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Final report

project

Enhancing tree seedling supply via economic and policy changes in the Philippines nursery sector

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Contents

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2 Executive summary

High quality seedlings are fundamental to the successful establishment of forests, both for timber production and reforestation of degraded land. However, in the Philippines, the quality of tree seedlings raised in most nurseries is generally very poor. Prior to ASEM/2006/091, there was little recognition of the importance of seedling quality by both nursery operators and those purchasing seedlings. It was common for most seedlings to have poor root structures (e.g. root coiling, J-rooting), etiolated stems and many seedlings were often overgrown. Seedlings were often not sun-hardened before being planted out in the field, resulting in high mortality rates. Disease and nutrient deficiency were also common in many nurseries.

The aim of the project was to improve the economic efficiency and policy environment of the Philippines tree seedling nursery sector.

The objectives of the project were to:

1. Examine the respective roles and effectiveness of the private and public sector in the tree nursery sector
2. Develop a policy assessment model and identify policy intervention points at both the national and at the local level
3. Implement local level policy changes in conjunction with DENR and pilot test strategies to increase the economic viability of the nursery sector

One of the first activities of the project was to analyse the structure of the tree nursery industry in the Philippines and the related policy environment. This included undertaking a comprehensive survey of approximately 160 nurseries in Mindanao and Leyte. Simultaneously, a comparative study of the seedling production policies for smallholder and community plantations in key south-east Asian countries was undertaken to identify policies and initiatives that may be applied to the Philippines. Based on data collected from these two initial project activities, a policy assessment model was developed and then used to analyse the institutional issues surrounding the Philippine nursery sector. That analysis revealed a complex mix of factors that influenced both seedling quality and nursery effectiveness, many of which were interrelated. Working in partnership with key stakeholders, team members identified a number of key areas in which to pilot test initiatives that were most likely to result in substantial improvements in seedling quality. These initiatives included the development of best practice guidelines suited to the Philippines, the design, implementation and testing of an information, education and communication (IEC) campaign. The ‘Q-Seedling’ brand was developed as part of these initiatives and proved very effective in communicating the benefits of producing quality seedlings. Demonstration activities including the establishment of a demonstration nurseriy at the Visayas State University and another in partnership with a large private company proved to be very effective. Outplanting demonstration sites and ‘hands-on’ training also proved to be effective means of conveying key messages about seedling quality. The project also pilot-tested the establishment of seed centres located at VSU, DENR Region 10 and in conjunction with Sagittarius Mining Incorporated (SMI) to supply quality germplasm for common timber species. The project also developed a mother tree program to identify sources of germplasm for both common timber species and hard to find native species. Both initiatives appear to have been successful in improving the access of nursery operators to quality germplasm. A capstone activity of the project was to develop and pilot test a nursery accreditation scheme at the local level. The accreditation program incorporated or drew upon elements of most project initiatives including the IEC activities, extension materials, best practice guidelines, training, use of quality germplasm from the seed centres etc. Accredited nurseries were then allowed to use the ‘Q-seedling’ brand in marketing their seedlings. Accredited nurseries were able to both increase their sales volume and the average price obtained per seedling. The local

accreditation program was used as a basis to draft a national policy which was subsequently incorporated into DENR Departmental Administrative Order 2010-1 Revised Regulations in Governing Tree seed and Seedling Production, collection and Disposition. In effect, this DAO institutionalised the national policy on forest nursery accreditation developed in ASEM/2010. Through DAO 2010-11, the project will have a major impact on the quality of seedlings produced in the Philippines in coming years. The implementation of ASEM/2006/091 has been timely and has corresponded with an increased demand for high quality seedlings for reforestation. In February 2011 President Aquino announced the establishment of the National Greening Program (NGP), which will reforest 1.5 M ha over the coming five years. There will be around 1.6 billion seedlings required for that program. DENR is responsible for the technical implementation of the NGP, including the oversight of seedling production. DAO 2011-11 will invariably have a major impact on how these seedlings are produced. Also, there will be a huge demand for the extension materials we have already developed, along with further training in nursery techniques. **There is a substantial opportunity to roll out our research results and extension materials from ASEM/2006/091 on a national scale. This presents a potential opportunity to ACIAR to demonstrate a huge impact of its research**.

3 Background

The aim of ASEM/2006/091 was to improve the economic efficiency and policy environment of the Philippines tree seedling nursery sector. High quality seedlings are fundamental to the successful establish of forests, both for timber production and reforestation of degraded land. However, in the Philippines, the quality of tree seedlings raised in most nurseries is generally very poor and there has been a lack of recognition of the importance of seedling quality by both nursery operators and those purchasing seedlings. It is common for seedlings to have poor root structures (e.g. root coiling, J-rooting), etiolated stems and for them to be overgrown. Seedlings are often not sun hardened before being planted out in the field, resulting in high mortality rates. Disease and nutrient deficiency was also common in many nurseries.

Seedling production is one of the major areas of support in which donor organisations provide funding to communities, especially by supporting the establishment of community nurseries. However, the effectiveness of this support is questionable because inadequate attention has been paid to seedling quality, and often high mortality rates of seedlings occur, both within the nurseries and on outplanting. Improving the efficiency and effectiveness of the nursery sector thus has the potential to improve the impact of aid programs.

The nursery sector in the Philippines (in Visayas and Mindanao) is characterised by low quality planting stock, unavailability of planting materials of a wide variety of species and poor matching of the species to planting sites. Recent studies by ACIAR project ASEM/2003/052 in Leyte and ICRAF in Mindanao, Bohol and Cebu indicate that this problem is widespread. There are no quality controls placed over nurseries, and many potential buyers lack knowledge about the existence of nurseries from which they could access seedlings.

The current nursery industry organisation is in a state of flux. In the years leading up to the start of the project, the budget for seedling production of DENR had been reduced, and municipal governments were attempting to expand seedling production. On the other hand, community and private nurseries had been producing seedlings only periodically, or failing financially, due to lack of seedling orders. This has been in part the result of DENR supplying free seedlings and inadvertently undermining the commercial nursery sector. There is currently no clear agreement or understanding of the appropriate roles of the different nursery groups. As well as operating their own nurseries, DENR has been contracting out for production of seedlings, but problems arise for private nurseries because of the uncertainty of DENR orders. Private nurseries generally do not have the capability to produce seedlings of the difficult-to-grow native species often demanded by smallholders. Further, to meet orders private nurseries often simply collect advanced wildlings, which they hold for relatively short periods before supplying to DENR. These practices impede the development of smallholder forestry in Leyte. The lack of plantation forestry leads to high pressure for illegal logging of native forests in Leyte and Mindanao. Weaknesses in forestry seedling production systems also constrain the production of seedlings of native species for environmental plantings, e.g. for watershed protection.

The project was designed to address a number of priorities in the 2006/07 ACIAR Operational Plan for the Philippines including:

- Propagation systems for indigenous trees for soil and water conservation
- Market identification and utilisation of industrial trees and fast-growing agroforestry species
- Policy constraints to agroforestry development on small farms.

Also, research into nursery practices is one of the Research and Development priorities identified by PCARRD (Aggangan 2005).

Previous ACIAR projects in the Visayas and Mindanao (FST/96/110, ASEM/2000/088) have developed some nursery techniques but these have yet to be widely applied. DENR budget constraints limit the number of seedlings produced, and there are a number of policy and practical constraints that result in inequitable access to these seedlings. 'Crowding out' of the private by public nursery sectors appears to be restricting the development of an expanded private nursery sector, especially for species in high demand including gmelina and mahogany.

The implementation of ASEM/2006/091 has been timely and has corresponded with an increased demand for high quality seedlings for reforestation. In 2004, there were nearly 21,000 ha reforested by government and smallholders (DENR-FMB 2006), which roughly equates to 63 M seedlings being planted per annum. Since the project commenced, the Philippine Government has implemented the Upland Development Program in 2009, with the intention of reforesting over 51,000 ha in that year. Even more recently, President Aquino announced in February 2011 the establishment of the National Greening Program (NGP), which will reforest 1.5 M ha over the coming five years. There will be around 1.6 billion seedlings required for that program. Reducing seedling mortality within nurseries and when out-planted is thus likely to have substantial economic benefits. The project has also addressed the need for improved seedling market structures and addressed issues of unmet demand for seedlings.

This project drew on research undertaken as part of ASEM/2003/052 and its predecessor ASEM/2000/088. These projects identified a lack of access to high quality germplasm as being a major constraint faced by smallholder tree farmers interested in growing native and exotic species. The physical quality of nursery stock was also found to be very low, including seedlings produced from government nurseries. ASEM/2003/052 also found that nursery propagation techniques developed as part of FST/1996/110 and ASEM/2000/088 had not been widely taken up within the nursery sector in Leyte and Mindanao. The nurseries identified as part of ASEM/2003/052 were included in the sample frame for several research activities in the ASEM/2006/091 project, and snowball sampling was used to identify further nurseries. This project also drew on research undertaken as part of FST/1996/110 and its predecessor FST/1992/08

As part of project ASEM/2003/052, strong relationships and cooperation have been developed between the Department of Environment and Natural Resources (Region 8 and 10) officers, Visayas State University staff and Australian researchers, with all three groups working closely together. The close working relationship developed with DENR has facilitated the uptake of research results and also to influence policy. The further prospects for uptake of project results are excellent.

One of the first activities of the project was to analyse the structure of the tree nursery industry in the Philippines and the related policy environment. Simultaneously, a comparative study of the seedling production policies for smallholder and community plantations in key south-east Asian countries was undertaken to identify policies and initiatives that may be applied to the Philippines. Flowing from these two activities, a policy assessment model was developed and then used to analyse the institutional issues surrounding the Philippine nursery sector. Policy recommendations at both the national level and the regional/local level were then developed. Local level initiatives were developed and implemented in conjunction with the DENR offices (in Region 8 and Region 10) and local government units (LGUs) and the impacts monitored. National level policy changes were subsequently communicated to the Ecosystems Research and Development Bureau (ERDB) and Forest Management Bureau (FMB) of DENR in Manila. The project resulted in a broader appreciation of the requirement for high quality seedlings to be produced as part of reforestation activities and a national level policy was informed by the pilot studies undertaken in the project.

4 Objectives

The aim of the project was to improve the economic efficiency and policy environment of the Philippines tree seedling nursery sector.

The objectives of the project were to:

1. Examine the respective roles and effectiveness of the private and public sector in the tree nursery sector
2. Develop a policy assessment model and identify policy intervention points at both the national and at the local level
3. Implement local level policy changes in conjunction with DENR and pilot test strategies to increase the economic viability of the nursery sector

The project objectives were then broken down into following eight tasks against which progress was reported on an annual basis:

1(a) Describe the current private and public seedling nursery sector industry and policy environment in the Philippines.
1(b) Undertake a comparative analysis with other SE Asian countries.

2(a) Develop a policy assessment model for the Philippines Tree Nursery Sector.
2(b) Develop policy recommendations with respect to the Philippines tree nursery sector at the national level.
2(c) Identify a set of policy options to be implemented by the project at the local level in conjunction with DENR.
3(a) Initiate local level policy change affecting the nursery sector and access of smallholders to seedlings and determine implications for national level policy changes.
3(b) Undertake an economic evaluation of private sector nurseries with a view of identifying strategies to enhance economic viability.
3(c) Test business strategies to enhance economic viability of tree seedling nurseries.

5 Methodology

5.1 Overview of General Approach

The issues associated with improving the overall quality of seedlings produced within the Philippines are complex and there are many interactions between biophysical, social, economic and policy elements of this process. A multidisciplinary approach was thus necessary and was implemented within a systems framework. The systems approach provided a framework that allowed effective integration of information generated from different disciplines and scales. Various systems 'tools' and techniques were used including regular facilitated meetings of key stakeholders and researchers during project conceptualisation and implementation, and the Netica modelling framework which allowed integration of quantitative research findings with expert (discipline-based) and local (stakeholder) knowledge.

The systems approach was used in conceptualizing the project. Nurseries were contextualised within the policy environment and within the broader system of expansion of smallholder forestry and of development of the seedling nursery sector. The nursery sector was viewed as comprising three interacting segments – private, community and government nurseries – operating within a policy framework largely administered by DENR. At a broad scale, a systems approach was applied in the conceptualization of the project. That is, the issues associated with improving the economic efficiency and policy environment of the Philippines Tree Nursery Sector were conceptualized as being interrelated and not capable of being addressed in isolation (as would have been the case if a reductionist research approach was applied). At a finer or operational level, systems thinking was embedded in a value chain and policy analysis undertaken in Objective 1; the development of the policy assessment model and identification of policy intervention points at both the national and at the local level as part of Objective 2, and guided all the activities undertaken as part of Objective 3.

This project was implemented within a policy analysis framework. The project team worked closely with DENR and other government agencies to modify seedling nursery policy implementation and also to influence policy formulation at a regional and national level. This has been highly successful because of the engagement of key stakeholders, particularly DENR, in all stages of the research, including project design and implementation.

The project was implemented in three phases. The first phase was to gain a better understanding of current nursery practices and industry organisation and to ascertain international best practices (Objective 1). The second phase involved developing a policy assessment model and using this model to identify key intervention points and then identify and develop specific pilot programs (Objective 2). The third phase involved the implementation and monitoring of the pilot programs (Objective 3). The following sections provide a general outline of the methods used in the research. They are organised along the lines of key activities, which in turn are linked to the three project objectives. The organisation differs slightly from the original project document, especially in relation to Objectives 2 and 3. This reflects the *action research* approach that the project applied in which the later stages of the research were influenced by the findings in the earlier stages. The methods described below are organised by task rather than objective, and many of the tasks or activities spanned at least two and sometimes all three of the objectives.

5.2 The Survey of Nurseries

Semi-structured surveys of seedling nursery operators were conducted in Leyte (reported by Gregorio *et al.* 2010a) and in Northern Mindanao (reported by Edralin and Mercado 2010a,b) to gain a better understanding of how the seedling nursery industry operates in Philippines Regions 8 and 10.

The research approach included a literature review, interview surveys of forestry seedling nurseries on Leyte Island, the Philippines in 2008, analysis of the survey data, and subsequent focus group discussions to present and critically evaluate survey findings. The nursery survey – conducted in 2008–09 – repeated and extended the 2003 study of Gregorio, reported in Gregorio (2006). The same three groups of nursery types (government, community and private) were included in the new survey. Both active and inactive nurseries in terms of seedling production were included. The questionnaire for private nurseries is attached as Appendix A; those for government and community nurseries draw on this questionnaire as much as possible. The nursery survey questionnaires developed in the Leyte nursery survey were, with minor revisions, also used in Mindanao, and some of the same team members carried out the interviews and data entry.

In that seedling nurseries do not need to be registered with the DENR, no comprehensive list of nurseries was available as a sampling frame. Inquiries were made with the DENR, Department of Agriculture (DA) and selected local government units of some municipalities, and snowball sampling was adopted in an attempt to identify all nursery operators on Leyte Island. Topics covered in the surveys are listed in Table 1.

Table 1. Topics included in the questionnaires

A. Demographic profile
B. Financial capacity and resources
C. Knowledge of and decisions on site-species matching
D. Technical skills in nursery seedling production
E. Flow/pathway of germplasm and planting stock
F. Familiarity about and attitudes towards tree species
G. Seedling marketing and pricing
H. Profile of the nursery, infrastructure and capital outlay
I. Nursery seedling culture and cost structure
J. Nursery stock quality assessment
K. Other relevant observations

Prior to the face-to-face interviews, arrangements were made with regard to the mechanics of the interviews and their timing. Letters expressing the interest of the project to carry out the interviews and the reasons for conducting the survey were sent to all nursery operators. Consent of the nursery operators to the proposed interviews was obtained through either phone calls or personal visits.

After obtaining consent from the respondents, permission to conduct the survey was sought from gatekeepers including the municipal mayors and barangay captains, through personal meetings and discussions with survey coordinator and the interviewers. Three teams of enumerators were formed to carry out the fieldwork with each team comprising three members. The enumerators included staff of the ACIAR project who had previous experience in carrying out socio-economic surveys. The ability to converse in local languages (Cebuano and Waray) was an essential criterion in the selection process. To avoid gender bias, each team was composed of both male and female members. Prior to the fieldwork, a one-day orientation and training session was conducted to discuss with the enumerators the protocols in carrying out the survey, to expose them to the questions

and to practice conducting the interviews. The enumerators also participated in testing the questionnaires and in identifying the required revisions.

For the private nursery category, the household heads were interviewed. The person in charge of each nursery together with the president of the people's organization answered the questions in the communal nursery category. For government nurseries, the staff members designated to manage the nurseries were the respondents. In addition to personal interviews, the interviewers made observations of the standard of design and operation of the nurseries, drew sketches of the nurseries and determined the nursery location using a global positioning system (GPS). Destructive testing of seedlings was also performed to measure seedling quality parameters and any visually observable symptoms were recorded. Each day after conducting interviews, the survey teams met and discussed their activity for the whole day. This was done to raise issues and clarify uncertainties of enumerators that would potentially hinder the survey process, and to develop solutions to avoid experiencing similar problems on succeeding days of the survey period.

The data collected were organized using the Microsoft Excel and Access packages. Partial analyses were done using the Statistical Package for Social Sciences (SPSS). Data were transferred into Access for further data organization and analyses, linking the survey data with data from other research activities of the seedling project. A financial analysis of the nursery enterprise was carried out using data from the surveys and other sources.

5.3 Nursery International Best Practice

The problems faced by the Philippines in production of high quality seedlings are also faced by other south-east Asian countries. Substantial detail about nursery practices throughout south-east Asia was collected by Harrison *et al.* and published in a double issue of *Small-scale Forestry* edited by Harrison *et al*. (2008a). These papers and other literature review suggested that some countries in south-east Asia have better organized and more technically advanced seedling production systems than the Philippines. For this reason, seedling production systems were investigated in three other countries in south-east and east Asia, namely Indonesia, Thailand and Vietnam, and policy implications were drawn from observations in these countries.

Details of the visits to Western Java in Indonesia are reported in Mercado *et al.* (2010). Visits were made over 10–13 December 2007 with key officials of Forest Research and Development Agency in Bogor, the BPTP nursery at Nagrak, a community nursery at Cepaku, the Korean Overseas International Cooperation Agency (KOICA) project in Rumpin and tree plantation plots at Jasinga, the Biotrop Laboratory at Bogor, and then the nursery of PT Kuntum, a clonal propagation facility of Pondok Pesantren, the BPTP in Bandung, and a community nursery at Sumedang.

Details of the visits to Thailand and Vietnam are reported in Harrison and Gregorio (2010). Locations visited over 19–28 February 2008 included the Forest Restoration Research Unit at Chiang Mai University and the FORRU research nursery, the Thai Royal Forest Department Nursery near Chiang Mai, the Regional Community Forestry Training Centre for Asia and the Pacific (RECONF) in Chiang Mai, Kasetsart University, the Forest Science Institute of Vietnam (FSIV) near Hanoi, the Australian Embassy in Hanoi (for a meeting with ACIAR program manager Geoff Morris), the Forest University of Vietnam (VFU), the Forest Research Institute at Phu Ninh in Phu Tho province, and the Department of Forestry in the Ministry of Agriculture and Rural Development (MARD). Details of the trip are set out in Harrison and Gregorio (2010). The activities of the FORRU are summarised in a commissioned paper by Elliot and Kuaraska (2008).

5.4 Development of the Policy Assessment Model

A Bayesian Belief Network (BBN) model developed for the Philippine forestry nursery sector, as reported in Gregorio (2006), has been used as the basis for the development of a policy assessment model to identify key leverage points for potential nursery policy intervention (Figure 1). This model was developed using data from a survey of nursery operators in Leyte Island and Northern Mindanao as well as information from literature and the experience of nursery experts. The nursery sample on Leyte Island included 96 nurseries from 29 municipalities of the 41 municipalities that comprise Leyte Island, including 35 from individually owned nurseries, 33 from communal nurseries and 28 from government nurseries. A total of 90 nursery operators were interviewed in Region 10, including operators from 36 private nurseries, 25 communal nurseries, and 29 government managed nurseries, covering 16 municipalities and four cities in Northern Mindanao. The process of the model development is outlined below:

Data collection

Data used for the development of the policy assessment model were obtained from the survey of the forest nursery sector involving interviews, workshops and direct measurements and observations, as outlined in Section 5.2. Survey questions put to the respondents were presented in the form of a semi-structured questionnaire. The questions were structured to elicit information about nursery operators' knowledge on site and species matching, nursery set-up, cultural practices in seedling production and nursery management, and to assess their technical skills, seedling production objective and volume of seedlings production, nursery facilities, pathways of germplasm and planting stock, and constraints encountered in nursery operation. Specific questions incorporated in the questionnaire for individual operators included questions regarding the socio-demographic and economic background of the respondents, attitudes towards common reforestation species, and the seedling sales and demand situation. Additional questions for communal nursery groups included the PO organization process, membership status, age distribution and educational background of members, and funding schemes for the PO operation. Questions regarding support programs and implementation schemes to enhance seedling availability were incorporated in the questionnaire for the government nursery group.

