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Conservation of seed sources of commercially valuable forest species in the Mútile forest

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Abstract

In Ecuador there are limited efforts to establish seed sources for the production of reproductive genetic material of native forest species capable of generating quality production in a timely manner. The species of the study were selected from the remaining forest of the Mútile Tropical Botanical Garden, which due to its conservation status has species of commercial value. Currently, the use of reproductive material of proven genetic quality in native forest species is limited. The availability of qualified seed sources is the first step in genetic improvement for the production of quality reproductive material. The objective of this work is to contribute to the conservation of seed sources of native forest species of commercial value that meet the phenotypic, phytosanitary and dasometric conditions acceptable for the development of forest genetic improvement programs. Three seed sources of commercially valuable species were established: laurel (Cordia alliodora), guachapelí (Pseudosamanea guachapele) and Fernán Sánchez (Triplaris cumingiana), consisting of 114 trees on 20 hectares. Phenotypic, phytosanitary and dasometric characteristics of the trees were evaluated. The phenotypic evaluation showed that

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73 trees achieved a rating of Excellent Trees and 41 trees have a rating of Good Trees. The laurel species has the highest number of trees evaluated (42 individuals), followed by guachapelí (38 trees) and Fernán Sánchez (34 individuals). The seed-producing source corresponds to the genetic category of Identified Seed Source.
Keyword: Conservation, seed source, plus tree, phenotype, quality seeds.

Conservación de fuentes semilleras de especies forestales de valor comercial en el bosque Mútile

Resumen

En Ecuador existen limitados esfuerzos que conlleven al establecimiento de fuentes semilleras para la producción de material genético reproductivo de especies forestales nativas que sean capaces de generar una producción con calidad y en tiempo apropiado. Las especies del estudio fueron seleccionadas en el remanente de bosque del Jardín Botánico Tropical Mútile, que por su estado de conservación tiene especies de valor comercial. Actualmente, el uso de material reproductivo de calidad genética comprobada en especies forestales nativas es limitado. Disponer de fuentes semilleras calificadas es el primer paso de la mejora genética para la producción de material reproductivo de calidad. El objetivo de este trabajo es contribuir a la conservación de fuentes semilleras de especies forestales nativas de valor comercial que cumplan con las condiciones fenotípicas, fitosanitarias y dasométricas aceptables para el desarrollo de programas de mejoramiento genético forestal. Se establecieron tres fuentes semilleras de especies de valor comercial: laurel (Cordia alliodora), guachapelí (Pseudosamanea guachapele) y Fernán Sánchez

(Triplaris cumingiana) conformadas por 114 árboles en 20 hectáreas. Se evaluaron las características fenotípicas, fitosanitarias y dasométricas de los árboles. La valoración fenotípica demostró que 73 árboles alcanzaron una calificación de Árboles Excelentes y 41 árboles tienen una calificación de Árboles Buenos. La especie laurel presenta la mayor cantidad de árboles evaluados (42 individuos), seguido de guachapelí (38 árboles) y Fernán Sánchez (34 individuos). La Fuente productora de semillas corresponde a la categoría genética de Fuente Semillera Identificada.
Palabra clave: Conservación, fuente semillera, árbol plus, fenotipo, semillas de calidad.

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INTRODUCTION

The research was carried out in an area of the natural forest of the Tropical Garden of the Universidad Técnica Luis Vargas Torres de Esmeraldas (UTELVT). The forest is part of Cerro Mútile located on the southern slope of the Esmeraldas River (0° 54' N, 79° 37' W). The topography of the forest is rugged with slopes ranging from 20 to 60%.

The study area has an area of 20 hectares and an altitudinal range from 25 masl to 125 masl, its geographic coordinates correspond to: 653774.00 - 98990.00 for the lower area and 655645.37 - 99654.39 for the higher area. The forest by its characteristics and species present corresponds to a semi-deciduous lowland forest with a mixture of species of lowland evergreen forest of the Coastal Cordillera sector of the northern subregion of the coast of Ecuador. The natural forest of the Mútile Tropical Garden belongs to the UTELVT and is protected by the administration; however, it is

sporadically subjected to invasions by outsiders who selectively cut canopy trees of commercially valuable species, which causes severe impacts and disturbances to the flora, fauna and the development of its ecological functions.

Acosta-Hernández et al., (2019) states that the management of natural resources is limited to economic, environmental, ethical and aesthetic aspects; however, when working for conservation, some of these aspects are left out and commercial value is weighted as the important factor.

As Brockerhoff et al., (2017) says, native forests provide many ecosystem services for human health and well-being, including maintenance of atmospheric carbon dioxide concentration, water quality and quantity, and high biodiversity. In the modern management of tree species, and especially those that find an industrial use, the technical implications do not consider important aspects from an overall perspective where value is provided to forests beyond the individuals suitable for commercialization (Acosta-Hernández et al., 2019).

On the other hand, natural populations of forest trees are being deteriorated at high speed, not only in size but also dysgenically (selection of genetic variables), this forces the construction of technologies that guarantee the increase of variation in their descendants, not only for adaptation, but for the permanence of this species and that this diversity of genes is used for uses such as watershed protection, CO2 capture, soil retention, environmental humidity and timber products (Rodríguez et al., 2021).

Currently, natural forests are under high pressure from the expansion of the agricultural frontier, land use change to meet urban population growth, and climate change impacts (Cué et al., 2019).

Cerro Mútile, is part of a chain of low ridges (200 to 300 masl) parallel to the coast and which are divided by the Esmeraldas River

(Parker, T.A., III, and J.L. Carr, eds. 1992), is part of the biogeographic Chocó, a natural corridor that extends from southern Panama, Colombia and Ecuador, has an area of 187,400 km2, is the rainiest area on the planet with 16 000 mm of precipitation / year (Herrera and Trujillo, 2019).

The area has been subject to constant modifications due to selective logging, which has caused the change in land use and consequently the decrease in vegetation cover especially of those species of the upper canopy (Parker, T.A., III, and J.L. Carr, eds. 1992). Nevertheless, there still remain forested remnants that hold important biodiversity that help maintain ecosystem processes (Mena-Valenzuela, P and J. Valdiviezo-Rivera (Editors). 2019).

The felling of trees without considering the technical aspects established in the MAATE forest harvesting standard reduces the possibilities of maintaining vegetation in healthy conditions, these inadequate practices lead to the skimming of forests and the loss of biodiversity. In addition, changes in land use and climate change affect natural ecosystems, making it necessary to implement in situ and ex situ conservation programs for commercially valuable forest species and plant communities.

