Understanding the challenges in implementing a national policy to regulate the quality of forest reproductive materials for reforestation programs in the Philippines

Understanding the Challenges in Implementing a National Policy to Regulate the Quality of Forest Reproductive Materials for Reforestation Programs in the Philippines

N. Gregorio[1, 2*], J. Herbohn[2], S. Harrison[1], A. Pasa[3], A. Ferraren[3], M. Avela[3] and J. Fernandez[3]

[1]School of Agriculture and Food Sciences, The University of Queensland, 4072, Australia
Email: n.gregorio@uq.edu.au and s.harrison@uq.edu.au
[2]Tropical Forests and People Research Centre, University of the Sunshine Coast, Locked Bag 4, Maroochydore DC, 4558, Australia. Email: jherbohn@usc.edu.au
[3]ACIAR Smallholder Forestry Project, Visayas State University, Leyte 6521-A Philippines
Email: artpasa@yahoo.com and asalmendras@gmail.com
*Corresponding author

ABSTRACT

The use of low quality forest reproductive material is one of the major reasons for the mixed results of past watershed rehabilitation programs in the Philippines. Since 2010, a national policy on forest nursery accreditation has been implemented to regulate the quality of forest reproductive materials. Implementers of forest rehabilitation programs are directed to use high quality seedlings from accredited seedling suppliers. Despite this requirement, low quality seedlings are still largely planted in reforestation projects including the recent National Greening Program (NGP). Surveys of the forest nursery sector in Eastern Visayas and Northern Mindanao regions were carried out to determine the effectiveness and challenges in implementing the forest nursery accreditation policy. The survey has identified factors that limit the effectiveness of seedling quality regulation including insufficient seedling production schedules due to delayed disbursement of project funds, inappropriate criteria for seedling quality assessment, lack of auditing of seedling quality in accredited nurseries, and insufficient monitoring of seedling supply chain among the network of nurseries supplying seedlings for reforestation programs. The limited sources of high quality germplasm, nursery operators' limited information on the attributes of high quality planting materials and insufficient knowledge on high quality seedling production technologies contributed to the widespread production of low quality seedlings. Nursery accreditation represents a huge leap in promoting the success of watershed rehabilitation nationally. However, considerable improvement of the implementation system and establishment of support mechanisms is necessary.

Keywords: Germplasm, mother tree, seedling production, nursery accreditation, reforestation

INTRODUCTION

The quality of forest reproductive material[3] is a major factor for the success of watershed rehabilitation. Harrison et al. (2008) argued that forest conservation and regeneration efforts require the use of reproductive materials that meet the appropriate genetic, morphological and physiological quality standards. Although seedling quality is widely understood as a requisite to effective watershed rehabilitation, the use of high quality planting materials is often overlooked in the overall reforestation process. Grossnickle (2012) claimed that while high

[3] A term referring to seedlings (including bare-root and containerised stock) or vegetative propagules (such as rooted cuttings, grafted stock and tissue culture material).

mortality of out-planted seedlings is attributed to several factors including environmental stress, damage by grazing animals, pests and diseases, in many cases low quality planting stock is a major cause of plantation failures. Sáenz and Martínez (2000) reported that in Mexico, the low survival of seedlings in most reforestation projects was mainly attributed to planting of low quality seedlings. Mc Dowell et al. (2008) also argued that the inferior quality of planting stock and inability to couple with environmental conditions largely explains low survival of seedling in large-scale reforestation programs of many countries.

While policies to regulate the quality of forestry seedlings have been institutionalized in various countries (see Sheil 2013, He et al. 2012, Nyoka et al. 2011, Department of Forestry and DANIDA 2007, House of Parliament 2002), there is a dearth of knowledge regarding the constraints and challenges encountered in the implementation of such policies and the corresponding intervention measures that were adopted. A few reports (e.g. Nyoka et al. 2014, Ha et al. 2011, Graudal and Lillesø 2007) revealed that developing an effective seedling quality regulation system is fraught with various constraints.

In the Philippines, it is well recognised that low quality seedlings significantly contributed to the less than expected success in reforestation programs (Israel and Lintag 2013, Combaliser 2010, Gravoso et al. 2007, Carandang et al. 2006, Gregorio 2006, Tolentino, et al. 2002, Lapis et al. 2001, Lasco et al. 2001, Nixon et al. 2000). With lessons from past watershed rehabilitation initiatives, the recent National Greening Program (NGP)[4] was designed to use only high quality planting materials in terms of both genetic and morphological characteristics (DENR 2011). For this purpose, the seedling production for the NGP is governed by Departmental Order 2010-11, which sets out the appropriate methods of collecting and handling high quality germplasm, and distribution to nursery operators in various regions of the country. It also states the protocol for accrediting germplasm sources and forestry nurseries. DAO 2010-11 states that only seedlings from accredited nurseries shall be used for government forestation programs including tree plantation development, tree farms, agroforestry, urban forestry and other reforestation activities (DENR 2010).

The implementation of the NGP in various regions of the Philippines has been successful in terms of achieving the target area of land for planting. The accomplishment report of the NGP for calendar years 2011, 2012 and 2013 revealed 129%, 111% and 111% of the target area had been planted, respectively (DENR 2014a). However, inventory of seedling survival in plantations revealed less success. For example, the performance validation report of the DENR for three-year old NGP plantations in 10 barangays in Philippines Region 8 (Eastern Visayas) revealed an average seedling survival rate of only 39% (lowest 16.2%; highest 68.7%) (DENR 2014b). This report was corroborated by the result of the NGP plantation assessment in Region 8 (Eastern Visayas) and Region 10 (Northern Mindanao) of the country undertaken by the ACIAR Watershed Project (Baynes et al. 2014). Senior staff members of the Ecosystems Research and Development Bureau of DENR admitted that low quality of planting materials is a major reason for the low survival of seedlings in NGP plantations (Barriga 2013). This is an unwelcomed finding given the recent legislation regulating the quality of planting materials for reforestation programs in the Philippines and the requirement to use high quality seedlings for the NGP.