The nursery set-up was assessed after the interview with the operator. The location, structure, design, production capacity and facilities present in the nursery were noted. The exposure, drainage, aspect and water supply conditions were also considered. This information was gathered to assist in assessing seedling market conditions, seedling quality, availability of support such as provision of soft and hard inputs[1], and the overall sustainability of the nursery operation. Also, this set of information helped to understand the technical expertise of the operators in relation to nursery management.

Assessment of seedling quality was carried out whenever seedlings were available at the time of the survey. Five seedlings per species at each nursery were used for destructive sampling, to measure seedling quality parameters. Following Jaenicke (1999), seedling quality was assessed in terms of sturdiness quotient (SQ), root-shoot ratio (R:S) and root form. Root morphology of the primary root of each sample seedling was described based on four categories, namely straight, coiled, spiral and J-shaped.

Data organisation and analysis

Data gathered from the survey were mainly processed and organized using the Statistical Package for Social Sciences (SPSS) computer software package. Qualitative responses were analyzed following three stages as outlined by Miles and Huberman (1994), namely

[1] Hard inputs include seeds, water, tools and other nursery materials. Soft inputs, on the other hand, include training, information and advice (Bohringer *et al.* 2003).

data reduction, data display and conclusion drawing and verification. The collected data were coded, transformed and summarized in order to note the regularities and patterns of information to arrive at the answers to the research questions. Data transformation was carried out in two stages. The first stage was designed to assist in the description of responses, and this was followed by re-categorization to reduce the number of categories and obtain sufficient observations in each category to provide reliable results from χ^2 tests. Statistical summaries including frequency counts, measures of central tendencies (mean and median) and measures of dispersion (standard deviation) were extracted to provide an initial understanding of the data gathered. Where appropriate, the transformed data were used for further statistical analysis including χ^2 tests and One-way Analysis of Variance to determine the relationships among survey variables.

Development of the policy assessment model

The development of the nursery operational effectiveness model basically followed three stages – development of a generic nursery operational effectiveness diagram, construction of the preliminary nursery operational effectiveness model and model validation. The generic nursery operational effectiveness diagram – which may be considered an influence diagram – served as the framework from which the preliminary nursery operational effectiveness model was developed. Based on the structural framework of the generic diagrams describing the operational effectiveness of the nursery industry and each of the component nursery groups, a preliminary model of the effectiveness of the nursery industry was developed using Netica. Conditional probabilities for every node were incorporated from the answers that were provided by the respondents during personal interviews and focus group discussions, from information obtained from archival records, elicited as expert opinions, and subjective estimates generated by the researcher. Depending on the type of data used to provide the *a priori* beliefs, conditional probability values for every state or state combination of each variable were populated either through direct estimates drawn from the data sources or by using case files from individual responses of survey respondents.

To ascertain that the initial model that was developed had captured the overall aspects that are necessary in portraying and examining the entire Leyte nursery system, a workshop with stakeholder groups was conducted at Visayas State University. The workshop lasted a full day and was attended by representatives of the three nursery groups. Persons in charge of the three nursery categories, relevant staff from the DENR and VSU also attended the workshop. The validation process applied the face-to-face Delphi approach to scrutinize the structure of the model and the names of variables and states, and to validate the subjective estimates of the probabilities of some states (particularly those that could not be generated from answers of individual respondents). Necessary changes were incorporated in the model after the validation workshops.

5.5 Identifying Interventions and Development of Pilot Studies

As part of the steps of further refining the model and in order to identify potential policy interventions for improving the forest nursery industry, the nursery operational effectiveness 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. 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 Seedling Enhancement 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 about nursery production systems that were identified on a whiteboard (Figure 1). 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.

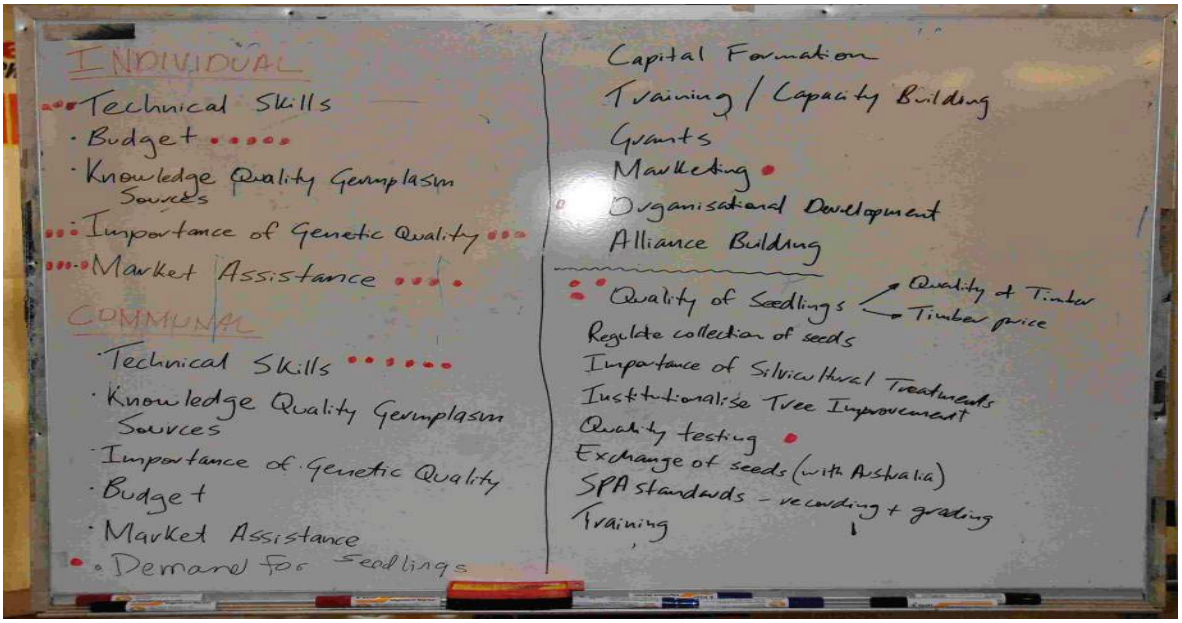

Figure 1. Major issues identified about nursery production systems

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, namely seedling market, production budget and seedling quality. The participants then self-selected into three groups to identify options to address each of the three problem areas (Figure 2). 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.

Figure 2. Workshop participants posting potential interventions for each of the problem areas

5.6 Best Management Practice Guidelines

Two important materials to promote BMP for forest seedling production were developed during the implementation of the ACIAR Seedling Enhancement Project. These are the 'Primer on Forest Nursery Accreditation' and the 'Guide on the Production of High Quality Seedlings in Smallholder Nurseries'. The 'Primer on Forest Nursery Accreditation' presents the BMP guidelines which serve as a major basis for assessing the quality of nursery seedling production (including the quality of the seedlings and the overall nursery) for the purpose of the nursery accreditation. The 'Guide on the Production of High Quality Seedlings in Smallholder Nurseries' demonstrates desirable practices for high quality seedling production. This guide was developed to support the primer by providing information on cost-effective and smallholder-based high quality seedling production technologies.

The BMP guidelines were developed through a series of meetings and workshops with various stakeholders. Two workshops were held in Leyte and Mindanao on December 2008 and January 2009, respectively. The workshops were attended by representatives of key stakeholder groups including the DENR, DA, tree farmers, timber processors, researchers and faculty members of VSU. A representative of the Development Bank of the Philippines (DBP) also attended the workshop in Leyte and presented the DBP scheme of nursery accreditation as practiced in the implementation of the DBP Forest Program. A representative of the Bureau of Plant Industries of the DA also presented the agency's nursery accreditation scheme for fruit trees. The workshops resulted in the development of the framework of the nursery accreditation. A series of meetings attended by staff of DENR Regions 8 and 10, VSU faculty members and researchers of the ACIAR Seedling Enhancement Project was held after the workshops to develop the specific BMP guidelines for assessing and accrediting forest nurseries. During the meetings, key seedling assessment parameters were identified and corresponding points were assigned from which approval of nursery accreditation application is to be based. The weight distribution of the parameters were scrutinised by the Filipino and Australian researchers of the ACIAR Seedling Enhancement Project to ensure the rigour of seedling quality assessment.

The 'Guide for High Quality Seedling Production in Smallholder Nurseries' is envisaged to provide nursery seedling producers a package of cost-effective and simple technologies for the production of high quality planting stock. The technologies presented in the BMP guide have been drawn from various sources including printed materials (e.g. books, journals, nursery manuals and research reports), internet-based information, results of research activities of the previous ACIAR-funded projects (PN 92/08 and PN 96/110) at

VSU, observations from seedling production practices in key southeast Asian countries and knowledge of experts.

Inasmuch as forest nursery accreditation is geared towards the promotion of the operational effectiveness of the forest nursery sector in the Philippines, in which the smallholder nursery group is the major component, the nursery BMP guide is focussed on smallholder-based high quality seedling production. Individual technologies and pieces of information have been drawn from various sources and collated to produce the entire package of nursery silvicultural practices presented in the BMP manual.

Considering that the BMP guide is designed largely to cater for smallholder seedling producers in the Philippines, only the practices that are feasible for adoption by smallholders have been included in the BMP manual. The distillation of technologies was mostly based on the socio-economic characteristics and technical capabilities of smallholder seedling producers as revealed from the results of surveys on the nursery sector including those of Tolentino *et al.* (2002) and Gregorio (2006). Best practices requiring high financial input and a high level of nursery management skills – e.g. establishing expensive nursery infrastructure involving sophisticated irrigation system, nursery climate control and tissue culture – are not included

The BMP manual has been reviewed by key stakeholders including the DENR, selected nursery operators, faculty members of the College of Forestry and Natural Resources at VSU. This has also been pilot tested in nursery accreditation policy implementation on Leyte Island and in Northern and Southern Mindanao. Changes have been made to the manual in response to the feedback of the reviewers and stakeholders who have used the manual.

5.7 Information, Education and Communication Campaign

Identification of information gaps

The ACIAR Seedling Enhancement Project has undertaken a substantial information, education and communication campaign (IEC) to improve the knowledge and skills of seedling producers and inform stakeholders about the protocol of the forest nursery accreditation. The IEC activities include the development of training and extension materials, establishment of demonstration nurseries and field trials, and conducting training classes for stakeholders.

The results of information needs assessment using the data from the survey of the forest nurseries in Leyte and Mindanao informed the development of IEC package. Focus group discussions were also held with stakeholders from pilot municipalities to determine the information gap that was deemed critical because it guided the design of communication objectives and interventions to respond to information needs. The ‘information gap’ is the difference between nursery operators’ current knowledge and practices and the level of knowledge and use of appropriate technologies that will enable them to produce high quality tree seedlings.

Discussions were held with subject matter specialists from the ACIAR Seedling Enhancement Project, DENR Regions 8 and 10 and College of Forestry and Natural Resources in VSU to identify the appropriate technologies and information that will form part of the IEC program. The meetings also gathered information regarding the availability of communication materials that may be adapted or modified so as to meet the needs of the clientele.

Development of training and extension materials

A collection of IEC materials were developed by the ACIAR Seedling Enhancement Project, including:

- BMP manual for high quality seedling production

- Primer on forest nursery accreditation for DENR
- Primer on forest nursery accreditation for LGUs
- Posters on characteristics of high quality seedling
- PowerPoint slides and training manuals for extension workers
    - Guide to assessment of mother trees
    - Guide to seedling quality assessment
    - Training slides for extension workers
    - Training manual on quality seedling production for extension workers
- Videos on high quality seedling production
- DVD jingle on high quality seedlings
- Hand-outs for high quality seedling production and nursery accreditation

These materials were developed in English and in Cebuano dialect to cater for a wide audience. These were disseminated to stakeholders during training events carried out at pilot sites of the project. Feedback from stakeholders regarding the extension materials was solicited and necessary improvements were made in response to comments and suggestions of stakeholders. A radio program to demonstrate best management practice in seedling production developed under the Seedling Enhancement Project was broadcast by VSU radio station DYAC. This radio program lasted for one month with a daily broadcast of 30 minutes.

Branding high quality seedlings

In line with the interest of the ACIAR Seedling Enhancement Project to promote the production and use of high quality seedlings, it was suggested during one of the workshops held at VSU that a brand name be created for high quality seedlings produced following the best management practices promoted by the ACIAR Seedling Enhancement Project. During the meeting, the name ‘Q-seedling’ was unanimously agreed upon. ‘Q-seedling’ has been used to indicate the high quality seedlings coming from nurseries accredited by DENR and LGUs as adopting the nursery accreditation policy promoted by the ACIAR Seedling Enhancement Project. This has also been used in IEC activities undertaken by the project.

5.8 Nursery Management Demonstration Activities

Training sessions and demonstration plantings were two major approaches used to demonstrate nursery best management practices and showcase favourable growth performance of high quality seedlings. A series of hands-on training events demonstrating the smallholder-based high quality seedling production were carried out in several places on Leyte Island and Northern and Southern Mindanao. To support the BMP promoted in training events, field demonstration trials were established at several sites in Leyte province. The trials demonstrate the advantages of using high quality seedlings in terms of growth development. Also, the trials investigated improved silvicultural practices to maximise the growth potential of outplanted seedlings.

5.9 Improved Access to Germplasm

To address the constraint on limited availability of high quality germplasm of various tree species, the ACIAR Seedling Enhancement Project has initiated four major interventions – establishment of tree seed centres, a survey of phenotypically superior mother trees, and development of a strategy for collecting wildings and establishing field trials.

5.9.1 Establishment of tree seed centres

Tree seed centres were established to improve access of nursery operators to high quality germplasm of a wide species base. Two centres were established – one in Leyte (at VSU) and another in Northern Mindanao (at the DENR-ERDS field office in Malaybalay,

Bukidnon). The centre at VSU was managed by staff of ACIAR Seedling Enhancement Project while staff members of the DENR-ERDS managed the seed centre in Northern Mindanao. The two centres were equipped with simple seed storing facilities including refrigerators and glass and plastic jars. The centres acquired high quality germplasm (seeds and wildlings) of several tree species from various sources in Leyte and Mindanao including the mother trees identified and assessed as part of the Seedling Enhancement Project. Seeds were both collected by staff managing the centres or purchased from dealers. Mother tree inspection by staff managing the centres was a standard procedure before germplasm were purchased. The seeds were processed at the centre, packed into small packets and distributed for free to nursery seedling producers. Germplasm distribution was recorded in each centre to monitor the flow of germplasm.

5.9.2 Survey and identification of superior mother trees

With the objective of improving the supply of high quality germplasm especially for native timber trees, the ACIAR Seedling Enhancement Project carried out a documentation of the distribution of mother trees of native timber species on Leyte Island and Mindanao, evaluating their phenotypic characteristics and collecting information on their phenology. Data were gathered through personal interviews with nursery operators, actual measurements of tree parameters and researchers' analysis on the physical qualities of identified mother trees. A questionnaire was developed and used to elicit local information from seedling producers regarding their knowledge about the location and phenology of the mother trees within their municipality that they have been using as sources of germplasm for their seedling production. In Southern Mindanao, however, most of the mother trees located in the natural forest had not previously been identified by the nursery operators. In this case, an inventory of mother trees was carried out by establishing circular plots with 30 m radius in the natural forest and recording phenotypically superior trees in every plot.

Physical measurements of tree parameters including tree height and diameter at breast height were carried out using a laser hypsometer. The phenotypic characteristics including stem form, branching characteristics and tree health were assessed based on the guidelines and criteria indicated in DENR Administrative Order (DAO) 95-09. Locations of individual mother trees were determined and recorded using a global positioning system (GPS), compass and laser hypsometer.

Locating the mother trees

No comprehensive record exists of the distribution of mother trees of timber species from relevant Philippine government agencies including the DENR. Information regarding the location of mother trees used by nursery operators and DENR was taken from key informants, particularly seedling producers in both the private and government sectors. In Leyte, the names of nursery operators, their locations and contact telephone numbers were obtained from the database of nursery operators developed by the ACIAR Q-Seedling Project. The names and addresses of nursery operators in Southern Mindanao were obtained from the DENR offices in the Regions 11 and 12.

Nursery operators were interviewed to gather information regarding phenological characteristics of the mother trees. The species and location of all mother trees identified by the nursery operators were recorded. Visits to identified mother trees were made by the researcher after the interviews. The nursery operators served as guides to locate the mother trees.

Mother trees in the natural forest of Southern Mindanao were identified with the aid of aerial photographs. Circular plots were illustrated on the photograph particularly on the highly vegetated part of the natural forest. The coordinates of the centre point of every plot were determined. The coordinates served as reference points in establishing the plots on the ground.

Assessment of the phenotypic characteristics of the mother trees

The phenotypic characteristics of mother trees were assessed following the method developed by the DENR and reported in Cacanindin *et al.* (2010), to choose the superior mother trees. Phenotypic quality is assessed in terms of the criteria of stem growth, stem form, health and branching characteristics. Tree parameters measured under these categories are presented in Table 2. Each parameter is graded on a scale of 1 to 6, with 1 as 'very unacceptable' and 6 as 'highly acceptable'.

Table 2. Criteria and corresponding parameters measured to assess the physical quality of the mother trees

Criterion	Parameter
Stem growth	Total height (m)
	Diameter at breast height (cm)
Stem form	Stem straightness
	Forking
	Circularity of the stem
Health	Tree health
Branching characteristics	Branch angle
	Branch thickness
	Branch persistence

The set of criteria for the straightness of the stem is described in Figure 3. A grade of 'unacceptable' (1 and 2) is given when the stem has two pronounced bends within its merchantable height, 'fair' (3 to 4) is accorded with one bend, and a stem is regarded as 'straight' (5 to 6) when there is at most a slight bend.

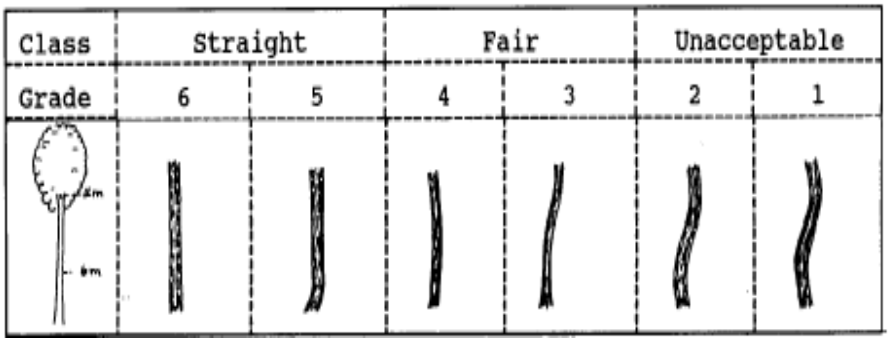

Figure 3. Description of stem form classes

In terms of forking, three or more stems emanating below the 6 m length from the base of the stem is considered 'unacceptable'. Two stems occurring below the 3 m length is considered fair and a small fork occurring close to the 12 m stem length is considered 'good' (Figure 4). Detailed illustrations describing all the parameters are presented in Cacanindin *et al*. (2010).

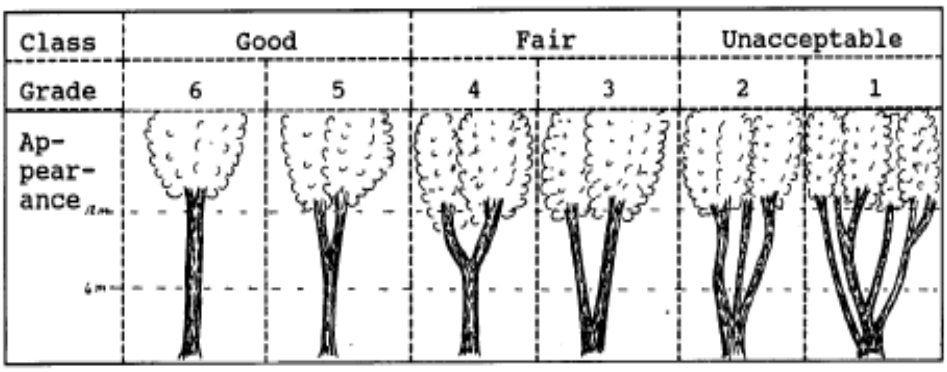

Figure 4. Description of stem forking classes

The ratings for every parameter were added and an overall score for every tree was determined by computing the mean score of individual tree. A scale of 1 to 6 was used to describe the overall rating with 1 as very unacceptable; 2 as unacceptable; 3 for relatively acceptable; 4 as fair; 5 as good and 6 as highly acceptable.

