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Plus and Mother Trees in Mt. Banahaw de Lucban, Quezon, Philippines

ABSTRACT

The selection of forest trees as planting materials in reforestation projects or plantation development could be based on the existing needs of the wood-based industry, and in support of the National Greening Program. It is anchored on natural adaptation to ensure high survival rates considering suitability to prevailing site conditions; purpose for planting; availability of planting stocks; and commercial value. Thus, selection and mapping of plus and mother trees at the northeastern slope of Mt. Banahaw de Lucban, Philippines were conducted to determine potential seed production areas as sources of quality planting materials. Information materials were developed for dissemination. Twenty-two species with 65 individuals representing families of Annonaceae, Fabaceae, Fagaceae, Clusiaceae, Meliaceae, Myrtaceae, Podocarpaceae, Sapindaceae, Sapotaceae, Symplocaceae, Theaceae and Tiliaceae showed vigorous growth and superiority in height and diameter compared with the surrounding trees. Phenotypic characteristics are influenced by temperature, rainfall, soil and elevation. Highest population of plus trees was distributed in moderate to steep slope. Favorable soils for growth were found at lower elevations. Species diversity of 2.00 showed moderately diverse plus trees at 700 masl and 800 masl. However, 11 species were found threatened as listed on DENR Administrative Order (DAO) No. 11, s. 2017 and the International Union for Conservation of Nature (IUCN).

Keywords: *selection, mapping, plus trees, quality planting materials, phenotypic*

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INTRODUCTION

The production of quality planting materials through clonal nurseries and vegetative propagation techniques are essential in the implementation of the National Greening Program (NGP) in the Philippines. Thus, the government through the Department of Environment and Natural Resources (DENR) promotes the use of high-quality planting materials in the establishment of tree plantations and other forestation activities (DENR Administrative Order [DAO] No. 2010-11). The expansion of NGP (*Executive Order No. 193. s. 2015*) aims to recover all the remaining unproductive, denuded, and degraded forest for the period 2016-2028. The production of quality planting materials is a priority.

The selection and characterization of forest tree species must be anchored on natural adaptation to ensure high survival rates.. The following factors should be considered: suitability to prevailing site conditions, purpose for which they are planted, availability of indigenous planting materials, and commercial value based on the existing needs of the wood-based industry in the region, and in support to the NGP. However, the main factors shaping-up quality planting materials of timber species are based on physical and genetic characteristics. The observable characteristics of tree species with the interaction of genotype to the environment make up its phenotypic characteristics. Thus, plus trees possess better or superior phenotypic characteristics compared with other trees of the same species grown under the same environment. A plus tree is selected from other trees for its outstanding and above-average growth, form, wood quality, and other desired characteristics that appear adaptable to the environment but have not been tested for genetic worth.

Mt. Banahaw de Lucban, a protected landscape under Republic Act 9847 of 2009 has extremities in elevation within it allowing the formation of a wide range of habitats supporting high diversity and endemicity of flora and fauna (*Samaniego 2016*). Forest trees in Mt. Banahaw de Lucban are candidate trees for identification, selection, and characterization for plus or mother trees. Plus trees are candidate trees with fair to good phenotypic characteristics with the potential to provide good quality seedlings/wildlings in the future

while mother trees are large/big trees in their productive age able to provide seedlings/wildlings at present.

This study selected, characterized, and mapped the plus/mother trees in Mt. Banahaw de Lucban. It specifically identified plus tree species for the production of quality planting materials; characterized selected plus trees in each elevation gradient; and developed Information, Education and Communication materials that showcase plus/mother trees existing in Mt. Banahaw de Lucban. The findings and outputs of this study could guide in the protection and maintenance activities of the Department of Environment and Natural Resources (DENR) and Southern Luzon State University (SLSU) as stakeholders of Mt. Banahaw-San Cristobal Protected Landscape.

MATERIALS AND METHODS

The study was conducted from June 2016 to June 2017 at the northeastern slope of Mt. Banahaw de Lucban in Lucban, Quezon, Philippines of approximately between the geographic coordinates 14° 4' 35" to 14° 5' 50" latitude and 121° 30' 44.5" to 121° 32' 30" longitude. It lies at an altitude from 700 to 1800 masl characterized by moderate to steep slopes. Reconnaissance survey was done before the data collection to determine the homogeneity and heterogeneity of the area and the number and location of sampling areas. Line intercept method was used within the established permanent plots in Mt. Banahaw de Lucban. Secondary data were collected from relevant information materials, maps and previous research studies.

Plus/Mother Tree Identification and Selection

Candidate trees for selection were those occupying dominant or co-dominant crown positions, straight-boled, and balanced- canopy trees in plots with 10 cm and above diameter at breast height (DBH). Total height (TH), merchantable height (MH) and crown dimensions were measured and recorded. Plus or mother trees were identified following the recommended criteria set in the DENR through its DAO 2010-11: Revised Regulations Governing Forest Tree Seed and Seedling Production, Collection and Disposition. Phenotypic characteristics of trees were the basis for selection that included stem straightness (1-6), stem forking/multi-stem (1-6), branch angle (1-6), stem circularity/twisting (1-6), tree health (1-6), branch thickness (1-6), and branch pruning/ persistence. Other potential mother trees outside Southern Luzon State University (SLSU) were also observed in Barangays Kulapi, Palola and Samil in Lucban, Quezon. Information indicating the location, species name (botanical and vernacular), date of collection, description of how to reach the area, access road description, natural boundaries, site and stand description, and protection, conservation, and management needs were also recorded in a data sheet.

Mapping

A GPS receiver was utilized to determine the geographic location of candidate plus/mother tree species. Necessary base maps including topographic, slope, soil, land cover, climate, and hydrologic maps collected were digitized using ArcGIS. Maps generated show the distribution of plus/mother trees as potential and suitable sources of seeds and planting materials for propagation purposes. The preferred habitation of the target species, and among other site-specific requirements with respect to slope and elevation, were considered as significant inputs in the development of IEC materials.

Data Analysis

Computation for species abundance, diversity, and evenness of plus tree species per elevation regardless of family was done. The most dominant species per elevation was determined using the formula from *Kuers* (*2005*). Total importance value of each species (IV) was used as basis for dominance given that it is the summation of relative frequency, relative dominance, and relative density.

RESULTS AND DISCUSSION

Location of Plus Trees and Factors Affecting their Distribution

Mt. Banahaw de Lucban is classified as mossy forest or mid-mountain forest and secondary growth forest that supports high floral and faunal diversity, and endemicity from 66 to 76 %. Various vegetation studies revealed the floral diversity and high endemicity in floristic composition at various altitudes; identification of some lesser-used tree species; bark and blaze characters of forest trees; inventory; identification and distribution of plants with medicinal value (*Gascon et al. 2011*). Sixty-five individual plus/mother trees in Mt. Banahaw de Lucban were mapped in the study at 700 masl to 1800 masl (**Figures 1 to 3**).

The slope in the area ranged from rolling to moderate to steep (18-50 %) to very steep (50 % and above). The distribution of high number of populations of plus trees was mostly at steep slopes (30-50 %), while two plus trees of *Banahaw Igem* (*Dacrycarpus cumingii* [Parl] de Laub.)

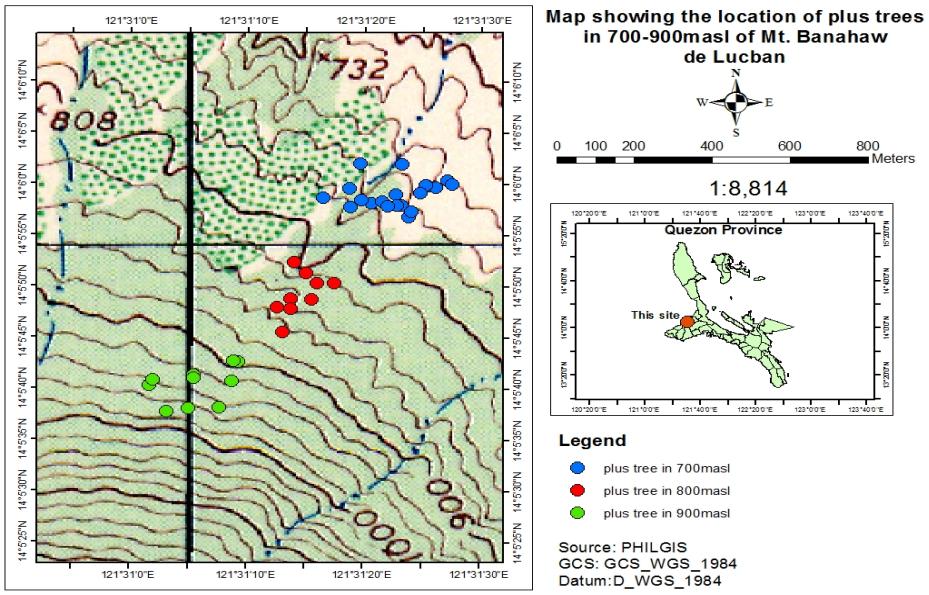

Figure 1. Plus trees at 700-900 masl of Mt. Banahaw de Lucban, Philippines.