[4] The NGP is a government-initiated and stakeholder-based watershed rehabilitation flagship program of Pres. Aquino which aims to reforest 1.5 M ha of public domain land from 2011 until 2016, to promote sustainable development for poverty reduction, food security, biodiversity conservation, environmental stability and climate change mitigation and adaptation (DENR 2012).

This paper discusses the seedling production system for the National Greening Program in the Philippines and the challenges in regulating the quality of seedlings. The study is envisaged to improve the success of regulating the quality of forest reproductive materials for watershed rehabilitation programs in the Philippines and in other developing countries. This study was undertaken as a component of the review of the effectiveness of National Greening Program (NGP) implementation in Philippines Regions 8 and 10, which is one of the major research activities of the project ACIAR ASEM/2010/050 *Improving Watershed Rehabilitation Outcomes in the Philippines through a Systems Approach.*

RESEARCH METHODS

Description of the Study Site

ACIAR research project ASEM/2010/050 – also named ACIAR Watershed Rehabilitation Project in partnership with the Department of Environment and Natural Resources (DENR) carried out a survey of forestry nurseries in six provinces in Regions 8 and 10 of the Philippines in June and July 2013. The provinces included are Biliran, Leyte, Southern Leyte, Samar, Bukidnon and Misamis Oriental (Figure 1). These regions were selected because they are the research sites of the ACIAR Watershed Rehabilitation Project. Region 8 is composed of three islands and six provinces. It comprises 7.2% of the country's total land area, and 52% of the area is classified as forest land[5]. Among all regions in the Philippines, Region 8 had the highest plantation target in the 2011 NGP planting.

Region 10 is composed of five provinces. It has a total land area of 2.05 M ha, with more than 60% classified as forest land. Agriculture and forestry make the greatest contribution to its regional economy in terms of income. In 2011, Region 10 achieved 100% of its NGP plantation target (DENR 2014).

Figure 1. Map of the Philippines with location of the study sites indicated by circles

[5] Forest land includes public forest, the permanent forest or forest reserves, and forest reservations. It covers all land of the public domain with a slope of 18% or more including those without forest cover.

Data Collection and Analysis

Nurseries included in the survey were selected based on recommendations of the DENR, particularly the Forest Management Service (FMS) of Region 8 and the Ecosystems Research and Development Service (ERDS) of Region 10. These nurseries produce seedlings for the National Greening Program. Operators of identified nurseries were notified and approval was sought for the project staff and DENR personnel to carry out the survey. The survey was undertaken in two parts, namely interviews with nursery operators and an assessment of the nursery seedling production including the evaluation of seedling quality. Using an open-ended questionnaire as a guide, information on the seedling production systems including nursery silvicultural practices and quality control measures, and the market of seedlings were gathered during the interview. The respondents were also asked about the constraints experienced in nursery operation and the marketing of forest reproductive materials. Discussions with key DENR personnel were also undertaken to obtain information regarding the organisation of the seedling production for the NGP, and the seedling quality control protocol of the DENR and the challenges encountered in its implementation. Interviews of nursery seedling producers and DENR staff allowed corroboration of some information provided by each group.

Nursery seedling production was assessed by examining the physical quality of seedlings, the nursery set-up and the technical capability of the nursery operator to produce high quality forest reproductive materials. The assessment adopted the method, criteria and standards developed by stakeholders (i.e. DENR, Department of Agriculture, forestry experts from both the academe and research groups, local government units, seedling producers and tree farmers) during the implementation of the earlier ACIAR project ASEM/2006/091, otherwise called the ACIAR Q-seedling Project. The latter project was implemented in Regions 8 and 10 during 2007 to 2010, with the aim of enhancing the supply of high quality seedlings for government and private reforestation programs in the Philippines (ACIAR 2011).

The process of assessing the physical quality of planting materials involved destructive sampling of 50 seedlings of plantable size (i.e. at least 20 cm tall) at each nursery, examining the seedling health and measuring seedling physical parameters, namely base diameter, seedling height, sturdiness, root-shoot ratio, stem form, root form and health. The seedlings in the nursery were considered as a population unit and sample seedlings were chosen following a systematic selection across all species available during the survey period. The overall volume of seedlings was divided by 50 and the quotient corresponds to the n^{th} seedling sample. The nursery owners provided all sample seedlings for free.

The height of seedlings, which is the distance from the stem base to the tip of the bud, was measured using a metre stick. The diameter at root collar was taken with digital callipers. These measurements were used to calculate the sturdiness quotient of the seedling, which is the ratio of stem height (cm) and root collar diameter (mm) (Jaenicke 1999). Roots of seedlings were separated from shoots at the root collar level and fresh weights were taken using a digital balance. The roots were thoroughly washed with water to remove soil particles and wiped with absorbent paper before weighing. Shoots and roots for each seedling were then placed in a paper bag and dried inside an oven at a temperature of 80°C for 48 hours to determine the dry biomass. Dry biomass measurements of shoots and roots were used in determining the shoot-to-root ratio of the seedlings. The root form was assessed by examining the taproot whether it was straight, coiled or having a J-form. The stem form was examined based on the deviation of stem growth from the vertical axis. Seedling health was evaluated by examining the presence of pests and pathogens or symptoms and signs of disease.

