Rubber Tree Cultivation and Improvement: Biological Aspects and the Risk of Inbreeding Depression

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Abstract— *Rubber trees (Hevea spp.) are among the essential plants cultivated and have contributed to Malaysia's economy growth for many decades. Latex harvested from rubber trees is an irreplaceable raw material and accounts for a wide range of uses in tires, tubes, footwear, rubber gloves, and other rubber-based products. There were many attempts to produce ideal rubber tree for increasing latex yield production through the improvement programmes since 1950s. However, the risk of inbreeding depression and the planting materials produced from the chosen parents that are closely related in the improvement programmes is fairly high. Inbreeding depression caused discouraging effects such as uneven bark surface, leaf disease infection, easily damaged by wind blows and eventually reducing the production of latex yield overall. This review highlights the important of biological aspects for latex production in rubber tree and seeing minimizing the risk of inbreeding depression with the necessity of broader genetic base in the rubber tree cultivation and improvement programmes.*

Keywords*— *Inbreeding depression, genetic base, rubber.

I. INTRODUCTION

Genus of *Hevea* belongs to the *Euphorbiaceae* family, mainly climber herbs, shrubs, and trees. It is among the largest families of plants, comprising over 230 genera and 5,700 species. Generally specified in the grasslands, *Euphorbiaceae* has the most vegetation types, including grain forest trees, weeds, and succulents. In South America, *Hevea* trees can be found in forests in Brazil, Bolivia, Colombia, Ecuador, French Guiana, Guyana, Peru, Suriname, and Venezuela (Webster and Paardekooper, 1989; Schultes, 1990; Priyadarshan, 2011). The successful transplantation and domestication of rubber trees from the Amazon forest has allowed Malaysia to play an essential role as one of the most critical natural rubber suppliers in the world for the past several decades. According to a report by the Malaysian Rubber Board (MRB) in 2019, the estimated total production of natural rubber in 2019 from smallholdings and estates in Malaysia was recorded to be 639,000 tons. The total export value of natural rubber and rubber products amounted to approximately RM 40 billion (Natural Rubber Statistics 2019, http://www.lgm.gov.my/nrstat). The primary destinations for raw rubber exports in 2019 were China, Germany, Finland, Iran, the USA, and other countries. In recent trends, the high global demand for natural rubber is a positive sign and robust progress for many rubber-producing countries such as Malaysia.

II. RUBBER TREE CULTIVATION AND IMPROVEMENT IN MALAYSIA

The most famous event in natural rubber history was the considerable amount of natural rubber produced by plantations to meet the Industrial Revolution's demand. Currently, the use of natural rubber has triumphed from diverse domestic products, to those used in industry. Natural rubber is the polymers' chain that displays high resilience and impact resistance, elasticity, and low heat swelling during production process. Due to the distinct molecular structure of rubber, it is difficult to be matched by synthetic rubber that is extracted from petroleum sources. It began in 1876 when Henry Wickham collected approximately 70,000 rubber seeds, primarily *H. brasiliensis*, near the Tapajos River in Brazil, and attempted to sow them in the UK. These small seedling populations were then transported to Ceylon (Sri Lanka) and Singapore in 1876. During the transportation journey, only 22 seedlings survived, and arrived in Kuala Kangsar in 1877. The 22 seedlings in Kuala Kangsar constitute the genetic base for rubber planting materials in The Federation of Malaya (Ong *et al.*, 1983; Baulkwill 1989; Barlow 1978; Loadman 2005, MRB 2005). In 1957, the Rubber Research Institute of Malaya, later known as the Rubber Research Institute of Malaysia (RRIM), launched its major *Hevea* improvement program. RRIM initiated with a small organization with only a few divisions, and took over the responsibility for research and support of works related to rubber from the Department of Agriculture, Malaysia. It has established several experimental stations in Selangor and Johor to provide technical support, services, and *Hevea* improvement programs in the country (MRB, 2005). Before the 1950s, seedlings that were germinated from rubber seeds were widely recognized as planting materials by either rubber plantations or smallholdings. Generally, seedling trees can produce different yields and unpredicted characteristics. However, seeds obtained from the established RRIM experimental gardens are considered useful and highly recommended for planting in quality (Mass, 1919; Cramer, 1924; Holder and Heusser, 1928; Heuser 1932; RRIM, 1957).