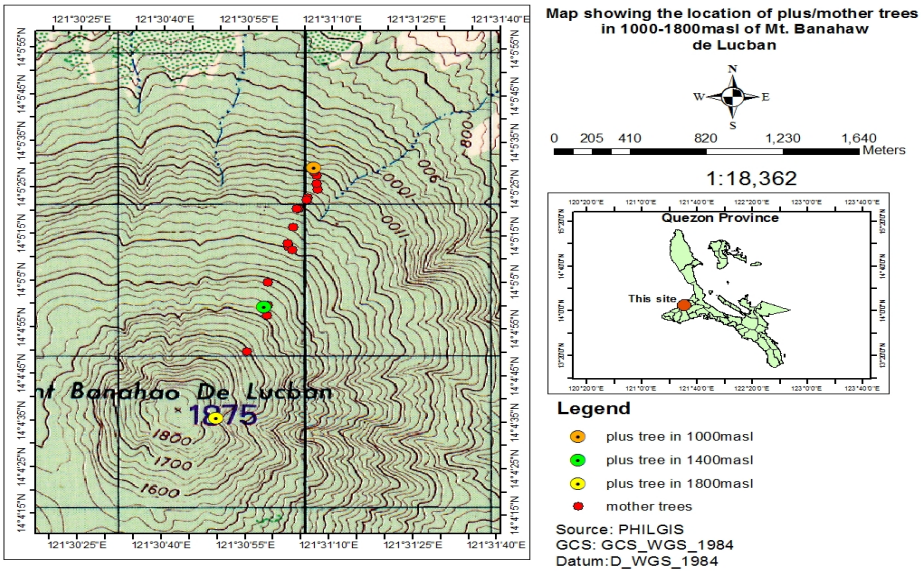

Figure 2. Plus trees at 1000-1800 masl of Mt. Banahaw de Lucban, Philippines.

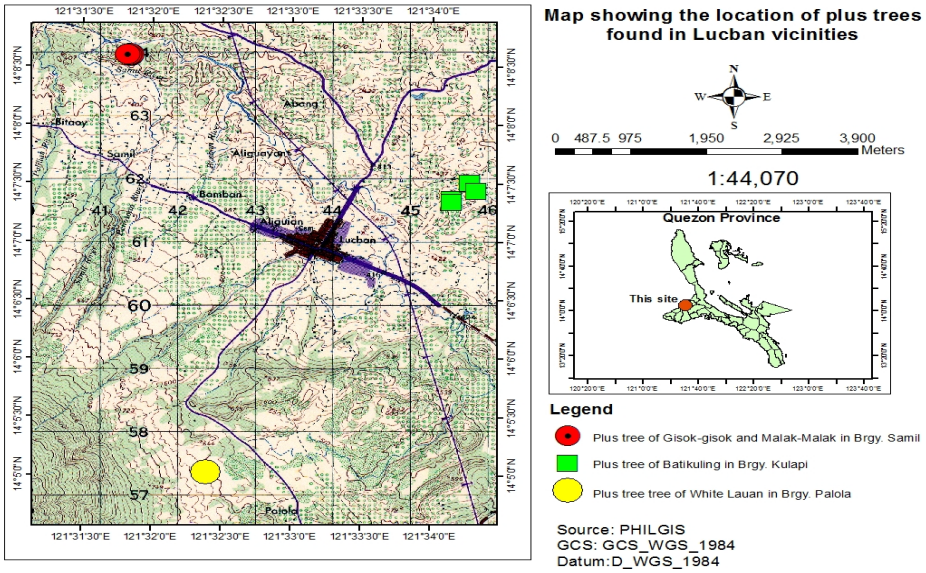

Figure 3. Plus trees identified in the vicinities of Mt. Banahaw de Lucban, Philippines.

at very steep slope of Mt. Banahaw de Lucban (**Figure 4**). Most of the selected and identified plus/mother trees were located near bodies of water of the mountain (**Figure 5**). Plus and mother trees found lying and distributed between streams were *Lahas* (*Palaquium obovatum* (Griff) Engl. var. *orientale*), *Makaasim* (*Syzygium nitidum* Benth.), *Kasau-kasau* (*Gongrospermum philippinense* Radlk), *Bigus Silangan* (*Goniotalamus trunciflorus* Merr.), *Malakmalak-bundok* (*Palaquium montanum* Elmer), *Ulaian* (*Lithocarpus llanosii* (A.DC) Rehd.) and *Kalantas* (*Toona calantas* Merr. & Rolfe). The stream found in Mt. Banahaw de Lucban is an ephemeral type that water flows only after a rainfall event. The Department of Science and Technology (DOST)-Philippine Atmospheric, Geophysical, Astronomical and Services Agency (PAGASA) recorded that the climate in Quezon Province is classified as Type IV where rainfall is evenly distributed throughout the year. In Lucban, rain is characterized almost throughout the year and no distinct dry season. The average annual rainfall was 2,606.7 mm; temperature was 21°C; and relative humidity of 8.3%. based on the data of the Agro-Meteorological Station (2014-2016). The condition favors the survival and growth of seedlings/wildlings that would ensure regeneration. Soil in Mt. Banahaw de Lucban is Luisiana sandy clay loam type (*REECS 2011*) that is generally dark brown with hues of red and yellow that is rich in iron and magnesium, high in organic matter and low in nutrient, such as Nitrogen, Phosphorus and Potassium as influenced by soil pH and environmental condition. At 700 masl and 1000 masl, soil pH is 5.7 which indicate moderately acidic while at 1300 masl and 1600 masl is

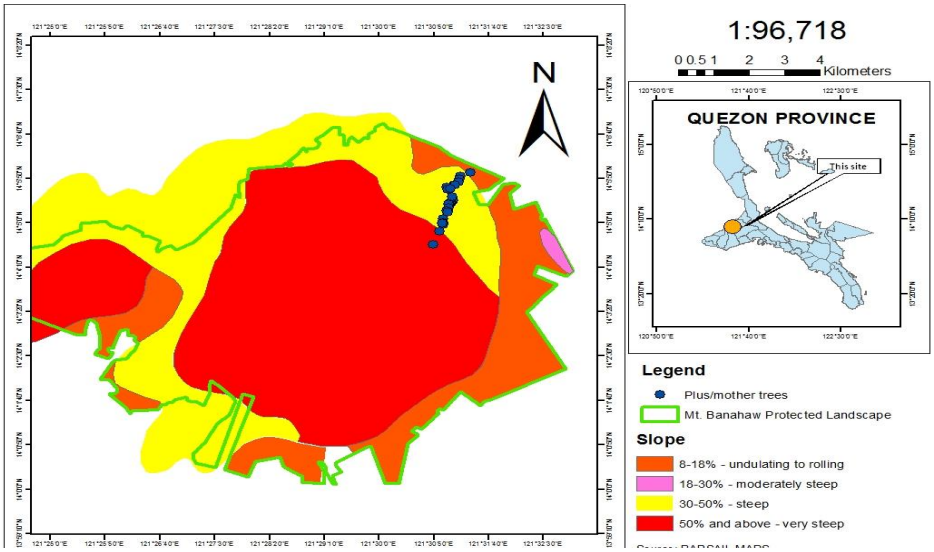

Figure 4. Slope map of Mt. Banahaw Protected Landscape, Philippines, showing distribution of germplasm at the Northeastern slope.