The technical capability of the nursery operator was assessed based on the number and type of training events relevant to nursery operations that they had attended and their experience in nursery seedling production. In regards to the nursery set-up, the facilities present in the nursery, the type of seedling container used and the quality of potting media were assessed. Table 1 summarizes the criteria used and parameters measured during the nursery and seedling quality assessment, and the importance weights attached to each criterion. The maximum overall score for a nursery is 32 and the minimum acceptable score is 20.

Table 1. Category and criteria used in assessing the nursery seedling production and seedling quality

Criterion	Description	Maximum score
Seedling physical quality		15
Health	Absence of pests and diseases	
Stem form	Straightness of the stem	
Root form	Absence of root deformations e.g. J-roots, pot bound roots and root curling	
Sturdiness	Sturdiness of the stem (Sturdiness Quotient)	
Shoot-root ratio	Balance of shoot to root biomass	
Skills of the nursery operator		6
Training	Training in nursery management	
Experience	Years of experience in nursery seedling production	
Nursery facilities		9
Facilities	Presence of necessary nursery facilities for high quality seedling production	
Seedling containers	The type of container used in seedling production	
Potting medium	Texture and nutrient content of the potting mix	
Production capacity	Capacity to supply planting stock in substantial quantity	2

The survey sample included 23 nurseries, 9 from Region 10 (8 from Bukidnon and 1 from Misamis Oriental) and 14 from Region 8 (5 from Biliran, 3 from Leyte, 3 from Southern Leyte and 3 from Samar). Of these nurseries, private operators owned 9, 12 were managed by people's organisations (POs) involved in the NGP implementation, and 2 were established and managed by the DENR.

A workshop with stakeholders was held in Naval in Biliran Province on July 2, 2013 to convey and validate the results of the survey. Key representatives of the DENR in Regions 8 and 10, seedling production contractors (private nursery operators, NGOs, POs), NGP implementers and researchers of the ACIAR Watershed Project attended the workshop. The methods used in the survey and key findings were presented, and reactions and comments from participants were sought. Discussions on some critical issues including the awarding of seedling production contracts and monitoring of seedling quality were facilitated. Important information arising from discussions and comments of stakeholders were recorded and incorporated in the survey results.

Data were analysed using the Statistical Package for the Social Sciences (SPSS). Descriptive statistics including frequency distributions and means were computed. Chi-square and

Pearson's correlation tests were undertaken to determine if a relationship exists between species category and type of germplasm used, hardening and seedling physical quality, and germplasm type and resulting seedling physical quality. A conceptual model of the seedling production system in Regions 8 and 10 was developed.

RESULTS AND DISCUSSSION

The Organisation of Seedling Production for the NGP

The implementing guidelines of the NGP described in DMC 2011-01 *Guidelines and Procedures in the Implementation of the National Greening Program* (DENR 2011) stipulated that seedling production should be a collaborative undertaking of several groups including local government units, government agencies, academic institutions, the private sector and communities. For the 2011 to 2013 NGP plantings in Regions 8 and 10, people's organisations, commercial large-scale individual nurseries and non-government organisations produced most of the seedlings. Although efforts had been made by the DENR to mass-produce genetically superior seedlings through clonal propagation in partnership with academic institutions (DENR 2014), the complexity of legal arrangements to transfer funds, the period required to construct clonal nurseries and the small number of centralised clonal nurseries limited the use of government-produced seedlings in several regions of the Philippines.

The conceptual model of the seedling production system for the NGP implementation in Regions 8 and 10 in the Philippines is presented in Figure 2. The production of planting materials is divided between the government and non-government sectors but the latter has the greater production share (approximately 75%). Seedling production with the non-government sector is categorised into two arrangements – (1) direct contracting with POs and (2) open bidding with accredited nurseries (including private seedling producers, POs and NGOs). In areas with prior tenure agreement with communities (including Community-based Forest Management and Protected Area Community-based Resource Management), the PO beneficiaries were given direct contracts by DENR to produce the seedlings. The solid arrow in Figure 2 from PO nurseries to NGP sites with tenure agreement indicates that POs produce most of the seedlings (approximately 70%) for these sites. In areas without existing tenure arrangements, selection of nurseries to supply seedlings is conducted through a bidding process following the Philippine Government Electronic Procurement System (PhilGEPS) as explained in RA 9184 '*An Act Providing the Modernization, Standardization and Regulation of the Procurement Activities of the Government and Other Activities*' (PhilGEPS 2013). PhilGEPS is an internet-based bidding system that provides seedling producers access to government bid notices; allowing them to enter the bidding and view bid results. For a nursery operator to participate in the bidding, the nursery must be accredited by DENR-ERDS and the operator must hold a PhilGEPS certificate of registration.

Monitoring the quality of seedlings from accredited nurseries and those managed by POs is the responsibility of the DENR. Specifically, the DMC 2011-01 indicates that it is the responsibility of the DENR Ecosystems Research and Development Service (ERDS) to ensure the production of high quality seedlings for the program. However, in practice the ERDS regulates the quality of seedlings for the NGP in untenured planting sites and the Forest Management Service (FMS) regulates seedling production for tenured areas. The FMS manages the implementation of reforestation projects in tenured areas including sites of Community-based Forest Management Program (CBFM).

