Research article

Growth Performance of Planted Indigenous Trees 12 years from Establishment

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Abstract This tree domestication research is an *ex-situ* conservation effort aimed to find out the growth performance of some indigenous timber species planted outside their natural forest habitat in Bohol Island, Central Philippines. Specifically, the study sought to characterize the growing conditions of the sites and the biometrics of the trees in three sites after 12 years of growth. We also wanted to find out the best "performers" when grown outside the natural forest habitat. Only indigenous trees were used and planted in a mixed manner. Most of the planting materials were selected wildlings from the local forests. A few were brought in from the nearby island of Leyte. Standard biometrics of trees were taken of all trees. A total of 1,040 trees belonging to 49 species and 25 plant families in 3 land parcels were inventoried. The three sites totaled 2.5 hectares located within the same village and similar growing conditions. These were typical degraded karst areas: shallow soils with pebbles and rock outcrops dotting the landscape. Scrubby vegetation and few scattered trees were the precursor vegetation. The sites used to be cogonal for a long time before scrubby vegetation set in. Annual rainfall is about 2,000 mm; flat to rolling topography; elevation of 320 meters above sea level. Daytime temperature ranges from 24-28 degrees Celsius most of the year and 28-33 degrees during summer (March-May). The standout performers were *Terminalia microcarpa*, *Shorea contorta*, *Vatica mangachapui*, *Shorea palosapis*, *Parashorea malaanonan*, and *Dracontomelon dao*. The biggest *Terminalia microcarpa* area measured 48 cm in diameter at breast height (dbh). *Shorea contorta* had a dbh of 29 cm and had a total height of 29 meters. *Shorea assamica* did not do well in the sites, and was stricken by dieback of unknown cause. *Quisumbing guisok* was noted to be very sensitive to moisture stress from seedling to the sapling stage. At 12 years, many forest-based timbers including dipterocarps responded well to domestication or ex-situ conservation even in a degraded karst land in tropical Philippines.

Keywords domestication, indigenous, karst, *ex-situ* conservation, rainforestation

INTRODUCTION

The Philippines needs an ideal 54% of forest cover to maintain its natural ecological processes. (Sajise, 1996). Disastrous logging and changing land uses have reduced the original amount of 17 million ha of forested area in the Philippines to 5.5 million ha (18% of total land area) during the last 40 years. This has also earned notoriety in Southeast Asia as the country with the thinnest forest cover (Ong, 2004). Less than 6% of the originally 60% of the total forested land area have remained as prime habitats for wildlife and genetic conservation. Bohol in particular had a remaining natural forest of only 4% from its original full forested area. The island is blessed, among many other indigenous timbers, some 16 endemic dipterocarp species (Fernando et al, 2008).

Among the governing state policies of the Philippines is "to protect and advance the right of

the people to a balanced and healthful ecology" (1987 Philippine Constitution). The latest policy support at the national level was the issuance of E.O. No. 26 in February of 2011 which launched a new National Greening Program for the planting of 1.5 billion trees covering about 1.5 million hectares for a period of six (6) years from 2011 to 2016 in lands of the public domain. The National Integrated Protected Areas System (NIPAS) Law or Republic Act 7586 mandates that only indigenous species should be used in the rehabilitation of Philippine watersheds. The maintenance of sufficient forest cover in Bohol Island is not only ecologically and economically of the utmost importance but also to keep its banner, nature-based tourism industry alive and productive. For local policy support, Section 10 of the Revised 2011 Bohol Environmental Code calls for Boholanos to be self-sufficient in wood needs through *tree farming* for domestic wood needs, thus reducing the dependence on commercial fuel as well as to conserve the naturally growing trees.