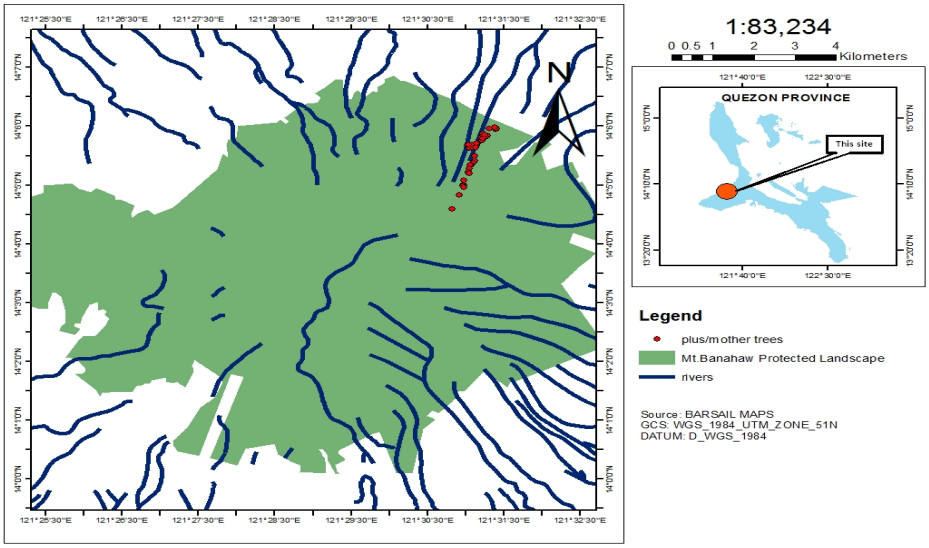

Figure 5. Hydrologic map of Mt. Banahaw Protected Landscape, Philippines, showing the distribution of germplasm at the Northeastern slope.

acidic-strongly acidic with pH of 5.5 to 5.51. The soil in the area is not compact, has low bulk density that promote higher infiltration rate, well drained and prone to soil erosion (*Arrabis 2013*).

The Philippines has geographic and ecological characteristics that allow it to support a varied and well-distributed diversity of species of wild fauna and flora. According to the *Foundation for the Philippine Environment* (*2018*), elevation has an influence on biodiversity and the case of Mt. Banahaw de Lucban, productivity stressors such as heat and atmospheric pressure decrease while other more life-supporting factors increase such as humidity and rainfall with rise in elevation. Several studies have been carried out to establish relationships between environmental factors and species diversity. In a study conducted in arid and semi-arid regions, species diversity was more impacted by soil properties as compared with topographic characteristics (*Ghollasimod et al. 2017*). However, *Van Nguyen et al.* (*2015*) confirmed the effect of environmental variables on the presence and abundance of tree species in a tropical lowland undisturbed limestone and non-limestone forest. Soil properties including pH, soil moisture content, and soil textures, were the most crucial factor in tree species composition and their distribution.

Diversity, Evenness and Importance Value of Plus and Mother Trees

Plus trees and mother trees at the northeastern slope of Mt. Banahaw de Lucban represent 13 families namely Annonaceae, Fabaceae, Fagaceae, Clusiaceae, Meliaceae, Myrtaceae, Podocarpaceae, Sapindaceae, Sapotaceae, Symplocaceae, Theaceae and Tiliaceae. At 700 masl, Mt. Banahaw de Lucban had the highest diversity of plus trees using Shannon's formula with 11 species, 19 individuals and species evenness of 0.905 (**Table 1**). Elevations of 1300, 1500 and 1800 masl had no species diversity and evenness of plus trees with only 1 plus tree species found. According to *Danoff-Burg* (*2003*), considering that the highest limit for species diversity is 4.5 while the lowest limit is 1.5 species diversity of 2 is considered as the median value between the two limits and can be interpreted as moderately diverse. Thus, 700 masl and 800 masl are moderately diverse with plus trees.

At 700 masl of Mt. Banahaw de Lucban, 28 candidate trees were characterized and assessed. Nineteen individuals were selected representing 9 families and 11 species (**Table 2**). *Kalantas* (*Toona calantas* Merr.) had an Importance Value (IV) of 44.72; Puyaka with 38.26; and *Makaasim* (*Syzygium nitidum* Benth) with 37.88. *Kalantas* (*Toona calantas* Merr.) was found to be the most dominant species at 700 masl. It is observed to be growing on a great variety of soils, fairly well in dry soils, preferably loamy with considerable humus and clay as topsoil and adobe rock as subsoil. However, it attains its best growth in areas where moisture is moderate and light intensity is adequate especially at the edge of open areas (*ERDB 2001*). At 800 masl, 19 candidate trees were characterized and assessed (**Table 2**). Six families, 7 species and 10 individuals were selected. The dominant species were *Lahas* (*Palaquium obovatum* (Griff) Engl. var. orientale Lam) with Importance Value (IV) of 57.93, *Malakmalak-bundok* (*Palaquium montanum* Elmer) with 44.53; and *Malaruhat* (*Cleistocalyx operculatus* Merr & Perry) with 43.96. At 800 masl, *P. obovatum* and *P. montanum* of family Sapotaceae are shade tolerant, long lived, and typically found in mature forests, generally dispersed by animal and some species are used as timber (*Lima and Mariano-Neto 2014*). At 900 masl, 22 candidate trees were characterized and assessed while only 5 families, 6 species and 10 individuals qualified (**Table 2**). The dominant species were *Lahas* (*Palaquium obovatum* (Griff) Engl. var. orientale Lam.) with Importance Value (IV) of 77.48; *Kalantas* (T*oona calantas* Merr.) with 62.95; and *Makaasim* (*Syzygium nitidum* Benth.) with 48.34.

Table 1. The diversity and evenness of candidate, plus, and mother trees at various elevation in Mt. Banahaw de Lucban, Philippines (2016-2017).

Elevation (masl)	No. of Species	No. of Individuals	Diversity	Evenness
700	11	19	2.172	0.905
800	8	10	2.024	0.973
900	6	10	1.608	0.897
1000	4	6	1.243	0.897
1100	3	6	0.868	0.790
1200	3	5	1.054	0.959
1300	1	1	0	0
1400	3	6	1.010	0.918
1500	1	1	0	0
1800	1	1	0	0

Plus trees and mother trees found at 1000 masl of Mt. Banahaw de Lucban was represented by 3 families, 4 species with 6 individuals (**Table 3**). The dominant species were *Makaasim* (*Syzygium nitidum* Benth) with Importance Value (IV) of 91.76; *Malaruhat* (C*leistocalyx operculatus* Merr and Perry) with 73.6; and *Lahas* (*Palaquium obovatum* (Griff) Engl. var. orientale Lam.) with 41.66. Mother trees thriving at 1100 masl were 2 families, 2 species and 6 individuals (**Table 3**). The dominant species were *Makaasim* (*Syzygium nitidum*

Benth.) with 144.18 Importance Value (IV); *Banahaw Igem* (*Dacrycarpus cumingii* (Parl.) de Laub with 91.72; and *Paguringon* (*Cratoxylum sumatranum* Jack) with 63.75. *Makaasim* (*Syzygium nitidum* Benth) is a fast-growing tree which develops an intensive rooting system particularly in low fertility soil that helps recover from degradation. It thrives mostly at high altitudes, indicating that there was a wide variation of species

Table 2. Plus trees at 700 masl, 800 masl and 900 masl of Mt. Banahaw de Lucban, Philippines (2016-2017).

