison, SR and Herbohn JL 2001, 'Evolution of small-scale forestry in the tropics', in SR Harrison and JL Herbohn (eds), *Sustainable Farm Forestry in the Tropics: Social and Economic Analysis and Policy*, Edward Elgar, Cheltenham.
- Herbohn, JL, Harrison, SR and Nixon, BJ 2001, 'Social and economic factors affecting the use of Australian species in community based forest management in the Philippines uplands', in SR Harrison and JL Herbohn (eds), *Socio-economic Evaluation of the Potential for Australian Tree Species in the Philippines*. ACIAR Monograph 75, ACIAR, Canberra, pp. 125–132.
- Jensen F 1996, *An introduction to Bayesian Belief Networks*, Springer, New York.
- Koffa, S and Roshetko, J 1999, 'Farmer-managed germplasm production-diffusion pathways in Lantapan, the Philippines', in J Roshetko and D Evans (eds), *Domestication of Agroforestry Trees in Southeast Asia*, Proceedings of a regional workshop held 4–7 November 1997 in Yogyakarta, Indonesia, ICRAF, Nairobi, pp. 142–150.
- Noordwijk, M and Roshetko, J, Ruark, G, Murniati, M, Suyanto, C and Tomich, T 2003, *Agroforestry is a form of sustainable forest management: lessons from Southeast Asia, New Zealand*. UNFF inter-sessional expert meeting on the role of planted trees in sustainable forest management, New Zealand, 24–30 March 2003.
- Robinson, R and Thompson, I 1997, *Fodder Trees, Nurseries and their Central Role in the Hill Farming Systems of Nepal*. *Social Forestry Network*. Rural Forestry Development Network, Overseas Development Institute (ODI), London, p.11.
- Tolentino, EL, Carandang, WM and Roshetko, J 2002, *Evaluation of Small-holder Tree Farmers Nursery: Quality Stock Production in Support of the Tree Domestication Program of the Philippines*, College of Forestry and Natural Resources, Los Baños and ICRAF, College, Laguna.