Forest seed sources are the basis for implementing forest genetic improvement programs. Seed sources are not available until they have been located, identified and documented (Cornelius, 2021). In each case, this creates a recognizable entity that can serve as a focus for future activities and funding and facilitates good seed collection practices.

Current seed sources are isolated trees on farms, roads and/or city parks and avenues, which does not necessarily ensure good seed condition. Therefore, the quality of the seedlings that are obtained later on are not necessarily adequate, making it impossible to develop clonal orchards in order to have guaranteed and

registered seed sources. This situation is also manifest in the coast and the Amazon Region (Valladolit et al., 2017).

For their part Atkinson et al., (2018), state that when analyzing the situation of the seed supply system for specific purposes of restoration implementation in Mexico, Guatemala, Costa Rica, Colombia, Peru, Chile and Argentina. They state that these countries have at least some aspects of the seed system for specific purposes, but there are two fundamental gaps common to all: a low diversity of native species is available and used in restoration projects and there is little consideration of the genetic origin and diversity of seeds used.

A successful experience in the field of forest seed production and certification in Latin America is the Forest Seed Bank (BSF) of the Tropical Agricultural Research and Higher Education Center (CATIE) in Costa Rica, reporting an experience of about 50 years of different initiatives aimed at forest restoration and genetic improvement. According to Mesén (2017), the "BSF is a self-sufficient unit commercializing high quality seeds, which annually distributes about 10 tons of seeds to about 20 countries". In Ecuador, the private company PROFAFOR S. A., is the exclusive distributor of seeds from CATIE.

Several studies analyze the situation of the forestry and timber sector in Ecuador with different emphases (MAE, 2018; Mejía and Pacheco, 2013; MAE, 2011; U. Malessa and W. Palacios, 2011; Romero, 2010) these works explore the implications of forestry policies on small-scale forest management by farmers. They also analyze the challenges they experience in achieving sustainable forest management. However, most of the studies focus on regulatory measures and leave aside the focus on productive and systemic linkages as important elements for the sustainable development of forestry activities.

Ecuador has a standard that regulates the use of forest seeds (MAE, 2004), but its implementation by institutions and users is weak. It also has a Procedural Manual for the Identification of seed sources and plus trees (MAGAP 2016), instruments that establish criteria for the establishment of seed sources and the management of forest seeds.

Seed sources can be established in natural forests or forest plantations depending on the genetic quality of the seed required to be produced (Cornelius, J.P. 2021a). Thus, the production of forest seeds from selected seed sources involves a series of activities such as planning, harvesting, processing, storage and marketing. In this sense, natural forests not only provide monetary values for timber, but also for products other than timber, such as forest seeds.

The presence of commercially valuable forest species in the remnants of Esmeraldas' natural forests is decreasing in population density, which could lead to genetic erosion. However, there is a remnant of natural forest in the Tropical Botanical Garden of the UTELVT that due to its conservation status has some species of commercial value in good condition and with interesting population densities that can be technically qualified as seed sources to supply seeds for afforestation and reforestation programs.

Currently, the use of quality reproductive material for native forest species is limited, which can have repercussions on the growth and development of forest plantations. The availability of qualified seed sources is the first step in genetic improvement and will support the production of reproductive material from trees qualified as quality seed producers.

According to the report on the State of Forest Genetic Resources in Ecuador - RGF, there is no well-structured genetic improvement program, but rather initiatives of private companies and

universities. These social actors have conducted specific research studies, but they are far from supporting and responding to a forest genetic improvement plan. On the other hand, the research that is developed is not articulated with the management needs of FGR (Grijalba et al., 2016).

In Ecuador there are limited efforts that lead to the establishment of seed sources for the production of reproductive genetic material of native forest species that are capable of generating quality production in a timely manner. Work to date has been limited to collaborative research projects of Intercooperation / COSUDE in the Andean region, Solidaridad International in Orellana, Amazonia, Fundación ECOPAR and the Metropolitan Municipality of Quito in the highlands and INIAP in some specific activities on the coast.

According to Cornelius (2021a), genetic quality is very important in agroforestry activities because tree species show a lot of genetic variation. Therefore, the genetic quality of two different seed sources can be very different. To address this variation and to choose the most appropriate seed sources or nursery stock, tree planters should consider the following three principles:

Principle 1. All trees should be locally adapted. This is an essential requirement.

Principle 2. All seedling lots should be genetically diverse. This is an essential requirement, except for cultivars.

Principle 3. Where possible, trees should be genetically improved.

According to Grijalva et al., (2016) describes that in Ecuador there are two strategies for seed conservation and/or production, in situ and ex situ conservation. In situ seed conservation and/or production shows results of seed source selection from different institutional actors, where the following can be identified:

EcoPar Foundation selected 20 seed sources in Andean forests in the Sierra.

Asociación de Agrónomos Indígenas de Cañar 13 native species in Cañar and Fundación Ecológica Arco Iris established 14 native species in Loja.
The Metropolitan Municipality of Quito identified 28 seed sources.
The Fundación Española Solidaridad Internacional established 33 seed sources in Orellana.
The initiation of a forest genetic improvement program is fundamentally based on the selection and identification of high yielding trees. This involves the generation of information on the site where seed can be collected in order to establish forest seed sources, as they are the basis for implementing forest genetic improvement programs (Cué et al., 2019).
A seed area is a delimited stand within a natural forest or plantation, which has the best trees and the less desirable individuals are eliminated to avoid crossing with the selected trees. In addition, they will have more space and less competition which will allow higher seed production per tree (SEMARNAT - CONAFOR, 2013 cited by Solís, 2018).
According to Rehfeldt et al., 2002 cited by Ipinza 2018 forest tree species and populations have evolved to adapt to the environment in which they grow. This evolution occurred at both the species and population level. Generally, populations of widely distributed forest tree species become genetically differentiated in order to adapt to the climate, soil conditions and disturbance factors (fire, pests and diseases) that prevail where they grow (Alfaro et al., 2014). Genetic differentiation means that populations of the same species may differ from each other in one or more traits or characters that allow them to survive, grow, compete and reproduce in a given environment. Examples of such adaptive traits are survival, growth rate, resistance to frost damage or drought stress, and timing of seed formation and dispersal (distance and time) (Ipinza, 2018).