Family Name	Scientific Name	Common Name	IV
700 MASL			
Myrtaceae	*Toona calantas* Merr.	Kalantas	44.72
Theaceae	*Adinandra elliptica* C.B. Rob.	Puyaka	38.26
Myrtaceae	*Syzygium nitidum* Benth.	Makaasim	37.88
Symplocaceae	*Symplocos whitfordii* Brand	Kaipan	27.95
Clusiaceae	*Cratoxylum sumatranum* Jack	Paguringon	27.73
Fabaceae	*Pterocarpus indicus*	Narra	26.20
Clusiaceae	*Cratoxylum formosum* Jack	Salinggogon	24.22
Fabaceae	*Parkia tomiriana* (DC) Merr.	Kupang	21.54
Tiliaceae	*Grewia setaceae* Merr.	Alinau	19.37
Theaceae	*Eurya coriaceae* Merr.	Bakig	19.37
Malvaceae	*Microcos stylocarpa* (Warb.) Burr.	Kamuling	12.76
800 MASL			
Sapotaceae	*Palaquium obovatum* (Griff) Engl. var. orientale Lam.	Lahas	57.93
Sapotaceae	*Palaquium montanum* Elmer	Malakmalak-bundok	44.53
Myrtaceae	*Cleistocalyx operculatus* Merr & Perry	Malaruhat	43.96
Fagaceae	*Lithocarpus llanosii* (A.DC) Rehd.	Ulaian	43.44
Clusiaceae	*Cratoxylum formosum* Jack	Salinggogon	35.98
Sapindaceae	*Gongrospermum philippinense* Radlk	Kasau-kasau	27.72
Myrtaceae	*Syzygium cortiflorum* (Elmer) Merr	Lipoteng Gubat	24.62
Sapotaceae	*Palaquium lanceolatum* Blanco	Palakpalak	21.83
900 MASL			
Sapotaceae	*Palaquium obovatum* (Griff) Engl. var. orientale Lam	Lahas	77.48
Meliaceae	*Toona calantas* Merr. & Rolfe	Kalantas	62.95
Myrtaceae	*Syzygium nitidum* Benth	Makaasim	48.34
Sapotaceae	*Palaquium montanum* Elmer	Malakmalak-bundok	43.39
Fagaceae	*Lithocarpus llanosii* (A.DC) Rehd.	Ulaian	36.11
Annonaceae	*Goniotalamus trunciflorus* Merr.	Bigus Silangan	31.69

Table 3. Plus tree and mother trees at 1000 masl, 1100 masl, 1200 masl and 1400 masl, of Mt. Banahaw de Lucban, Philippines (2016-2017).

Family Name	Scientific Name	Common Name	IV
1000 MASL			
[1]Myrtaceae	*Cleistocalyx operculatus* Merr & Perry	Malaruhat	73.60
[2]Myrtaceae	*Syzygium nitidum* Benth	Makaasim	91.76
[2]Sapindaceae	*Gongrospermum philippinense* Radlk	Kasau-kasau	33.37
[2]Sapotaceae	*Palaquium obovatum* (Griff) Engl. var. orientale Lam.	Lahas	41.66
1100 MASL			
[2]Myrtaceae	*Syzygium nitidum* Benth	Makaasim	144.18
[2]Podocarpaceae	*Dacrycarpus cumingii* (Parl.) de Laub.	Banahaw Igem	91.72
[2]Clusiaceae	*Cratoxylum sumatranum* Jack	Paguringon	63.75
1200 MASL			
[2]Myrtaceae	*Syzygium nitidum* Benth	Makaasim	169.79
[2]Myrtaceae	*Syzygium simile* Merr.	Panglomboien	68.30
[2]Symplocaceae	*Symplocos whitfordii* Brand	Kaipan	61.92
1400 MASL			
[1]Podocarpaceae	*Dacrycarpus cumingii* (Parl.) de Laub.	Banahaw Igem	201.92
[2]Myrtaceae	*Syzygium nitidum* Benth	Makaasim	70.27
[2]Podocarpaceae	*Podocarpus lophatus* de Laub.	Igem Pugot	27.94

[1]Plus tree; [2]Mother tree

in the area (*Beltran et al. 2015*). Mother trees found at 1200 masl were represented by 2 families, 3 species and 5 individuals (**Table 3**). The dominant species were *Makaasim* (*Syzygium nitidum* Benth.) with Importance Value (IV) of 169.79; *Panglombein* (*Syzygiumsimile* Merr.) with 68.30; and *Kaipan* (*Symplocos whitfordii* Brand) with 61.92. Plus tree and mother tree species at 1400 masl were *Banahaw Igem* (*Dacrycarpus cumingii* (Parl.) de Laub.) with 201.92 Importance (IV); *Makaasim* (*Syzygium nitidum* Benth) with 70.27 Importance Value; and *Igem Pugot* (*Podocarpus lophatus* de Laub.) with Importance Value (IV) of 27.94 (**Table 3**). *Banahaw Igem* (*D. cumingii* (Parl.) de Laub.) usually occurs in mossy forest like Mt. Banahaw de Lucban (*Farjon 2013*). It occurs at altitudes and in forest types which are less affected by human activities. It is a slow growing and late maturing tree mainly due to extreme habitat. In the Philippines, *Banahaw Igem* (*D. cumingii* (Parl.) de Laub.), a source of face veneer, is common. Saplings of *Banahaw Igem*, *Igem Pugot* and regenerants of *Makaasim* were observed at 1400 masl during the entire study period from June 2016 to June 2017.

The plus and mother tree found at 1300, 1500 and 1800 masl was represented by 1 family, 1 species and 1 individual in each elevation (**Table 4**). *Banahaw Igem* (*D. cumingii*) of family Podocarpaceae was observed at 1300 and 1500 masl which was classified as mother tree while at 1800 masl as plus tree. The observed trees At 1600 masl and 1700 masl, were smaller in diameter (below 10 cm) and height compared to the trees at lower elevations. Tree bole and branches were distorted and twisted covered with moss, ferns, liverworts, vines and orchids. As elevation goes up to the summit, the numbers of trees were decreasing. It was more exposed to lower temperature and strong winds and relative humidity. These affect the adaptability and phenotypic characteristics of trees and other plants that may thrive in higher elevations.

The trees found in Sitio Usiwan, Brgy. Palola is White *Lauan* (*Shorea contorta* Vidal); in Brgy Kulapi is *Batikuling* (*Litsea leytensis*); and at the riparian vegetation in Brgy. Samil is *Gisok-gisok* (*Hopea philippinensis*) and *Malakmalak* (*Palaquium philippense* (Perr.) C.B. Rob.) (**Table 5**).

Phenotypic Category of Plus Trees per Elevation

The total rating of each tree was obtained by weighing each trait measured according to importance and adding the score together. The highest score represents the best tree or plus/mother tree. Plus trees assessed at 700 masl with good (4-5) phenotypic characteristics were *Kamuling* (*Microcos stylocarpa* (Warb.) Burr.); *Paguringon* (*Cratoxylum sumatranum* Jack); *Makaasim* (*Syzygium nitidum* Benth); and *Puyaka* (*Adinandra elliptica* C.B. Rob.). Other species that hasfair (3-4) phenotypic characteristics were *Kasau-kasau* (*Gongrospermum philippinense* Radlk), *Kalantas* (*Toona calantas* Merr), and *Narra* (*Pterocarpus indicus* Willd.). Compared with surrounding trees, these plus trees showed vigorous, healthy, superiority in height and diameter, which qualified them for seed production areas (SPAs) with high frequency of phenotypically good planting materials (*ERDB 2010*). At 800 masl, *Lipoteng Gubat* (*Syzygium cortiflorum* (Elmer) Merr) and *Ulaian* (*Lithocarpus llanosii* (A.DC) Rehd.) had good stem quality, branching and tree health. Other plus trees that were categorized fair based on DAO 2010-11 criteria should be managed for improved production of seeds and quality planting materials. This could be done through various silvicultural treatments or practices that would enhance the productivity of trees to produce quality seeds. At 900 masl, *Malakmalak-bundok* (*Palaquium montanum* Elmer) was marked with good phenotypic characteristics, while *Bigus Silangan* (*Goniotalamus trunciflorus* Merr.) in fair category (3-4). *Malakmalak-bundok* is a potential seed source when at 800-900 masl as these elevations show good stands of the species. According to *ERDB* (*2010*), the practice of collecting seed in selected seed stand is commonly used and better

Table 4. Plus/mother tree identified at 1300, 1500 and 1800 masl of Mt. Banahaw de Lucban, Philippines (2016-2017).

Family Name	Scientific Name	Common Name
[a]Podocarpaceae	*Dacrycarpus cumingii* (Parl.) de Laub.	Banahaw Igem
[b]Podocarpaceae	*Dacrycarpus cumingii* (Parl.) de Laub.	Banahaw Igem
[c]Podocarpaceae	*Dacrycarpus cumingii* (Parl.) de Laub.	Banahaw Igem

[a]1300 masl; [b]1500 masl; [c]1800 masl

Table 5. Plus trees in the vicinities of Mt. Banahaw de Lucban, Quezon, Philippines (2016-2017).