Recording locations of mother trees

The locations of phenotypically superior mother trees were taken were recorded for the purpose of mapping their distribution and locating these trees again for tagging. For mother trees in circular plots established in the natural forest of Southern Mindanao, the location of every tree within the plot was determined using a compass and laser hypsometer to measure the azimuth angle and distance of the tree from the centre of the plot, respectively.

After the phenotypic quality assessment, all mother trees with mean assessment scores of not less than 3 (from relatively acceptable to highly acceptable) were marked by painting a band of high visibility paint around the stem at a height of 1.5 m from the ground. In Leyte, tags made up of aluminium sheets with a dimension of 30 cm by 15 cm were nailed to the stem at approximately 3 m from the ground. Each tag displays information including the common name of the species, its scientific name and family name. The tags were placed to aid seed collectors in recognizing the mother trees accredited by the ACIAR Q-seedling Project. Also, it was felt that the tags might discourage illegal loggers from cutting the trees because they indicated that the trees have been recorded by a particular agency.

Data collected from the inventory have been used as input for creating a database of the mother trees developed by the ACIAR Q-seedling Project. The database contains information regarding the species of the mother trees, their location and phenology. The database also includes the names and contact numbers of the owners of those trees growing on private land. A guidebook about the mother trees has been developed to provide information about the mother trees that were identified including the names (common, local and botanical), location, growth habits, wood characteristics, uses and propagation techniques.

5.9.3 Designing a wilding collection program

Wildlings – seedlings which have germinated naturally under or near mother trees which are uprooted and grown in nurseries – have traditionally been widely used for producing planting material for indigenous species including dipterocarps, which do not regularly set seed and for which seed may have a short viability period. Data from various sources were collected to formulate a strategy for wildling collection, which could be used for example in large scale planting of native tree species, say as green offsets for a major land-use-change project. This included discussions with foresters, and extensive literature search, and financial modelling of the training and supervision of field teams for wildling collection.

5.9.4 Field trials to test a strategy to improve the supply of high quality germplasm

The survey of the forest nurseries on Leyte Island and in Northern Mindanao revealed that there is a limited supply of high quality germplasm and nursery operators are collecting germplasm from unselected sources. There was a need to develop mechanisms to improve the supply of high quality germplasm. Nursery and field trials were established during the implementation of the ACIAR Seedling Enhancement Project to develop strategies to improve the supply of high quality germplasm. These trials were initially focusing on gmelina considering that this is the species that is commonly planted on tree farms and reforestation projects in the country.

Field trials were established in the municipalities of Mahaplag and Matalom in Leyte. The aim of the research trials was to investigate whether the initial outplanting performance of gmelina seedlings could be improved by the selection of better performing seedlings within a cohort of seedlings produced from unselected seed sources and whether these seedlings perform as well as germplasm from selected mother trees and improved imported germplasm. This research has significance for the selection of planting material for smallholder tree farms in the Philippines and elsewhere, including the identification of best performing planting material. Identifying the morphological and physiological characteristics of seedlings that influence outplanting performance will aid in the development of benchmarks for seedling quality specific to *Gmelina arborea*. The results will shed light on whether selective use of seedlings produced in the nursery is an effective strategy for smallholders to improve tree growth performance. This will assist smallholders to gain ready access to better performing genetic material from local sources at low cost rather than relying on the import of improved germplasm.

Seedlings were produced using unselected, selected and superior seeds. A total of 1000 seedlings were grown from each germplasm category. The seedlings were assigned an identity number and randomly placed on elevated hardening beds three months after potting. After two months of sun-hardening the seedlings were graded according to their height and assigned to deciles. Assignment to deciles was based on the position of seedlings after grading, i.e. the first 100 seedlings belong to the first decile and the last 100 seedlings belong to the 10^{th} decile. Seedling height, base diameter and number of leaves were recorded every month. Maximum photosynthesis was measured a week before seedlings were outplanted. Also, 10 seedlings were randomly selected from each decile for biomass, root-to-shoot ratio and root length measurements.

From each decile, 48 seedlings were randomly selected for outplanting (40 as sample seedlings and 8 as buffers). The planting design was random stratified comprising of three plots with four strata consisting 100 randomly selected seedlings from each decile of each of the three germplasm sources, i.e. unselected, improved and superior. For the purpose of complete randomisation across the deciles and germplasm sources, the 40 randomly selected seedlings from each decile were divided into four blocks with 10 seedlings per block. The first 100 seedlings from 10 randomly picked blocks across all deciles of the three germplasm sources comprised the first stratum of seedlings planted at a spacing of 3 m x 3 m (coordinates X_i; Y_j). The second stratum was established by offsetting by 1.5 m in the X coordinate (i.e. $X_{i+1.5)}$; Y_j). The third layer was established by offsetting 1.5 m in the Y coordinate (i.e. X; $Y_{j+1.5}$). The fourth strata was established by offsetting 1.5 m in both X and Y coordinates (i.e. $X_{i+1.5}$; $Y_{j+1.5}$). It is planned that at the time of thinning, 3 of the 4 strata would be completely removed leaving a final spacing of 3 m x 3 m with even numbers of individuals for each of the deciles. For example, removing strata 2, 3, and 4 would result in the planting configuration. However, any combination of 3 strata could be removed resulting in a similar configuration after thinning. A total of 1200 seedlings were outplanted, 400 for each of the three plots.

Plant height and base diameter were measured immediately before outplanting and the number of leaves per seedling was counted. Post planting measurements include the maximum photosynthesis, seedling height, base diameter and health. The maximum photosynthesis was measured from 300 selected seedlings (100 seedlings from each germplasm source) two days after outplanting. Seedling height, base diameter and health are assessed quarterly.

5.10 Pilot Schemes to Assist Smallholder Nursery Operators

Lack of funds or 'budget' was one of the three key intervention areas identified during the policy modelling workshop held in Ormoc City. Generally, operators of forest nurseries in the Philippines are resource-constrained smallholders. Among the suggested interventions to offset the constraint of limited funds to sustain the nursery operation are a smallholder grant scheme and increasing the seedling demand by providing a strong link between buyers and sellers of planting stock.

The smallholder grant scheme was pilot tested in a private nursery in Baybay, Leyte and the LGU nursery in Palompon, Leyte. The nurseries were initially provided with nursery materials including polyethylene sheets used as roofing for the germination and transplant sheds. Seeds and wildlings from identified mother trees were also provided to the nursery operators through the tree seed centre at VSU. The germplasm was distributed free of charge but the nursery operators paid back the cost of the acetate after they had sold their seedlings.

In response to the potential buyers' limited knowledge of nursery locations, a database of nursery seedling producers was developed facilitating better linkages between nursery operators and potential buyers. The database contains information including names of nurseries and operators, addresses, contact phone numbers, species produced and prices for each seedling. Information included in the database was drawn from the data collected during the surveys of the nursery sector in Leyte and Mindanao. Printed copies of the information in the database were distributed to stakeholders including potential seedling buyers.

5.11 Nursery accreditation

The idea of developing and implementing a nursery accreditation policy in the Philippines emerged from the policy workshop of the ACIAR Seedling Enhancement Project held in Ormoc City, Leyte, on 12 February 2008. Two major workshops were held in Leyte and Mindanao to develop the mechanisms for accrediting forest nurseries. The workshops were attended by stakeholder representatives including nursery operators, tree farmers, timber processors, key personnel of DENR and the Bureau of Plant Industries of the Department of Agriculture, as well as staff members of LGUs and faculty members of the VSU College of Forestry and Natural Resources. The workshop involved presentations from stakeholders regarding their perspectives and relevant information useful for the formulation and implementation of the forest nursery accreditation policy. After the two major workshops, a series of meetings were held in VSU which were attended by selected key stakeholder representatives who participated in the major workshops. The meetings were held to draft the forest nursery accreditation policy designed for implementation at the local DENR offices and by the LGUs. As well as formulating the accreditation process, criteria for assessing nurseries and seedlings were developed. The draft of the localised nursery accreditation protocol was sent to the research scientists at The University of Queensland for comments and suggestions.

Consultation meetings were carried out with local DENR and LGU officers before pilot testing the nursery accreditation policy. Two meetings were held with DENR and four meetings with LGUs. During the meetings, the nursery accreditation process was explained and the nursery assessment procedure was demonstrated. Memoranda of

Agreement (MOAs) with the LGUs were developed and mutual agreement was established between the local DENR, the ACIAR Seedling Enhancement Project and the VSU, for the DENR and LGUs to adopt the forest nursery accreditation policy. The Regional Executive Director of DENR in Malaybalay, Bukidnon Province issued Memorandum 2009-1 'Piloting the Forest Nursery Accreditation and Management of Forest Nurseries in CENRO Malaybalay', and the LGU of Palompon, through a series of public consultations, issued the Municipal Ordinance No. 327-010909 'An Ordinance Providing Regulations on the Accreditation of Forest Nurseries within the Municipality of Palompon' on 1 September 2009.

To ascertain the impact of the localised implementation of the forest nursery accreditation policy, a preliminary assessment was carried out by researchers of the ACIAR Seedling Enhancement Project six months after commencement of the accreditation policy implementation. Interviews and focus group discussions with stakeholders – particularly the nursery operators and policy implementers in Palompon, Leyte and Northern Mindanao – were undertaken to determine the benefits farmers derived from the implementation of the nursery accreditation scheme. Members of the group that set up and maintained the communal nursery participated in the FGDs. A thematic analysis (following the method described by Aronson, 1994) was conducted on responses. This involved producing transcripts of responses to the questions during the FGDs, which were read and re-read to identify regular recurring benefits described by the nursery operators. These regular recurring patterns were then classified into themes which gave an overall view of the benefits farmers experienced from the implementation of the policy.

While the preliminary assessment has provided information about the effect of nursery accreditation on improving the operational effectiveness of the forest nursery sector, a more comprehensive evaluation will require an impact evaluation on a broader scale after a longer period from the implementation of the policy.

5.12 Nursery economies of scale analysis

In terms of nursery business models, it was assumed that new nurseries will be privately owned and operated, by smallholders, communities or companies (depending in part on nursery size). In reality, nurseries producing less than about 5000 seedlings a year are likely to be operated by individuals – particularly smallholders – producing seedlings in part for their own use, while nurseries producing up to about 50,000 seedlings a year might be operated by communities, and large nurseries could be owned and operated by companies (e.g. in forestry or mining) or government.

Financial analysis was carried out for six nursery sizes, in terms of annual seedling production, of 2000, 5000, 25,000, 50,000, 100,000 and 200,000 units, produced in two batches. The construction and operation of nurseries of these sizes were treated as financial investment projects, analysed by investment project analysis (IPA) methods. For this analysis, the factors affecting seedling production costs were standardized as much as possible in the financial models. As the nursery size increased, the size of the nursery components and the allowance for labour and other variable inputs was increased. Minor variations were made in capital and labour intensity with nursery size.

The analysis setting involved some specific features in relation to the production of forest reproductive material (FRM):

1. FRM was to be produced mainly for large-scale plantings, with a reliable market over the assumed project life.
2. The nurseries were to be certified for producing high quality seedlings, following BMP standards. This implied a need for training, and for quality inspection.
3. Some capital support would be available for nurseries operated by disadvantaged (e.g. mine affected) individuals, groups or communities.

4. Durable materials were to be used, because of uncertainty about availability of asset replacement capital for small nurseries operated by indigenous communities, and the need for tight production schedules by large nurseries.
5. A relatively high proportion of wildlings was to be used as germplasm, due to the difficulty of obtaining seed for dipterocarps and other indigenous species and the desirability of using endemic genetic material as much as possible.

All of these requirements made for relatively high-cost seedling production, relative to the existing smallholder and even government forestry nurseries in the Philippines.

The general nursery physical structure for each nursery size option followed that described by Gregorio *et al*. (2010b). Project costs were divided into capital outlays and operating costs. The main capital outlays were for land, nursery buildings (germination shed, potting shed, transplant shed and hardening beds) and tools and equipment. Annual operating costs were incurred for labour, potting medium, polybags, fertilizer and other annual inputs. Project revenue arose from sale of seedlings.

The nursery size alternatives were evaluated over a project life of 12 years. A *required rate of return* or discount rate (approximating the weighted average cost of capital from any sources) of 15% was adopted (the rationale of which is reported by Harrison *et al*. 2010). A *constant price analysis* was conducted, which assumes that there are no differences in the rates of increase in prices of inputs and outputs over time. All costs and revenues are reported in US dollars (US$1 = 50 PhP approximately). It was assumed that sufficient seed can be obtained for 50% of the production, and that wildlings collected from the mining project area will account for the other 50% of FRM.

Where possible, the same assumptions were made for each nursery size. However, some variations were needed, including exclusion of some of the capital and operating cost items, and lower rates for others (including the regular wage rate) for the smaller nurseries.

Data to inform the financial modelling draws on nursery studies reported by Gregorio *et al*. (2010a) for Leyte and Edralin and Mercado (2010b) for Mindanao, visits to seedling nurseries in various regions in the Philippines by the authors, cost data recorded from the construction of the demonstration nursery at Visayas State University (VSU), and literature search

5.13 Influencing the national policy

Results of the initial evaluation of the localised implementation of the forest nursery accreditation revealed a considerable improvement of the operational effectiveness of the forest nurseries in pilot sites. This has motivated the researchers of ACIAR Seedling Enhancement Project to promote the policy on forest nursery accreditation to the national scale. Together with senior staff of DENR R10, researchers of the ACIAR Seedling Enhancement Project drafted the national forest nursery accreditation policy. The draft was forwarded to the Ecosystems Research and Development Bureau (ERDB) of DENR in Manila for review by the top ERDB officials. ERDB is the research arm of the DENR and has been influential in developing a number of forest policies in the country. After the Director had reviewed the draft, it was forwarded to the Forest Management Bureau (FMB) of DENR Central Office. FMB is the DENR bureau responsible for formulating national policies for sustainable development of natural resources in the country. A meeting with the top FMB officials including the Director of FMB, top DENR officials in R10 and the researchers of ACIAR Seedling Enhancement Project was held in Manila on January 2010to present the proposed nursery accreditation policy. The proposal received a highly positive response from the DENR officials. On May 2010, a national policy DAO 2010-1 otherwise known as ‘Revised Regulations Governing Tree Seed and Seedling Production and Disposition’, was approved by the DENR Secretary which incorporates the policy on forest nursery accreditation. Subsequently, the implementing guidelines setting

out the details of the forest nursery accreditation process and the set of criteria for assessing seedlings and nurseries have been drafted by the project researchers and forwarded to the FMB for review.

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6 Achievements against activities and outputs/milestones

Objective 1: Examine the respective roles and effectiveness of the private and public sector in the tree nursery sector

Objectives/ Activities	Outputs	Completion date	Comments (how achieved, related publications)
1(a) Describe the current private and public sector industry and policy environment in the Philippines	(i) A review of current nursery industry structure and policy environment	Apr 08	Surveys of government, community and private seedling nursery operators were conducted in Leyte and Northern Mindanao (reported by Gregorio *et al*. 2010a; Edralin *et al.* 2009; Edralin *et al*. 2010a; Edralin *et al.* 2010b) to gain a better understanding of how the seedling nursery industry operates in Philippines Region 8.
	(ii) A critical appraisal of smallholder nurseries established by the Landcare project in Claveria	Apr 08	Surveys of seedling nurseries in Northern Mindanao were conducted (reported by Edralin and Mercado 2010 a,b) to gain a better understanding of how the seedling nursery industry operates in Philippines Region10.
1(b) Undertake a comparative analysis with other SE Asian countries	(i) A literature review of policy and industry initiatives in the nursery sector in SE Asia	Nov 07	Substantial detail about nursery practices throughout south-east Asia was collected by Harrison *et al*. and published in a double issue of *Small-scale Forestry* (Harrison *et al*. 2008a). These papers and other literature reviews suggested that some countries in south-east Asia have better organized and more technically advanced seedling production systems than the Philippines. For this reason, it was decided to investigate seedling production systems in three other countries in south-east and east Asia, namely Indonesia, Thailand and Vietnam, and to draw any relevant policy implications from observations in these countries.
	(ii) A detailed analysis of most promising initiatives identified in (i)	Nov 07	Visits were made to foresters in government research institutes and universities, in Western Java in Indonesia (reported by Mercado et al 2009; Mercado *et al.* 2010) and to Thailand and Vietnam (reported by Harrison and Gregorio 2009; Harrison and Gregorio 2010). These were designed to investigate seedling nursery practices in these countries, particularly in regard to non-industrial forestry, and to draw policy implications for seedling production for forestry in the Philippines.

Objective 2: Develop a policy assessment model and identify policy intervention points at both the national and at the local level

Objectives/ Activities	Outputs	Completion date	Comments (how achieved, related publications)
2(a) Develop a policy assessment model for the Philippines Tree Nursery Sector	A policy assessment model	Sept 07	A policy assessment model was developed drawing upon data from multiple sources, including the survey of nursery operators, interviews with other key stakeholders and expert opinion The model was developed in Netica and validated during policy workshops with stakeholders (reported by Gregorio *et al*. 2009b and Gregorio *et al*. 2010d). Key interventions to improve the nursery operational effectiveness were identified in the workshops and incorporated in the nursery policy model.
2(b) Develop policy recommendations with regards to the Philippines Tree Nursery Sector at the national level	Detailed analysis of current and potential policy initiatives at the National level	Nov 07	A policy workshop with stakeholders was carried out in Ormoc, the Philippines to identify constraints in forest nursery sector and develop potential interventions. Forest nursery accreditation came out as a major policy intervention to improve the operational effectiveness of the forest nursery sector. Two major workshops with stakeholders to develop mechanisms for nursery accreditation were carried out in Leyte and Mindanao. Another meeting and workshops with key DENR officials from Regions 8 and 10 were carried out to develop the draft the national policy on nursery accreditation. The proposed policy was forwarded to the national DENR office for perusal by the DENR policy-makers. A meeting with the top DENR officials was held in Manila to present the details of the proposed policy. The national policy on forest nursery accreditation was institutionalised through the issuance of DAO 2010-11.
	Policy recommendations	Nov 07	The forest nursery accreditation policy is envisaged to ensure the sustainable production of high quality seedlings from seedling nurseries. The accreditation process involves the assessment of the nursery system in four major aspects namely: seedling quality; skills of the nursery operator; nursery set-up and facilities and seedling production capacity.

			The nursery accreditation policy was pilot tested at the local DENR office in Region 10 and LGUs in Leyte and Southern Mindanao through the issuance of a Memorandum Circular (for DENR) and Municipal Ordinance (LGUs). Under this scheme, nurseries will be assessed by the Forest Nursery Accreditation Committee, which will recommend the accreditation of the nursery to the RED (for DENR) or the mayor (for a LGU).
2(c) Identify a series of policy options to be implemented by the project at the local level in conjunction with DENR	Detailed analysis of current and potential policy initiatives at the local level	March 08	Details of identifying policy options are reported in Gregorio *et al*. (2009b) and Gregorio *et al*. (2010d). Potential policy interventions were identified during the policy workshop in Leyte. The scale of importance of these interventions in improving the operational effectiveness of the forest nursery sector was analysed using the nursery model.
	Recommendations for policy options to be implemented	March 08	Forest nursery accreditation policy was developed and pilot-tested at the local level by DENR and LGUs. A national policy of forest nursery accreditation was also advocated. The pilot testing of the forest nursery accreditation policy involved the following key interventions: • Develop best practice guidelines for forestry seedling production the Philippines • Information, Education and Communication (IEC) campaign to be developed including 'Q-Seedling' brand and development of extension materials for nursery operators and other target audiences • Demonstration activities to be developed, i.e. demonstration nurseries, hands-on training and outplanting activities • Improved access to germplasm involving the establishment of seed centres and the identification of mother trees • Develop a smallholder grants scheme and database of seedling buyers and sellers • Develop a nursery accreditation scheme at the community and regional level for implementation by DENR and LGUs

Objective 3: Implement local level policy changes in conjunction with DENR and pilot test strategies to increase the economic viability of the private nursery sector

Objectives/ Activities	Outputs	Completion date	Comments (how achieved, related publications)
(a) Initiate local level policy change affecting the nursery sector and access of smallholders to seedlings and determine implications for national level policy changes	Pilot testing of policy changes, e.g. removing requirement for proof of landownership, introducing a small charge for seedlings	March 10	*Pilot testing of nursery accreditation by LGUs* and local DENR office Forest nursery accreditation was pilot tested in one LGU in Leyte and in two cities and three municipalities in Northern Mindanao within the jurisdiction of the CENRO-DENR office. Also, the accreditation policy has recently been adopted in two LGUs in Southern Mindanao. The paper of Gravoso *et al*. (2011) reports the process of pilot testing the nursery accreditation policy. Under the LGU accreditation scheme in Leyte, the LGU of Palompon purchased high quality seedlings from the accredited nurseries. The seedlings were distributed to smallholder tree farmers without requiring proof of landownership (as opposed to the practice of DENR). *Improved access to germplasm* Seed centres were established at VSU, DENR 10 provincial office and SMI office in General Santos The seed centres provided seeds and wildlings to nursery seedling producers particularly the smallholders. The centres have also distributed extension materials about the superior mother trees identified in Leyte and Mindanao, the importance of using seeds from selected sources and other information about high quality seedlings. A mother tree program was established to identify sources of seed and wildlings for nursery operators. In Leyte, a total of 502 mother trees belonging to 32 species were recorded in the database (Gregorio *et al.* 2010c). The survey in Mindanao identified 763 phenotypically superior mother trees belonging to 117 species. A monograph describing the key species was produced in conjunction with SMI Gregorio *et al.* 2010f).