Populations must be large (at least several hundred mature trees capable of reproduction) to maintain their inherent adaptive potential and ideally, to facilitate adaptive responses to environmental stimuli or stresses, gene flow to other populations should not be inhibited. Most tree species are characterized by both high diversity and high fecundity; over the lifetime of a single tree, millions of seeds can be produced, and a single surviving offspring is sufficient to replace each parent tree and maintain the population (Cornelius, 2021b).

Forest genetic resources are the heritable material conserved in and among trees and other woody plant species with actual or potential economic, environmental, scientific or social value; they determine the adaptive potential of trees and influence the long-term value of planting efforts to mitigate the effects of climate change. Consequently, forest genetic resources are essential elements on which the effectiveness of adaptation and mitigation responses depend (Loo, 2016).

According to Loo (2016), genetic diversity comprises the heritable differences of individuals that are part of the same species, and the concept of forest genetic resources alludes to tree genetic diversity that is of actual or potential importance to humans. According to Marín (2017), genetic diversity provides the indispensable basis for the evolution of forest tree species.

Nature thus has an enormous potential for selection. However, for this directional selection to be successful, a second condition is that changes in climate conditions are directional and uniform. It is much more unlikely that trees can adapt to survive extreme events than that they will gradually accommodate their behavior to directional changes (Loo, 2016).

The accelerated consumption of natural resources, the change in land use added to climatic variations with greater intensity in recent years causes strong pressure on the populations of forest species

of high ecological and commercial value at the local level, as is the case of species such as: laurel, guachapelí, Fernán Sánchez, dormilón, esmeraldeña mahogany, moral, among others.

Dynamic conservation (in situ) seeks that the existing genetic variation in the conserved material not only guarantees its current adaptability, but also the continuous evolution of the species, maintaining a wide genetic diversity and adaptive potential, through the natural selective pressure of the environment and sexual reproduction. In this way, new genotypes appear by recombination and mating, without phenotypic selection of the parent trees. This strategy requires effective protection against genetic introgression from outside, as well as against fire or other threats to the conserved population (Joseau M.J., et al. 2021).

Modern forestry tends to the establishment of forest plantations with high percentages of seedlings, which form homogeneous populations with acceptable yields in growth and development, but its limitations are presented at the time of having quality reproductive material for the production of quality seedlings (Cornelius, 2021b).

Joseau M.J., et al. (2021) argue that genetic improvement programs for forest species widely used in global forestry, such as in the Pinus and Eucalyptus genera, are more easily carried out thanks to the accumulation of knowledge achieved through several decades of research. However, in poorly domesticated native species, a smooth development of breeding programs is difficult.

In such circumstances, any reforestation program must have a forest genetic resources management program, hence the need to establish seed sources of native forest species for the provision of seeds of known origin and quality that can become seed-producing areas in the future.

In this sense, a forest seed source corresponds to a set of trees of the same species or of different species with acceptable

phenotypic, phytosanitary and dasometric characteristics, which is technically managed for the production of seeds in quantity and quality in a timely manner (Cué., et al, 2019).

As pointed out by Ipinza et al., 2011 cited by Joseau M.J., et al (2021) the high value in native species is not only reduced to timber quality, but extends to non-timber forest products and ecosystem and environmental services. Many of them also have a high adaptive potential, including the possibility of adapting to future climatic changes.

Although the species selected in our study (laurel, guachapelí and Fernán Sánchez) correspond to less diverse families within the Mútile forest (Parker and J.L. Carr, eds. 1992 and Mena-Valenzuela, P and J. Valdiviezo-Rivera, 2019), they possess an interesting number of individuals of codominant and dominant trees with appreciable sizes, in addition, they are pioneer species of the secondary forest and have rapid growth, hence the need for the conservation of genetic resources in situ.

It is a tree that has minimum desirable characteristics for seed production, these individuals are selected in the natural forest or as trees outside the forest or within a forest plantation, the important thing is to define the criteria they should have under the purpose of the plantation (Cornelius, 2021a).

Trees in a natural forest have a high degree of adaptation to the local environment, which they transmit to their seeds through genetic inheritance mechanisms (Gutiérrez, 2019). Seeds, for their part, disperse at relatively limited distances in relation to their progenitors, which allows them to find a similar environment in which to germinate and develop.

From the point of view of forest genetic resource conservation, the main objective is to ensure the survival, adaptation and continued evolution of a species in a continuously changing environment (Ipinza, 2018).

Differences between populations of the same species occupying different regions can be attributed, in part, to phenotypic modification processes in response to different local climatic and edaphic conditions, a phenomenon known as phenotypic plasticity. However, there are important differences that have a genetic basis and have been subject to selection over multiple generations. These genetic differences are the basis on which the delimitation of the areas of origin of forest species is established (Gutiérrez, 2019).

The traits of any living organism are determined by its genetics and the environmental circumstances in which it lives. By genotype (or genetic composition) is meant the set of genes that an individual has. However, the environment in which an organism lives can also influence how its traits are displayed and thus its phenotype. This interaction between genotype and environment is very important for breeding programs so that a program will have to consider the environment in which individuals are intended to grow (Gonzalez, 2019).

In our study the establishment of seed trees with acceptable phenotypic, dasometric and phytosanitary characteristics is for the production of seeds for the establishment of plantations that have the purpose of producing commercially valuable timber. According to Cornelius (2021a), the seed is the starting material for the production of seedlings, and it is essential that it has a good response under planting conditions and that it produces a vigorous seedling to achieve maximum yield in the plantation.

According to Gutiérrez (2019), provenance zones are designed to facilitate the trade of forest reproductive material by identifying the area where the fruits or seeds were collected. They are of great importance due to their impact on relevant aspects of a plantation, such as its adaptability and the reduction of risks of genetic contamination of pre-existing native stands. For this reason, it is

highly convenient to have a division of origin zones to guide and regulate the movement of seeds of native forest species, an aspect that will be particularly relevant to support initiatives for the restoration of degraded forests.

As Cornelius (2021a) states, good quality seeds meet the following requirements: they are healthy and in good condition so that they produce the necessary quantity of seedlings and are of good genetic quality. It is better than the seed used for seedling production from an area with a climate similar to that of your future climate. Climate change specialists usually forecast a range of possible climate conditions, so it will often be best to obtain seed from a variety of sources.

To know if a batch of seed or seedlings has acceptable levels of diversity, you need to know the seed source and how the collection was made. When the seeds collected come from only a few trees, the collection may lack diversity. In general, seed collections should include seeds from about 30 parent trees.