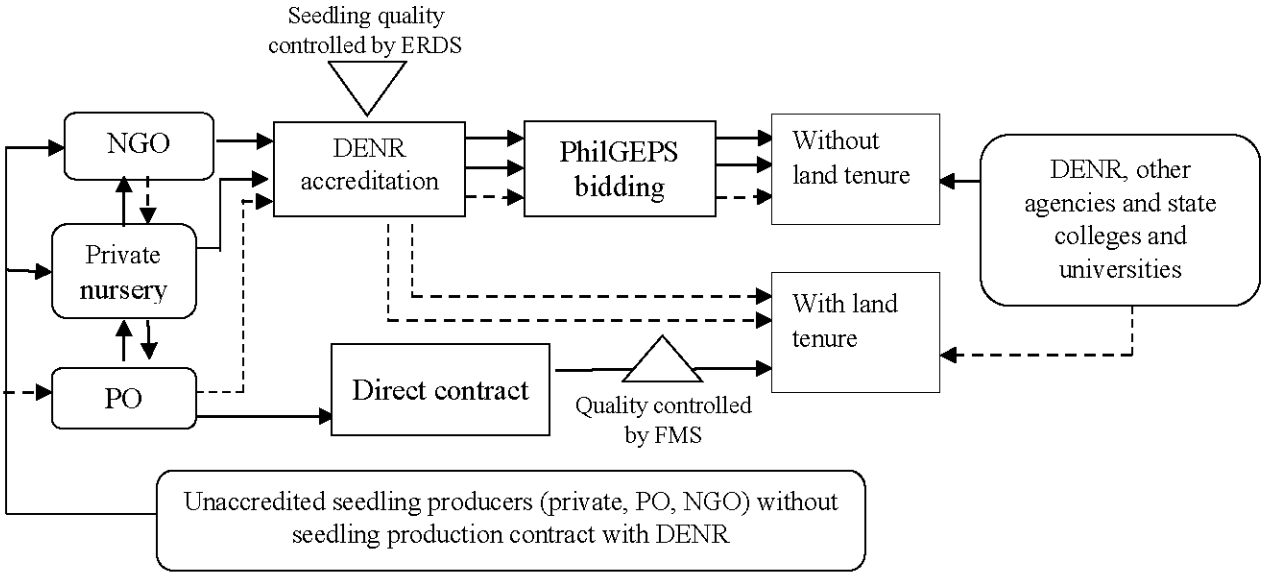

Figure 2. A conceptualized model of the seedling production system for the NGP

Most accredited nurseries (about 80%) in Regions 8 and 10 are owned by NGOs and private seedling producers, hence the solid lines in Figure 2 connecting NGOs and private nurseries to NGP sites without tenure arrangements. A relatively small quantity of seedlings from POs (approximately 20% of the overall seedling requirement) is planted on sites without existing tenure instruments (indicated by dotted line in Figure 2) because few POs have been able to obtain nursery accreditation. Most POs are unaware of the accreditation process and those who are informed view the application for accreditation as a daunting task. A DENR officer in Region 8 indicated that NGOs and private seedling producers are favoured for accreditation because of their greater financial resources and technical capability. Unlike POs, the activities of which are usually dependent on the mobilisation fund provided by the DENR, NGOs and private seedling producers have the financial resources to continue to produce seedlings and bridge the usual delayed disbursement of funds. Also, it is presumed that NGOs and private seedling producers are more likely to have the experience and technical skills to produce high quality seedlings. With the NGP having limited funds to support the capacity building of POs to produce high quality planting materials, assigning of the seedling production to experienced private seedling producers and NGOs is considered as the safest way to quickly satisfy the high quality seedling requirement for the program.

The above schemes of seedling production for the NGP are the most prominent, but other schemes also exist. The POs with contracts to produce seedlings for their respective NGP areas purchase seedlings from other nurseries (particularly from other POs and private nurseries mostly not accredited by DENR) instead of establishing their own nurseries. Although POs with seedling production contracts purchasing seedlings from other nurseries is not widely practiced (hence the broken line in Figure 2), seedlings from unaccredited seedling producers enter into the NGP seedling supply system through this scheme. Seedlings are sold at a lower price than indicated in the seedling production contract between the DENR and the PO. For example, the DENR pays PhP10 to the PO for each seedling but the latter purchases the seedling from other seedling producers at PhP4, hence imposing a mark-up of PhP6/seedling. While this may appear desirable in the view of providing income to the POs, a major drawback is that the capacity of POs to produce high quality planting stock is not improved. Also, with seedlings purchased from unaccredited sources, the objective of using high quality seedlings in the program is undermined to some extent.

Accredited seedling producers (i.e. accredited private nursery operators and NGOs) having seedling production contracts with the DENR are also engaging in the purchasing of seedlings from unaccredited nurseries. Approximately 80% of accredited private nurseries included in the study have purchased seedlings from unaccredited seedling suppliers. This practice is very pronounced, hence indicated in Figure 2 by solid lines from unaccredited nurseries to accredited private and NGO nurseries. An extreme case is that some accredited nursery operators cease operating their nurseries and purchase seedlings from unaccredited nursery operators. This scheme is widespread because of the absence of auditing and monitoring of the seedling production of accredited seedling suppliers. The accreditation process involves examination of the quality of seedlings of the supplier at the time of application for accreditation. The quality of seedlings on subsequent production runs is less regularly monitored. A lack of DENR personnel and trust that nursery operators conscientiously comply with the requirement to produce high quality planting materials are reasons for the limited monitoring of seedling production in accredited nurseries.

A slight modification of POs purchasing seedlings from other nurseries was noted in some municipalities. The DENR purchased seedlings from accredited nurseries and delivered these to POs for planting in tenured and untenured sites. For example, seedlings for the NGP in some municipalities in Region 8 were provided by an NGO operating outside the municipalities but contracted by DENR at the regional level. The POs that are recipients of the seedlings indicated that this approach is undesirable for several reasons including site-species mismatch in terms of biophysical conditions of the planting site and social preference. Also, seedlings are largely damaged during transport.

The bidding process to supply seedlings for most of the untenured sites is open to all accredited nursery seedling producers. It was noted that there are a few nursery seedling producers in the province who receive the majority of seedling production contracts. While a single nursery winning most of the bid for nursery seedling production quota could result from a fair and unbiased bidding process, several seedling producers have expressed their suspicions that the awarding of contracts is largely influenced by strong affiliations of a few nursery operators with officials involved in the contract and awarding process.