			Demonstration activities Capacity building activities demonstrating best management practice in seedling production were carried out. These included hands-on training, establishment of demonstration nurseries and field trials and demonstrations. Demonstration nurseries were established in VSU, at the compound of DENR Research Section in Malaybalay in Bukidnon Province and in the municipality of Palompon in Leyte. A number of hands-on training sessions on high quality seedling production and nursery assessment processes were conducted in these nurseries. The seven field trials in Leyte were visited by tree farmers and seedling producers from various places in Leyte and Mindanao.
	Assessment of the effectiveness of policy changes	March 10	Evaluation of the impact of the policy changes at the local level was undertaken. The paper of Gravoso *et al*. (2011) presents the process of assessing the impact of the policy implementation and results of the evaluation.
(b) Undertake an economic evaluation of private sector nurseries with a view of identifying strategies to enhance economic viability	Report from survey of nursery operators and analysis of cost structures	March 10	Reports of survey findings were prepared by Gregorio *et al*. 2010a; Edralin and Mercado 2010a,b.
	A nursery financial model	March 10	A financial model of nurseries was developed in Excel and used to undertake an economies of scale analysis, as reported in Harrison and Gregorio (2010 – EoP workshop proceedings).
	Strategies for improving the economic viability of nurseries	March 10	Capital outlays, operating costs and seedling revenue were estimated for seedling nurseries with outputs of between 2000 and 200,000 seedlings a year, and a number of financial performance criteria were produced. The economies of scale analysis identified that the optimal size of a smallholder nursery in terms of controlling seedling production costs but providing livelihood benefits might be at the 25,000 unit level.

(c) Test business strategies to enhance economic viability of tree seedling nurseries	Pilot tests of strategies for improving economic performance of nurseries, e.g. seed branding, improved financial structures, application of better technologies	Sept 10	Data from various sources were collected to formulate a strategy for wildling collection, which could be used, for example, in large-scale planting of native tree species. A number of training and extension materials (manuals, videos, posters and flyers) were developed to promote the best management practice in nursery seedling production and use of high quality seedlings. These materials include the guidelines for nursery best practice in smallholder production, guide in assessing mother trees and primer on forest nursery accreditation. A database of seedling producers was developed and the information was disseminated to prospective seedling buyers. The database used the information from the survey of nurseries in Leyte and Mindanao. A smallholder grant scheme was initiated in Leyte and Southern Mindanao. VSU and SMI have provided nursery materials to smallholder nursery operators, including polybags and polyethylene roofing sheets for transplant and germinating beds. The cost of the materials was paid by the operators after considerable sales of the seedlings.

7 Key results and discussion

7.1 Survey of nurseries

7.1.1. Findings of the nursery survey in Leyte

The seedling nursery survey in Leyte revealed some undesirable nursery practices, e.g. the collection of seed on the basis of convenience rather than quality, lack of soil sterilization and failure to raise seedlings off the ground, as reported in Harrison *et al.* (2008a). A summary of the weaknesses in the Philippines seedling nursery practices was reported in Harrison and Gregorio (2008).

The forest nursery industry on Leyte Island is not effective in delivering high quality planting materials of a wide species base to tree farmers. The seedling production enterprise is hampered by the combination of social, technical, economic and political constraints. The majority of private nursery owners have limited education, and they lack knowledge about the attributes and importance of seedling quality and skills in the production of high quality planting stock. Seedling production is largely quantity-oriented. The lack of financial resources, limited access to germplasm of a wide species base and a small market prevented most of the private nurseries from sustaining their operation. There are government regulations on the quality of nursery-grown forestry seedlings but these have not as yet resulted in an improvement in the quality of planting stock.

The current situation shows that there is no 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. Most of the seedlings distributed from government nurseries duplicate the species sold in private nurseries. The continued operation of private nurseries is important because of declining funds for government seedling production, greater accessibility of private nurseries for the majority of tree farmers and the development of the human and social capital of smallholders from the decentralized nursery operation.

There is a need to improve the organization of forestry seedling nursery production in the Philippines. The market of seedlings for industrial plantations, small-scale forestry and upland rehabilitation projects is evident but low sales remain a major constraint hampering the operation of most nurseries. There is a need to develop and institutionalize a policy that will regulate seedling quality and improve the financial viability of private nurseries. Also, it is imperative to improve the germplasm pathway and the technical capacity of the forest nursery operators.

7.1.2 Findings of the nursery survey in Mindanao

The three nursery types in northern Mindanao – private, community and government nurseries – differ in management as well as in other aspects such as the operator handling the nursery, the capacity to produce seedlings, support available and sustainability. Private nurseries are usually managed by a single individual with the help of household members. In some instances, in the case of well-established nurseries, licensed professionals in forestry and agriculture are responsible for the management of the nursery. Private nurseries are stable considering the large number of private nurseries that have been operating continuously since initial establishment.

Communal nurseries are managed by the People's Organisation headed by the organization president, who usually had attended training but in most cases had been unable to finish their formal education. Government nurseries are mostly staffed by trained individuals, and in some cases are overseen by licensed professionals in agriculture and forestry.

The production of low quality seedlings is common in Northern Mindanao, with seedlings often being etiolated, having deformed stems, J-shaped primary roots and showing signs of various diseases. A few private nurseries are practicing sound nursery management technologies, including the collection of germplasm from phenotypically superior mother trees. Low quality seedlings dominate the seedling market because of the low selling price and tree farmers' lack of concern about using high quality seedlings.

The constraints on the forestry nursery sectors in Northern Mindanao can be reduced through the adoption of an accreditation scheme for nurseries with the support of DENR. This scheme may regulate seedling quality, thus minimizing, if not eliminating, the supply of inferior seedlings in the market. Through tree nursery accreditation, nurseries standards including the quality of seedlings produced, will be improved. On the other hand, the government sectors' practice of acquiring low-priced seedlings – which undermines quality – should be ceased and replaced by the purchase of high quality planting materials. Moreover, the use of high quality seedlings should be incorporated in government programs such as the NFP and GPP. Locally, capacity building of nursery operators may be undertaken through training in high quality seedling production technologies. At the same time, the mindset of the buyers should be changed through an intensive information campaign to increase their demand for high quality seedlings. Such a demand-driven initiative will in turn lead to the production of high quality seedlings by the nursery operators. Improved organisation of tree nurseries in Northern Mindanao is also important to facilitate the transfer of high quality seedling technology from researchers to nursery operators.

7.2 International Best Practice

7.2.1 International nursery best practice in Thailand and Vietnam

Production of seedlings for forestry plantations in both Thailand and Vietnam – for both industrial and smallholder forestry – is conducted at a large scale and is technologically advanced. In both countries, the government is playing a major role, although the private sector is increasingly becoming involved in Vietnam.

There is a high demand for forestry seedlings in northern Vietnam, due to the high tree planting targets, especially under the 5MH program. A reasonably sophisticated system of both seed and seedling production has been established in Vietnam, with a strong incentive for certification being the access to government seedling supply contracts. The national networking of forestry including seedling production in Vietnam is impressive.

Progress in seedling nursery systems in Thailand and Vietnam provides important lessons for the Philippines. There is a critical need for high quality planting stock in tree planting programs in the Philippines. One of the major reasons for mixed results of government and private reforestation activities is the use of low quality planting stock. Most private and public nursery seedling production still uses germplasm from unselected sources. The high quality germplasm pathway is not well established in the Philippines. There are limited sources of genetically superior planting materials and the technology on the production of high quality planting stock is not well advanced; for example, the use of tissue cultured germplasm is still non-existent among nursery operators.

National networking

There is a big scope for international networking to improve the germplasm pathway in the Philippines. Vietnam has gone a long way in terms of developing technologies and implementing policies to ensure the production and use of genetically improved materials in the country's tree planting programs. Accordingly, Vietnam could be a useful example for the Philippines especially on the aspect of promoting an effective and efficient pathway of germplasm with high genetic quality.

Certification (plus branding and higher seedling prices), research and extension

The accreditation of forest nurseries which is being done in Vietnam is currently observed in the Philippines through the issuance of DAO 2010-11 which development was informed by the results of the ACIAR seedling enhancement project. Prior to this policy, there is no national protocol that regulates the quality of seedlings from private and government nurseries.

Species choice (indigenous, exotic)

Forestry seedling production in the Philippines is limited to a few common species, mostly exotics. The limited species base of seedlings is due to the limited availability of germplasm. This is particularly true for premium native species, especially dipterocarps, because of the often long interval between seed years and the scarcity of mother trees. The tissue culture technology in Thailand and Vietnam and the macro-somatic propagation of teak in Thailand could be popularized in the Philippines to facilitate the production of seedlings of a wide species base. This would increase the options of tree farmers in selecting the species to plant and help solve the problem of planting species outside of their environmental requirements.

Producing seedlings for small-scale versus government nurseries

The presence of small-scale private nurseries is evident in Thailand and Vietnam, which is similar to the Philippines. The crowding-out of small-scale private nurseries in Thailand is a situation that is also evident in the Philippines. However, in Vietnam and Thailand, the existence of small-scale private nurseries is not so critical for meeting the demand of planting materials for state and private plantations. The government nurseries have sufficient technologies and resources to produce the number of seedlings required by the country. The situation in the Philippines is different. The government nurseries in the Philippines do not have sufficient resources (e.g. finance, equipment and labour) to carry out large-scale production of high quality seedlings to meet the country's seedling requirement. Accordingly, the existence of smallholder private nurseries is crucial.

Appropriate technology

In terms of the production of planting stock for forest trees, Thailand and Vietnam are apparently considerably more advanced than Philippines. A tissue culture laboratory is a common facility in government and some large-scale private nurseries. The impressive seedling production facilities and technologies in Thailand and Vietnam could be used in the Philippines. Surveys have revealed that most of the small-scale private nursery operators in the Philippines lack information on appropriate seedling production technologies.

Seedling pricing

The sustainability of the small-scale private seedling production in the Philippines is hampered by the low financial viability of nursery enterprise. The common production of low quality planting stock results in low seedling sales quantity and low prices. The use of appropriate seedling production technologies such as those practiced in Vietnam and Thailand will improve the quality of seedlings from the nurseries in the Philippines and consequently increase the financial viability of nursery seedling businesses. The ACIAR seedling enhancement project in the Philippines is developing strategies to increase the financial viability of forest nurseries. One of the interventions is the introduction of best management practices to smallholders that were taken from research results, nursery manuals and observations of the seedling nursery industry in Thailand, Indonesia and Vietnam.

Certification and BMP

Nursery accreditation and seedling certification is viewed as a sound intervention for improving the operational effectiveness of the nursery industry in the Philippines. The

ACIAR seedling enhancement project has carried out activities towards institutionalizing the nursery accreditation policy which was piloted on Leyte and Mindanao Islands.

In summary, both Thailand and Vietnam suffered major forest destruction in the second half of the 20th century, and both countries have taken determined and well targeted steps to increase tree cover and promote forest industries. This has included large-scale seedling production and an emphasis on seedling genetic quality. The Philippines has much to learn from the actions and experiences in both of these countries. While seedling production for both industrial and smallholder forestry is dominated by government in both Thailand and Vietnam, government provision of free seedlings retards the private nursery sector in Thailand whereas there is much more private seedling production in Vietnam where the government charges for seedlings. The Vietnam system of seed and seedling certification for both government and private nurseries is perhaps one to which the Philippines could aspire. The application of the framework method for forest restoration in Thailand, which involves the production of seedlings for mixed plantings of a wide range of indigenous species, could perhaps be adopted for watershed protection in the Philippines.

7.2.2 International nursery best practice in Indonesia

The main insight gained on the study tour was how the importance of tree seed quality and sound nursery management practices in commercial farm forestry success is recognised and valued amongst farm forestry stakeholders in Western Java. The appreciation of germplasm and seedling quality is reflected in ‘certified’ tree seedlings receiving a preferred status by buyers and a higher price in local markets.

The focus on and appreciation of high quality is largely attributable to the extension efforts of FORDA and BPTP staff as well as NGOs including CIFOR, FORDA and BPTP, which place great emphasis on seed and seedling quality in their activities. Seed quality is enhanced by the contribution of the tree seed centres operated by BPTP and in some foreign aid projects, including KOICA which is sponsored by the Korean Government and the Swedish International Development Agency (SIDA) which provided funds to establish eight tree seed centres across Indonesia. Vegetative propagation techniques are also used to good effect in combination with the tree seed centres and certification system, to consistently produce a large quantity of high quality tree seedlings.

A number of important lessons were learnt during this study tour about designing high quality seed and seedling supply systems which can be implemented in the Philippines to improve seed and seedling quality, including:

1. Nursery operators must have well-developed entrepreneurial skills ensuring business efficiency.
2. Appropriate technologies to facilitate efficient production of seeds and seedlings (e.g. tissue culture and clonal propagation) must be available.
3. High credibility and accountability of seeds and seedlings quality can be achieved by procuring certified seed and seedlings from appropriate sources and following prescribed high standards as well as ensuring correct documentation of seed source and seedling production methods.
4. Support systems and mechanisms for capacity building, certification and monitoring (e.g. tree seed centres) must be established to ensure compliance with best management practice.
5. A knowledge-sharing system is required to insure that seed and seedling quality are appreciated and provided prime attention through community institution development.
6. Multi-stakeholders and collective actions and partnerships are necessary to ensure sustainable programs on seed and seedlings production requirement.

7. Private investments are necessary to sustain demand for high quality seed and seedlings, while at the same time keeping nursery businesses financially viable, through tax incentives to wood processors and other businesses that are involved in tree growing.
8. Proactive role of the Philippine DENR as the government arm in ensuring that tree growers in the Philippines are receiving high quality seed and seedlings apart from policing illegal utilization of forest and forest products.

In many ways the Indonesian farm forestry tree seedling nursery sector is more 'developed' than its equivalent in parts of the Philippines, particularly in Leyte (described by Gregorio *et al.* 2009a and Mercado and Duque-Piñon 2008). This is arguably the result of more effective longer-standing extension efforts by Indonesian government departments, NGOs and international research organisations including World Agroforestry Centre (WAC/ICRAF) and the Centre for International Forestry Research (CIFOR) that have targeted improvements in germplasm selection and nursery management practices in the nurseries supplying the farm forestry sector.

In conclusion, the study tours in Indonesia were a useful exercise in identifying some key lessons for the development of the small-scale tree seedling nursery sector in Leyte and Mindanao in the Philippines. Of particular value were observations of how stakeholders in the Indonesian farm forestry sector valued the importance of seed and seedling quality and how certification can be used to provide incentives for high quality seedling production through the payment of a premium for certified seedlings.

7.2.3. Key outcomes

A manual on best management practice (BMP) was developed as part of the ACIAR project and was the basis for the technologies to be adopted by the nursery operators with accredited nurseries. The technologies presented in the manual include those that were observed in Thailand, Indonesia and Vietnam.

7.3 Development of the Policy Assessment Model

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). During the Seedling Sector Policy Modelling and Analysis Workshop held on 12 February 2008 in Ormoc workshop participants 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 the 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 3 summarizes the outcomes of these group sessions. A modified version of the nursery BBN has been developed to include the policy interventions identified by the workshop participants.

Table 3. Summary of the three key issues identified by stakeholder workshop and suggested intervention measures, predicted outcomes and monitoring procedures

Issue	Details	Possible intervention
Marketing 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
Limited budget	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
Seedling quality, 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 Poor nursery cultural practices	Establishment of seed production areas and seed orchards Accreditation of seed sources Accreditation of nursery operators Appropriate site-species matching Hands-on training on proper nursery practices, design, infrastructures

7.4. Identifying Interventions and Development of Pilot Studies

With the interventions outlined in Table 3 as a basis, a modified version of the policy assessment model was developed by the project researchers. Simulation experiments 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 'low 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.

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.

Most of the identified policy interventions were pilot tested at the local level in partnerships with local government units and the local DENR office. For example, the municipality of Palompon in Leyte established a Memorandum of Agreement (MOA) with the ACIAR Seedling Enhancement Project to pilot test the implementation of the forest nursery accreditation policy which was identified during the model validation workshops as one of the major interventions to improve the operational effectiveness of the forest nursery sector. The LGU of Palompon has issued Municipal Ordinance No. 327-010909 institutionalizing the adoption of a LGU-based forest nursery accreditation policy for the DBP Forest Project implementation in the municipality of Palompon. A partnership was also established between the DENR Regional Office in Region 10 and the ACIAR Seedling Enhancement Project resulting in the issuance of DENR Memorandum Circular 2009-001 Series of 2009 mandating the implementation of forest nursery accreditation within the jurisdiction of CENRO Malaybalay covering three cities and two municipalities.

Aside from piloting forest nursery accreditation, initiatives were also pilot tested to improve the pathway of high quality germplasm to smallholder seedling producers through the survey of mother trees and establishment of tree seed centres in Leyte and Northern Mindanao. Capacity building of nursery operators in the form of hands-on training and demonstration using various extension materials was also strengthened to address the problem of the lack of skills as an impediment in producing high quality seedlings. A database of nursery seedling producers was also developed to increase seedling market through the promotion of the nurseries.

7.5 Best Practice Guidelines

The BMP guide for the production of high quality seedlings in smallholder nurseries comprises eight sections (see Table 4). It is developed to clearly convey the information and ensure a high level of understanding of the content, and is suitable for users with a low educational background. It makes extensive use of illustrations to convey key messages in simple terms.

Table 4. Brief description of the contents of the BMP manual

Topic	Description
Introduction	Presents the theme of the BMP guide; highlights the importance of high quality seedlings and the need to improve the supply of high quality seedlings in Philippine forestry
What is seedling quality	Discusses the concept and importance of seedling quality in tree farming and reforestation
Establishing a small-scale forest nursery	Presents the design of a model smallholder nursery for high quality seedling production and explains the importance of each nursery structure
Sources of germplasm	Provides information about the various sources of germplasm and explains the importance of using germplasm from selected sources
Germplasm collection, processing and storage	Provides details of the appropriate germplasm collection processing and storage procedures and discusses the pros and cons of each method
Seed dormancy and pre-sowing treatments	Explains the concept of seed dormancy and elaborates methods of breaking seed dormancy

Seed sowing and germination media	Outlines the process of preparing appropriate sowing media according to seed size and explains the characteristics of ideal sowing medium
Potting media, bagging and potting	Outlines the process of preparing potting media and explains the characteristics of ideal potting medium
Seedling maintenance activities	Explains the important seedling maintenance activities including seedling hardening and placing seedlings on an elevated hardening bed
References	Provides an alphabetical list of books, manuals, reports and other sources of information that were used in developing the BMP guide

Copies of the BMP guide were disseminated to the LGUs and DENR offices involved in the implementation of the ACIAR Q-seedling Project and to nursery seedling producers in pilot municipalities. Copies have also been disseminated during training events on high quality seedling production undertaken as part of the implementation of the Q-seedling project and at conferences attended by tree farmers and seedling producers. About 300 copies of the guide have been distributed in Leyte and Mindanao.

Although no assessment of the effectiveness of the BMP in improving the technical capability of seedling producers has been carried out yet, some nurseries which are managed by training participants and have received copies of the manual have been accredited for the production of high quality seedlings by LGUs. This is a clear manifestation that the BMP guide and associated training sessions have been instrumental in improving the skills and knowledge of nursery seedling producers to produce high quality planting stock.

7.6 Information, Education and Communication Campaign

The IEC activities of the project include training classes for stakeholders, the development and dissemination of training and extension materials, a radio program and establishment of demonstration nurseries and field trials. The project has developed a range of education, training and extension materials including nursery manuals, primers on nursery accreditation, flyers and posters on characteristics of high quality seedling and production techniques, and posters on the nursery accreditation process. An electronic version of the extension and training materials, including the guide to the production of high quality seedlings in smallholder nurseries, has also been published by The University of Queensland and the Rainforestation Network to provide access to the manual to a wide audience. Table 5 describes some of the IEC materials produced under the ACIAR Seedling Enhancement Project.