In the 1950s, bud grafting was tested and recognized as a useful technique in which clonal seedlings produced a high amount of latex from the planting materials, including Tjirandji 1, RRIM 501, RRIM 526, AVROS 157, and PR 107 (RRIM, 1952; Webster and Baulkwill, 1989). Subsequently, the planting materials derived from bud-grafting rapidly substituted the unselected seedlings from the experimental seed gardens (Burkill, 1959; Priyadarshan, 2011). Rubber planting guidelines began with the first introduction in 1957, and provided information and evidence on high yielding planting materials, disease resistance, and wind damage incident in Malaysia's rubber growing areas (Ong *et al.*, 2011). PB 86, Tjirandji 1, RRIM 501, RRIM 513, and GI 1 were recognized as excellent planting materials at the time, and were recommended for wide-scale planting in Malaysia. In 1967, the RRIM 500 clone series was replaced by the RRIM 600 clone series; which later emerged to be the most popular planting materials for several decades (RRIM, 1959; RRIM, 1961; RRIM, 1963; RRIM, 1967; Shepherd, 1969). Later, numerous rubber-planting materials were introduced in the 1970s, including RRIM 709, RRIM 801, IAN 873, PB, and 230, PB 243, PB 253, PB 254, PB 259, PB 262, PB 310, PB 311, and PB 312. However, all of these planting materials were derived from the parent trees of *H. brasiliensis* (RRIM, 1975; RRIM, 1977).

In 1980-1997, RRIM planting recommendations were reported to detect major leaf diseases, soil categorization, and wind damage incidents. Planting materials were classified into three primary categories and grouped into Classes I, II, and III. This planting recommendation highlighted Class I planting materials for a wide area of planting. RRIM 600, RRIM 712, GT 1, PB 217, PB 260, PR 255, and PR 261 were highly recommended for planting from 1980 to 1994 (RRIM, 1980; RRIM, 1983; RRIM, 1986; RRIM, 1989). RRIM thus tested several rootstocks with proven performance like the PB 5/51 and the RRIM 623, which produced a high survival rate when bud-grafted with commercial planting materials such as GT 1, RRIM 605, RRIM 712, RRIM 901, PB 217, and PB 235 (RRIM, 1983; RRIM, 1986; RRIM, 1992). In 1995-97, MRB planting recommendations emphasized the selection of Latex Timber Clones (LTC) as suitable planting materials for producing high latex yields and rubberwood through their breeding programs. Latex yield remains the most auspicious characteristic, while rubberwood production was another aspect of planting LTC (RRIM, 1995; Ong and Nasaruddin, 2011; Ratnasingam *et al.*, 2011). Currently, commercial planting materials typically originate from the Large Scale Clone Trials (LSCT) such as RRIM 901, RRIM 908, RRIM 911, RRIM 921, RRIM 936, RRIM 940, PB 260, PB 350, PB 355, PB 359, and PB366 (Ramli *et al.*, 1996; MRB, 2006; MRB, 2009). The typical commercial planting materials were developed from *H. brasiliensis* ever since then and were extensively cultivated in Malaysia.

III. BIOLOGICAL ASPECTS FOR YIELD PRODUCTION

3.1 Flowers and Fruits

Rubber trees and other *Hevea* species have a diploid number of chromosomes (2n = 36) (Ong, 1981; Webster and Paardekooper, 1989; Vinod and Meenattoor, 1991). The standard features of *Hevea* species include prominent trifoliate leaves with separated male and female flowers at the same inflorescence and a trilocular capsule fruit pod, containing three seeds and latex in almost all parts of the tree. The inflorescence has multiple branches and panicles with both male and female flowers. The female flowers are produced at the end of the branches, while the male counterparts are born on other panicle parts. After five years of planting, they begin to blossom, but rarely open together, encouraging cross-pollination (Barlow, 1978). Insects usually pollinate the flowers, and cross-pollination is common in rubber trees. Five months after the female flowers are pollinated and fertilized, they ripen as a trilocular capsule of fruit pods that explode and eventually disseminate the seeds (Barlow, 1978; Webster and Paardekooper, 1989).