The Seedling Quality Regulation Policy of the DENR

The DMC 2011-01 stipulates that seedling production for the NGP must be governed by DAO 2010-11. This departmental order introduces the seedling documentation and registration system for effective and sustainable forest tree seed and seedling production. It also indicates the protocol for accrediting germplasm sources and forest nurseries, illustrates the methods of establishing and maintaining seed production areas, and outlines the criteria for assessing the physical quality of mother trees. The accreditation of germplasm sources (e.g. seed stand, seed production area, seed orchard and seed trees) implies the necessity to use genetically superior germplasm. However, no process currently exists which requires seedling producers to procure germplasm from accredited sources. Although seedling producers are required to indicate germplasm sources when applying for accreditation, the mechanism to monitor the collection and use of germplasm from accredited sources is lacking. A senior officer of the DENR R10 indicated that the number of identified, established and recognised germplasm sources nationwide is not enough to supply the volume of high quality planting materials for the NGP. Also, the diffusion pathway of high quality germplasm is not well established. Given this scenario, suppliers of seedlings for the program including the accredited seedling producers are not strictly required to use high quality germplasm. This condition in effect defeats the fundamental purpose of forest nursery accreditation.

The forest nursery accreditation process, as stipulated in DAO 2010-11, involves the two stages of lodging the application and assessment of the nursery and the seedling quality. The set of assessment criteria for seedling quality includes seedling health (leaf colour and absence of infestations), size of seedlings (height and stem diameter), stem form, root form, sturdiness, age of seedling and sun hardening state. However, details on how the criteria should be applied – for example, specific weights assigned for each criterion and information on how the seedlings will be rated – is absent. It was emphasized by the DENR officer that their office uses subjective judgement of their trained staff when assessing seedling quality. However, without the specific guidelines, seedling producers will never be guided on appropriate silvicultural treatments in order for their seedlings to pass the assessment process. Also, the absence of the guidelines leaves seedling quality assessment decisions by DENR staff subject to questions and arguments, particularly for nursery operators who fail to reach the passing mark.

A seedling production contract obtained from a PO in Region 8 indicates that DENR officers may have devised a modified set of criteria in their respective jurisdictions. The contract stipulates that seedlings should be assessed based on sufficient height (more than 30 cm from the root collar), at least 5 mm base diameter, with straight stem, good health and having at least 6 leaves. Apparently, the seedling height requirements of more than 30 cm (and 50 cm depending on the species) do not preclude overgrown seedlings because the evaluation criteria do not indicate an upper limit on seedling height. The number of leaves is not a particularly useful criterion in judging seedling physical quality. A large number of leaves together with low root volume are detrimental to seedling survival (Ritchie 1984). This is aggravated when there is low soil moisture, which is a common characteristic of reforestation sites in the Philippines.

While stipulated in DAO 2010-11, in practice the root system assessment is not included in the evaluation criteria even though root form and volume in relation to above-ground biomass are crucial indicators of seedling survival and establishment in the field.

Observations on the Quality of Planting Stock in the Nursery

Interviews with seedling producers revealed that the quality of mother trees was given little emphasis in germplasm collection. About half of the nursery operators (48%) were found to deliberately collect germplasm from phenotypically superior trees. The limited number of mother trees, lack of concern on the importance of genetically superior gemplasm for trees, and the need to grow a high volume of seedlings in a short period are among the main reasons for the failure to procure high quality germplasm. This finding is consistent with the result of the surveys on the nursery sector of Leyte and Mindanao Islands reported in Gregorio et al. (2010), Edralin et al. (2010), and Koffa and Roshetko (1999). While substantial efforts to improve the supply of high quality seedlings in Regions 8 and 10 were undertaken by local and foreign research and development agencies, these have not totally resolved the aforementioned constraints. DENR officials of Regions 8 and 10 unanimously indicated that the lack of germplasm sources is a bottleneck in using genetically superior germplasm.

A total of 1,150 sample seedlings belonging to 54 species from 23 nurseries in Regions 8 and 10 were examined to assess the physical quality of seedlings. Of the nurseries investigated, only three have produced high quality seedlings. Table 2 presents the summary of percentages of sample seedlings in all nurseries that passed each assessment criterion and the average values of parameters measured. The mean score of sample seedlings for physical quality of 4.5 (range of scores 0 to 11), was very low compared to the maximum possible score for this

criterion, which is 15. This indicates the prevalence of seedlings with inferior physical quality. Most of the sampled seedlings (88%) appeared healthy with relatively straight stems. However, many of them (36%) had root systems that were deformed (J-rooting and coiling) and growing outside the container. Further, the majority of the seedlings were not sturdy (82%) and had imbalanced shoot-to-root ratio (79%). The J-rooting occurs when seedlings with long taproots such as wildlings are potted without root pruning or insufficient care is taken to avoid bending the taproot during potting (Carter 1987). The low sturdiness and imbalanced shoot-to-root ratio was largely attributed to the commonly observed practice of over-shading and dense stacking of seedlings on transplant and hardening beds, and placing seedlings on the ground instead of using elevated beds. Elevated beds promote sturdy seedlings because of root air pruning preventing the unregulated absorption of water and nutrients from the ground. Also, the use of elevated beds minimizes the physical damage of root system when seedlings are removed for out-planting (Wightman 1999, Gregorio 2009).

A Chi-square test of data from sample seedlings failed to find a significant relationship between sturdiness and use of elevated hardening bed ($\chi^2 = 12.74$; p = 0.47). However, this does not imply that placing seedlings on elevated beds does not have a positive impact on seedling sturdiness. Nurseries using elevated hardening beds also produced lanky seedlings because these were arranged densely and watering and application of fertiliser were not optimised.