METHODOLOGY

The study subscribes to the Naturalistic paradigm. The approach used was qualitative. Methodologically it is an interpretative, naturalistic approach to the object of study. This means measuring and understanding the visual characteristics of the forest trees that were selected for the study under methodological procedures. In this research work, the techniques of observation and measurement of the trees of the species under study in the field were applied in order to develop a deep and reflexive analysis of the results.

Forms and matrices were used for the collection of field data in the natural forest, we proceeded to collect measurable and quantifiable information on the phenotypic, dasmetic and phytosanitary parameters of the candidate trees of the three forest

species that make up the seed source in the forest of the Mútile Tropical Botanical Garden.

After running the matrix in the field and analyzing the information, the results of the parameters and characteristics evaluated for each of the native trees of the established seed source were defined. Likewise, a bibliographic review of the subject was carried out to compare the results. For the definition of the genetic category of the seed source, interviews were conducted with professors specialized in the subject.

The methods used were: bibliographic review, scientific, exploration and descriptive, and the main techniques used were the instruments that describe the parameters for the evaluation of the phenotypic and phytosanitary characteristics of the trees and the qualitative qualitative qualification table of the trees.

The work was developed in the Mutile forest of the Tropical Garden of the Universidad Técnica Luis Vargas Torres de Esmeraldas - UTELVT, San Mateo parish, Esmeraldas canton, which has an area of 867 ha. According to the Ecosystem Classification System of Continental Ecuador (MAE 2013) these forest remnants present altitudinal and floristic characteristics of a seasonal lowland evergreen forest ecosystem of the Equatorial Chocó and are located between 20 and 300 meters above sea level.

In the Jardín Tropical forest, an area of 20 hectares was selected where the three commercially valuable species of interest (laurel, guachapelí and Fernán Sánchez) are found. The area is located in an altitudinal range of 25 to 125 meters above sea level.

Phase 1. A diagnosis was made of the commercially valuable forest species present in the Mútile forest.

The areas to be studied are those that within the forest of the Tropical Garden of the UTELVT are dominated by the three forest species of commercial interest (Laurel, Guachapelí and Fernán

Sánchez) and associated with other forest species. The work consists of two fundamental aspects:

The literature review on the tree forest species of interest and associated species present in the study area in the Tropical garden.

A description of the forest species of the adult stand and of economic value and also of the fauna associated with these species and which are the seed dispersers.

Field trips were conducted to identify the area of interest to diagnose the characteristic floristic composition, as well as the surrounding area and rapid phenotypic description of the trees and their accompanying vegetation, soil type, slope and topography where the species grow. During the walks it was possible to identify, count and diagnose the laurel, Fernán Sánchez and guachapelí trees, which are the species of interest in the study. Observations of the phenological periods of the species were also made. All this information was accompanied by photographic records of the moment when the areas were diagnosed.

Finally, the information resulting from the diagnosis based on the field visits was processed and analyzed. The most representative tree families and species of the forest were considered. The canopy trees that are present in the area and that possibly have a commercial value due to the uses of these species are described. The trees that have commercial value and share the same habitat as the three species of interest in our work are described. The reason for listing and describing the companion species is so that in the future they can become new seed sources.

Phase 2. Consists of the evaluation of the trees of the species in relation to their phenotypic, phytosanitary and dasometric characteristics.

For the collection of field information on dasometric, phenotypic, phytosanitary parameters, altitude and geographic coordinates, a Field Data Record form was used (Annex 1) contained in the

Manual of methodological procedures for the identification of seed sources and plus trees of MAGAP (2016).
Laurel, Fernán Sánchez and guachapelí trees that were diagnosed within the boundaries of the identified lot were selected.

RESULTS

The natural forest of the Mútile Tropical Botanical Garden is located within the Mútile Hill, located on the southern slope of the Esmeraldas River (0° 54' N, 79° 37' W), those forest remnants present altitudinal and floristic characteristics of a seasonal lowland evergreen forest ecosystem of the Equatorial Chocó (Mena-Valenzuela, P and J. Valdiviezo-Rivera, 2019). Although the area is protected by the UTELVT it is subject to encroachment and illegal timber extraction causing the loss of natural vegetation for the implementation of agricultural crops.
The forest has a rugged topography, with slopes that fluctuate between 20% and 60%. There are shallow, shallow depressions that retain most of the water during the rainy season, which causes noticeable changes in the vegetation. The soil in the sector is rich in nutrients with 960 ppm of potassium (K), 15.8 ppm of phosphorus (P) and 6770 ppm of nitrogen (N), without acidity and with a pH of 7.1-7.2 (Parker, T.A., III, and J.L. Carr, eds. 1992).
The total richness of Cerros Mútile and Zapallo is represented by 52 families, 112 genera and 182 species. The best represented families, in the case of the Mútile forest, are Moraceae (16%) is the family with the highest species richness, followed by Fabaceae (14%) and Rubiaceae, Sapindaceae and Sapotaceae with 6% each, Annonaceae and Meliaceae with 5%, Euphorbiaceae, Lauraceae, Malvaceae and Myrtaceae.
The most representative species for their abundance correspond to: Sorocea arcocarpa, Faramea occidentalis, Talisia setigera, Trichilia martiana, Guarea glabra, Pseudolmedia rigida,

Eschweilera caudiculata and Grias multinervia (Mena-Valenzuela, P and J. Valdiviezo-Rivera, 2019).

In the area where the seed source is established, the topography of the terrain is not very rugged (slopes between 20% - 40%), the natural drainage is moderate in the lower parts, in these places the water withdraws slowly from the surface also due to the presence of organic matter produced by tree litter. There are also naturally fallen trees that are decomposing and contributing organic matter to the soil.

The study area has an area of 20 hectares (5.7 trees / ha) where the three species of commercial value were identified (laurel, guachapelí and Fernán Sánchez), covers an altitudinal range of 25 masl to 125 masl corresponding to a semi-deciduous lowland forest with a mixture of species of lowland evergreen forest of the Coastal Cordillera sector of the northern sub-region of the coast of Ecuador. Geographic coordinates for altitudes above 25 masl correspond to: 653774.00 - 98990.00 and for 250 masl to: 655645.37 - 99654.39).