Family Name	Scientific Name	Common Name
[a] Dipterocarpaceae	*Shorea contorta* Vidal	White Lauan
[b] Lauraceae	*Litsea leytensis* Merr.	Batikuling
[c] Dipterocarpaceae	*Hopea philippinensis* Dyer	Gisok-gisok
[c] Sapotacaeae	*Palaquium philippense* (Perr.) C.B. Rob.	Malakmalak

[a]Sitio Usiwan, Brgy. Palola; [b]Brgy.Kulapi; [c]Riparian Vegetation at Brgy.Samil

than collecting seed from individual or single tree. At 1000 masl, *Malaruhat* (*Cleistocalyx operculatus* Merr & Perry) was in fair category. At 1400 and 1800 masl, *Banahaw Igem* (*Dacrycarpus cumingii* (Parl.) de Laub.) was also categorized fair.

Near Mt. Banahaw de Lucban, eight individuals with four species of plus trees had very good phenotypic characteristics. In Brgy. Palola at the southwestern part of Mt. Banahaw de Lucban, three individuals of White *Lauan* (*Shorea contorta* Vidal) of family Dipterocarpaceae were assessed to have good phenotypic characteristics. These trees were planted during the reforestation program in the 1990's to rehabilitate the denuded site due to *kaingin* (slash and burn) activities. In Brgy. Samil, four individuals of *Malak-Malak* (*P. philippense*) had good phenotypic characteristics, while nine individuals of *Gisok-gisok* (*H. philippinensis* Dyer) were assessed to be fair. *Batikuling* (*Litsea leytensis* Merr.) found in Brgy. Kulapi was assessed to be fair.

Characteristics of Selected Plus Trees

The phenotype is any characteristics of tree that can be measured or observed. It is influenced by the genotype and environment in which the tree grows as determined by climate, soil, diseases, pests, and competition with other trees (*McGraw-Hill 2002*). Crown cover and other visible characteristics that describe quality of plus trees were included. There were 21 identified plus trees that were dominant and co-dominant in Mt. Banahaw de Lucban (**Table 6**).

Banahaw Igem (*Dacrycarpus cumingii* (Parl.) de Laub). Banahaw Igem of family Podocarpaceae is distributed from 1100 masl to 1800 masl and was observed to exhibit fair in phenotypic characteristics. A plus tree located at 1400 masl had good stem straightness, circularity and forking but fair in branching habit and health. Its height measured 14 cm, diameter of 19.1 cm and 3.5 m^2 crown cover. Regenerants and saplings were observed at 1200 and 1400 masl. These are large trees reaching 10 m high and diameter up to 100 cm. The leaves are simple and phyllomorphic. It has footed-fruits with bark light brown in color. The species is used for veneer production and carpentry works since the wood is easy to work on (*ITTO 2015*). The conservation status of Banahaw Igem is of least concern in the *IUCN Red List* (*2022)* as assessed by *Farjon* (*2013*), however, very lowpopulation could lead to threatened status if conservation of the species is ignored. The tree was identified in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as listed in the study of *Gascon et al.* (*2013*).

Batikuling (*Litsea leytensis* Merr.). Batikuling of family Lauraceae, is an endangered species listed in DAO No. 11, s.2017 while near threatened species in the *IUCN Red List* (*2022)* based on the assessment of the *Energy Development Corporation* (*EDC 2020a*). It is a medium-sized tree with a height of 13.5 m, 46.79 cm diameter and 9.25 m^2 crown cover. Plus trees of Batikuling show good phenotypic characteristics. It was found on its required habitat in low and medium altitudes (*ERDB 1999*). Wood of *Batikuling* is light and soft with relative density of 0.37 green, 0.49 at 12 % MC. It is commonly used for carvings, sculptures and pattern making (*Escobin et al. 2015*). Batikuling and other closely related species are known for their demand in the wood carving industry in Paete, Laguna, Philippines. Most sacred images in Catholic churches throughout the country were made of wood carvings from these species. Wood supply is not abundant and over-exploitation of its wood may have contributed to the decreased in supply, thus reaching it in a critical level. This wood was most used during the Spanish regime owing to its resistance to dry wood termites, and ease of conversion into boards (*Escobin et al. 2015*).

Bigus Silangan (*Goniothalamus trunciflorus* Merr.). Bigus Silangan of family Annonaceae is often located near creeks. Wildlings are widely observed from lower and middle altitudes. Height is 10 m, 27.7 cm in diameter and with 9 m^2 crown cover. It shows fair quality of stem forking, circularity and branching but good quality in stem straightness. It is co-dominant in the area, thus, dying of branches occur when there is not enough light received compared to dominant trees. It was observed to flower in October. According to *Synder* (*2015*), low branches on the trunk die from shading and competition. *Goniothalamus* species are known for medicinal uses, among others. For example, leaf stalks are used as treatment for stomach ache. The bark is used to frighten bees during collection of honey (*PROSEA 2016*). *Bigus Silangan* is categorized as critically endangered species on the *IUCN Red List* (*2022)* as assessed by the *EDC* (*2020b*).

Danglin *(Grewia multiflora* Juss.) Danglin of family Malvaceae (Tiliaceae) is native in the Philippines. Plus tree of *Danglin* has a height of 15 m, diameter of 31 cm and with 4.8 m^2 crown cover. It has good stem straightness, forking, circularity, branch thickness, pruning and tree health. According to *Escobin et al.* (*2015*), wood of Danglin is like Lanutan (*Mitrephora lanotan* (Blanco) Merr.) where sapwood is lighter colored compared to heartwood, moderately hard to cut; moderately heavy with relative density 0.63 at 15 % moisture content (MC). *Grewia* spp. wood can be used in construction as basswood or whitewood. It is an ornamental popular for

street planting. Due to overexploitation, its supply is in critical level. This resulted to the creation of guidelines issued by the DENR to preserve and prohibit the cutting of the remaining trees. Danglin was identified in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as listed in the study of *Gascon et al.* (*2013*).

Gisok-gisok (*Hopea philippinensis* Dyer). **Gisok-gisok** of family Dipterocarpaceae is classified as critically endangered based on DAO No. 11, s.2017 while endangered in the *IUCN Red List* (*2022)* assessed by the *EDC* (*2020c*). It is a small, smoothed-barked, and buttressed tree (*Rojo 1999*) of 12 m, 35.9 cm in diameter and 5.7 m^2 crown cover with fair phenotypic characteristics. Wildlings of the species were found near mother trees. Gisok-gisok belongs to the "Manggachapui Group" traded in Southeast Asia as "merawan" species. Its bole is relatively small and only used as hewn posts and railroad ties. Wood is hard and heavy with relative density of 0.61-0.83 at 15 % MC (*Escobin et al. 2015*). At present, wood supply is available but with uncertain limited quantities. Gisok-gisok produces resin that is used for varnish, torches and wound treatment, while tannins from the bark are used for leather tanning and also for tannin-formaldehyde adhesive (*Escobin et al. 2015*).

Kalantas (*Toona calantas* Merr and Rolfe). **Kalantas** of family Meliaceae is an endemic species and listed as vulnerable in DAO No.11, s.2017. It has a straight and cylindrical bole. The crown is wide spreading rather open (*ERDB 2014*). Kalantas can be found growing on great variety of soils in the country. It grows well in dry soils, preferably loamy with considerable humus and clay as topsoil (*Baltazar et al. 2010*). Height of plus tree is 19 m, diameter of 57 cm and with 5.4 m^2 crown cover. It has good stem straightness, circularity, and tree health. Stem forking, branch angle, thickness, and pruning are fair. The wood has a relative density of 0.29 at green condition and 0.33 at 12 % MC with a strong and lasting cedar-like odor, light and soft. It is used for high-grade cigar boxes, furniture, musical instruments, carvings, sculptures, among others (*Escobin et al. 2015*). Supply of Kalantas wood is reported to be widely distributed in the country, but it is nowhere abundant in quantity (*ERDB 2014*). Thus, updated field information on supply of Kalantas is needed due to over-exploitation.