Table 2. Percentage of sample seedlings that passed each assessment criterion (mean of all sample seedlings, minimum and maximum for individual nurseries); and mean, maximum and minimum scores of samples for physical quality, sturdiness and shoot to root ratio

Statistic	Health	Stem form	Root form	Shoot to root ratio	Sturdiness	Physical quality (Ideal 15)	Sturdiness (ideal <6)	Shoot-root ratio (ideal 1)
Mean	88.4	79.8	64.3	21.0	17.6	4.5	8.6	2.8
Min.	58	32	22	0	0	0	5	1
Max.	100	100	100	92	60	11	14	5

Measurements of seedling height indicated an average of 38 cm. Jaenicke (1999) argued that the optimal height of seedling for out-planting is between 20-25 cm. Over-grown seedlings, as tall as 60 cm, were noted in several nurseries. It was noted that overgrown seedlings were all grown on the ground. With small seedling containers (usually 4 in. by 6 in.), seedlings grew tall because root mass developed outside the polybag and absorbed excessive moisture and nutrients from the ground. With roots often cut when seedlings are pulled from the bed immediately before field planting, overgrown seedlings are less likely to survive because of faster transpiration than water uptake. Grossnickle (2012) argued that tall seedlings could be ideal for planting if seedlings have to compete with other vegetation in terms of above-ground growth requirements (e.g. sunlight and space). But when the competition is below ground (i.e. for moisture and nutrients), height is of less importance than root system development. In most reforestation sites in the Philippines, sunlight is not as limiting a factor as soil nutrients and moisture, hence seedlings need not be tall but root systems should be well developed.

A strong correlation was found between seedling physical quality and the type of germplasm used in seedling production. A negative correlation (r=-.450; p=0.031) existed between the use of wildling and the resulting physical quality of the planting material. This implies low

seedling quality is more likely when wildlings are used. For example, more seedlings had imbalanced shoot-to-root ratios and lanky and less developed root systems when wildlings were used. This observation was attributed to the insufficient recovery period of wildlings in the nursery. It is normal for wildlings to have severe root damage during collection but root systems recover while the seedlings are growing in the nursery. However, the tight production schedule commonly reported by the nursery seedling producers resulted in seedlings that appeared healthy with suitable height for out-planting (based on DENR criteria) but having root systems that were barely developed.

The use of wildlings is common in propagating seedlings of native tree species. The cross tabulation of frequencies in Table 3 shows that most of the native species were grown using wildlings while exotics were produced from seed. Chi-square tests proved that the use of either wildlings or seed in seedling production is related to the nature of the species, being native or exotic (χ^2=152; p=0.005). The limited information pertaining to the location of germplasm sources, and phenology and seed technology of native species is one of the reasons why seedling producers use wildlings. The use of wildlings has escalated due to the DENR's recommendation to plant more native tree species for the NGP (DENR 2014).

Table 3. Number of seedlings by species category and germplasm type

Category	Number of sample seedlings		Total
	Seed	Wildlings	
Exotic	257	128	385
Native	75	690	765
Total	332	818	1150

Another reason for the widespread use of wildlings is the short seedling production schedule due to delayed release of funds for seedling purchase. This is particularly true for seedling production of POs that are relying on the mobilisation fund from the DENR to commence the nursery operation. With late release of funds, a fixed planting schedule and the need to satisfy the seedling quality assessment criteria of the DENR, nursery seedling production is squeezed to a short period, usually 2-3 months. Growing seedlings from seed will definitely not meet the height and diameter requirements from DENR (i.e. more than 45cm tall, with a diameter of at least 5mm and with at least 6 leaves) within this period. Consequently, wildlings (generally relatively old ones) are used for planting and must meet the seedling quality evaluation criteria. However, relatively old wildlings are more prone to root damage during collection and have lower capability to recover from collection and potting stress.

CONCLUSION AND POLICY IMPLICATIONS

The success of the NGP, like any reforestation program, is largely influenced by the quality of planting materials. DAO 2010-11 provides guidance on how nursery seedling production should be regulated, however, as with many government policies, the implementation of DAO 2010-11 has several flaws, which result in low quality seedlings being widely used. Nursery accreditation represents a huge leap for the DENR to promote the success of Philippine watershed rehabilitation. But further improvement in its implementation is necessary.

The widespread production of low quality planting materials is attributed to several factors, principally the following:

- lack of awareness and information regarding the use of high quality planting materials;

- limited sources of high quality germplasm and lack of information on the phenology of mother trees, particularly of native species, resulting in the widespread use of wildlings;
- absence of regulation measures ensuring that seedling producers collect germplasm from accredited sources;
- limited knowledge and skills on high quality seedling production technologies;
- late release of funds resulting in insufficient period for seedling production;
- in practice, less appropriate criteria adopted by the DENR for seedling quality assessment; and
- a lack of appropriate auditing and monitoring on the quality of seedlings and seedling production system of accredited nurseries.

Capacity-building support is needed for the nursery operators. This may include information dissemination to improve nursery operators' understanding of the attributes of seed quality and high quality seedlings. Also, training could be provided to enhance their skills in high quality seedling production, especially for native tree species. Providing support to enhance their knowledge about the forest nursery accreditation process and online bidding procedure is clearly necessary.

It is apparent that a stringent process to monitor the operation of accredited nurseries is required. In the absence of monitoring, accredited nursery seedling suppliers are producing low quality planting materials, and their purchasing of seedlings from unaccredited nurseries instead of producing high quality planting stock is common. Nursery accreditation should not culminate in the issuance of accreditation certificates and assume that accredited seedling suppliers will always deliver high quality seedlings. There should be a mechanism of auditing the performance of accredited nurseries to ensure that the accreditation will serve its intended purpose and the standards for high quality seedlings are maintained.