Table 5. Some of the IEC materials produced in the project and their description

Communication material	Description and use
Guide to the production of high quality tree seedlings	Covers topics such as the characteristics of high quality seedlings and smallholder-based nursery BMP. This guide is highly illustrated to ensure high level of understanding the technologies even for stakeholders with limited education. This manual is intended for extension workers, farmer-trainers and nursery seedling producers.
Training guide and videos on quality tree seedling production	Following the constructivist learning design, the use of videos is embedded in the training where learners – in this case farmers or extension workers – actively construct their own meanings. Briefly, the trainers ask trainees to judge the nursery production practices of a fictitious character, Mang Eman. The farmer-participants' solutions to Mang Eman's problems serve as a springboard for learning. A pilot implementation of the training module revealed that farmers enjoy this strategy. Further, they commented that the videos made them think and correct their misconceptions about seedling quality and production technologies.
Instructional posters	The instructional posters focus on the characteristics of high quality seedlings, collecting and growing of wildlings and reminders about growing high quality seedlings in the nursery. Farmers commented that the posters could be effective tools in disseminating technology on tree seedling production and tree farm management. They said that the instructional posters will serve as the best alternative during training when an extension worker or a farmer-trainer does not have the projection equipment to show the process of applying the recommended practices. These posters were given to nursery operators to serve as their guide in applying the recommended seedling production technologies. A poster outlining the steps in forest nursery accreditation was also developed to guide nursery operators and policy implementers through the application process and the aspects of nurseries and seedlings that will be evaluated as a requirement for accreditation.
Primer on forest nursery accreditation	A guide on nursery accreditation produced in English and in Cebuano to explain the qualifications of nursery operators for accreditation, steps in accrediting forest nurseries, requirements, criteria, and the forms used.

The IEC campaign of the project has produced significant impacts on nursery operators and staff of LGUs and DENR directly involved in implementing the forest nursery accreditation policy. According to the seedling producers interviewed, the training and extension materials have: (1) helped them understand the characteristics of high quality seedlings and importance of using high quality seedlings in tree farming; (2) improved their knowledge and skills in high quality seedling production; (3) encouraged them to adopt best management practices; (4) improved the market viability of their seedlings; and (5) developed their confidence in producing high quality planting materials of forest trees.

7.7 Demonstration Activities

Technologies promoted by the project were demonstrated through training events, printed and video extension and training materials, radio broadcasts and establishment of field trials and demonstration nurseries. About 13 training sessions on nursery BMP were carried out in 2009 to 2010 attended by approximately 300 key stakeholder representatives in various municipalities in Leyte and Mindanao. Topics delivered during the training sessions included the production of high quality tree seedlings and methods of assessing tree seedlings for accreditation.

The printed materials were disseminated to various stakeholders including nursery operators and DENR and LGU personnel, particularly those directly involved in the assessment of nurseries for accreditation. These materials have been used by nursery operators as guides in producing high quality seedlings and identifying aspects for improving the nursery operation in order to pass the accreditation testing. For example, nursery seedling producers in Palompon, Leyte have used the 'Guide to High Quality Seedling Production in Smallholder Nurseries' as their manual for the production of high quality seedlings. Also, many of the operators have indicated they learned the characteristics of high quality seedlings not only from the training sessions but also through the posters demonstrating characteristics of high quality seedlings placed in the LGU-managed nursery in Palompon.

The impact of the radio program broadcast on the nursery BMP is difficult to assess due to the remote and dispersed locations of the rural poor who made up much of the audience. However, it is likely that these broadcasts effectively disseminated the information about the technologies because of the large coverage of the VSU radio station signal and the popularity of the station among the farmers in Leyte Island as a source of farming technologies.

The field trials have attracted visits from stakeholders including tree farmers and nursery seedling producers from various communities in Leyte Island. For example, in 2009, 30 nursery operators from Leyte Island visited the field trial at VSU comparing the growth performance of physically superior versus physically inferior seedlings of gmelina and mahogany. In the same year, seven tree farmers and nursery managers from Mindanao visited the field trials investigating the mixed species and variable spacing planting in Leyte municipality. Also in 2009, a group of students from Australia doing a forestry course visited the same trials in Leyte, Leyte.

The demonstration nurseries in Leyte and Mindanao showcasing the BMP for high quality seedling production were used as a training facility for nursery seedling producers. In 2009, a total of 72 nursery operators from Leyte Island visited the demonstration nursery in VSU during the hands-on training on high quality seedling production. Aside from extension purpose, the nursery also became a subject for instruction. For example, in 2009 a financial analysis of the BMP nursery was carried out by an Australian student. Also, the demonstration nursery served as an instruction tool for students of VSU studying forestry.

7.8 Improved Access to Germplasm

The need to provide a sustainable supply of high quality germplasm is imperative for improving the operational effectiveness of the forest nursery sector in the Philippines. Interventions of the Seedling Enhancement Project to improve the supply of high quality germplasm include the establishment of tree seed centres, a survey of phenotypically superior mother trees, wildling collection program and nursery and field trials to improve access to high quality seeds.

7.8.1 Tree seed centres

The tree seed centres in VSU and DENR 10 were instrumental in improving the sustainability of tree seedling production in private nurseries. For example, the VSU tree seed centre has provided seeds and wildlings of various timber trees to the nursery operators in the municipalities of Isabel, Palompon and Libagon. Seeds and wildlings of various native and exotic tree species including dao, narra, mahogany, hindang, kalumpit, musizi, white lauan and bagtikan were either given for free or sold at a token price. Technical advice on how to germinate the seeds and prepare the wildlings was provided to the farmers during the time the germplasm was provided.

Aside from providing germplasm, the seed centres have distributed extension materials to stakeholders. About 150 flyers and 60 manuals on high quality seedling production have been distributed by the VSU tree seed centre. DENR 10 has distributed 48 copies of the manual. It is clear from these experiences that tree seed centres are critical for the improvement of the access of private nursery operators to high-quality germplasm and to provide an important conduit for the dissemination of extension materials and advice.

7.8.2 Identification of superior mother trees

The survey of mother trees was carried out on Leyte and Mindanao Islands. A total of 502 phenotypically superior mother trees belonging to 32 species were identified on Leyte Island. Of the identified mother trees, 15 species belong to the *Dipterocarpaceae* family[2] and five species – namely tindalo, narra, molave, dao and bolong-eta – are regarded as premium indigenous timber trees based on DAO 78 series of 1987. Four species of the identified mother trees – namely lauan, molave, dao and nato – have been declared as threatened and vulnerable species under the Convention for International Trade of Endangered Species (CITES) and conservation action is required by the Food and Agriculture Organization (FAO). The five tree species with the highest number of inspected mother trees are mayapis, tanguile, yakal, almon and narra. However, for narra only 44% of the total number of mother trees was found to be of acceptable phenotypic quality. Most of the narra trees have poor stem form while almost all mayapis, tanguile, yakal and almon trees have desirable stem characteristics. These species belong to the dipterocarp group.

In Mindanao, the survey identified 763 phenotypically superior mother trees belonging to 117 species (81 species from the natural forest and 51 species on farms but 15 species are common on the two sites). Of the total number of identified mother trees, 3 species are regarded as endangered based on the IUCN and DAO 2007-1 classifications, 11 are considered critical and 9 are classified as vulnerable. Among the species of mother trees that were identified, white lauan (*Shorea contorta*) has the highest number of mother trees followed by bagtikan (*Parashorea malaanonan*). Both species belong to the Dipterocarpaceae family. They are regarded as premium species and identified as among the many dipterocarp species for which the supply of germplasm is very limited. The low availability of germplasm is attributed two main factors, namely a limited number of mother trees and long seed year interval. Dipterocarps are preferred by loggers because of their premium timber quality, thus the population of dipterocarp trees in the wild is continuously declining. The result of the survey, however, shows that a considerable number of mother trees of bagtikan and white lauan are still growing in Southern Mindanao. Interestingly, some of the dipterocarps – particularly white lauan – are largely identified on farms indicating that these have been successfully domesticated and are accessible to seedling producers.

A publication showing the identified mother trees has been developed through the support of SMI. The publication presents the basic characteristics of the tree species with supporting photographs. Information on the phenology, distribution and uses were also included.

7.8.3 Wildling collection program

Due to seed scarcity for indigenous tree species including dipterocarps, consideration was given to the requirements for setting up a wildling collection program. This could be particularly useful in areas where large-scale revegetation is required (particularly watershed rehabilitation programs) and for programs where plantation establishment including use of indigenous species is to be expanded. Such a program could for example

[2] Dipterocarps once constituted 80% of the Philippine timber resource and provided the bulk of what is sold on the market as 'Philippine mahogany' (Newman *et al.* 1996).

be introduced as a livelihood activity in tribal areas. A number of implementation steps have been identified for a wildling collection program, and are as follows:

1. Locate areas where green offsets or watershed rehabilitation planting with native species is to take place.
2. Compile lists of tree species for which wildlings are to be collected, target proportions of each species, and also species abundance. This information will assist seedling wildling collection targets by species, and upper limits and scarcity incentives.
3. Recruit team members, with input from tribal or barangay officers, taking into account traditional tribal areas.
4. Training of wildling collectors (classroom, field site and nursery training), and perhaps conduct refresher training later.
5. Develop an information brochure, in appropriate dialects, on: species identification (with illustrations), methods of lifting and packaging and transport of wildlings; working on difficult terrain, using equipment; map reading, and workplace security and health and safety.
6. Identify areas and approximate dates within and near any forest areas to be cleared (e.g. mine footprint areas) to schedule wildling collection effort.
7. Acquire tools and equipment for track clearing and wildling collection, protective clothing and first aid items.
8. Organize transport to and from collection areas.
9. Identify nurseries to which wildlings are to be delivered, in relation to collection sites, and the potting rate capacities of nurseries.
10. Continuously monitor quantities of wildlings collected by species in relation to quantity targets, and adjust species quotas when necessary.
11. Monitor the security situation in areas where wildling collection is taking place, and adjust collection areas where alerts arise.

Major tree planting programs are typically required as a component of land development projects in which substantial biodiversity loss occurs. Large quantities of wildlings may be required for green offsets or watershed rehabilitation. Developing a cost-effective and socially acceptable wildling strategy involves a large number of decisions, and is surprisingly complex. Wildling collection, subsequent management of wildlings in nurseries, and tree planting and maintenance are potentially important livelihood activities for communities affected by resource development projects. Over time, seed production and collection, and production of clonal material may provide alternative sources of germplasm.

7.8.4 Field trials to improve access to high quality germplasm

Field trials to improve access to high quality germplasm of gmelina were established in the southern parts of Leyte Province. The trials commenced when seedlings were in the nursery and this continued through outplanting in the field sites. The seedlings were established on August 2010 and data collection is continuing. At this early stage of the trials, three field data collections have been made and analysis is still to be undertaken.

7.9 Pilot Schemes to Assist Smallholder Nursery Operators

A number of potential interventions to improve the operational effectiveness of the forest nursery sector were suggested by stakeholders during the policy workshop held in February 2008 in Ormoc, the Philippines. These include capacity building, IEC program, nursery accreditation, supply of high quality seeds, market assistance and support in establishing the nursery. Interventions which were pilot tested during the implementation of the project included: pilot schemes on nursery accreditation; an IEC campaign; training and evaluation of training impacts; establishment and use of demonstration nurseries and

plantations; support to improve seedling market and assistance in the establishment of the smallholder nursery.

To improve the market of high quality seedlings, a database of nursery operators was developed by the project. Information on the database was printed and distributed to potential seedling buyers including the DENR. Although there was no formal investigation undertaken to determine the impact of this intervention, it is expected that the continued promotion of the existence of private nurseries will substantially enhance the market for seedlings.

The project has piloted the provision of nursery materials to smallholder nursery operators to help them adopt the nursery BMP. Polybags, acetate for transplant and germination beds, and high quality seeds were provided to selected smallholder seedling producers in Baybay and Palompon, Leyte. The polybags and acetate materials and the cost of these materials were paid by the seedling producers once they had accumulated enough money through the sales of their seedlings. Adopting this strategy, the SMI is going to provide nursery materials of up to PhP20,000 for every nursery operator. This amount will be repaid by the nursery operator when SMI purchases their high quality seedlings.

7.10 Nursery accreditation

An assessment of the impact of the pilot implementation of the forest nursery accreditation was conducted in the municipality of Palompon. The thematic analysis of the responses gathered through the FGD with nursery seedling producers revealed that the nursery operators have derived the following benefits from their participation in the nursery accreditation: (1) improved knowledge and skills in high quality seedling production, (2) encouraged adoption of best management practices, (3) an additional source of income, (4) opportunity to forge close relationships with each other, (5) encouraged utilization of farmers' time in productive activities, (6) confidence in ability to produce high quality planting materials, and (7) interest from various groups (Gravoso *et al*. 2011).

Theme 1 – Improved knowledge and skills in high quality seedling production. The communal nursery operators reported that their efforts to have their nursery accredited have given them the opportunity to improve their knowledge and skills in high quality seedling production. They attributed this improvement to the training workshops on tree seedling production and the communication materials distributed by the Q-seedling project. They value this knowledge because, according to them, this is something that they can share with their children.

Theme 2 – Encouraged adoption of best management practices. The nursery accreditation scheme encouraged farmers to adopt BMP for tree nurseries. They reported that, based on their agreements, the DBP forest will buy seedlings only from accredited nurseries. Hence it was necessary that they follow BMP because this was among the requirements for accreditation.

Theme 3 – Provided an additional source of income. Foremost among the benefits the nursery operators have derived was the additional income they received from participating in the communal nursery. In fact, according to the barangay captain of Brgy. Cambacbac, in January 2010 they were able to generate a net operating profit of PhP7000 (USD155.56) from their first production cycle from late August to November 2009 of the previous year. As agreed, the DBP Forest Project purchased the seedlings. The PhP7000 profit was divided among the 12 members. Additional income from nursery operation has also been reported by the group in Bgry. Tinubdan.

Theme 4 – Opportunity to forge close relationships with each other. According to the barangay captain of Cambacbac, members of the group operating the communal nursery

report for a 'pintakasi'[3] every Tuesday and Wednesday. While working they interact and these interactions have led them to establish closer relationship with each other. Thus, families with who used to have misunderstandings have now resolvedd them. For the barangay captain, closer relationships are important because this is a way to attain peace and cooperation in the community.

Theme 5 – Encouraged utilization of farmers' time in productive activities. According to the members of the group operating the communal nursery in Brgy. Cambacbac, now that they are busy with their nursery operations, they are no longer tempted to engage in activities such as playing cards and rumour mongering, especially the women. As one farmer said, 'Cockfighting and playing cards on Sundays and lazy days have been displaced in favour of working in the nursery'.

Theme 6 – Greater confidence in producing high quality planting materials. Farmers reported that through their participation in the communal nursery, they now feel confident that they can produce high quality materials. They have planted some of their seedlings on their farms, and observed that their seedlings grew fast and were healthy. For example, in January 2010, their falcata farms established from late August to November 2009, were already about 3 ft tall. On the other hand, in the other upland development project in which they have participated, the seedlings given to them had all died. They said that should there be demand for high quality tree seedlings, their communal nursery could surely supply the need.

Theme 7 – Favourable attention from various groups. Members of the communal nursery in Brgy. Cambacbac claimed that due to their success in adopting BMP for nurseries, many people and organizations have begun noticing them. They reported that media groups, students (both local and foreign), and researchers have been visiting them since they started producing and selling high quality seedlings. They reported that, towards the end of 2009, a crew from the television channel CNN came to take videos of their nursery and interview them. A group of students from Germany also visited and interviewed them about their nursery practices. This is in addition to the regular visits by the Q-seedling project staff and the staff of the municipal government of Palompon who usually take photos and show these in various places and special gatherings.

7.11 Nursery Economies of Scale Analysis

Table 6 summarizes financial performance criteria over various nursery sizes. The first five of these set out the financial performance, in terms of capital outlays, net present value and extent of capital subsidy required for the nursery size options to be financially viable. Nurseries in the two smallest size classes lack financial viability, even if the capital outlays (including initial training costs) are fully subsidized. Only the largest sized nursery is expected to be financially viable without any financial support. Internal rate of return (and payback period) provide little information in the financial analysis, because of the relatively low capital intensity, particularly if financial support is provided.

[3] 'Pintakasi' means cooperative work. In this case, farmers worked to achieve a particular project task, e.g. building nursery structures, bagging and other tasks.

Table 6. Financial and social indicators by nursery size

Performance indicator	Nursery size (1000 seedlings per year)					
	2	5	25	50	100	200
Initial capital outlay ($)	4144	4313	17,136	41,631	87,501	123,247
NPV with no capital subsidy ($)	-5500	-4510	-1514	-2829	-17,407	76,949
NPV with 100% capital subsidy ($)	-1356	-197	15,623	38,802	70,093	200,196
Breakeven capital subsidy (% of capital outlay)	133%	105%	9%	7%	20%	0%
IRR with no capital subsidy (%)	Negative	Negative	13.0%	13.5%	10.4%	27.3%
Number of full-time labour equivalents (FLU)	0.6	1.54	4.2	6.4	10.8	16.6
Labour/capital ratio (% of present values)	108.3%	216.7%	181.6%	135.1%	109.7%	117.0%
Labour cost as share of ann. operating cost (%)	76.8%	81.9%	77.1%	76.6%	65.4%	63.7%
Operating cost/seedling produced ($)	0.59	0.46	0.32	0.29	0.29	0.23
Total cost/seedling produced ($)	0.77	0.53	0.38	0.37	0.37	0.28

Seedling nurseries can contribute to job creation for mine-affected communities. In present value terms, the labour to capital ratio is high, even with the durable infrastructure budgeted in the analysis. Labour cost accounts for well over half of annual operating costs, even for the largest nurseries.

Figure 5 illustrates how seedling production cost varies with nursery size, in terms of operating cost and in terms of total cost (including capital outlays). The operating cost per seedling produced indicates the seedling price which would need to be obtained for an established nursery to continue to operate. The total cost is relevant when deciding whether to establish a forestry nursery, and indicates the seedling price which would be needed to justify the nursery establishment and operating costs. The graph of this latter curve is known as the long-run average cost (LRAC) or planning curve for the nursery industry[4]. These costs are very high for small nurseries, but become approximately constant for nurseries producing 25,000 seedlings a year or more, at about 30 to 40 cents per seedling.

[4] It is assumed that the discrete nursery sizes are the efficient sizes for the output levels specified, i.e. that the nurseries would produce these outputs at the lowest possible cost. The long-run average cost curve is by definition the lower envelope of the many possible short-run average cost curves (with fixed infrastructure).

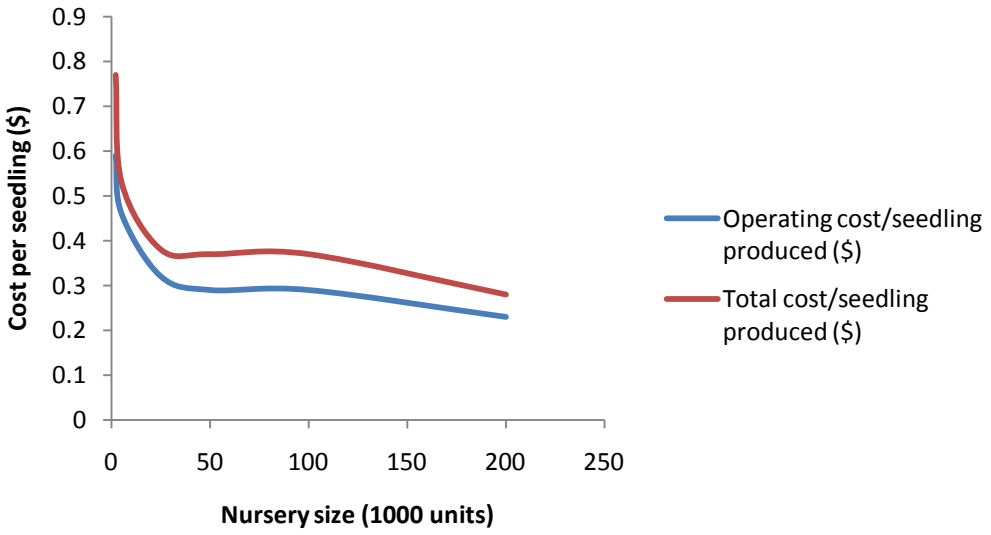

Figure 5. Seedling production cost in relation to nursery size

From an industry planning perspective, it would seem that an optimal size in terms of controlling seedling production costs but providing livelihood benefits might be at about the 25,000 unit level. A nursery of this size might also provide reasonable access for non-industrial customers. A very large nursery could probably reduce seedling production cost further, through use of labour saving measures, and might be more suitable for large-scale planting programs.

The research reported here represents a major step in the financial analysis of seedling production costs. It seems clear that very small nurseries (typical of smallholder nurseries) will incur high seedling production costs, and would probably not justify the expenditure required for durable infrastructure and certified seedling production. However, medium sized nurseries (possibly community nurseries) and large industrial nurseries are likely to produce seedlings at acceptable cost. Medium sized nurseries probably have advantages in terms of job creation.