Kasau-kasau (*Gongrospermum philippinense* Radlk). **Kasau-kasau** of family Sapindaceae is an endemic species and classified as critically endangered in DAO No.11, s.2017. Height of plus tree is 11 m, diameter of 22.3 cm and with 3.70 m^2 crown cover. Stem straightness, circularity, branch angle and health are good but fair in stem forking, branch thickness and pruning. It thrives in middle elevation of Mt. Banahaw de Lucban. Wildings of Kasau-kasau with 10-15 cm in height are abundantly observed under the canopy of mother trees, usually during the month of February which were collected and widely used in the tree planting activities of SLSU. It is a potential source of quality planting materials for clonal nursery propagation. It is a small tree reaching 10 m in height and 15 cm in diameter. Leaves are pinnate with opposite to sub-opposite arrangement. The bark is brown with fine lenticels. *Gascon et al.* (*2013*) identified Kasau-kasau in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as it can thrive at mid-latitude up to 1000 masl.

Kamuling (*Microcos stylocarpa* (Warb.) Burr.). Kamuling of family Malvaceae, has a height of 19 m, diameter of 5.7 cm and with 5.4 m^2. crown cover. All phenotypic characteristics are good based on stem straightness, forking, and circularity; branch angle, thickness, pruning; and tree health. *Escobin et al.* (*2015*) cited that the wood of Kamuling is moderately soft to moderately hard; moderately light with relative density of 0.40 at green condition and 0.42 at 15 % MC. It is used for general construction under cover and small objects requiring strength and elasticity such as tool handles and agricultural implements. Also, for pulp and paper production and bark resin as fuel while bark fibers for ropes and tying materials. However, wood supply of Kamuling is limited and overexploitation may have decreased supply to a critical level (*Escobin et al. 2015*). Kamuling is categorized as least concern on the *IUCN Red List* (*2022)* as assessed by the IUCN SSC Global Tree Specialist Group and BGCI (2019).

Kupang (*Parkia timoriana* (DC) Merr.). Kupang of family Fabaceae: Mimosoideae, is a large tree with 16 m in height, 35 cm diameter and with 9.65 m^2 crown cover. Its stem straightness, forking, circularity, branch angle, thickness, pruning, and tree health are of good quality. Wood of Kupang with a disagreeable odor when freshly cut, soft and light, with relative density of 0.30 at 15 % MC. It is used for light and temporary construction, cheap sidings, boxboards and fish floats (*Escobin et al. 2015*). Kupang is categorized as least concern on the *IUCN Red List* (*2022)* based on the assessment of *Harvey-Brown* (*2019*).

Lahas (*Palaquium obovatum* (Griff) Engl. var. *orientale*). Lahas of family Sapotaceae was locally known as Dulitan. The height is 16 m, 49 cm diameter and 9.75 m^2 crown cover. Stem straightness and forking is good; stem circularity is fair; branch angle and pruning is good; branch thickness is fair. Tree health of Lahas

was good. Population of Lahas is densely distributed in 800 and 900 masl. *Rojo* (*1999*) stated that most Sapotaceae species are found in low to middle altitudes. Thus, these plus trees dominated such elevations adapting to the environmental conditions in the area. The flowers of Lahas are in bloom in February with other tree species of family Sapotaceae like Palak-palak (*Palaquium lanceolatum* Blanco) and *Malakmalak-bundok* (*Palaquium montanum* Elmer). Lahas is endemic in the Philippines and found to exist in Mt. Banahaw (*Gascon 2002*). It a least concern species in the *IUCN Red List* (*2022)* as assessed by *Olander and Wilkie* (*2018*).

***Lipoteng gubat* (*Syzygium cortiflorum* (Elmer) Merr).** *Lipoteng gubat* of family Myrtaceae is an endemic forest tree species in the area. It was found along the trail at 800 masl. The height is 14 m, 32.8 cm diameter, and 3.7 m^2 crown cover. It has good stem straightness, forking, branch angle, pruning and health but fair in stem circularity and branch thickness. Wildlings of Lipoteng gubat were observed under the canopy of mother trees in February, measuring 10-15 cm in height. It could be a good source of quality planting materials for clonal nursery propagation.

***Makaasim* (*Syzygium nitidum* Benth)**. Makaasim of family Myrtaceae is a vulnerable forest tree species as listed in DAO No.11, s .2017. It is a dominant species in Mt. Banahaw de Lucban as revealed in previous vegetation analysis and biodiversity assessment studies in different elevations of the mountain. It is a tall tree reaching 20 m in height and 70-90 cm in diameter. Leaves are simple, opposite to decussate with anastomosing veins. Bark is light brown, and is smooth to scaly. Plus trees of Makaasim has a height of 14 cm, diameter of 19.1 cm and 3.5 m^2 crown cover. Good phenotypic characteristics were observed in terms of stem (straightness, circularity and forking; branch angle and thickness and health; but fair in branch pruning. Wildings of *Makaasim* under canopy of a mother tree are observed in March measuring 10-20 cm in height, Flowering of Makaasim is from January-March. Fruiting is observed in January-March and wide distribution of wildlings is observed in March. *Apon* (*2015*) cited that natural regeneration of seedlings has the highest population followed by saplings and poles. Seedlings dominated the population indicating continued process of regeneration initiated from seed formation, dispersal, and germination. It was also identified in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as listed in the study of *Gascon et al.* (*2013*).

The wood of Makaasim is hard and heavy, light-colored sapwood, not marked off from the reddish-brown heartwood, odor slightly acidic when fresh and disappears when dry. Its relative density is 0.78 green and 0.88 at 12% MC (*Escobin et al. 2015*). Its wood is used for ship building, general construction, cabinet work and furniture, telegraph poles, tool handles, railway ties, pilings and implements. Although Makaasim is widely distributed throughout the Philippines (*Escobin et al. 2015*), the availability of wood supply is observed in small quantities.

***Malakmalak (Palaquium philippense* (Perr.) C.B. Rob.** Malakmalak of family Sapotaceae is a medium to large tree and common in primary forests at low and medium altitudes (*Rojo 1999*). It was identified in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as stated in the study of *Gascon et al.* (*2013*). It is classified as vulnerable in DAO No. 11, s. 2017 while a least concern species in the *IUCN Red List* (*2022)* based on the assessment of *EDC* (*2021a*). The height of plus trees reached 12 m, 35.9 cm in diameter and 5.7 m^2 crown cover. It has good phenotypic characteristics. It is a large tree with smooth, white to light brown outer bark. Leaves are simple, alternate to spirally arrange. Fruits are orange color when ripe, sweet, and dispersed by bats. It thrives at low and medium altitudes. The wood of Malakmalak is moderately heavy and moderately hard with relative density of 0.46 at green condition and 0.49 at 12 % MC (*Escobin et al. 2015*). It is put to similar uses as the lauans for house building not in contact with the ground, musical instruments, and cheap cigar boxes. It is a favorite wood for fine furniture due to its workability and not prone to warping. Seeds are edible and seeds contain fat for cooking or illumination.

Malakmalak-bundok* (*Palaquium montanum Elmer). Plus tree of Malakmalak-bundok of family Sapotaceae is flowering during the conduct of the study in June. It is dominant at 800 masl with a height of 16 m, diameter of 43.9 cm and 5.44 m^2 crown cover. It has good stem straightness, forking and pruning but fair in stem circularity, branch characteristics and tree health. Flowers of *Malakmalak-bundok* are in bloom in February including tree species of family Sapotaceae like *Palak-palak* (*Palaquium lanceolatum* Blanco) and Lahas (*Palaquium obovatum* (Griff) Engl. Var. orientale Lam). *Malakmalak-bundok* is endemic in the Philippines and found to exist in Mt. Banahaw (*Gascon 2002*). It is listed as vulnerable species on the *IUCN Red List* (*2022)* based on *EDC* (*2021b*) assessment.

***Malaruhat (Cleistocalyx operculatus* Merr & Perry)**. *Malaruhat* of family Myrtaceae has a height of 21 m, 53.5 cm diameter and 8.4 m^2 crown cover. It has good stem

forking and tree health. Stem straightness, circularity, and branch characteristics (angle, thickness, and pruning) is fair. Wood of *Malaruhat* is hard and heavy. Its sapwood is lighter-colored than the light to dark reddish-brown heartwood. It is used for house construction (beams, posts, flooring, windowsills), cabinet work and furniture (*Escobin et al. 2015*).