To support the production of high quality seedlings, a strategy is necessary to promote a sustainable supply of high quality germplasm for a wide species base. With the promotion of indigenous trees in the NGP, there is a need to identify new seed sources of native trees. It is necessary to scale up the identification of superior mother trees and establishment of SPAs so as to increase the supply of high quality seeds. A database of mother trees and SPAs are necessary to provide information about mother tree distribution and corresponding seed years. Mother tree identification could be conducted in partnership with communities, and an effective mother tree conservation program could be instigated.

A review to improve the seedling quality assessment criteria developed by the DENR could be undertaken. The present criteria do not consider important attributes for seedling survival including adequacy of root systems. It is particularly necessary to consider root systems during seedling inspection, especially given that wildlings dominate the production system for planting materials. Wildlings may appear healthy with appropriate height and collar diameter even though the roots are poorly developed.

The nursery accreditation protocol appears to favour a few large-scale private nurseries and non-government organisations. People's organisations have limited knowledge of the accreditation procedure making the entirety of the accreditation process daunting and complicated. Also, the POs are poorly informed of the PhilGEPS bidding process, hence unaware of the protocol and the opportunity for them to engage in seedling production as a livelihood enterprise in implementing the NGP and other reforestation programs. The opportunity to enhance community livelihoods through engagement in reforestation programs

in developing countries is widely recognised (Estoria 2004, Scherr et al. 2004, Sayer and Campbell 2001). In the NGP, a substantial proportion of the reforestation funding is allotted to seedling production. Recognizing the aim of the NGP to reduce poverty and the need to provide livelihood projects for communities, it is worthwhile providing support to the POs to venture into seedling production. Besides seedling production skills, support could include information dissemination to promote understanding of the nursery accreditation protocol and the PhilGEPS bidding process, and guidance in the application for nursery accreditation and participation in the bidding process. He et al. (2011) cited that incentives in the form of providing market information and capacity-building are essential in promoting the participation of smallholders in the sustainable supply of high quality planting materials for the national reforestation program in China.

Lastly, it is necessary to allow ample production time for seedlings to reach the planting size and exhibit a well-developed root system before out-planting. Reducing the seedling production schedule to two or three months because of delayed awarding of seedling production contracts and disbursement of funds negatively affects the quality of seedlings and the success of planting activities. Sun-hardening was not practiced in several nurseries because of the limited seedling production period. Planting unconditioned seedlings is a waste of resources as this results in lower seedling survival. Similarly, when wildlings are used, sufficient time is necessary to ensure full root system recovery prior to out-planting.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the financial support of ACIAR Watershed Rehabilitation Project and the collaboration of local and regional DENR officials in Regions 8 and 10 in undertaking the survey. The authors are also indebted to the nursery operators in Regions 8 and 10 for providing crucial information during the interviews and allowing the authors to carry out destructive sampling of their seedlings without cost.

REFERENCES

Australian Centre for International Agricultural Research (ACIAR). 2011. Final Report: Enhancing tree seedling supply via economic and policy changes in the Philippine nursery sector (ASEM/2006/091), FR2011-08, Canberra.

Barriga, C. 2013. Tougher seedlings eyed for the NGP. *Bayanihan: Filipino news about people, events and the environment*. Accessed 21 July 2014. http://bayanihan.org/2013/01/07/tougher-seedlings-eyed-for-ngp/

Baynes, J., Herbohn, J., Dressler, W. and Gregorio, N. 2014. Governance and power relationships: their effect on community forestry organisations and local people in the Philippines. Draft paper. Forest Industries Research Centre, University of the Sunshine Coast, Maroochydore.

Carandang W.M., Tolentino Jr E.L. and Roshetko J.M. 2006. Smallholder tree nursery operations in southern Philippines - supporting mechanisms for timber tree domestication. *Forests, Trees and Livelihoods* 16: 71-83.

Combaliser, M., Lee, D., Woo, S., Lee, Y. and Jang, Y. 2010. Early growth and physiological characteristics of planted seedlings in La Mesa Dam Watershed, Philippines. ISTF News, Special Report March 2010, Maryland, USA.

Department of Environment and Natural Resources (DENR). 2010. DMC 2010-11 'Revised regulations governing forest tree seed and seedling production, collection and disposition. DENR Homepage. Accessed 20 August 2014. <http://server2.denr.gov.ph/files/dao-2010-11_180.pdf>

Department of Environment and Natural Resources (DENR). 2011. DMC 2011-10 'Guidelines and procedures in the implementation of the national greening program', Diliman, Philippines. Accessed 03 August 2014. <http://forestry.denr.gov.ph/dmc-2011-01.pdf>

Department of Environment and Natural Resources (DENR). 2014a. National Greening Program. Accessed 24 July 2014. <http://www.ngp.denr.gov.ph/index.php/site-administrator/ngp-accomplishment-report>

Department of Environment and Natural Resources (DENR). 2014b. 100% performance validation of NGP plantation established in CY 2011. PENRO, Biliran.

Department of Forestry and DANIDA. 2007. Essential documents on management and technologies for forest reproductive materials in Vietnam, Vietnam Tree Seed Project, Ministry of Agriculture and Rural Development, Hanoi.

Edralin, D.I. and Mercado Jr, A. 2010. Profiling tree nurseries in Northern Mindanao, the Philippines. *Annals of Tropical Research* 32(2): 15–26.

Estoria, E. 2004. An investigation of the factors affecting the success of community organizations, Masters thesis, School of Natural and Rural Systems Management, The University of Queensland, Brisbane.