3.2 Bark

Natural rubber or latex is harvested by cutting the outer layers of the bark structure of a rubber tree where a group of specific cells known as laticifers (commonly known as latex vessels) are located in the inner bark (Shamsul Bahri, 2000). The bark structure consists of several distinct soft and hard layers. Soft bark is the thin layer of cells that produces rows of cells as concentric cylinders of parenchymatous tissues and tube cells that eventually form the laticifers. The laticifers are arranged in regular rows that are nearly parallel to the cambium that ultimately routes up in a tree trunk. Meanwhile, hard bark is the waterproof layer with an abundance of stone cells and active phellogen, forming a cork layer that hardly produces latex (Barlow, 1978; Gomez, 1982).

3.3 Leaves

The leaves are typically arranged into three leaflets on a rubber tree, sometimes with prominent leaf stories and canopies, and often experience leaf defoliation once a year (Webster and Paardekooper, 1989; Schultes, 1990). Features such as the leaf shape and orientation allows the identification of different planting materials observed in *H. brasiliensis* (Md.Zain *et al.,* 1997; Mercykutty *et al.,* 2002). Leaf characteristics in the plant kingdom usually show higher dissimilarities in morphological appearance than those of the stems and roots; leaf shape and venation architecture are particularly useful identification features (Dale *et al.,* 1971; Hickey, 1973; Dickinson *et al.,* 1987). Hickey (1979) and Mercykutty *et al.* (2002) found the essential morphological features for the classification of specific plant species in a type like a leaf shape, leaf size, leaf venation pattern, leaf margin, and the shape of the leaf's tip and base. In budwood nurseries, the leaf's presence for clonal identification is particularly important to ensure the propagation of correctly identified planting materials. More than 200 rubber budwood nurseries currently exist in the country country, and the private and public sectors annually produce nearly 1 million clonal polybag plants (Shamsul Bahri *et al.,* 2013).

3.4 Stomata

The guard cells are specialized epidermal cells assisted by subsidiary cells in a normal condition, where the contraction and expansion of the stomata for gas exchange occurs during photosynthesis. Stomata actively open and close during the daytime, due to a response to light intensity, carbon dioxide concentration, and humidity, with the aid of surrounding cells. Several stomata classifications are proposed for *Hevea*; primarily based on the evolution of related ontogeny structures (Metcalfe and Chalk, 1950; Esau, 1977; Hickey, 1979; Patel, 1979; Baranova, 1992; Das, 2002; Carpenter, 2005). However, the most commonly accepted classification of stomata is based on the mature stomata and subsidiary cells proposed by Metcalfe and Chalk (1950). In general, several types of stomata in dicotyledonous plants are classified based on the number and arrangement of the subsidiary cells into anisocytic, anomocytic, actinocytic, cyclocytic, diacytic, and paracytic groups. Anisocytic type stomata are surrounded by only three subsidiary cells that vary in their position, shape and size, and are distinctly smaller than the other two. Stomata of the anomocytic type are surrounded by many subsidiary cells that are irregular in shape and size. Moreover, actinocytic type stomata are surrounded by at least four or more subsidiary cells. On the other hand, the diacytic type stomata are surrounded by a couple of distinct or indistinct subsidiary cells that are at right angles to the guard cells. The cyclocytic type stomata are surrounded by several subsidiary cells encircling the guard cells. In contrast, in the paracytic type of stomata, stomata are surrounded by two subsidiary cells that are arranged parallel to them.