Narra *(Pterocarpus indicus* Willd.) The height of Narra plus tree is 14 m, 42 cm in diameter and 11 m^2 crown cover. It has good stem straightness, circularity, branch thickness and pruning but stem forking, branch angle and health is fair. Narra of family Fabaceae: Faboideae is a large tree normally with an irregularly fluted deformed short trunk (*Baltazar 2010*). It has a pronounced buttress with a spreading crown and sometimes with drooping branches (*ERDB 2013a*). It is classified as vulnerable based on DAO No. 11, s.2017 while an endangered species in the *IUCN Red List* (*2022)* as assessed by *Barstow* (*2018*). The species is widely used in reforestation activities nationwide because of its limited potential to invade native plant communities, fast growth, adaptation to stress, ease in reproduction and industrial importance (*Delos Reyes et al. 2016*). Wood of Narra is moderately hard and moderately heavy with relative density of 0.53 green and 0.55 at 12 % MC. Sapwood is light colored, distinct from the pale yellow to dark reddish-brown heartwood. It is used for high-grade furniture, cabinetry, veneer, and plywood (*Escobin et al. 2015*).

***Palak-palak* (*Palaquium lanceolatum* Blanco)**. Palak-palak of family Sapotaceae has a height of 14 m, diameter of 26.10 cm and 5.25 m^2 crown cover. Stem straightness, circularity, branch thickness and pruning, and health are fair. Stem forking and branch angle of Palak-palak shows good quality. The flowers of Palak-palak are in bloom in February including tree species of family Sapotaceae like Malakmalak-bundok (*Palaquium montanum* Elmer) and Lahas (*Palaquium obovatum* (Griff) Engl. Var. orientale Lam). Palak-palak is endemic in the Philippines and found to exist in Mt. Banahaw (*Gascon 2002*). It is categorized as vulnerable on the *IUCN Red List* (*2022)* based on *EDC* (*2021c*) assessment. Wood of Palak-palak is hard and heavy with relative density of 0.60 green, 0.68 at 12 % MC. Its wood is probably with similar uses as Malakmalak. Its fruits are edible and seed fat is for cooking or illumination (*Escobin et al. 2015*).

***Paguringon* (*Cratoxylum sumatranum* Jack).** Paguringon of family Clusiaceae (Guttiferae) is mostly found in primary and secondary forest on well-drained soils. Plus tree of *Paguringon* is 10 m in height, 20.7 cm diameter and 4.3 m^2 crown cover. Paguringon can reach a height of up to 25 cm and trunk diameter of up to 50 cm (*Marciano 2015*). Majority of the phenotypic characteristics measured is good except for branch angle which is fair. Flowering of Paguringon was observed in June. The wood of Paguringon is used for light construction, shelving, flooring, furniture, boxes, concrete forms, and interior parts of ships (*Ella et al. 2008*). Also, leaves and bark with medicinal values; recommended for landscaping, urban greening, and pioneer species for forest restoration (*Marciano 2015)*. It is a least concern species on the IUCN Red List as assessed by *BGCI and ICUN* (*2019*).

***Salinggogon (Cratoxylum formosum* (Jack) Dyer). Salinggogon** of family Clusiaceae (Guttiferae) has a height of 14 m, 28.97 cm diameter and 4.45 m^2 crown cover. Plus tree has good quality in terms of stem straightness and tree health, but fair in stem forking, circularity, branch angle, thickness and pruning. Salinggogon is a small to large tree up to 20 m tall with trunk diameter up to 30 cm. It can be fully deciduous in the dry season and flowers develop from bare parts of branches just before or as new leaves come out (*Fernando et al. 2018*). Uses of Salinggogon wood are the same as Paguringon. The young shoots can be eaten raw or cooked; the wood can be used in indoor construction and charcoal production, while the bark is a source of brown colored dye (*Ella et al. 2008*). Salingogon is a least concern species on the *IUCN Red List* (*2022)* as assessed by the *World Conservation Monitoring Centre* (*1998*).

***Ulaian (Lithocarpus llanosii* (A.DC) Rehd)**. Ulaian also known as Philippine oak of family Fagaceae. It attains a height of 17 m, 52.8 cm diameter and 8.35 m^2 crown cover. Phenotypic characteristics of Ulaian like stem straightness, circularity; branch angle and health are good but fair in stem forking, branch thickness and pruning. It is a medium sized tree with diameter reaching 40-50 cm while leaves are simple alternate to spiral leaf arrangement (*Beltran et al. 2015*). Flowers of Ulaian were in bloom in February including tree species of family Sapotaceae like Malakmalak-bundok (*Palaquium montanum* Elmer), Palak-palak (*Palaquium lanceolatum* Blanco) and Lahas (*Palaquium obovatum* (Griff) Engl. Var. *orientale* Lam). Ulaian was identified in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as listed in the study of *Gascon et al.* (*2013*).

White *Lauan (Shorea contorta* Vidal). White Lauan of family Dipterocarpaceae, is a large tree with v-fissured buttressed that is endemic in the Philippines. The average height of plus tree is 15 m, diameter of 34.4 cm and 6 m^2 crown cover. It has good phenotypic characteristics. It is

a large tree that is endemic throughout the Philippines but categorized as vulnerable species based on DAO No.11, s.2017 while a least concern species in the *IUCN Red List* (*2022)* as assessed by the *EDC* (*2020d*). The leaves are simple whitish underneath and oval. Leaves are arranged alternate to spiral. The crown is flat, irregular and open and phenology usually begins to flower and bear good seeds before its 30th year. It starts flowering at 17 years up to 36 years and seeds are usually shed off toward the start of wet season. Seed collection is best during June-August (*ERDB 2013b)*. It is also identified in Sitio Kinabuhayan of Mt. Banahaw de Dolores in Quezon as listed in the study of *Gascon et al.* (*2013*).

Wood of White Lauan is moderately hard and moderately heavy with a density of 0.42 at green condition, 0.45 at 12 % MC (*Escobin et al. 2015*). The sapwood is light gray, but not distinct from the heartwood which is grayish and turns light pink when dry or with pinkish tinge in some specimens, moderately hard and

Table 6. Plus trees selected in Mt. Banahaw de Lucban, Philippines (2016-2017).

Species of Plus Tree	Family Name	Conservation Status		Phenotypic Characteristics	Adaptation
		DAO 2017-11	IUCN ver.2022-2		
1. Banahaw Igem *Dacrycapus cumingii* (Parl.) de Laub	Podocarpaceae		Least Concern	Fair	Medium altitude
2. Batikuling *Litsea leytensis* Merr.	Lauraceae	Endangered	Near Threatened	Fair	Lower and medium altitude
3. Bigus Silangan *Goniotalamus trunciflorus* Merr.	Annonaceae		Critically Endangered	Fair	Lower and medium altitude
4. Danglin *Grewia multifloria* Juss.	Malvaceae			Fair	Low altitude
5. Gisok-gisok *Hopea philippinensis* Dyer	Dipterocarpaceae	Critically Endangered	Endangered	Fair	Low to medium altitude
6. Kalantas *Toona calantas* Merr and Rolfe	Meliaceae	Vulnerable		Fair	Low altitude
7. Kasau-kasau *Gongrospermum philippinense* Radlk	Sapindaceae	Critically Endangered		Fair	Middle elevation
8. Kamuling *Microcos stylocarpa* (Warb) Burr.	Malvaceae		Least Concern	Good	Low altitude
9. Kupang *Parkia timoriana* (DC.) Merr.	Fabaceae		Least Concern	Fair	Low altitude
10. Lahas *Palaquium obovatum* (Griff) Engl var. orientale	Sapotaceae		Least Concern	Fair	Low to middle altitude
11. Lipoteng Gubat *Syzygium cortiflorum* (Elmer) Merr	Myrtaceae			Good	Low altitude
12. Makaasim *Syzygium nitidum* Benth	Myrtaceae	Vulnerable		Good	Low to high altitude
13. Malakmalak *Palaquium philippense* (Perr) C.B. Rob	Sapotaceae	Vulnerable	Least Concern	Fair	Low to medium altitude
14. Malakmalak-bundok *Palaquium montanum* Elmer	Sapotaceae		Vulnerable	Fair	Low altitude
15. Malaruhat *Cleistocalyx operculatus* Merr & Perry	Myrtaceae			Fair	Low to medium altitude
16. Narra *Pterocarpus indicus* Willd	Fabaceae	Vulnerable	Endangered	Fair	Low altitude
17. Palak-palak *Palaquium lanceolatum* Blanco	Sapotaceae		Vulnerable	Fair	Low altitude
18. Paguringon *Cratoxylum sumatranum* Jack	Clusiaceae		Least Concern	Good	Low to medium altitude
19. Salinggogon *Cratoxylum formosum* (Jack) Dyer	Clusiaceae		Least Concern	Fair	Low altitude
20. Ulaian *Lithocarpus llanosii*	Fagaceae			Good	Low altitude
21. White Lauan *Shorea contorta* Vidal	Dipterocarpaceae	Vulnerable	Least Concern	Good	Low altitude

moderately heavy. It is also known as the Philippine Mahogany group which is traded in Southeast Asia as "white meranti" and "seraya" (*Escobin et al. 2015*). It is used for general construction, furniture, cabinets, veneer, plywood, pulp and papermaking (*ERDB 2013b*).