Clearly, further analysis is needed on various aspects of forestry nursery systems. An important area concerns obtaining better estimates of labour cost. This could involve time measurements and recording for various tasks in seedling production, e.g. preparing germination trays, pricking out and potting up, control of weeds and other pests, culling defective seedlings, and watering. Another area for study of costs concerns how these vary with species type – e.g. exotic versus indigenous, timber versus other species including fuelwood and rubber – and between individual species and species mixtures. Research is also needed into the benefits of vertical and horizontal integration of forestry nurseries. Examples of integrated seedling production and marketing systems include where nurseries have multiple showrooms and selling points, and where high-volume seedling users contract out with small-scale nurseries. Further data collection and more complex modelling would be required to examine the financial aspects of these business models.

7.12 Influencing Policy

The pilot implementation of the forest nursery accreditation policy in Leyte and Northern Mindanao has spilled over to other municipalities. In early 2010, four local government units in Regions 11 and 12 in southern Mindanao – namely Malungon in Sarangani Province, Kiblawan in Davao del Sur, Tampakan in South Cotabato and Columbio in Sultan Kudarat – indicated their interest in implementing the nursery accreditation policy in their respective municipalities. A workshop to design the implementation strategy of forest

nursery accreditation in these four municipalities was held in January 2010 and hands-on training was conducted on the production of high quality seedlings. Also, in March 2010, a follow-up workshop was conducted with representatives of these LGUs to draft the accreditation policy, and develop the nursery accreditation guidelines and criteria based on the results of the workshops in Leyte and Mindanao.

The draft of the national policy on forest nursery accreditation developed under the seedling enhancement project gained considerable attention from the forestry policy makers at the national level. During a meeting with senior staff of the Forest Management Bureau (FMB) and the Ecosystems Research and Development Bureau of the DENR held on 5 April 2010 at the DENR central office in Manila, it was announced that the draft of the policy, guidelines and criteria developed by the project served as a major input in crafting the Department Administrative Order Number 2010-11 otherwise known as *Revised Regulations in Governing Forest Tree Seed and Seedling Production, Collection and Disposition* signed by Sec. Horacio Ramos on 5 May 2010. This DAO institutionalised the national policy on forest nursery accreditation.

8 Impacts

8.1 Scientific impacts – now and in 5 years

The project has provided an understanding of how the tree seedling nursery sector operates in the Philippines and this research will have wide applicability in many developing tropical countries. It has contributed to the body of knowledge on forestry science, particularly in the areas of nursery seedling production and silviculture, communication and economics through the papers the researchers have published in international peer-reviewed publications. It is, however, very difficult to quantify the precise scientific impact that both current and future publications will have. Some limited insights might be gained by the number of citations, but these metrics only give an indication of how many authors cite the work, not how many researchers have been influenced by the research. This is an important distinction, especially in an applied field such as seedling nursery research.

The systems approach applied in the project is a novel example of how a BBN has been used to identify potential interventions in a system (i.e. nurseries) and then implemented. This approach is highly innovative and has the potential to be a model for the development and implementation of other applied research projects. An important feature in the implementation of the project is the use of multi-stakeholder participatory approaches from the identification of the problems to the evaluation of the interventions. For example, in developing the strategies to improve the operational effectiveness of the of the nursery sector, key stakeholders were invited to provide inputs into the identification of the key problems, designing potential interventions and identifying field activities. As opposed to the agency-based or top-down approach of identifying development interventions, the project has showcased the authentic 'participatory approach', involving stakeholders in each stage of project implementation. In terms of national development, the project has initiated the development of the forest nursery accreditation policy and nursery assessment criteria. On the basis of the positive effects created by the pilot implementation of nursery accreditation, the project influenced the Philippine Government through the DENR to issue a national policy on forest nursery accreditation embodied in DAO 2010-11.

In February 2011, President Aquino issued Executive Order 26 which set out the National Greening Program. Under the NGP there are plans to reforest 1.5 million ha over 5 years. The aim is to produce 1.5 billion seedlings, with DENR to provide technical support. DAO 2010-11 will invariably have a major impact on how these seedlings are produced and will hence lead to improved seedling quality. Also, there will be a huge demand for the extension materials already developed by the project, along with further training. **The NGP *presents an opportunity to showcase the research results and extension materials from the nursery project on a national scale. This presents a potential opportunity for ACIAR to demonstrate the huge impact of its research*.**

Aside from accomplishing the research objectives, the Seedling Enhancement Project has contributed to the improvement of academic programs, particularly at VSU where the project was based. Faculty members of College of Forestry and Natural Resources involved in the project have used their field experience in the revision of the BS in Forestry curriculum and also the offering of the BS in Environmental Science. Likewise, faculty members of the Department of Development Communication involved in the Q-seedling project are improving the BS in Development Communication program through incorporating more environmental management and forestry courses. The move to integrate more environmental management and forestry courses is anchored in the DevCom Faculty members' experiences as researchers in the project – that knowledge of the technical area is an important tool to popularize technical and scientific information.

Experiences and lessons gained from the field implementation of the project have been incorporated in instructional material used in several forestry courses. For example, in a course on silviculture (For. 131 – Silviculture I), the lessons have incorporated experiences in the Southeast Asian countries obtained through the study tours as well as the realities in the Philippine nurseries as gathered from the surveys, training workshops and promotional activities (IEC) of the project. Experiences in the development and advocacy for a national policy on nursery accreditation have also been injected in a course on forest governance.

8.2 Capacity impacts – now and in 5 years

The project has developed the skills of project staff and research partners from the Philippines particularly on the aspects of developing research proposals, designing biophysical and social research, collection and analyses of quantitative and qualitative data, and writing scientific publications. The mentoring that the Australian project scientists have been offering and the implementation of the ACIAR project have escalated the number of research paper publications of faculty members of CFNR by 80% since 2005. Further, Filipino research partners have won awards in presenting project research results including 'Best Poster' during the 2007 Regional Research and Development Network (RRDEN) and 'Best Paper' and 'Best Poster' awards in the Development Category during the Regional (R8) Research and Development Symposium in 2009. The awards and publications on the research results of the ACIAR projects in international journals, have significantly improved the professional careers of the faculty members of CFNR.

Australian project partners have brought a number of state-of-the-art research items of equipment including digital laser hypsometers, global positioning systems, environmental data logging devices and a portable infrared gas analyser to the Philippines and trained the Filipino researchers to use this equipment for various experiments both in the nursery and in the field, which broadened their understanding and appreciation of undertaking research. Computer software including Netica and ArcGIS was also introduced. For example, students doing forest surveying have used the laser hypsometer and GPS to determine the location of forest plantations, denuded forests, critical watersheds, and potential mother trees. The infrared gas analyser, canopy analyser, light meters and data loggers were introduced to students taking tree physiology and ecology courses. Lectures regarding BBN model development and its usefulness were attended by graduate students from CFNR, faculty members and researchers of VSU. In a course on managerial economics (Econ 146 – Managerial Economics) taken by junior BS in Economics students, the financial analysis undertaken for the smallholder nurseries was given as a class example for computing the financial viability of a business venture. In a risk analysis course (Btec 151 – Risk Assessment and Management) taken by senior BS in Biotechnology students, the Bayesian Belief Network (BBN) was demonstrated. Lecturers of these courses studied BBN through the seedling enhancement project.

The equipment and computer programs introduced in the project had not been available to them during the formal academic training of the Filipino project partners. The training and demonstration carried out by the Australian project partners have significantly improved the capacity and self-sufficiency of the Filipino research partners to operate this new research equipment. This capacity has not been developed at most other Philippine universities.

8.3 Community impacts – now and in 5 years

8.3.1 Economic impacts

In the short term, there is evidence that the project has improved the incomes of smallholder nursery operators involved in the project. For example, some nursery operators in Palompon and Baybay, Leyte have reported increased prices for seedlings obtained through the 'Q-seedling' brand. Seedlings of commonly propagated timber species including mahogany and narra were generally sold at PhP5 but after adopting the BMP, the price has increased to PhP8 – PhP10. Similarly, Q-seedlings of dipterocarps are sold at PhP20 compared to the normal market price of PhP10.

The localized implementation of nursery accreditation policy developed by the project has started to improve the financial viability of private nursery enterprises. For example, accredited private nurseries in Palompon have become exclusive suppliers of planting stock for reforestation projects of the LGU and private tree farmers. There is also currently on-going discussion between the project and DENR to agree that accredited private nurseries in Region 10 will become the source of seedlings for the seedling requirements of Region 10 in the implementation of the nationwide Upland Development Program. Also, the SMI in Mindanao is engaging private nurseries to supply Q-seedlings for the reforestation requirement of the company aside from the seedlings that will be produced from the nurseries of the company.

The economic significance of the research is evidenced by a number of private companies, LGUs and private individuals approaching the project for assistance in nursery production techniques and quality control measures developed by the project. For example, the LGU of Palompon in Leyte approached the Seedling Enhancement Project management to assist in the nursery seedling production system of the LGU to produce high quality planting stock for the watershed rehabilitation program of that municipality. This partnership has resulted in Palompon becoming one of the pilot municipalities implementing the forest nursery accreditation policy. Also, individual farmers from municipalities including Baybay, Palompon and Isabel, Leyte have approached the project and requested nursery manuals, extension materials and training sessions on high quality seedling production. This interest developed after they learnt that the seedling production venture of other nursery and other communities had become viable after having been accredited because of the adoption of BMP.

The SMI in Mindanao has also established a partnership with the Seedling Enhancement Project to assist the company in the implementation of forest nursery accreditation. The nursery accreditation scheme will be used as the quality control mechanism for seedlings from private nurseries that will supply part of the planting stock requirement for SMI reforestation program.

In the longer term, the ability of the project to influence national-level policy through DAO 2010-11 has been a major achievement. As a result of this initiative, the accreditation of forest nurseries has become an integral part of the reforestation program of the Philippine Government. Under this policy, accredited forest nurseries in the country will become the primary source of planting stock for government-funded reforestation projects.

8.3.2 Social impacts

The project's information campaign to promote the awareness of various stakeholders of the importance of using high quality planting materials and the pilot nursery accreditation policy has started to have an impact at the local level. This is evidenced by reforestation program implementers in the pilot municipality utilizing high quality seedlings only from accredited nurseries. Further, the collaboration of the project with industries and municipalities implementing watershed rehabilitation programs, a partnership that was sought by the latter, is also a manifestation of the positive impact of the project interventions.

The nursery operators' adoption of best management practices demonstrated by the project is an indication of the success of the project in enhancing the capacity of the private nursery operators. Also, the capacity building program implemented by the project was instrumental in improving the technical capacity of LGU and DENR in leading the implementation of the forest nursery accreditation policy. Nursery accreditation requires LGUs and the DENR to assess the seedling and nursery quality parameters and provide technical support to private seedling producers. Staff members of LGU, DENR and SMI trained by the project have conducted training sessions on high quality seedling production and lectures on nursery accreditation with private seedling producers. This is a manifestation of the successful building up of the social capital of the project stakeholders.

8.3.3 Environmental impacts

The research and extension activities of the project and the subsequent implementation of policies to ensure that seedlings used in private and government tree planting projects are of high quality will result in the high survival rate of planted seedlings. Accordingly, in the long run there will be more timber available from plantations, which will largely reduce logging pressure on the remaining patches of forests in the Philippines.

The implementation of the nursery accreditation trial at the local level, that controls the quality of planting materials and facilitates the marketing of seedlings from private nurseries, is promoting a sustainable livelihood opportunity to smallholders. Having a reliable source of income should stop them from going in to the forests and practicing destructive farming activities. Also, the application of the nursery accreditation policy in LGU and industry watershed rehabilitation projects is envisaged to result in high seedling survival and better seedling growth performance, thus contributing significantly to ecological restoration.

8.4 Communication and dissemination activities

List of project-related workshops and meetings

Title	Date	Venue	Number of participants
Meeting/Workshop with Project Collaborators	14–16 October 2007	Australia	8
Seedling Sector Policy Modelling and Analysis Workshop	12 February 2008	Ormoc, the Philippines	32
Planning and Implementation Workshop	13–14 February 2008	Ormoc, the Philippines	37
Planning Workshop for Specific Research Activities	5–7 May 2008	Australia	8
Consultative Meeting with DENR 8	19 May 2008	Tacloban, Leyte	12
Project Stakeholders' Meeting	6 June 2008	VSU, Leyte	25
MOA Signing and Consultative Meeting	20 June 2008	Isabel, Leyte	30
Partnership Meeting/Workshop with DENR 8	24 June 2008	Tacloban, Leyte	11
Meeting/Workshop with DENR 10	10–11 July 2008	Cagayan de Oro	8
Meeting with Palompon LGU	18 August 2008	Palompon, Leyte	12
DENR 8 Project Briefing Session	5 September 2008	VSU, Leyte	15

Workshop with various stakeholders to develop mechanisms for accrediting forest nurseries (Leyte stakeholders) Partnership Meeting/Workshop with PNOC-EDC-LGPF	4–5 December 2008 19 December 2008	VSU, Leyte Ormoc, Leyte	44 16
Project Team Workshop	13 February 2009	VSU, Leyte	60
Workshop with various stakeholders to develop mechanisms for accrediting forest nurseries (Mindanao stakeholders)	19 January 2009	Claveria, Mizamis Oriental	38
Project team workshop to draft the nursery accreditation policy	4 April 2009	VSU, Leyte	6
Meeting/workshop with Palompon LGU to pilot the nursery accreditation policy	17 April 12009	SB Hall, Palompon, Leyte	15
Meeting workshop with DENR R10 and ICRAF to discuss the pilot testing of the nursery accreditation policy	15 May 2009	Cagayan de Oro City	6
Meeting/Workshop on Developing a Bayesian Belief Network for Assessing the Success of Forest Rehabilitation Projects in the Philippines	17 November 2009	Eco-FARMI, VSU, Baybay, Leyte	30
Meeting/Workshop with stakeholders (LGU, DENR, nursery operators, DA) to develop nursery accreditation mechanism in Malungon, Kiblawan, Tampakan and Columbio	January 2010	Nature Park, Tampakan, General Santos	32
Meeting with senior staff of FMB and ERDB	5 April 2010	DENR FMB, Manila	18
Meeting/Workshop with LGU staff of Malungon, Kiblawan, Tampakan and Columbio to discuss the pilot testing of forest nursery accreditation	1–4 June 2010	Tampakan General Santos and Kiblawan Davao del Sur	15
Q-Seedling Project: End-of-Project Workshop	19–20 July 2010	CCE, Building, VSU	56

9 Conclusions and recommendations

9.1 Conclusions

Conclusions

The implementation of ASEM/2006/091 has been timely and has corresponded with an increased demand for high quality seedlings for reforestation. In 2004, nearly 21,000 ha were reforested by government and smallholders (DENR-FMB 2006), which roughly equates to 63 M seedlings being planted per annum. Since ASEM/2006/091 commenced in 2007, the Philippine Government has implemented the Upland Development Program in 2009, with the intention of reforesting over 51,000 ha in that year. Even more recently, in February 2011 President Aquino announced the establishment of the National Greening Program (NGP), which will reforest 1.5 M ha over the coming five years. There will be around 1.6 billion seedlings required for that program. Improved seedling quality through the implementation DAO 2010-11 which was developed based on project outputs, will be used to guide the production of these 1.6 billion seedlings. The seedlings produced following the guidelines set out in DAO 2010-11 will meet basic quality standards which will then result in better outcomes of reforestation efforts, including reduced mortality and improved growth on outplanting.

Initial research found that the factors influencing seedling quality and nursery effectiveness are highly complex and there are many interactions between various factors. To help deal with this complexity a systems approach was used in which various systems thinking tools were used that allowed team members to integrate both quantitative information from the survey and qualitative information from stakeholders to produce a visual representation (model) of the nursery sector in the Philippines that identified the major interactions between key elements. Working in partnership with key stakeholders, team members then used this policy assessment model to identify a number of key areas in which to pilot test initiatives that were most likely to result in substantial improvements in seedling quality. This approach proved highly effective and has great potential for application to other complex problems in the agricultural and natural resource management fields. For example, one of the key factors influencing seedling quality was that few nursery operators were using high quality germplasm (nothing new here!), seemingly because no such germplasm was available. A simple solution was to establish a seed supply centre that had stocks of common exotic species in high demand. However, by understanding the interactions between different interventions, it has been possible to predict ex ante that simply providing access to improved germplasm would not work. The analysis done with the policy assessment model indicated that it would be necessary to simultaneously: (1) improve the technical skills of the nursery operators (some of the species needed special propagation procedures); (2) ensure that they had knowledge about the benefits of using improved germplasm; and (3) ensure nursery operators could afford to purchase the seed. In response, a training program was established that addressed points 1 and 2 and provided the initial supply of seeds from the seed centre to nursery operators at no cost. The combined initiatives were highly effective in improving the quality of seedlings produced in participating nurseries. In addition, the survey on which the model was based revealed a very high demand for native species, for which seeds for most were difficult to obtain and store. In response, a program of marking ‘mother trees’ of high demand native species was established and provided details about location and fruiting patterns to nursery operators wanting to propagate these species. The requirement to use quality germplasm was subsequently incorporated into a national nursery accreditation program set out in DAO 2010-11. Previously the importance of germplasm quality was not recognised by the DENR as being important.

The project has developed many extension materials that have the potential for much broader distribution, and which will help nursery operators produce seedlings of high physical and genetic quality. The best practice guidelines set out in simple terms the basic requirements to produce high quality seedlings and offer a simple manual for nursery operators to follow to assist in improving the physical infrastructure and the propagation techniques that they use. In addition, the project has produced many posters and DVDs (in English, Cebuano and Waray) that highlight important aspects of seedling production. The demonstration activities, including demonstration nurseries and 'hands on' training have proven to be effective in educating nursery operators about better practices and can be used as a template for expanded program. In addition, the outplanting activity at Mahaplag appears to have been effective in demonstrating the benefits of using superior germplasm to both buyers and nursery operators – the difference in growth of trees from improved germplasm is marked, even at a relatively young age. Initial indications are that the seed centres and mother tree programs proved to be very effective in improving the access to germplasm by nursery operators. There is great scope for expansion of these programs to other regions within the Philippines.

9.2 Recommendations

Recommendation 1

ACIAR and project staff approach AusAID to fund the outscaling of the project extension materials and training programs to other areas in the Philippines. This can be done in conjunction with the development of the National Greening Program.

Justification

President Aquino has announced the National Greening Program (NGP) through Executive Order 26 issued in March 2011. This is a very significant commitment to reforestation in the Philippines. As outlined earlier, some 1.6 billion seedlings will be produced under the NGP. The various project outputs have great relevance to the production of those seedlings. In addition, this would allow the Australian Government to demonstrate a strong commitment to assisting the Philippines in addressing its substantial problems with highly degraded watersheds through funding the implementation of a training program based on previous research it has funded through ACIAR.

Recommendation 2

Develop a new ACIAR project aimed at improving the way in which reforestation is undertaken within the Philippines.

Justification

Past efforts in watershed rehabilitation in the Philippines have had limited success, largely due to the failure of programs to adequately address key socio-economic and institutional issues. The NGP will face similar challenges unless a better understanding of the factors that contribute to the success and failure of rehabilitation is gained. The methodology and approach that were used in ASEM/2006/091 have great potential to be applied in a similar manner to address the complex issues that affect the success of reforestation efforts. In addition, much of the research had been undertaken in previous ACIAR projects (e.g. ASEM/2004/0 Project ASEM/2003/052 *Improving financial returns to smallholder tree farmers in the Philippines*). That project also highlighted the need for watershed restoration using indigenous tree species in critical catchments, with a particular focus on the socio-economic, policy and technical issues.

10 References

10.1 References cited in report

Aronson, D. (1994). Targeted Innovation: Using Systems Thinking to Increase the Benefits of Innovation Efforts. *Innovative Leader*, vol. 6, no. 2.

Bohringer, A., Ayuk, E., Katanga, R. and Ruvuga, S. (2003). Farmer Nurseries as a catalyst for Developing Sustainable Land Use Systems in southern Africa, Part A: Nursery Productivity and Organization. *Agricultural Systems*, vol. 77, no. 3, pp. 187–201.

Cacanindin, D. and Agne, L. (2010*).* Tree improvement in North Eastern Mindanao. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 111–116.

Cacanindin, D. (2010). Pilot Testing of the Forestry Seedling Nursery Certification System in DENR Region 10. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010, pp. 67–72.

Edralin, D. and Mercado Jr, A. (2009). Profiling Tree Nurseries in Northern Mindanao, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 63–72.

Edralin, D, Gregorio, N., Mercado Jr, A. and Harrison, S. (2010a). The Seedling Nursery Survey in Leyte Island and Northern Mindanao, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010, pp. 7–23.

Edralin, D.I. and Mercado Jr, A. (2010b). Profiling Tree Nurseries in Northern Mindanao, the Philippines. *Annals of Tropical Research,* vol. 32, no. 2, pp. 15–26.