3.5 Laticifers

Latex is harvested by systematically removing the external bark layers of rubber trees. Gomez (1981) and MRB (2005) stated that the anatomical organization of the bark structure of *Hevea* could be divided into two distinct layers of the internal soft zone (closer to the cambium) and the external hard zone (stone cells and cork). In *Hevea*, the laticifer is developed mainly in the soft bark layer in which latex is produced, and the laticifers are successively produced in the cambium region. However, in previous research, the rubber plant breeders paid little attention to describing the bark surface and several laticifers in *Hevea* species (Frey-Wyssling, 1930, RRIM, 1957; RRIM, 1963, RRIM, 1994). The laticifers' functions are speculated as latex production, physiological activities, cellulose content production, protection against insect attacks, and contribution in a transportation pathway (Pakianathan *et al.,* 1989; Kutchan, 2005; Pickard, 2008; Konno, 2011). Esau (1965) and Shamsul Bahri (2000) distinct that rubber tree laticifers as a series of articulated fused cells that sustain latex and form systems that penetrate the plant body via various tissues. There exist other plant species that also comprise similar laticifer systems, including *Papaver* and *Lactuca* (lettuce) species. Meanwhile, non-articulated laticifers are produced from individual cells and develop into branched or unbranched tube-like structures where these type of laticifers are not fused (de Fay and Jacob, 1989; Shamsul Bahri, 2000; Hagel *et al.,* 2008).

3.6 Rubber Particles

Rubber particles derived from *H. brasiliensis* are described as the hydrophobic center of cis-1, 4-polyisoprene surrounded by complex lipoprotein layers with two types of rubber particle proteins known as Rubber Elongation Factor (REF) and Small Rubber Particle Protein (SRPP) (Siler *et al.,* 1997; Cornish *et al.,* 1999; Nawamawat *et al.,* 2001). In *Hevea* latex, REF and SRPP range from 117 to 298 amino acids with molecular weights of 14.5 and 24-kiloDaltons (kDa) respectively. REF and SRPP are vital proteins taking part in latex production initiation in rubber trees (Oh *et al.,* 1999; Wood and Cornish, 2000;

Cornish, 2001; Wititsuwannakul *et al.,* 2008). The variations in the surface protein contained in *Hevea* plant were indicated by studies on Large Rubber Particles (LRPs) and Small Rubber Particles (SRPPs), mainly for commercial planting materials, but no direct links were made between rubber-formed particles size and molecular weight suspended in latex, and surface proteins (Cornish, 1993; Wood and Cornish, 2000; Sight *et al.* 2003). According to Paardekooper (1989), latex collected from *Hevea* is a cytoplasm that is rich of mainly rubber particles and other cell organelle such as plutoids in which rubber particles are made of a group of polymer chains that are bound together by a glycoprotein membrane. Additionally, lipids membranes, proteins, and other substances surround rubber particles in *Hevea* (Cornish *et al.,* 1993). The rubber particles' surface comprises various types of enzymes, binding undertaking sites for latex biosynthesis (Oh *et al.,* 1999; Kang *et al.,* 2000; Singh *et al.,* 2003). Previous studies on latex and rubber particles were primarily focused on the consistency aspects such as dry rubber content percentage, mechanical stability, Wallace plasticity, Mooney viscosity, and plasticity retention index relevant to rubber growers and smallholdings in Malaysia (Yip, 1990; Bonfils *et al.,* 2000; Ong, 2000).

3.7 Seeds

Rubber seeds are vital for producing seedling planting materials and as rootstock for bud-grafting of high-yield clones in natural rubber-producing countries. There is one or sometimes two seed fall seasons a year in many rubber-producing countries such as Malaysia. A mature rubber tree can be identified by patterns on the seed coat that display noticeable differences in size and color. The rubber seed coat characteristics are inherited from the female parent. The rubber seeds originating from the same female parent are identical, irrespective of the pollen source, although seed size may vary because of the growth environment (Lacey *et al.,* 1997; Mercykutty *et al.,* 2002). Thus, a visual description of the variations on the seeds' morphological characteristics can be utilized to verify the authenticity of the planting material (Mercykutty *et al.,* 2002; Md.Zain *et al.,* 2003). Each rubber seed has its dorsal and ventral sides. The dorsal side is convex with a central ridge, while the ventral side is nearly flat with lateral cheeks. The seed coat color among planting materials may vary from grey to light brown, brown, and dark brown. The presence of mottling of deep brown or greyish brown shades on the seed coat is evident in different planting materials of *H. brasiliensis* (Md.Zain *et al.,* 2003).