Likewise, in the area selected as a seed source there are associated tree species that are part of the middle and upper canopy (trees with heights greater than 15 m and diameters greater than 20 cm); these tree species have commercial value and diversity of uses for the construction and furniture industry, in addition, some also have rapid growth (rubber, laurel, Fernán Sánchez, guachapelí, ebony, beldaco).

The species correspond to: laurel (Cordia alliodora, Boraginaceae), Fernán Sánchez or muchina (Triplaris cumingiana, Polygonaceae), guachapelí (Pseudosamanea guachapele, Mimosaceae), sandalwood (Myroxylon balsamum), ebony (Zizyphus thyrsiflora, Rhamnaceae), fig tree (Ficus máxima, Moraceae), beldaco (Pseudobombax milleii, Bombacaceae), moral (Clarisiaracemosa, Moraceae), merequende (Brosimum guianense), pialde (Guarea

guidonia, Meliaceae), caucho (Castilla elástica, Moraceae), guayacán (Minquartia guianensis, Olacaceae), tachuelo (Zanthoxylum spp. , Rutaceae), sabaleta (Clarisia biflora, Moraceae), jigua (Ocotea cernua, Lauraceae), clove (Cestrum sp., Solanaceae), mahogany (Platymiscium sp. Leguminosae), mambla (Erythrina poeppigiana, Leguminosae), tillo (Brosimum alicastrum, Moraceae), dormilón (Cojoba arborea, Fabaceae), ceibo (Ceiba pentandra, Bombacaceae), nacedera (Cornutia microcalycina, Verbenaceae), mate (Crescentia cujete). There are also several species of Ficus (Moraceae) and Inga (Leguminosae) in the area. In this area of the forest where the species of interest in this study are located, there is a prevalence of lianas, especially of the Bignoniaceae family.

In that same area are also found the most common species and the smallest trees (less than 10 m high) such as: Swartzia haughtii (Leguminosae), Sorocea sarcocarpa (Moraceae), and Trichilia pallida (Meliaceae). The most common shrubs (up to 5 m tall) include Psychotria horizontalis (Rubiaceae); Annona sp. (Annonaceae); Acalypha sp., Cleidion sp. (Euphorbiaceae); Piper laevigatum (Piperaceae); Picramnia latifolia (Simaroubaceae); Eugenia galalonensis (Myrtaceae); and a robust Dieffenbachia (Araceae).

Three native tree species of the upper canopy (laurel, guachapelí and Fernán Sánchez) were selected for this work because the individuals share the same area (20 ha and 5.7 trees / ha), are adult trees and generate seeds. The trees have acceptable diameters and heights and correspond to the adult stand, they are scattered in the forest area, as a sample of the natural regeneration process or ecological succession after a disturbance.

The three selected species are of ecological importance, as they are used in agroforestry and silvopastoral systems, in ornamentation (guachapelí and Fernán Sánchez), and of

commercial value due to the diversity of uses, they are used by the industry for construction, elaboration of fine furniture in fine woods. In forest harvesting, the species are cut as trees outside of the forest, but they are found as isolated individuals and their densities and sizes are decreasing.

According to the logging regulations, the minimum cutting diameter (MCD) for laurel is 40 cm, guachapelí 40 cm and Fernán Sánchez 30 cm. However, in this study of conservation of seed sources for laurel diameters at breast height (DBH) were found between 32 cm and 57 cm and total heights between 14 m and 35 m; for guachapelí the DBH found were 29 cm and 71 cm with total heights between 14 m and 28 m and for Fernán Sánchez diameters between 65 cm and 139 cm and total heights between 18 m and 26 m were found.

Phenotypic, phytosanitary and dasometric evaluation of the trees of commercially valuable forest species in the Mútile forest.

A total of 114 candidate trees were identified and selected for phenotypic, phytosanitary and dasometric evaluation for the three commercially valuable forest species (laurel, guachapelí and Fernán Sánchez) in 20 hectares of area. Forty-two laurel, 38 guachapelí and 34 Fernán Sánchez trees were evaluated (Table 1).

Table 1. *Trees identified for phenotypic and sanitary evaluation in Bosque Mútile.*

ESPECIE	Árbol Identificado	%	Superficie evaluada (Ha)
Laurel	42	37	20
Guachapelí	38	33	
Fernán Sánchez o Muchina	34	30	

	114	100

Elaboración: Autor 2022

The three species share the same habitat in the natural forest remnant, therefore, they present altitudinal and floristic characteristics of a seasonal lowland evergreen forest ecosystem of the Equatorial Chocó.

According to the tree classification table, it was determined that of the total (114 individuals) of trees evaluated, 73 reached the rating of Excellent Trees, which correspond to Class 1, and 41 trees reached a rating of Good Trees and are in Class 2 (Table 2 and 3).

In this sense, for the laurel species, the phenotypic, phytosanitary and dasometric parameters of a total of 42 trees of the adult stand were identified and evaluated.

According to the score calculated for the phenotypic and phytosanitary evaluation, 25 trees (60%) were rated as Excellent Trees and obtained values between 27 and 31 points, which corresponds to Class 1.

On the other hand, 17 trees (40%) achieved a rating of Good trees, which is between the ranges of 19 to 26 points, corresponding to Class 2 (Table 2). In this evaluation, 2 trees were found dead and standing but were not considered for the study due to their condition.

Table 2. *Rating of trees evaluated according to phenotypic and phytosanitary evaluation.*

ESPECIE	Árbol Identificado	Árbol Evaluado	%	Calificación de los árboles evaluados		Total de árboles calificados
				Excelente (27-31 puntos)	Buena (19-26 puntos)	
Laurel	42	42	37	25	17	42
Guachapelí	38	38	33	31	7	38

Fernán Sánchez o Muchina	34	34	30	17	17	34
	114	114	100	73	41	114

Elaboración: Autor 2022

The trees evaluated and qualified in the two categories found in the study have the following characteristics: in relation to the shape of the trunk and the bifurcation, 32 trees are found in the upper canopy and are dominant or co-dominant trees, straight and without branch bifurcations, however 10 trees had bifurcations in the upper third. The predominant crown shape characteristic of the trees is irregular circular for 25 trees (60%), 15 have circular crowns (35%) and 2 trees have half-circular crowns.

The Mútile forest covers an area of 899.64 hectares and the natural vegetation cover is the largest with 641.16 hectares of forest area (71.27%). The recovery area is located next to the Tropical Garden and has an area of 33.06 hectares and represents 3.67%.