Production of Quality Planting Stocks and Development of Information, Education Campaign (IEC) Materials

Based on DAO No.11, s.2017– Updated National List of Threatened Philippine Plants and their categories and the IUCN Red List of Threatened Species, 11 species of plus/mother trees in Mt. Banahaw de Lucban were categorized with threatened status (**Table 6**). Species endemicity with various anthropogenic activities could be one of the potential causal factors. Strict implementation of rules and regulations and providing information on the importance of flora and fauna could be done to minimize negative impacts on protected areas like Mt. Banahaw de Lucban (*Santiago and Buot 2015*) Through the Southern Luzon State University's clonal nursery, Banahaw igem, Batikuling, Igem pugot, Makaasim and White lauan were propagated based on developed rooting protocols using stem cuttings in non-mist and mist system with 70-80 % survival (*Gutierrez et al. 2016*). Cloned planting stocks were distributed to various National Greening Program sites in CALABARZON and other regions thru the Ecosystems Research and Development Bureau of the DENR. Tree farmers, private nursery owners, and other government agencies were the seedling recipients.

Developed IEC materials that showcased plus and mother trees in Mt. Banahaw de Lucban were in the form of printed material and video clip- these have been registered and deposited at the National Library of the Philippines (**Figure 6**). The IEC materials were disseminated to the various stakeholders, institutions through the university's extension project, "Promoting Nursery Management Techniques for Production of Quality Planting Materials in Paete, Laguna" in 2018. It capacitated stakeholders on planting materials production and nursery management of indigenous forest tree species.

CONCLUSION AND RECOMMENDATIONS

Species of plus trees/mother trees at the northeastern slope of Mt. Banahaw de Lucban were represented by 12 families namely Annonaceae, Fabaceae, Fagaceae, Clusiaceae, Meliaceae, Myrtaceae, Podocarpaceae,

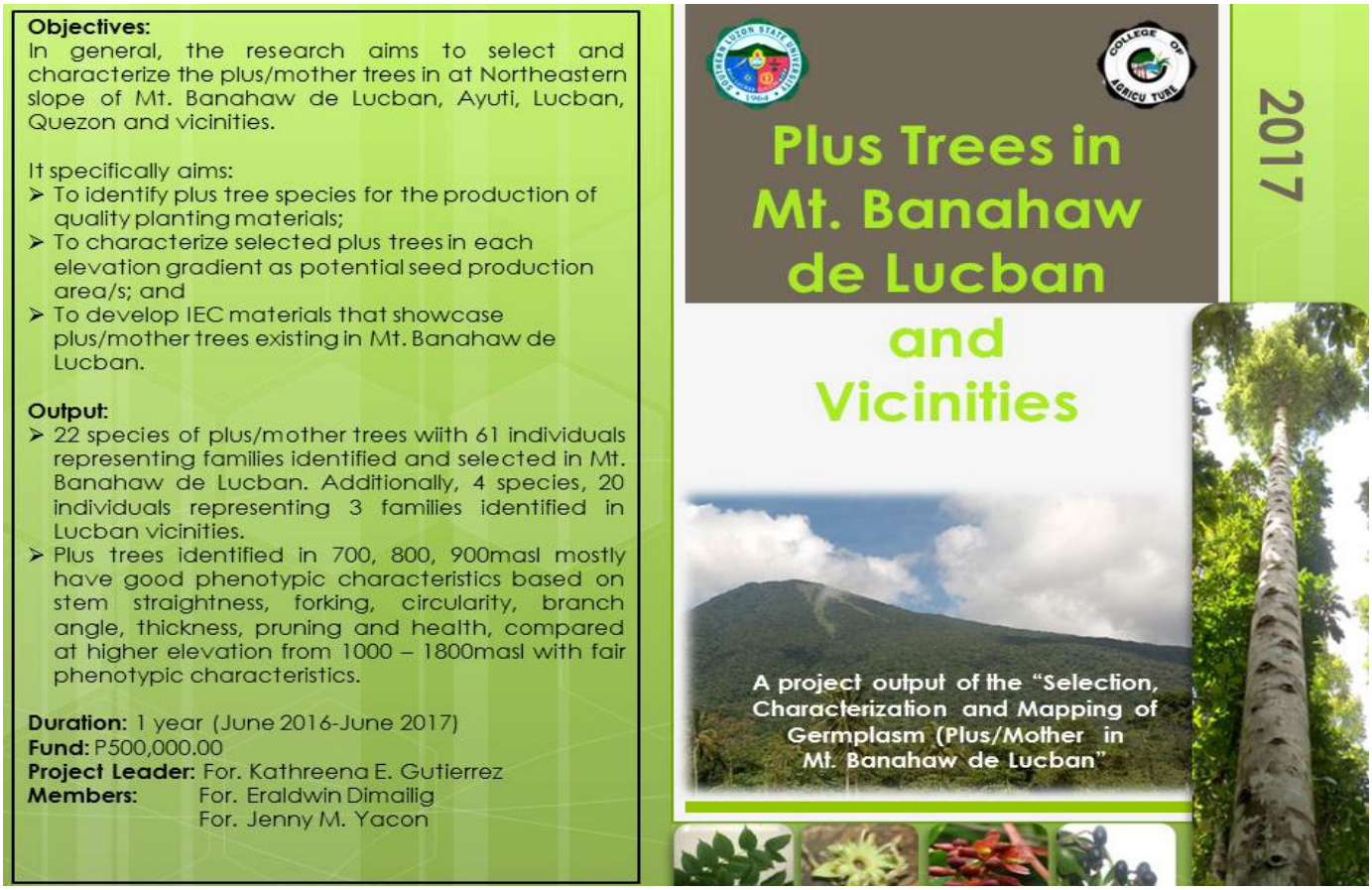

Figure 6. Front page of printed IEC material as one of the outputs of the study.

Sapindaceae, Sapotaceae, Symplocaceae, Theaceae and Tiliaceae. Good phenotypic characteristics (5-6 average score) of plus/mother tree most found in 700, 800 and 900 masl and have potential as seed production compare in 1000 masl-1800 masl with fair (3-4 average score) phenotypic characteristics of plus/mother tree. The identified plus trees have the potential for seed production or sources of propagules such as *Kalantas* (*Toona calantas* Merr.) at 700-900 masl while *Makaaasim* (*Syzygium nitidum* Benth.) and *Banahaw Igem* (*Dacrycarpus cumingii* (Parl.) de Laub.) at higher elevations. The assessment of growth and survival; and selection of plus trees was based on their phenotypic expressions and characteristics that appeared to be influenced by temperature, rainfall, soil, and elevation. Considering that the highest limit for species diversity is 4.5 while 1.5 as the lowest limit, species diversity of 2.0 was computed at 700 masl and 800 masl these were considered as the median value, interpreted as moderately diverse. Thus, 700 masl and 800 masl are moderately diverse with plus trees.

The quality of planting materials determines the success of any plantation establishment or reforestation project. It is essential to select the correct seed sources, but when in need of immediate seed supply, several methods can be used to obtain improved planting materials for immediate planting. With this, a similar study should be done in other portions of Mt. Banahaw de Lucban to determine and document potential sources of quality planting materials in the area. It is also important to establish a monitoring system and conservation measures of the identified plus trees from destructive agents. A biodiversity database that contain valuable information on phenotypic characteristics of forest tree species in Mt. Banahaw de Lucban should be developed. This will serve as reference material for related activities/research. The possibility to undertake studies for plus trees identified at the genetic or molecular level to further evaluate the superior characteristics of forest tree species could also be explored.

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