3.8 Rootstock-Scion Compatibility

The observation of planting materials' latex yield with specific rootstock resulted in several findings to evaluate the rootstock effects. Several attempts were made to select elite rootstocks that enhanced scion growth and overall yield performance (Djikman, 1951; Buttery, 1961). Several seedling families and commercial planting materials were tested as rootstock. The majority exhibited strong evidence of high latex yield and diverse rootstock dynamic form (Buttery 1961). More recent experiments tested several commercial planting materials such as PB 5/51, RRIM 600, RRIM 628, SG 170, RRIC 52, and 48 E/130, grafted on the rootstocks derived from PB 5/51, RRIM 623, RRIM 600, RRIM 501, Tjir 1 and unselected seedling as an initial screening for elite rootstock (Ng *et al.,* 1982; Ng, 1983). Ng *et al.* (1983) demonstrated that rootstocks derived from *H. brasiliensis* could significantly influence the scions' growth and production through rootstock-scion interaction. Although plant breeders emphasized the selection of rootstock capacity before bud grafting from RRIM since the 1980s (Leong and Yoon, 1979; Ng *et al.,* 1982; Ng, 1983), there exist no specific standardized criteria for rootstock selection, particularly after the replacement of PB5/51, RRIM 501 and RRIM 603 by newly planting rootstock (RRIM 1992; RRIM 1994). Nowadays, it is common for seeds to be collected from various sources without knowledge about their origin or rootstock-scion compatibility.

IV. GERMPLASM RESOURCES

Rubber plant breeders from the Rubber Research Institute of Malaysia have been attempting to resolve the narrow genetic basis of rubber plants in the country, including the conservation of germplasm and planting material exchange exercises with other countries. There might be several attempts to apply the rubber genetic resources by private plantations and smallholdings over the past few decades, but there remains a lack documentation and clarity in records of the improvement programmes in germplasm availability and utilization.

4.1 Seedling Trees Exchanged Programmes in the 1950s

In 1951-52, RRIM introduced several *Hevea* seedlings from Brazil, including *H. brasiliensis*, *H. spruceana* and *H. benthamiana*. These seedling trees displayed strong resistance against the South American Leaf Blight (SALB) disease that attacked rubber trees in South America. However, the main objective was to employ these seedlings for high latex production in the RRIMM breeding programs. The progress of identifying potential planting materials from *Hevea* species was halted for several years, attributable to their low yields and poor growth, compared to commercial planting materials such as RRIM Clone Series (RRIM, 1952; RRIM 1957; Ong and Tan, 1987).

4.2 *Hevea* Germplasm 1967

About 100 rubber trees originated from the Amazon and were brought to Malaysia, including species of *H. brasiliensis*, *H. benthamiana*, *H. camargoana*, *H. guianensis*, *H nitida*, *H. pauciflora*, *H. spruceana*, and *H. rigidifolia*. These trees were planted and tested in a small plot area at the RRIM Research Station, Sungai Buloh. Ong (1977) concluded that these *Hevea* species were inferior in latex production and morphological characteristics, including bark renewal and commercial planting materials. However, the reporting and improvement programs on these *Hevea* species have remained unclear, with few publications and limited information publicly available to rubber planters and growers in Malaysia.

4.3 *Hevea* Germplasm 1981

In 1981, the International Rubber Research and Development Board (IRRDB) and the Brazilian Government initiated a joint expedition to collect *Hevea* seeds and budwood in South America. The expedition explored the Amazon forest in three leading states of Brazil, namely, Acre, Mato Grosso, and Rondonia, where the *Hevea* species were distributed. The expedition collected 64,736 rubber seeds and 1,522 meters of budwood. Malaysia received about 24,000 seeds for preservation and conservation, while the remaining seeds were retained in Brazil. The materials collected from the expedition focused on *H. brasiliensis*, and approximately 13,000 seedlings were successfully germinated and transplanted to the conservation site at RRIM Research Station, Sungai Buloh (Ramli *et al.*, 1996). Over the years, progenies derived from the hand-pollination program have been evaluated in several experimental sites. These progenies were primarily assessed for latex yield potential and growth, two and a half years after planting (Ong and Tan, 1987; Ong and Nasaruddin, 2011). According to Ramli *et al.* (1996), the potential yield of the trees planted in 1981 was lower than the commercial planting materials. The most vigorous trees were from the state of Acre, and the growth vigor between the trees was considerably different from the same state. The selected tree was explored as parents and incorporated into the improvement programs.