Elliot, S and Kuaraska, C. (2008). Producing framework tree species for restoring forest ecosystems in Northern Thailand. *Small-scale Forestry*, vol. 7, no. 3–4, pp. 403–415.

Gravoso, R., Gregorio, N. and Godoy, J. (2009a). Working with Local Government Units in Accrediting Forest Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 135–140.

Gravoso, R., Gregorio, N., Gerona, A. and Godoy, J. (2009b). Design and Implementation of a Communication Campaign on Best Management Practice for Forest Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 141–148.

Gravoso, R., Gregorio, N., Gerona, M.A., Serino, M.N., Harrison, S., Pajaron, H. and Godoy, J. (2011). Development and Implementation of a Nursery Accreditation Policy at a Local Level in Leyte, Philippines. *Small-scale Forestry*. (Online First, 23 March 2011).

Gregorio N.O. (2006). Improving the Effectiveness of the Forest Nursery Industry in Leyte Province, PhD thesis, School of Integrative Systems, The University of Queensland, Brisbane.

Gregorio, N., Harrison, S. and Herbohn, J. (2009a). The Seedling Nursery Survey on Leyte Island, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 51–62.

Gregorio, N., Smith, C., Herbohn, J. and Harrison, S. (2009b). Identifying Leverage Points for Policy Reform in Seedling Production in Leyte, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 73–84.

Gregorio, N.O., Harrison, S.R., Herbohn, J.L. (2010a). The Seedling Nursery Survey on Leyte Island, the Philippines, *Annals of Tropical Research, vol.* 32, no. 2, pp. 1–14.

Gregorio, N.O., Harrison, S.R. and Herbohn, J.L. (2010b). Developing the Best Management Practice Guide of High Quality Seedling Production In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010, pp. 73–86.

Gregorio, N., Doydora, U., Harrison, S., Herbohn, J. and Sebua, J. (2010c). Inventory and Assessment of Mother Trees of Indigenous Timber Species in Leyte Island and Southern Mindanao, Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010, pp. 113–125.

Gregorio, N., Smith, C., Herbohn, J. and Harrison, S. (2010d). Designing Intervention Strategies for Forestry Seedling Production in the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010.

Gregorio, N.O., Herbohn, J.L. and Harrison, S.R. (2010e). Guide to quality seedling production in smallholder nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector*, Proceedings of the Mid-term Workshop held at the Visayas State University, 13 February 2009, pp. 183–208.

Gregorio, N., Bosch, A. and Herbohn, J. (2010f). Trees of Tampakan Mine and Surrounding Areas: Characteristics of important mother trees for SMI reforestation activities. The University of Queensland, Brisbane. 192 pp.

Harrison, S.R., Gregorio, N.O, and Herbohn, J.L. (Guest Editors) (2008a). Seedling Production Systems. *Special Issue of Small-scale Forestry*, 7(3–4) prepared in conjunction with review of nursery production systems in Asia as part of ASEM/2006/091.

Harrison, S., Gregorio, N., Herbohn, J. and Mercado, A. (2008b). Seedling Production Systems for Smallholder Forestry Development. In: Small-scale Rural Forest Use and Management: Global Policies versus Local Knowledge, (G. Buttoud, ed.) Proceedings from the June 2008 IUFRO 3.08 Conference in Gerardmer, France.

Harrison, S.R., Gregorio, N.O, Herbohn, J.L. and Dargusch, P. (2008c). Designing and Implementing Best Management Practice in Smallholder Forestry Nurseries. *Proceedings from the FORTROP II International Conference*, November 17-20, 2008, Kasetsart University, Bangkok, Thailand.

Harrison, S. and Gregorio, S. (2009). Observations of Forestry Seedling Production Systems in Thailand and Vietnam. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 35–50.

Harrison, S.R. and Gregorio, N.O. (2010). Observations of Forestry Seedling Production Systems in Thailand and Vietnam, *Annals of Tropical Research*, 32(2) pp. 51–70.

Harrison, S.R. (2010). Deriving the Discount Rate for Seedling Nurseries and other Livelihood Projects. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010, pp. 171–177.

Jaenicke, H. (1999). *Good Tree Nursery Practices: Practical Guidelines for Research Nurseries*, ICRAF, Nairobi, pp. 8–15.

Mercado, A.R. Jr and Duque-Piñon, C. (2008). Tree Seedling Production Systems in Northern Mindanao, the Philippines. *Small-scale Forestry*, vol. 7, no. 3–4, pp. 225–243.

Mercado, A. Jr, Dargusch, P. and Gregorio, N. (2009). Insights from the Farm Forestry Tree Seedling Nursery Sector in Western Java, Indonesia. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay,

Mercado, A. Jr, Dargusch*, P.* and Gregorio, N. (2010). Insights from the Farm Forestry Tree Seedling Nursery Sector in Western Java, Indonesia. *Annals of Tropical Research,* vol. 32, no. 2, pp. 35−50.

Miles, M.B. and Huberman, M.A. (1994), *Qualitative Data Analysis, an Expanded Sourcebook,* SAGE Publications, Thousand Oaks, London and New Delhi.

Newman, M., Burgess, P. and Whitmore, T. (1996), *Manual of Dipterocarps for Foresters: Philippines*, Royal Botanical Gardens, Edinburgh.

Tolentino, E.L., Carandang, W.M. 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. UPLB, Los Baños and ICRAF.

10.2 List of Publications Produced by Project

Reports and Briefing Documents

PRIMERS

Nursery Management for Smallholder Tree Farmers. Mangaoang E.O. and Cedamon, E.D.

Growing and managing Trees on Your Farm. Baynes, J.

Poster Primer. Mangaoang, E.O. and Cedamon, E.D.

Primer – *English version*. Mangaoang E.O., Gordon, M.J., Balbarino, E.A., Gravoso, R.S., Herbohn, J.L., Harrison, S.R., Nasayao, E.E., Calub, F.S. and Cedamon, E.D.

Primer – *Cebuano version – Tamdanan sa Pagparehistro, Pagputol, Paghakot, ug Pagbaligya sa Kahoy sa Mga Pribadong Yuta*. Balbarino, E.A., Mangaoang E.O., Gordon, M.J., Herbohn, J.L., Harrison, S.R., Nasayao, E.E., Calub, F.S. and Cedamon, E.D.

Primer – *Waray version – Giya han Pagparehistro, Panmulod, Pagbiyahe ngan an mga Palisiya han Pamaligya han mga Kahoy dida ha mga Pribado nga Tuna.* Balbarino, E.A., Mangaoang E.O., Gordon, M.J., Herbohn, J.L., Harrison, S.R., Nasayao, E.E., Calub, F.S. and Cedamon, E.D.

2007 TRAINING MANUALS

Financial and Economic Research Methods for Agricultural Resource Managers, Training Workshop, Manila, 24–29 September 2007. Harrison, S.R. and Herbohn, J. (eds).

2008 BRIEFING DOCUMENT

Key outputs from ACIAR Smallholder Forest Research in Leyte and Mindanao: A Briefing Document for the Briefing Session for the Department of Environment and Natural Resources, 5 September 2008, Dusit Hotel, Manila, Philippines. Herbohn, J., Harrison, S., Gregorio, N., Vanclay, J., Smith, C., Dargusch, P., Mangaoang, E., Mercado, A. and Bosch, A. (eds).

2009 BRIEFING DOCUMENT

Key Outputs for ACIAR Smallholder Forest Research in Leyte and Mindanao, Briefing Document for the Department of Environment and Natural Resources meeting held in Manila, 10 February 2009: Herbohn, J., Harrison, S., Gregorio, N., Vanclay, J., Smith, C., Dargusch, P., Mangaoang, E., Mercado, A. and Bosch, A. (eds).

2009-2010

Guide to Quality Seedling Production in Smallholder Nurseries. Baybay, Philippines Gregorio, N.O., Herbohn, J.L. and Harrison, S.R. pp. 44.

Primer on LGU-based Nursery Accreditation, Baybay, Philippines: Gregorio, N., Cacanindin, D., Mangaoang, E., Herbohn, J., Gravoso, R., Mercado, A. Jr., Pasa, A. and Harrison, S. pp. 21.

Primer on DENR-based Nursery Accreditation, Baybay, Philippines. Gregorio, N., Cacanindin, D., Mangaoang, E., Herbohn, J., Gravoso, R., Mercado, A. Jr., Pasa, A. and Harrison, S. pp. 24.

Guide in Assessing Mother Trees: A Training Manual, Baybay, Philippines. Gregorio, N.O.

Training Video on Quality Seedling Production in Smallholder Nurseries. Baybay, Philippines. Gregorio, N. and Gravoso. R.

Sumbanan sa Forest Nursery Accreditation nga ipatuman, sa LGU. Baybay, Philippines. Gregorio, N., Cacanindin, D., Mangaoang, E., Herbohn, J., Gravoso, R., Mercado, A. Jr., Pasa, A. and Harrison, S. pp. 17.

JOURNAL ARTICLES

Annals of Tropical Research 32(2)

1. Gregorio, N., Harrison, S. and Herbohn, J. (2010). The Seedling Nursery Survey on Leyte Island, the Philippines. *Annals of Tropical Research,* 32(2): 1−14.
2. *Edralin, D.I. and Mercado Jr, A. (2010).* Profiling Tree Nurseries in Northern Mindanao, the Philippines. *Annals of Tropical Research,* 32(2): 15−26.
3. *Edralin, D.I. and Mercado Jr, A.(2010).* The Need for Improved Nursery Management Practices and Marketing in Tree Nurseries of Northern Mindanao. *Annals of Tropical Research,* 32(2): 27−34.
4. *Mercado Jr, A., Dargusch, P. and Gregorio, N. (2010).* Insights from the Farm Forestry Tree Seedling Nursery Sector in Western Java, Indonesia. *Annals of Tropical Research,* 32(2): 35−50.
5. *Harrison, S. and Gregorio, N.* (2010). Observations of Forestry Seedling Production Systems in Thailand and Vietnam. *Annals of Tropical Research,* 32(2): 51−70.
6. *Mangaoang, E. (2010).* Review of Current Nursery Accreditation and Seedling Certification System for Fruit Trees in Leyte and Samar Islands, the Philippines. *Annals of Tropical Research,* 32(2): 71−80.
7. *Edralin, D.I. and Mercado, Jr, A. (2010).* Ensuring Seedling Quality through Fruit Tree Nursery Accreditation and Implications for Forest Nursery Accreditation. *Annals of Tropical Research,* 32(2): 81−88.

8. *Gravoso, R., Gregorio, N., Gerona, A. and Godoy, J. (2010).* Design and Implementation of a Communication Campaign on Best Management Practice for Forest Nurseries. *Annals of Tropical Research,* 32(2): 89−100.
9. *Harrison, S., Gregorio, N. and Wilson, W. (2010).* Financial Modelling of Smallholder Seedling Production. *Annals of Tropical Research,* 32(2): 101−112.
10. *Cadiz, R., Landicho, M. and Aparente, M. (2010). Research Note:* ERDB Research, Development and Extension Strategies for the Production of High Quality Planting Materials. *Annals of Tropical Research,* 32(2): 113−123.

In preparation

Herbohn, J.L., Mangaoang, E., Gregorio, N. and Vanclay, J. Using Bamboo Scaffolding to Access Forest Canopies: Some Lessons from their Use in the Philippines

Small-Scale Forestry

1. Vanclay, J.K., Baynes, J. and Cedamon, E. (2008). Site Index Equation for Smallholder Plantations of *Gmelina arborea* in Leyte Province, the Philippines. *Small-scale Forestry*, 7(1):87−93.
2. Harrison, S.R., Gregorio, N.O, and Herbohn, J.L. (Guest Editors) (2008). Seedling Production Systems. *Special Issue of Small-scale Forestry*, 7(3-4) prepared in conjunction with review of nursery production systems in Asia as part of ASEM/2006/091.
3. Harrison, S., Gregorio, N. and Herbohn, J. (2008). Overview of Forestry Seedling Production Policies and Practices in Relation to Smallholder Forestry in Developing Countries. *Small-scale Forestry*, 7(3−4), 207−223.
4. Gregorio, N., Harrison, S. and Herbohn, J. (2008). Enhancing Tree Seedling Supply to Smallholders in Leyte Province, Philippines: An Evaluation of the Production system of Government Nursery Sector and Support to Smallholder Tree Farmers. *Small-scale Forestry*, 7(3−4): 245−261.
5. Bernaldez, S. and Mangaoang, E. (2008). Tree Adoption and Nursery Propagation Practices in Smallholder Upland Farms in Inopacan and Isabel, Leyte, the Philippines. *Small-scale Forestry,* 7(3−4): 295−309.
6. Baynes, J. and Gregorio, N. (2008). Nursery Training for Smallholders: An Evaluation of Two Extension Programs in the Philippines. *Small-scale Forestry*, 7(3−4): 387−401.
7. Gravoso, R., Mangaoang, E., Gerona, A., Pasa A. and Harrison. S. (2009). Users' reactions to the Primer on Tree Registration Policies: lessons for designing extension materials and improving information flow. *Small-scale Forestry*, 8(3): 275−287.
8. Baynes, J., Herbohn, J., Russell, I. (2009). Bringing Agroforestry Technology to Farmers in Leyte, the Philippines: A Comparison of Two Extension Assistance Regimes. *Small-scale Forestry,* 8(4): 381−398.
9. Goliat, J. and Pasa, A. (2010). Local Knowledge on Tree Utilization and Conservation: The Case in Butigan, Baybay, Leyte, Philippines. *Small-scale Forestry,* 8(4): 399−410.
10. Baynes, J., Herbohn, J., Russell, I. and Smith, C. (2010). Bringing agroforestry technology to farmers in the Philippines: Identifying constraints to the success of extension activities using systems modelling. *Small-scale Forestry* DOI 10.1007/s11842-010-9153. (Accepted: December 2010)
11. Cedamon, E., Harrison, S., Herbohn, J. and Mangaoang, E. (2010). Compiling Market and other Financial Data on Smallholder Forestry in Leyte, the Philippines. *Small-scale Forestry* (On line first). Accepted: 26 March 2010.
12. Baynes, J., Herbohn, J. and Russell, I. (2010). The Influence of Farmers' Mental Models on an Agroforestry Extension Program in the Philippines. *Small-scale Forestry* DOI: 10.1007/s11842-010-9154-7.

13. Gravoso, R., Gregorio, N., Gerona, M.A., Serino, M.N., Harrison, S., Pajaronand, H. and Godoy, J. (2011). Development and Implementation of a Nursery Accreditation Policy at a Local Level in Leyte, Philippines. *Small-scale Forestry*. (Online First, 23 March 2011).

OTHER JOURNALS

1. Gregorio, N.O., Herbohn, J.L., Harrison, S.R. and Smith, C. (2010). A Bayesian Belief Model to Improve the Operational Effectiveness of the Forest Nursery Sector in Leyte, Philippines. *Agroforestry Journal* (accepted, in press).

INTERNATIONAL CONFERENCE PAPERS

A. IUFRO 3.08 Conference on Small-scale Rural Forest Use and Management: Global Policies versus Local Knowledge, G. Buttoud (ed.), Proceedings from the June 2008 IUFRO 3.08 Conference, 23–27 June 2008, Gerardmer, France

1. Herbohn, J., Harrison, S., Gregorio, N., Smith, C., Vanclay, J. and Dargusch, P. (2008). A Systems Approach to Understanding Linkages between National Level Policies, Local Action and the Use of Traditional Knowledge to Improve Tree Seedling Production for Smallholder and Community Forestry in the Philippines. *Small-scale Rural Forest Use and Management: Global Policies versus Local Knowledge,* G. Buttoud (ed.), Proceedings from the June 2008 IUFRO 3.08 Conference, 23–27 June 2008, Gerardmer, France, pp. 97–104.
2. Baynes, J., Herbohn, J., Russell, I. and Smith, C. (2008). Bringing Agroforestry Technology to Farmers in the Philippines: Using a Bayesian Belief Network to Model Uncertainty Associated with Extension Program Variables. In: *Small-scale Rural Forest Use and Management: Global Policies versus Local Knowledge,* (G. Buttoud, ed.), Proceedings from the June 2008 IUFRO 3.08 Conference in Gerardmer, France. pp. 251.

D. Proceedings from the FOTROP II International Conference, November 17-20, 2008, Kasetsart University, Bangkok, Thailand

Harrison, S., Gregorio, N., Herbohn, J. and Dargush, P. (2008). Designing and Implementing Best Management Practice in Smallholder Forestry. In: *Proceedings from the FOTROP II International Conference*, Sapit Diloksumpun and Ladawan Puangchit (eds), 17–20 November 2008, Kasetsart University, Bangkok, Thailand. pp. 59–77.

WORKSHOP PROCEEDINGS

A. Proceedings from the ACIAR project ASEM/2006/091 Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector, Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009, pp. 21–34, (eds) Steve Harrison, Annerine Bosch, Nestor Gregorio and John Herbohn

1. Harrison, S. (2009). Workshop Program and Objectives. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 1–2.
2. Herbohn, J., Harrison, S. and Gregorio, N. (2009). Objectives and Scope of the ACIAR Seedling Enhancement Project. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 3–6.

3. Quimio, J. The Nursery Sector and the Paradigm Shift towards Entrepreneurial Forestry. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 7–10.
4. Vanclay, J. and Herbohn. J. (2009). Target Characteristics for Seedlings-based Nursery and Outplanting Trials: Experimental Design, Initial Results from Field Trials and Future Research. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 11–20.
5. Mercado, J. Jr, Dargusch, P. and Gregorio, N. (2009). Insights from the Farm Forestry Tree Seedling Nursery Sector in Western Java, Indonesia. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 21–34.
6. Harrison, S. and Gregorio, S. (2009). Observations of Forestry Seedling Production Systems in Thailand and Vietnam. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 35–50.
7. Gregorio, N, Harrison, S. and Herbohn, J. (2009). The Seedling Nursery Survey on Leyte Island, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 51–62.
8. Edralin, D. and Mercado Jr, A. (2009). Profiling Tree Nurseries in Northern Mindanao, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 63–72.
9. Gregorio, N., Smith, C., Herbohn, J. and Harrison, S. (2009). Identifying Leverage Points for Policy Reform in Seedling Production in Leyte, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 73–84.
10. Jesusco, J., Mangaoang, E., Gregorio, N. and Smith, C. (2009). Assessment of the Effectiveness of Government Extension Methods for Tree Seedling Production in Leyte. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 85–98.
11. Wilson, W. and Harrison, S. (2009). Financial Modelling of Smallholder Seedling Production. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 99–110.

12. Cacanindin, D. and Agne, L. (2009*).* Tree Improvement in North Eastern Mindanao. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 111–116.

13. Rafael Cadiz, Marilyn Landicho and Mylene Aparente (2009). ERDB Research, Development and Extension Strategies for the Production of High Quality Planting Materials. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 117–124.

14. Gregorio, N., Doydora, U., Harrison, S. and Herbohn, S. (2009). Inventory and Assessment of Mother Trees of Indigenous Timber Species on Leyte Island, the Philippines*.* In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 125–134.

15. Gravoso, R., Gregorio, N. and Godoy, J. (2009). Working with Local Government Units in Accrediting Forest Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 135–140.

16. Gravoso, R., Gregorio, N., Gerona, A. and Godoy, J. (2009). Design and Implementation of a Communication Campaign on Best Management Practice for Forest Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 141–148.

17. Mangaoang, E. (2009). Review of Existing Nursery Accreditation and Seedling Certification System for Forest and Fruit Trees in Leyte. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 149–156.

18. Edralin, D. and Mercado Jr, A. (2009). Ensuring Seedlings Quality through Nursery Accreditation. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 157–162.

19. *Harrison, S. and Gregorio, N.* (2009). Some Considerations in Designing and Implementing a Best Management Practice Scheme for Smallholder Forestry Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 163–170.

20. Vanclay, J., Herbohn, J. and Harrison, S. (2009). Identifying Best Management Practice in Forestry Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/ *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 171–176.

21. Edralin, D. and Mercado Jr, A. (2009). The Need for Improved Nursery Management Practices and Marketing in Tree Nurseries of Northern Mindanao. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 177–182.
22. Gregorio, N., Herbohn, J. and Harrison, S. (2009). Guide to Quality Seedling Production in Smallholder Nurseries: Q-Seedling Manual. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Improving the Effectiveness and Efficiency of the Philippines Tree Nursery Sector,* Proceedings from the Mid-term Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 13 February 2009. pp. 183–208.