According to Mena-Valenzuela, P and J. Valdiviezo-Rivera (2019), the best represented families in relation to their abundance in the Mútile forest, are Moraceae (16%) is the family with the highest species richness, followed by Fabaceae (14%) and Rubiaceae, Sapindaceae and Sapotaceae with 6% each, Annonaceae and Meliaceae with 5%, Euphorbiaceae, Lauraceae, Malvaceae and Myrtaceae and Bignoniaceae. However, the legume family is the least diverse in relation to this type of cloud forest (Parker, T.A., III, and J.L. Carr, eds. 1992.).

On the other hand, the most representative species according to their abundance are: Sorocea arcocarpa, Faramea occidentalis, Talisia setigera, Trichilia martiana, Guarea glabra, Pseudolmedia rigida, Eschweilera caudiculata.

Other species that have commercial value in the market and that are associated with the species of our study and that possibly have

lower population density in that sector of the natural forest are: sandalwood (Myroxylon balsamum), ebony (Zizyphus thyrsiflora, Rhamnaceae), fig (Ficus máxima, Moraceae), beldaco (Pseudobombax milleii, Bombacaceae), moral (Clarisiaracemosa, Moraceae), merequende (Brosimum guianense), rubber (Castilla elastica, Moraceae), guaiac (Minquartia guianensis, Olacaceae), sabaleta (Clarisia biflora, Moraceae), jigua (Ocotea cernua, Lauraceae), mahogany (Platymiscium sp. Leguminosae), mambla (Erythrina poeppigiana, Leguminosae), tillo (Brosimum alicastrum, Moraceae), dormilón (Cojoba arborea, Fabaceae), among others.

According to Aguirre (2012), in the case of the species in this study: Cordia alliodora, Triplaris cumingiana, and Pseudosamanea guachapele are species that are present in dry forests and have a greater distribution area, since they can grow and develop in primary and successional forest from 0 m to 1500 m above sea level. However, they are not the most representative species of the Mutile forest. On the other hand, the three species of commercial value in this study grow at altitudes from 0 to 125 m above sea level, which corresponds to a semi-deciduous lowland forest with a mixture of lowland evergreen forest species from the Coastal Cordillera sector of the northern subregion of the Ecuadorian coast.

As noted by Mena-Valenzuela, P and J. Valdiviezo-Rivera (2019), the species laurel, Fernán Sánchez and guachapelí are not among those of greatest abundance, in our study we were able to learn that in an area of 20 ha there are about 5.7 trees per hectare for DBH greater than 30 cm and with commercial heights greater than 15 m.

According to MAGAP (2016), laurel, Fernán Sánchez and guachapelí are species that are part of the 19 forest and agroforestry species encouraged for reforestation due to their demand as raw material for supplying the timber industry, for the

production of fine furniture and other household products. These species established in commercial forestry plantations, agroforestry plantations, and in strips contribute to the reduction of the natural forest and incorporate new lands with forestry vocation to the productive sector.

An interesting aspect of the presence of forest species of commercial value in this forest is the guachapelí tree, which is also found in this forest with interesting sizes (DBH from 0.30 m to 0.7 m and total heights of 28 m) and was encouraged by MAGAP as a species for commercial purposes in strips. According to Parker, T.A., III, and J.L. Carr, eds. (1992), the area where the study species are found is an area that several decades ago was influenced by changes in land use and selective exploitation of trees; however, this situation has changed and there is less disturbance of the forest, especially in the lower parts due to the activities of the Tropical Garden of the University.

In the present study it was determined that in the recovery area adjacent to the Tropical Garden (20 ha of surface for this study) there are more than a hundred canopy trees with DBH greater than 30 cm with good sizes, healthy and developing of the three species (laurel, Fernán Sánchez and guachapelí); that there are also other species that have commercial value but possibly have low population densities. In this case, the state of development, growth, phytosanitary and population densities of laurel, Fernán Sánchez and gachapelí found in the upper canopy trees and with DBH greater than 30 cm shows that they can be an important source for seed supply, since trees with these sizes and population densities in small areas are not present in areas of secondary forest and outside the forest because they have been harvested. Hence the need for conservation of these forest genetic resources for commercially valuable species.

Phenotypic, phytosanitary and dasometric evaluation of trees of commercially valuable forest species in the Mútile forest.

The three species were identified and selected for phenotypic valuation due to the commercial value they represent for their demand as timber for the construction industry and furniture making, mainly for laurel and Fernán Sánchez. However, for guachapelí its commercial value is presented as a tree to produce wood for posts, fences, constructions and cabinetmaking on a smaller scale.

Before starting the process of phenotypic, phytosanitary and dasometric evaluation of the candidate trees, it was necessary to know that the species of interest in the study were present in the forest area of the Tropical Garden of the university and that they are young and physiologically mature trees, that the area is not subject to tree exploitation and is easily accessible. According to Mena-Valenzuela, P and J. Valdiviezo-Rivera (2019) the area where the candidate trees to be evaluated are located is located in an area called Recovery Zone of 33.6 hectares. After a series of visits to the forest and conversations with the person in charge of the university's Tropical Garden, it was determined that the area with the greatest presence of trees is located in this sector.

Although it is true that there are several methods for the selection and establishment of seed trees with a variety of criteria (tree comparison method for coetaneous stands, regression or baseline selection method for disetaneous stands, individual valuation method for disetaneous or heterogeneous forests). The method used in our work was the individual valuation that valued 10 parameters and 30 characteristics presented in the Manual of procedure for the identification of seed sources and plus trees (MAGAP, 2016). According to the characteristics of the natural forest that presents environmental variation and trees with different

ages, the heritability in this type of populations is low from the point of view of Cornelius, J.P. 2021.

As noted by Grijalba et al, (2016) in their report of the State of Forest Genetic Resources for Ecuador that several institutions and organizations have established seed sources in Andean and Amazonian forests using different methods and criteria for valuation, although this was important for the selection of seed trees, there was still a need for a manual with unified criteria for the phenotypic valuation of trees in natural forests that would allow a more technical valuation and integrate phenotypic and genotypic aspects for the founder population as pointed out in the Manual for the identification, selection and evaluation of seed sources of MAGAP (2016).

In the study, a total of 114 trees of the three species (laurel, Fernán Sánchez and guachapelí) were evaluated in two in two types of tree grades evaluated. It was determined that 73 trees correspond to Class 1 rated as Excellent Trees and 41 trees achieved a rating of Good Trees and are in Class 2.