In support of the national and local policies, and as the leading higher educational institution (HEI) on natural resources management (NRM) in Bohol, Bohol Island State University has long since taken significant steps to increase its role in biodiversity conservation and poverty reduction in the island -province through *in-situ* and *ex-situ* conservation. One of these is the domestication of forest-based valuable timber species in three sites with a total area of 2.5 hectares which were established in 1997- 1998 within the land of the University. These were planted with more than 40 tree species taken from the island's remnant forests. Raising these trees in farms or in homesteads would ease up the pressure of extraction from their present natural forest habitat and could also save them from eventual local extinction (Bullecer and Stark, 2002). Part of the domestication program is to come up with species-site compatibility recommendations for possible wider community adoption.

OBJECTIVE

The main aim of the study was to find out the domestication potential after more than a decade of growth of some forest-based tree species in Bohol Island, Philippines. Specifically, it sought to characterize the growing conditions of the domestication sites, the biometrics of the trees and identify the best performers after over decade of growth.

METHODOLOGY

The study sites are located the interior portion of the island- province of Bohol in the central part of the Philippine archipelago.

Site selection: The domestication sites were in 3 parcels of land, totaling 2.5 hectares, within the same village and with similar growing conditions. Climatic and elevation data were taken from existing secondary data. Edaphic and landscape characteristics were determined by field observation.

Planting stock sources and farm establishment: Wildlings of indigenous trees from nearby forests were collected and nurtured until they were big enough for field planting. Other seedlings were obtained from nearby Leyte Island. Adopting the rainforestation technology, the seedlings were planted in mixed manner, 1.5 to 2.0 meters apart.

Data collection and analysis: A 100% inventory was conducted. Total and merchantable heights were taken with the use of the Abney hand level and fiber glass tape. Diameter at breast height (dbh) was taken using diameter tape and crown diameter with the fiber glass tape.

Total height was determined by the following formula:

$$H = \tan^0 (D) + \text{eye level height} \quad (1)$$

where H is the height in meters; $\tan^0$ = the angle reading from the eye level mark the stem to the tip of the tree; D = distance from the base of the tree to the spot where the researcher stood.

The merchantable height was measured from the base of the tree up to the portion just before the heavy branching started. It was obtained using the following formula:

$$H=tan^0 = (d) + eye\ level\ height \quad (2)$$

where tan^0 = the angle reading from the eye level mark to the merchantable top; d = distance from the base of the tree to the spot where the researcher stands.

The diameter at breast height was measured at the standard point of 1.3 meters from the ground or base. Crown cover or crown area was obtained by getting the average crown diameter of each tree and calculate the radius there from. Individual crown cover was computed using the following formula:

$$A = \prod r^2 \quad (3)$$

where, A: crown area, $\prod$ is the pi (3.1416) and r = radius

Merchantable volume was obtained by making use of the dbh and merchantable height values. Qualitative description of biometric data was employed in determining the growth performance. No other statistical analysis was made. Periodical field observations were made on species reactions during summer or dry conditions.

RESULTS AND DISCUSSION

Biophysical conditions of the tree domestication sites

The domestication sites, with a total land area of 2.5 hectares, were typical degraded karst areas as evidenced by shallow soils and rock outcrops. Soil depth was less than 10 cm in most (about 90%) areas. After a decade some ground litter began to occupy the ground. The prior vegetation consisted of scrubby plants, viny thickets and a few scattered mahogany trees at the pole and young timber stage. The soil texture is silty-clayloam in all three sites. The limestone soils were generally shallow (less than 10 cm) and slightly alkaline. Annual rainfall is about 2,000 mm; flat to rolling topography; elevation of 320 meters above sea level. Daytime temperature ranges from 24-28 degrees Celsius most time of the year and 28-33 degrees during summer (March to mid-May).

Species composition and family distribution of the tree domestication farms

Table 1 lists the species at the research sites. A total of 49 species belonging to 25 plant families were planted in the three land parcels. Dipterocarpaceae was the most represented family with 7 species, followed by Fabaceae, 5 species and Moraceae, 4 species. Most (37%) families had only one species representative. Two of the species, *Vitex parviflora* and *Artocarpus heterophyllus* are already known to be thriving in open areas or outside natural forest stands.