B. Proceedings from the ACIAR project ASEM/2006/091 Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector, Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010, (eds) Steve Harrison, Annerine Bosch, Nestor Gregorio and John Herbohn

1. Herbohn, J. (2010). Nature and Objectives of the ACIAR Seedling Enhancement Project and Overview of the Workshop Program. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 1–5.
2. Mercado Jr, A. and Edralin, D.I. (2010). Forestry Seedling Nursery Practices in Leyte and Northern Mindanao: Observations from Nursery Operator Surveys. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 7–23.
3. Smith, C. and Gregorio, N. (2010). The Role of Systems Modelling and Bayesian Belief Networks in Forestry Seedling Production Research in the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 25–32.
4. Herbohn, J. (2010). Designing and Conducting Field Trials to Evaluate Early Growth Performance, Site Suitability and Improved Forestry Seedlings. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 33–47.
5. Mangaoang,E., Gregorio, N., Pajaron, H., Baldoza, R. and Gravoso, R. (2010). Promoting High Quality Seedling Production through LGU-Based Nursery Accreditation: Successes and Challenges. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector, Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 49–53.
6. Florido, L. and Javier, J. (2010). National Policy on Accrediting Forest Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 55–60.

7. Gravoso, R., Gregorio, N. and J Godoy, J. (2010). Development and Implementation of a Nursery Accreditation Policy at the Local Level in Leyte, Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 61–65.
8. Cacanindin, D. (2010). Pilot Testing of the Forestry Seedling Nursery Certification System in DENR Region 10. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 67–72.
9. Nestor Gregorio (2010). Developing the Best Management Practice Guide for High Quality Seedling Production in Smallholder Nurseries. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 73–86.
10. Herbohn, J. (2010). Strategies to Improve Seedling Quality in Smallholder Forestry in the Philippines: A Synthesis of Findings from a Systems Research Program. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 87–91.
11. Galinato, C., Cacanindin, D. and Dichoso, M. (2010). Reforestation Program and Policy in DENR-10: Integration of Tree Improvement. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 93–98.
12. Gregorio, N., Smith, C., Herbohn, J. and Harrison, S. (2010). Designing Intervention Strategies for Forestry Seedling Production in the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 99–112.
13. Gregorio, N., Doydora, U., Harrison, S., Herbohn, J. and Sebua, J. (2010). Inventory and Assessment of Mother Trees of Indigenous Timber Species on Leyte Island and Southern Mindanao, the Philippines. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 113–125.
14. Gravoso, R., Gregorio, N., Gerona, A. and Godoy, J. (2010). Promoting Adoption of Best Management Practice for Forest Nurseries through a Communication Campaign. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 127–134.

15. Pasa, A., Gravoso, R., Gregorio, N., Gerona, A. and Mangaoang, E. (2010). Some Observations from Seedling Demonstration and Training Projects in Local Government Units. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 135–139.

16. Harrison, S., Gregorio, N. and Herbohn, J. (2010). Modelling Production Cost and Financial Return of Forest Reproduction Materials in Relation to Nursery Size. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 141–152.
17. Thomas, S., Herbohn, J. and Dargusch, P. (2010). Opportunities for Philippine Small-Scale Forestry in Carbon Markets: Initial Notes. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 153–161.
18. Mercado Jr, A. and Edralin, D.I. (2010). Financial Analysis of Production of Clonal Rubber Planting Stock for Rubber Agroforestry Systems in Mindanao. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 163–169.
19. Harrison, S. (2010). Deriving the Discount Rate for Seedling Nurseries and other Livelihood Projects. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 171–177.
20. Harrison, S. and Gregorio, N. (2010). Designing a Wildling Collection Strategy to Support Production of Planting Materials for Green Offsets in Southern Mindanao. In: S. Harrison, A. Bosch, N. Gregorio and J. Herbohn (eds), ASEM/2006/091 *Enhancing Tree Seedling Supply via Economic and Policy Changes in the Philippines Nursery Sector,* Proceedings from the End of Project Workshop held at the Visayas State University, Baybay, Leyte, the Philippines, 19–20 June 2010. pp. 179–188.

11 Appendixes

11.1 Appendix 1:

Questionnaire for Private Nurseries

Location details: _____ Distance from the main road (km):_____ GPS position:_____ Date:_____ Time: _____

Respondent's code: _____ Respondent's name: _____
Phone no: _____ Interviewer's name:_____

A. Demographic profile

1. Name of respondent: _____
2. Gender (M/F): _____
3. Age class (less than 30 yrs; 30-49 yrs; 50-69 yrs; 70 yrs or over): _____
4. Highest educational attainment *(please circle)*
    a. not completed primary
    b. completed primary
    c. not completed secondary
    d. completed secondary
    e. not completed tertiary
    f. completed tertiary
    g. postgraduate award
    h. other _____
5. Community group affiliation: _____
6. Family size: _____

B. Financial capacity and resources

7. What is your major source of livelihood?

Name of activity	Household members involved	Status *(seasonal/ permanent)*	Average working time per week	Salary rate *(PhP/day)*

8. What are your other sources of livelihood/income?

Name of activity	Household members involved	Status *(seasonal/ permanent)*	Average working time per week	Salary rate

9. Do you have some land used for farming? How many parcels? Do you own, lease or rent it?

What is its size? How long have you managed it? What are the crops grown? Is there any tree you have planted there?

Parcel	Tenure	Years managed	Size	Slope	Crops grown	Species of trees present

10. If trees are planted, what is the purpose for planting?

_____

_____

11. Do you have land available on which you could outplant seedlings you grow? (Yes/No):

_____

12. What percentage of your produce is sold and how much is the estimated revenue?

Crop	% of the harvest sold	Estimated annual revenue

13. Do you have livestock? (Yes/No): _____. If yes, what species do you have? _____. Do you sell any of the livestock species? (Yes/No):_____.

If *yes,* how much is the estimated revenue earned per year from sale of livestock for the last three years? _____

14. What is your staple food? (e.g. rice, corn) _____. What proportion of your land area is planted with staple food? *(Please circle one)*

a. 0-25% b. 26-50% c. 51-75% d. 76-100%

15. What proportion of the household's total food needs do you produce? *(Please circle one)*

a. 0-25% b. 26-50% c. 51-75% d. 76-100%

C. Nursery history and business arrangements

16. When was the nursery established? (MONTH &YEAR)

_____

_____

17. What made you decide to establish the nursery?

_____

_____

8. Has this nursery operated continuously since first opening? (Yes/No): _____. If No, why and at what times has it operated?

_____

19. What changes in nursery size have taken place over the period of operation? (years and percentage changes in number of seedlings produced): _____

20. Do you operate nursery activities or sell seedlings at any other sites?

(Yes/No): ____

Details:

_____

21. Do you have business association with any nurseries owned by other persons or agencies? (Yes/No): _____

Details:

_____

22. Do you purchase seedlings from any other nurseries or government agencies? (Yes/No): _____

Details:

_____

23. Do you sell seedlings to any other nurseries or government agencies?

(Yes/No): _____ Details:

_____

24. Have you received any assistance (e.g. training, seeds, financial) from support agencies in running your nursery? (Yes/No): _____. If *Yes,* what is the name of the supporting agency?

    _____

25. What is the type of support that you received?

_____

26. What were the conditions?

    _____

27. What is the purpose of raising the planting stock? *(Please encircle one or more item)*

    a. for sale c. for free distribution

    b. for personal use d. other (please specify) _____

28. What are the species of planting stock you have raised in the last three years and what are the reasons for choosing these?

Species	Reason *(e.g. high demand, available planting material, for timber, food, easy to raise, dictated by support agency)*	Type of planting materials used *(e.g. seeds or wildlings)*	Sources of planting materials

29. How do you decide on what preferred species to raise?

    e.g. demand of seedlings, suitability to planting conditions of the farm, availability of planting materials, end use of the tree (timber, etc) fast growth, timber quality, knowledge and ease of propagation

    _____

    _____

D. Technical skills on nursery seedling production

30. Did you have experience or involvement in any forest nursery or related projects prior to managing this nursery?

Project/activity *(e.g. nursery mgt. trng, seed collection trng, seed technology trng, observation tour, etc.)*	Role	Duration

31. Have you attended any forestry-related training courses or events?

Training course *(e.g. Nursery mgt trng, Seed collection trng, Seed technology training, Observation tour*)	Sponsor	When

32. Do you have any family members or employed staff who have undergone training in seedling production techniques? (Yes/No): _____. If *Yes*, complete the table below

Training course *(e.g. Nursery mgt trng, Seed collection trng, Seed technology training, Observation tour*)	Sponsor	When

33. Are you satisfied with the quality of seedlings you produce? (Yes/No): _____

34. Are you aware of any forms of low quality (defects) in seedlings you produce? (Yes/No): _____.

    If Yes, what are the types of defects you noticed?_____

    _____

35. Aside from the species that you have raised, what other species do you want to produce? Why are you not able to raise them?

Species	Reason for not raising

36. How important do you rate the following list of problems in your seedling production activities? (*Use the scale of 1 to 5 with 1 as not important through to 5 as highly important)*

Problem	1	2	3	4	5
Difficulty of obtaining seeds					
Distant seed sources/suppliers					
Expensive seeds					
Low seed germination					
Difficulty in germinating seeds					
Pests and diseases					
Inadequate funds/supplies					
Unclaimed orders					
Low sales quantity					
Damage from grazing of domestic animals					
Lack of nursery facilities					
Labour unavailability					
Adverse weather					
Other (please specify)					

37. What are the specific problems that you have encountered in raising the seedlings of different reforestation species in your nursery? Indicate NA if not raised the species

Species	Constraints
Gmelina	
Acacia sp	
Mahogany	
Bagras and other Eucalyptus spp.	
Narra	
Falcata	
Dipterocarp spp.	
Teak	
Other (pls specify)	

38. If information on nursery seedling production were to be provided what do you think would be the best way for this information to be made available to you?

How *(e.g. hands-on trng, nursery visits)*	Where *(e.g. DENR nursery, local nurseries)*	Reason	Whom *(e.g. DENR personnel, local nursery operators)*	Reason	Rank of extension measures (1-5)

39. If training workshops on nursery seedling could be provided within the municipality, would you be interested in attending? (Yes/No): _____

40. If nursery visits by seedling nursery experts could be made available, would you be interested that your nursery be visited? (Yes/No): _____

41. Do you think that a training video is a useful material to enhance your knowledge on nursery seedling production? _____ Why? _____

_____

E. Pathway and flow of germplasm and planting stock

42. What is your preferred source of planting materials? _____. Why?

_____

43. Of the following types of planting stock, which do you prefer most? Why? (*Rate preference using the scale of 1 to 5 with one as not preferred and 5 as mostly preferred)*

Type of planting material	Preference (1-5)	Reason
Seeds		
Wildlings		
Grafted stocks		
Rooted cuttings		
Other (specify)		

44. How do you obtain the seed or other propagation materials? *(Pls. encircle one or more choices)*

    a. Purchased at full cost
    b. Collected
    c. Purchased at subsidized cost
    d. Other *(pls. specify)* _____

45. If you collect the seed or other propagation materials, from where and how do you collect them?

    _____

46. Do you consider the physical appearance of the mother tree (seed source) during the collection process? (Yes/No): _____. If yes, what characteristics of mother trees do you look for?

Species	Characteristics of mother trees

47. If the planting materials are purchased, from where are these obtained from, and how much is the purchase price?

Species	Type of planting material and source	Price per unit

48. If the planting materials are obtained free of cost, from where do you get these? Is there any condition or agreement with the provider? What are these conditions?

Agency	Conditions or agreement

F. Familiarity with, and attitudes towards, tree species

49. Do you have preference on what species to raise? (Yes/No): _____.

50. Of the following timber species for reforestation, which would you prefer to raise? Why? (Rank preference using the scale of 1 to 5 with 1 as least preferred through to 5 as most preferred)

Species	Preference (1-5)	Reason
Gmelina		
Acacia species		
Mahogany		
Bagras and other eucalypt species		
Narra		
Falcata		
Dipterocarp spp.		
Teak		
Other *(pls. specify)*		

51. Are you interested in raising indigenous species? (Yes/No): _____ Why?
_____

52. Between indigenous and exotic species, which would you prefer to raise?
Why? _____

G. Profile of the Nursery, Infrastructure and Capital Outlays

53. What does your nursery structure consist of? (Complete the table)

Structure	Materials	Approx. dimensions (size, height, length)	Age (yrs)	Component costs	Labour days in construction
Fences					
Shadehouses					
Shelves for potting					
Raised benches for holding seedlings					
Watering facilities					
Hardening beds					
Potting materials storage					
Other					

Photographs and a rough sketch of the nursery are needed. Interviewers to record observations, *e.g. whether nursery fenced off, whether seedlings are raised off the ground, standard of general nursery hygiene.*

54. What are the equipment and materials you have used in operating the nursery and proportion of time these are used in the nursery?

Equipment item	Quantity	Year when purchased or built	Age and cost at purchase, or construction cost	Proportion of time used

55. What is the total land area (square metres) of the nursery? What is its proportion in relation to your total land area? _____; _____

56. How many seedlings can you produce at one time? _____ How many seedling batches per year do you produce? _____

57. Exposure to the sun (*e.g. shaded, partly shaded, exposed):* _____

58. Exposure to the wind (*e.g. protected, partially protected, exposed):* _____

59. Water source, supply and distance from the nursery (*e.g. barangay water system, spring, water pump, harvested water).*

    _____

60. What equipment are used in storing and delivering water to seedlings? (*e.g. pumps, holding tanks, underground pipes*).

    _____

61. Typically, how frequently do you water the seedlings in each production season?

    _____

62. What is the approximate volume of water used in each watering activity?

_____

63. Nursery drainage (*excellent, fair, poor)* _____

64. What monitoring of seedling performance do you carry out? (*e.g. visual observation, verbal check with the customers).* _____

65. How do you plan your seedling production schedule?

    _____

66. How long on the average seedlings stay in the nursery? _____

67. What is the longest time you hold seedlings for in the nursery? _____

68. What proportion of your seedlings raised is held for longer than a year? _____

69. What are the sources of the inputs used in seedling production? (e.g. seeds and other propagules, supplies and materials such as plastic bags and pesticides, fertilizers, shading and construction materials, germination and potting media).

Nursery inputs	Sources

H. Nursery seedling culture and cost structure

70. What are the sowing methods you adopted per species? What are the types and size of containers used?

Species	Sowing method *(e.g. direct sowing on pots, use of seedboxes, use of seedbeds*	Container type *(e.g. polyethylene bags, recycled containers)*	Container size
Mah	**seedbed**		

Remarks: _____

71. What are the potting media used and the proportion of each medium in the mixture?

Potting material	Mixture/proportion

Remarks: _____

72. What is the annual quantity of potting medium (tones) do you use? _____

73. How do you obtain and store the ingredients of the potting medium? What is the cost of various ingredients?

Medium	Annual quantity and units	source	Storage method	Purchase cost and unit

74. Do you apply treatments before using the potting medium? (Yes/No):____. If Yes, what treatment do you carry out before re-using of potting medium?

_____

75. What is basis for choosing the timing of potting and transplanting?

Species	Basis of transplanting/potting		
	Potting height (cm)	Age (wks)	Other criteria

Note: *Check especially about root pruning, shading, transplanting practice, watering after potting.*

_____

76. What equipment or method do you use for watering seedlings? *E.g. sprinkler, hose, flooding, use of water scoopers or improvised sprinkler cans*

_____

77. Do you apply fertilizer to your seedlings? (Yes/No): _____. If Yes, what is the type of fertilizer, the application rate and the timing of application?

Fertilizer type	Amount	Application method	Schedule/frequency

Remarks: _____

78. Do you carry out grading of seedlings? (Yes/No): _____. If Yes, what is your basis? *(e.g. height or diameter)* _____

79. Do you carry out hardening of seedlings before sale? (Yes/No): _____ If Yes, what is the hardening practice that you follow? *(Please encircle one or more items)*

Hardening procedure	Frequency/duration
Root pruning	
Water reduction	
Full light exposure	
Other (specify)	

Remarks: _____

80. What pests and diseases have you noticed in your nursery? At what seedling stage does each of these occur? Have you carried out any control measures? What measures have you used?

Species	Disease/pest	Seedling stage to occur	Control measures

81. What labour type do you normally use in the nursery?

Family	Average hour per week	Pay rate (PhP/day)
Farmer		
Spouse		
Family member 1		
Family member 2		
Family member 3		
Permanent non-family (hired)		
Employee 1		
Employee 2		
Employee 3		

82. Do you employ seasonal workers? (Yes/No): _____. If Yes, what is the number of workers?_____

83. On the average, approximately how many weeks a year do they work?_____

I. Seedling marketing and pricing

84. Do you sell seedling? (Yes/No): _____ Why?

_____

(If No, proceed to Question 110)

85. Who are the usual buyers of the planting stock? *(e.g. government agencies, schools, communities, farmers)*_____

86. What is the height or age of seedlings when you sell them?

Species	Height when sold	Age when sold

87. What are the species that are of greatest demand? (Please rank from highest)

_____

88. Were you able to supply the species that are mostly demanded by the buyers in the last three years? (Yes/No): _____. If No, why?

_____

89. For which species are you unable to meet customer demand?

_____

90. Do you deliver your seedlings to customers or other sale points? (Yes /No): _____. (If No) To your knowledge, what was the greatest distance a customer came from?

_____

91. Do you grow seedlings under sales contract? (Yes/No): _____. (If yes) What timber and fruit tree species and numbers of seedlings did you produce in your most recent production year? What was the customer type of these seedlings?

Species	Number of seedlings	Customer type

92. Do you estimate the cost of producing seedlings? (Yes/No): _____

93. How do you decide the price of the seedlings you sell? _____

94. How much is the estimated production cost of the seedlings and how much do you charge customers?

Species	Production cost	Sale price

95. How much is your estimated sale revenue of seedlings for the whole year?

_____

96. What was the date of your last seedling sales? _____

97. How frequent are your seedling sales? _____

98. What quantity do you typically sell per sale? _____

99. Do you lose any seedlings due to natural hazards or pests? (Yes/No): _____. If Yes, provide details:
_____

100. What advertising or other sale promotion activities do you carry out?
_____

101. Is raising of seedlings for sale a profitable activity for you? (Yes/No):_____.

102. Are you willing to continue producing seedlings for sale? (Yes/No): _____ Why?
_____

103. Do you have any plans to change the size of the nursery? (Yes/No): _____ If Yes, what plans?
_____

104. Do you have any plans to change the percentage of the various seedling species you produce? (Yes/No): _____ If Yes, what changes do you plan?
_____
_
_____

J. Perceptions on seedling production industry opportunities and obstacles

105. Do you see a favourable future for private seedling nursery operators?
(Yes/No): _____ Reasons:
_____

106. What would it take to make your nursery more profitable? _____
_____

107. What factors are likely to lead to improved nursery seedling business? _____
_____

108. What factors are likely to lead to poorer business? _____
_____

109. Do you have any plans to upsize or downsize your nursery? (Yes/No):_____

110. What prevents you from expanding your nursery operations? _____

_____

111. How do you think nurserymen in Mindanao could operate more efficiently?

_____

112. Can you think of any ways in which you might improve the operation of your nursery?

_____

_____

113. What improvement would you like to see in your nursery in terms of operating efficiently?

_____

_____

114. What prevents you from attaining your view?

_____

115. What improvement would you like to see in the nursery in terms of profitability?

_____

What prevents you from attaining this improvement?

_____

116. What improvement would you like to see in the nursery in terms of seedling quality?_____

What prevents you from attaining this improvement?

_____

_____

117. What improvement would you like to see in the nursery in terms of establishing customer loyalty?

_____

What prevents you from attaining this improvement?

_____

118. What actions do you think government agencies including DENR could take to improve the quality of seedlings produced in private nurseries?

_____

119. What actions do you think government could take to improve the financial viability of private seedling nurseries?

_____

K. Local knowledge on seedling production practices

120. Do you have any practices on the following seedling production activities which you learned from your ancestors or from actual experiences *(as distinct from training from school or from training classes done by support agencies)?*

Activity	Local practices
Mother tree identification (selection)	
Germplasm collection (collection time, processing, handling, storage)	
Germination (medium, sowing techniques)	
Potting (medium, containers, techniques)	
Seedling maintenance (hardening, watering, fertilizer application, control of pest and diseases)	
Other (pls specify)	

L. Nursery stock quality assessment

121. Do you assess the quality of the planting stock that you raise? (Yes/No):_____. If yes, what are the parameters that you use? (*E.g. quantitative: height, diameter vs. qualitative: health, leaf flushing*).

_____

122. Do you reject or cull some of your seedlings before selling? (Yes/No): _____. If Yes, what is your basis?

_____

123. What is the usual percentage of culled seedlings? _____

124. Collect five (5) sample seedlings for each species to complete the table below. Sturdiness, root-shoot ratio and root morphology

Species	Total height (cm)	Root collar diameter (mm)	Root ODWOD W (g)	Shoot ODW (g)	Root form (e.g. Straight, coiled, twisted, J-form)

Remarks: _____

M. Other relevant observations *(e.g. on weeding, seedling position, pot piling, overgrown seedlings)*.

_____

_____

_____

_____

_____

_____