Graudal, L. and Lilleso, P. 2007. Experiences and future prospects for tree seed supply in agricultural development support – based on lessons learnt in Danida supported programmes 1965-2005. DANIDA Working paper April 2007, Ministry of Foreign Affairs of Denmark, Copenhagen.

Gravoso, R., Gregorio, N. Gerona, A., Serino, M., Harrison, S., Pajaron, H. and Godoy, J. 2007. Development and implementation of forest nursery accreditation policy at a local level in Leyte, Philippines. *Small-scale Forestry* 10:473-488.

Gregorio, N., Smith, C., Herbohn, J. and Harrison, S. 2010. Designing intervention strategies for forestry seedling production in the Philippines. In: HARRISON, S., BOSCH, A., GREGORIO, N. and HERBOHN, J. (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.

Grossnickle, S. 2012. Why seedlings survive: Influence of plant attributes. *New Forests* 43:711–738.

Ha, H., Roshetko, J., Johansen, M., Hoa, N., Lan, D. and Jamnadass, R. 2011. Farmers' tree nurseries in Vietnam: opportunities and constraints. World Agroforestry Centre (ICRAF), Vietnam.

Harrison, S.R., Gregorio, N.O, Herbohn, J.L. and Dargusch, P. 2008 '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.

He, J., Yang, H., Jamnadass, R., Xu, J. and Yang, Y. 2012. Decentralization of tree seedling supply systems for afforestation in the West of Yunnan Province, China. *Small-scale Forestry* 11:147–166. DOI 10.1007/s1 1842-011-9176-9.

House of Parliament. 2002. Act on forest reproductive material. Official Law Gazette 1:32, Bonn.

Israel, D. and Lintag, J. 2013. Assessment of the efficiency and effectiveness of the reforestation program of the Department of Environment and Natural Resources. Philippine Institute of Development Studies: Final Report, Manila.

Jaenicke, H. 1999. Good Tree Nursery Practices: Practical guidelines for research nurseries. ICRAF, Nairobi, pp. 8-15.

Koffa, S.N. and Roshetko, J.M. 1999. Farmer-managed germplasm production-diffusion pathways in Lantapan, Philippines. 142-150 pp. In: J.M. Roshetko and D.O. Evans (eds). Domestication of agroforestry trees in Southeast Asia. Forest, Farm, and Community Tree Research Reports, Special Issue. Winrock International, Morrilton, Arkansas, USA. 242 p.
Lapis, A., Posadas, J., and Pablo, N. 2001. Seedlings/planting materials: A nationwide supply and demand scenario. *Canopy International*, March – April, pp. 3, 10-11.

Lasco, R.D., Visco, R.G. and Pulhin, F.B. 2001. Secondary forests in the Philippines: formation and transformation in the 20th century. *Journal of Tropical Forest Science* 13:652–670

Margraf, J. and Milan, P.P. 1996. Ecology of dipterocarp forests and its relevance for island rehabilitation in Leyte, Philippines. A. Schulte, A. and D. Schöne (eds) *Dipterocarp Forest Ecosystems: Towards sustainable management.* World Scientific, Singapore. Pp. 124–154. http://books.google.com.au/books?id=oHNzvs02F5wC&pg=PA124&ots=p85m5ub3Ks

Mcdowell, N., Pockman, W. and Allen, C. 2008. Mechanisms of plant survival and mortality during drought: why do some plants survive and others succumb to drought? *New Phytologist* 178:719-739.

Nixon B.J, Herbohn, J.L. and Harrison, S.R. 2000. 'Social and economic factors affecting community based forest management in the Philippine uplands: a review of previous research', in S.R Harrison and J.L. Herbohn (eds), *Socio-economic Evaluation of the Potential for Australian Tree Species in the Philippines*, ACIAR, Canberra, pp.111-124.

Nyoka, B.I., Roshetko, J., Jamnadaas, R., Muriuki, J., Kalinganire, A. Lillesø, J-P B., Beedy, T. and Cornelius, J. 2014. Tree seed and seedling supply systems: a review of the Asia, Africa, and Latin America models. Small-scale Forestry. DOI 10.1007/s11842-014-9280-8

Nyoka, B.I., Ajayi, O.C., Akinnifesi, F.K., Chanyenga, T., Mng'omba, S.A., Sileshi, G., Jamnadass, R. and Madhibha, T. 2011. Certification of agroforestry tree germplasm in Southern Africa: opportunities and challenges. *Agroforestry Systems* 83 (1):75–87.

Philippine Government Electronic Procurement System (PhilGEPS). 2014. About PhilGEPS. Accessed 20 May 2014. http://philgeps.gov.ph/GEPSNONPILOT/aboutGEPS/aboutGEPS.aspx?menuIndex=5

Ritchie, G.A. 1984. Assessing seedling quality. In: DURYEA, M. and LANDIS, T. (eds.) *Forest Nursery Manual: Production of Bareroot Seedlings.* Martinus Nijhoff/Dr W. Junk Publishers. The Hague/Boston/Lancaster, for Forest Research Laboratory, Oregon State University, Corvallis.

Saenz-Romero, C. and Martinez-Palacios, A. 2000. Variación genética altitudinal de pinos. *Nuestro Bosque* 1(2): 10-11.

Scherr, S.J., White, A. and Kaimowitz, D. 2004. A new agenda for forest conservation and poverty reduction: making markets work for low-income producers. Forest Trends, Washington, D.C.

Shiel, S. 2013. Seeds and other plant reproductive materials: towards new EU rules. Library of European Parliament. Accessed 13 June 2014. http://www.europarl.europa.eu/RegData/bibliotheque/briefing/2013/130547/LDM_BRI(2013)130547_REV1_EN.pdf>

Tolentino, E., Carandang, W. and Roshetko, J. 2002, Evaluation of smallholder 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, Laguna.