The selection of trees with acceptable phenotypes is for the conservation of forest genetic resources of commercially valuable species and for the production of seeds with wide genetic diversity. Cornelius (2021) mentions that the use of seeds with low genetic diversity can cause problems due to inbreeding depression, for this reason, he suggests that seed collection should be done from at least 20 individual trees. As a result of the study, the phenotypically acceptable qualified trees correspond to 42 individuals of laurel, 34 individuals of Fernán Sánchez and 38 of guachapelí.

All qualified trees have a DBH equal to or greater than 30 cm, in order to be physiologically mature and capable of producing viable seeds.

For this study, the distance between the selected seed trees was 20 m, regardless of the species; however, the founding seed

population could be expanded in the future to favor the development of superior material.

Although the phenotypic, phytosanitary and dasometric aspects are included in the results, it should be noted that the three species show a good state of health, likewise, the laurel trees show homogeneous sizes in DBH, but diverse in total heights, it should be noted that the site where the trees are located is a recovery area or secondary forest in development and competition with associated species.

It is important to note that the weighted values for DBH are 0.99 (DBH = 57 cm), for commercial height 1 (Hc = 28 m) and for total height 1 (Ht = 35 m), one of the reasons for these sizes is explained by the condition in which these trees grow and the state of health of the natural forest. Trees of these sizes are no longer found in areas outside the forest and in protected forests their sizes are smaller in relation to population densities.

In the case of Fernán Sánchez, which is a dioecious species with a Dioecia sexual system (it has male and female flowers in different trees), there are 34 individuals with very interesting DBH and heterogeneous heights, due to the condition of the sexual system of the species, it is necessary to know the percentage of male and female trees within the selected source.

The values of the phenotypic characteristics are 17 individuals for Excellent Qualification and 17 trees for Good Qualification, the differences between these two categories, mainly lies in the sizes of the diameters, heights and the bifurcation in the upper third of the tree.

Initially we had pointed out that this species is part of the recovery zone, which is a secondary forest with some clearings and moderate slopes. Possibly the reason for the homogeneity in DBH and total tree heights in this species is that the trees are growing and developing in the open field since it is a pioneer species of the

secondary forest and there is also less disturbance in the recovery area.

For the characteristics evaluated for the guachapeli trees, the study was able to show that 38 canopy trees were evaluated; 31 are qualified as Excellent Trees and 7 individuals as Good Trees, on the other hand, the weighted values for DBH correspond to 0.7 which shows certain homogeneity in the diameters found which are less than 45 cm, only few individuals reached values of 60 to 70 cm in diameter. However, under this same analysis heterogeneous weighted values were found that are less than 0.6 for both total heights and commercial heights.

This is the only one of the three species that showed much variability in the measurements of total heights, commercial heights and diameters, this is possibly due to the fact that the trees are in competition with other species and that it was probably the species selectively harvested several years ago. However, under this analysis most of the trees achieved a rating of excellent trees. It should be noted that this species is deciduous and grows in areas outside the forest, as isolated individuals and with limited competition.

According to MAGAP (2016) and Aguirre (2012) guachapelí, in addition to producing wood of high strength and quality, is a tree that provides a lot of high quality forage for livestock, fixes nitrogen and is drought resistant. Guachapelí has a high potential as a quality raw material for the timber industry, as long as the area planted with trees is increased. Therefore, it is important to encourage the establishment of trees with quality seeds from conserved seed sources.

In the case of phenotypic, phytosanitary and dasometric assessment for native trees of commercial value, using a methodology with unified criteria it has been difficult to establish comparisons with other studies (Valladolid et al., 2017, Moreno et

al., 2018), because some studies are conducted for trees in plantations with coeval ages and with fewer phenotypic parameters and characteristics to evaluate.

Characterized seed-producing sources of commercially valuable species for conservation.

In order to improve the protocols for forest propagation of commercially valuable species of laurel, Fernán Sánchez and guachapelí and to promote the conservation of genetic resources, three seed sources were established in the Tropical Garden of the Mútile forest.

Forest seed sources are the basis for implementing forest genetic improvement programs. As stated by Cornelius (2021a), seed sources are not available until they have been located, identified and documented. Gutiérrez (2019) refers that it is widely accepted that in any reforestation work it is of great importance to know the origin or provenance of the material to be established.

Different forms of characterization of the trees can contribute to the efficiency of harvesting and in the quality of the seed, for our study the sources were characterized from the evaluation of phenotypic, phytosanitary and dasometric parameters under parameters and characteristics with weighted values that allowed defining a classification of the trees that make up the seed source.

Cordia alliodora (laurel), Triplaris cumingiana (Fernán Sánchez) and Pseudosamanea guachapele (guachapelí) are species of commercial value for the country, with a diversity of uses and widely used especially in the construction industry and fine furniture production. However, there are no records of published works on conservation and genetic improvement; what is found are works on the selection of seed sources of forest species in the Andean region and the Amazon developed by different institutional actors, but as

specific actions and not from the management for seed production (Grijalva et al., 2016).

The seed source defined in the genetic category Identified Source for the three species of the study consists of 114 trees. The results of the evaluation of phenotypic, phytosanitary and dasometric characteristics state that 73 trees achieved a rating of Excellent Trees (Class 1) and 41 trees obtained a rating of Good Trees (Class 2).

The greatest contribution of Class 1 trees corresponds to guachapelí (31 individuals) and laurel (25 individuals), while Fernán Sánchez contributed 17 individuals. For Class 2, laurel contributed 17 individuals, Fernán Sánchez 17 trees and guachapelí 7 individuals.

The analysis of the results of the phenotypic and phytosanitary evaluation showed that most of the trees evaluated are in Class 1 and Class 2; which reveals that they are dominant and co-dominant trees, straight with little sinuosity in the stem and that they present bifurcations in the upper 1/3, they are healthy and vigorous trees for those in Class 1. Likewise, Class 2 trees are dominant or co-dominant with slight sinuosity in the stem, with slightly inclined, thick and medium thick branches, they can present bifurcations in the middle third, this aspect can be characteristic for Fernán Sánchez. In this work there were no Class 3 trees (unacceptable trees).

Once the number of trees qualified in the different classes has been determined, we proceeded to define that the seed source should be formed by the 114 individuals of Class 1 and Class 2. Under these considerations, it is proposed that the collection of forest seeds be made from the trees that make up Class 1 and Class 2 for the three commercially valuable forest species.