Overall biometrics of the domesticated indigenous trees

Table 2 shows the overall list of the domesticated species with their corresponding biometrics. A total of 1,040 individuals belonging to 49 species representing 25 families were inventoried in the three domestication areas. The domesticated trees have the following biometrics: The trees had a mean dbh of 10.8 cm; mean total height of 9.0 m; mean merchantable height of 5.4 m; total merchantable volume of 47.9 cu m; mean crown diameter of 4.5 m and a total crown area of 11,608.8 sq m or 1.2 hectares. *Terminalia microcarpa* and *Shorea contorta* were among the top performers in diameter and total height growth. The biggest *Terminalia microcarpa* measured 48 cm in dbh while the biggest *Shorea contorta* had a dbh of 29 cm and had an impressive total height of 29 meters. Some 604 dipterocarps consisting of 8 species dominated (58%) the domestication farms. *Myristica philippinenses* came second with 50 individuals. The stand of trees in each domestication land parcel had provided a good ground cover through its close canopies.

Table 1 Species composition of the *Treedom* or *Rainforestation* ex-situ conservation sites in Bilar, Bohol, Philippines which were established in 1998-1999

Species	Family	Species	Family
1. Albizia procera	Fabaceae	*26.Horsfieldia megacarpa*	Myristicaceae
2. Antidesma subolivaceum	Euphorbiaceae	*27.Intsia bijuga*	Fabaceae
3. Artocarpus blancoi	Moraceae	*28.Madhuca Betis*	Sapotaceae
4. Artocarpus heterophyllus	Moraceae	*29.Mangifera altissima*	Anacardiaceae
5. Artocarpus nitidus	Moraceae	*30.Myristica philippinensis*	Myristicaceae
6. Artocarpus sericicarpus	Moraceae	*31.Ormosia calovensis*	Fabaceae
7. Barringtonia racemosa	Lecythidaceae	*32. Parashorea malaanonan*	Dipterocarpaceae
8. Bischofia javanica	Fabaceae	*33. Planchonella duclitan*	Sapotaceae
9. Callophylum blancoi	Clusiaceae	*34. Podocarpus rumphii*	Podocarpaceae
10. Callophylum inophyllum	Clusiaceae	*35.Pometia pinnata forma repanda*	Sapindaceae
11. Cananga odorata	Anonaceae	*36. Pouteria macrantha*	Sapotaceae
12. Canarium luzonicum	Burseraceae	*37. Pterocarpus indicus*	Fabaceae
13. Casuarina nodiflora	Casuarinaceae	*38. Pterocymbium tinctorium*	Malvaceae
14.Cinnamomum microphyllum	Lauraceae	*39. Pterospermum celebicum*	Sterculiaceae
15. Cynometra ramiflora	Caesalpiniaceae	*40. P. diversifolium*	Sterculiaceae
16. Diospyros copelandii	Ebenaceae	*41. Pygeum coccineum*	Pittosporaceae
17. Diospyros copelandii	Ebenaceae	*42. Shorea assamica*	Dipterocarpaceae
18.Discocalyx cymbianthoides	Myrsinaceae	*43. Shorea contorta*	Dipterocarpaceae
19, Dracontomelon dao	Anacardiaceae	*44. Shorea palosapis*	Dipterocarpaceae
20. Dracontomelon edule	Anacardiaceae	*45. Strombosia philippinensis*	Olacaceae
21. Elaeocarpus macranthus	Elaeocarpaceae	*46. Syzygium brevistylum*	Myrtaceae
22. Gomphandra luzoniensis	Icacinaceae	*47. Terminalia microcarpa*	Combretaceae
23. Guioa koelreuteria	Sapindaceae	*48. Vatica mangachapui*	Dipterocarpaceae
24. Hopea philippinensis	Dipterocarpaceae	*49. Vitex parviflora*	Lamiaceae
25. Hopea quisumbingiana	Dipterocarpaceae		