Once the number of phenotypically acceptable trees was defined, the type of seed source that corresponds to the evaluated lot was

determined in order to declare it as a seed-producing area. According to the Forest Seed Standard for Ecuador (MAE, 2004) and the Manual for the identification of seed sources and trees plus MAGAP (2016), 5 genetic categories of seed sources were established: Proven Seed Orchard - HSC, Unproven Seed Orchard - HSNC, Seed Stands - RS, Selected Seed Source - FSS and Identified Seed Source - FSI.

For the genetic categorization of the seed source or seed stand it is required to comply with some characteristics: area of the stand or seed producing area, number of trees per hectare that make up the seed stand, number of trees suggested for seed collection and the area of isolation of the stand or seed source depending on the genetic category.

In our study the seed source is formed by a total of 114 trees of the three forest species: 42 trees for laurel, 38 trees for guachapelí and 34 trees for Fernán Sánchez, the area occupied by the seed source for the three species is 20 hectares, the number of trees recommended for seed collection in Class 1 and Class 2 is greater than 30 individuals.

With the information obtained, it was determined that the corresponding genetic category for the seed producing area is the Identified seed source, since this type of seed source has as criteria that the stand has less than 50 trees per hectare with desirable phenotypic characteristics, the area is less than 1 hectare and suggests the collection of seeds from at least 20 trees in the stand, these stands do not present isolation because they are considered a temporary seed source in the absence of other seed sources.

The size of the source can vary in relation to the characteristics of the seeds, it is necessary to maximize the number of seed trees in a managed forest. In the case of dioecious species, such as Fernán Sánchez, it is important to leave the same number of male and female trees to avoid a genetic bottleneck and as a result reduce

the extent of genetic variation in the species (Cornelius, J.P. 2021b).

As stated by Brockerhoff et al., (2017), the diversity of forest structure and composition must be maintained at regional and landscape scales as a spatial insurance to provide habitats for a large assemblage of specialized forest species. The first efforts to try to conserve forest genetic resources in fragmented natural forests with a significant number of commercially valuable species stem from this type of work that seeks to establish seed sources with phenotypically acceptable trees to ensure the conservation of genetic variation. It is important to note that this type of forest, of which very few remain in a healthy form in the province of Esmeraldas, provides habitat for other taxa (legumes, lianas and lianas) and other key ecosystem services (animal pollination) for the functioning of the forest ecosystem, for this reason, it is important to deepen studies with basic metrics (abundance, species composition, phenotypic and dasometric assessment, among others) in order to have data to implement actions to reduce the loss of species.

CONCLUSIONS

The identification, selection and evaluation of forest seed sources is essential for the development and sustainability of afforestation and reforestation programs implemented at the regional or national level, which will help to obtain quality seeds or propagation material.

Forest species present a great variability of characters related to adaptation to different ecological conditions. This variability can have a marked effect on growth, health, development and production. Hence the need to conserve seed sources or seed-producing areas with phenotypic and genetic characteristics similar to the site where the plantation will be established.

Three seed sources of forest species were characterized: laurel (Cordia alliodora, Boraginaceae), Fernán Sánchez or muchina (Triplaris cumingiana, Polygonaceae), guachapelí (Pseudosamanea guachapele, Mimosaceae) with 114 trees and 20 ha of surface, the trees are located between the altitudinal ranges of 25 to 125 masl of the native forest Mútile, and their parameters and characteristics were evaluated as positive using the MAG (2016) methodology that has unified criteria for the establishment and conservation of seed sources in natural forests.

It is determined that the 3 seed sources have phenotypically acceptable trees because in the qualitative qualification they reached ratings of Excellent Trees (Class 1) and Good Trees (Class2). Of the total number of trees evaluated, 73 were rated Excellent and 41 Good trees. For laurel, 25 trees were rated Excellent and 17 Good Trees; for guachapelí 31 individuals are Excellent and 7 are Good and for Fernán Sánchez 17 are Excellent Trees and 17 are Good Trees.

The three forest species that make up the seed source of interest occupy the same habitat and their population densities as canopy trees are low (5.7 trees / ha for the 3 species), since they are natural forest species. However, these trees have appreciable sizes and development and are located in an area of easy accessibility and undulating to flat topography that facilitates the conservation and management of the seed source.

According to the categories of seed sources established in the Procedure Manual for the identification of seed sources and plus trees (MAGAP, 2016 and MAE, 2004), it is established that the seed sources are qualified in the Genetic Category of Identified Seed Source - FSI, due to the low density of canopy trees (it is not a forest plantation) and has more than 20 individuals with phenotypic, health and dasometric characteristics acceptable to be considered as seed trees.

In relation to the quantitative parameters and the number of seed trees registered in one hectare, they do not comply with what is suggested in genetic conservation studies such as from Cornelius 2021a, which suggests that for genetic variability to exist, the seed source must contain at least 50 mother trees, However, the established seed source reaches more than 30 seed trees in each species, which represents an apt number for seed collection as pointed out by MAGAP (2016) and Cornelius (2021b).

According to the qualitative parameters of the seed trees evaluated, it is determined that for the three species there are trees that achieved ratings of Excellent Trees and Good Trees, which suggests that seeds can be collected from both classes, taking into consideration what is suggested by Cornelius (2021b), MAGAP (2016) and MAE (2004).

Based on the dasometric parameters found for the three species: laurel (Cordia alliodora), Fernán Sánchez or muchina (Triplaris cumingiana), guachapelí (Pseudosamanea guachapele), it can be noted that guachapelí trees show weighted values higher than 0.7 for DBH and 1 for total and commercial heights, for laurel it reached 0.99 for DBH and 1 for heights and for Fernán Sánchez it reached weighted values of 1 for DBH and 1 for total and commercial heights, which indicates that the trees are dominant and co-dominant and have good development in both heights and diameters. These dasometric characteristics associated with the phenotypic and phytosanitary characteristics of the population, define it as a suitable seed source for seed collection in the absence of other seed sources.

The species Triplaris cumingiana is a dioecious species that for our study the seed source consists of 34 phenotypically acceptable trees, however, we do not know the number of female and male trees in this source. In the case of dioecious species, it is necessary

to select in the natural forest the same number of seed trees and male trees to ensure an acceptable amplitude in genetic variation. The Mutile forest contains important species of commercial value that need to be qualified as seed sources for the supply of seeds for reforestation programs of commercial species. It is important that these studies continue and expand in order to document phenotypic and genetic variability in more depth, and thus better support the management of forest genetic resources.

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