A decade of difference and initial impacts

Aside from garnering data and some learning in tree domestication and species potentials for watershed rehabilitation, the Tree Dom farms had gradually transformed what used to be a degraded landscape to a wooded land as shown in Fig. 1. In 2004, the provincial Research Consortium, where BISU is a member, put up the Bohol Biodiversity Complex (BBC) adjacent to one of the tree farms for a learning continuum in nurserying and tree farming. The Consortium and the Complex do biodiversity research, trainings and indigenous tree seedlings production. In the last 5 years, the Tree Dom farms have been part of the regular alternative ecotourism route in the island. The tree farms have become a learning area for students, farmers, policy makers, researchers and other environment advocates from the local, national and international community.

Standouts in domestication and species enrichment

Based on growth performance and general vigor, some of the tested species for domestication have stood out as having domestication potentials. These were *Terminalia microcarpa, Shorea contorta, Vatica mangachapui, Shorea palosapis, Parashorea malaanonan, Dracontomelon dao, Syzygium brevistylum, Vitex parviflora, Gomphandra luzoniensis, Cinnamomum microphyllum, Callophylum blancoi* and *Elaeocarpus macranthus*. Except for *Shorea assamica*, the rest of the plants are exhibiting acceptable survival and growth rates. The problem with *Shorea assamica* seems to be related to fungal infection causing dieback. *Hopea quisumbingiana* at the seedling and pole stage seemed very sensitive to moisture stress. In the last three years, Rainforestation Sites 2 and 3 had been enriched with the planting of more dipterocarps and other trees which are endemic to Bohol island. These are *Shorea palosapis*, *Hopea acuminata*, *Dipterocarpus kerril*, *Shorea malibato*,

Shorea falciferoides and *Vatica mangachapui*. They were not included in this inventory, yet at this early stage, the new additions have manifested promising growth performance.

Table 2 Biometric summary of the planted indigenous timber species at 12 years of age

Species	N	Mean DBH(cm)	Mean Total Height(m)	Mean Merchantable Height (m)	Total Mer. Volume(m)	Mean Crown Diameter (m)	Total Crown Area (sq. m)
Albizzia procera (topped off)							
Antidesma subolivaceum	1	9.5	4.0	4.4		3.9	12.2
Artocarpus blancoi	14	11.0	8.6	6.8	1.8	3.8	247.8
Artocarpus heterophyllus	7	9.5	8.4	5.2	0.1	3.8	75.6
Artocarpus nitidus	12	14.7	9.6	4.7	0.8	5.8	272.8
Artocarpus sericarpus	4	11.8	10.3	3.6	0.1	5.5	94.7
Barringtonia racemosa	23	10.3	9.8	5.7	1.0	4.2	71.2
Bischofia javanica	23	11.0	7.1	4.0	3.0	4.0	397.7
C. inophyllum	9	16.0	12.0	4.8	0.9	5.5	353.2
Callophylum blancoi	27	9.0	7.0	3.7		3.8	343.6
Cananga odorata	3	18.0	14.6	8.3	0.6	4.6	60.6
Canarium luzonicum	16	19.2	13.4	6.8	0.7	6.0	407.9
Casuarinas nodiflora	3	14.3	12.9	6.0	0.2	7.3	57.0
Cinnamomum microphyllum	3	14.4	6.3	2.8	0.01	2.6	15.2
Cynometra ramiflora	1	5.1	5.4	5.4		3.4	9.1
Diospyrus copelandii	5	9.7	9.9	4.6		3.8	44.3
Discocalyx cymbianthoides	2	7.8	5.0	2.8		3.6	20.4
Dracontomelon dao	33	15.3	11.0	6.6	4.4	5.3	465.2
Dracontomelon edule	1	8.5	14.3	11.4		5.8	26.2
Elaeocarpus macranthus	8	13.5	10.7	6.5	1.8	5.1	231.3
Gomphandra luzoniensis	31	10.2	5.3	5.7	0.1	5.1	633.3
Hopea philippinensis	148	7.1	7.1	4.5		3.8	284.7
Hopea quisumbingiana	152	6.2	6.6	4.1		3.0	89.7
Horsfieldia megacarpa	4	16.7	10.4	4.3	0.3	7.0	157.5
Instia bijuga	5	17.2	11.8	6.8	0.8	10.0	206.2
Kamagong-like	1	5.4	5.5	3.9		3.4	9.3
Litsea glutinosa	1	10.5	9.4	4.8		4.7	17.1
Madhuca betis	1	13.4	5.2	9.3		5.6	24.6
Mangifera altissima	5	9.0	8.2	4.6		4.0	68.3
Myristica philippinensis	50	8.5	7.2	4.2	2.7	4.3	1,836.1
Ormosia calovensis	1	10.5	9	5.9		3.4	8.6
P. celebicum	14	10.3	11.6	7.7	0.7	4.7	277.8
Parashorea malaanonan	73	7.8	8.6	4.0		4.3	22.5
Planchonella duclitan	3	8.9	9.1	6.7		2.5	624.1
Podocarpus rumphii	3	5.6	5.5	2.3		2.8	19.1
Pometia pinnata	7	13.0	13.1	8.6	0.6	5.2	184.3
Pouteria macrantha	1	5.7	9.2	4.8		2.9	6.7
Pterocarpus indicus	7	10.2	9.5	5.1	0.2	6.2	171.8
Pterocymbium tinctorium	11	10.3	9.0	5.4	0.7	4.3	241.9
Pterospermum diversifolium	13	15.5	15.1	6.7	2.9	6.0	468.1
Shorea assamica	2	6	3.2	5.3		3.1	38.7
Shorea contorta	68	14.6	12.1	8.6	4.4	3.8	216.3
Shorea palosapis	100	6.9	6.1	4.3		3.0	94.2
Shorea polysperma	16	5.4	5.3				2.6
Strombosia philippinensis	1	4.1	4.3	2.0		1.8	8.8
Syzygium brevistylum	3	9.0	11	6.9		4.6	22.0
Terminalia microcarpa	34	21.7	16.3	8.1	16.8	7.7	1,093.6
Vatica mangachapui	45	7.1	7.4	4.9		3.2	288.8
Vitex parviflora	45	13.3	9.0	4.2	2.3	5.7	1,286.1
Total / Mean	**1,040**	**10.8**	**9.0**	**5.4**	**47.9**	**4.5**	**11,608.8**

Fig. 1 A changed landscape from being a scrubland in 1998 to woodland after a decade

CONCLUSION

Many indigenous forest timbers can be successfully conserved through domestication even in degraded karstic upland environment of Bohol, Central Philippines. Except for two species, the rest of the 49 domesticated indigenous timbers studied have adapted very well after 12 years to growing conditions outside the forest habitat. Some species like *Shorea contorta* and *Terminalia microcarpa* manifest outstanding growth performance than others. Domestication of selected tree species is imperative especially in regions where communities are heavily dependent on the natural resource for daily survival.

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REFERENCES

Bullecer, R.C. and Stark, M. 2002. Local knowledge on indigenous trees in the Central Philippines". A study conducted under the ICRAF Tree Domestication Program. Summary submitted to ICRAF Southeast Asia Regional Office, Bogor, Indonesia. 12-14.

Fernando, E.S., Bande, M.J.M., Piollo, R.A., Sopot, D.D., Dolotina, N.E. and Granert, W.G. 2008. Dipterocarpaceae of Bohol Island, Philippines. Asia Life Sciences Suppl. 4.

Ong, P. 2010. State of Philippine biodiversity: Changing mindscapes amidst the crisis.

Sajise, P. 1996. Sustainable agriculture in the marginal uplands of Southeast Asia. Bohol Environmental Code (2011 edition) .Philippine Constitution. (1987. Article II, Sec. 16.RA 7586. The NIPAS Law of 1991).