4.4 *Hevea* Germplasm 1995

The Rubber Research Institute Malaysia (RRIM), Forest Research Institute Malaysia (FRIM), and Forestry Department Peninsular Malaysia (FDPM) have initiated the Amazon forest expedition in 1995 to collect Hevea seeds. The expedition aimed to collect *Hevea* seeds that would produce high rubberwood and latex yields, and return to Malaysia. The expedition took place across 13 locations in Brazil, including Acre, Atalia de Norte, Belem, Borba, Benjamin Constant, CPAA Manaus, Iranduba, Manaus, Manicore, Sao Gabriel, Sao Paulo de Olivencia, Tapajos, and Tabatinga (Ong and Nasaruddin, 2011). Seeds of eight *Hevea* species, including *H. brasiliensis*, *H. benthamiana*, *H. camargoana*, *H. guianensis*, *H. nitida*, *H. pauciflora*, *H. rigidifolia*, and *H. spruceana* were identified and brought back to Malaysia. However, two *Hevea* species were not brought back from this expedition, namely, *H. camporum* and *H. microphylla*. These germinated seedlings were subsequently assigned to the planting site according to seedling batches. Moreover, the unsatisfactory low germination percentage of less than 20% of the total seeds' sowing and survival percentage forced the seedlings to be planted without properly assigned accession numbers (RRIM, 1995; Ong and Mohd Nasaruddin, 2011). Ong and Nasaruddin (2011) reported that two selections were made to select a new planting source. However, both selections were focused on a high rubberwood potential rather than a latex yield. The capacity of these *Hevea* species as planting materials was established by sorting the highest truncated wood volume (Ong and Nasaruddin, 2011). The circumference of these *Hevea* species was measured at the 5th and 10th year after planting.

V. THE RISK OF INBREEDING DEPRESSION

From the beginning of the improvement programs, parent trees were chosen for the crossing, where the pollen of selected male parents was collected and introduced into female parents through the hand-pollination program. Seedlings resulting from the hand-pollination program were selected into Hand Pollinated Seedling Trials and further evaluated in Small Scale Clone Trials. The trees that presented promising characteristics such as high latex yield and healthy leaves were selected for Large Scale Clone Trials. Lastly, the trees that indicated potential in high latex production and other favorable characteristics were recommended as new commercial planting materials for wide-area planting. Plant breeders found it challenging to improve the rubber tree in yield and growth vigor, due to the inbreeding decline complemented by the narrow genetic base. This effect was seen in the frequently used classical breeding system of "Generation Wise Assortative Mating" (GAM) that involves the sibling mating of rubber planting materials derived from *H. brasiliensis* (Tan, 1987; Ramli *et al.*, 1996). In such a breeding system, the finest genotypes in one generation of planted rubber planting materials were selected as parents for the next cycle of breeding, subsequently continuing the same procedure in the coming cycles (Simmond, 1989; Ramli *et al.*, 1996). Homozygosity and the occurrence of lethal alleles in the *Hevea* plant lead to general weaknesses such as low latex yield, loss of general vigor and adverse morphology affecting bark smoothness; the biochemical quality of rubber particles from inbred progenies are the critical consequences of the inbreeding method. Such developments would severely affect the performance of the rubber tree as a crop plant. Inbreeding depression caused by the narrow genetic base in *Hevea* affects not only future breeding programs for yield improvement, but also the availability of gene sources for useful morphological and biochemical characteristics.

Hereafter, attempts must be made to improve the genetic base by adding new genetic materials from germplasm to overcome these issues. Once a new pool of genetic resources is introduced, efforts can then be made to utilize them for complete crossing. Subsequently, close consideration and caution must be taken concerning the use of novel materials in breeding to improve yields and other essential characteristics. Broadening the *Hevea* genetic base is an essential strategy to produce high latex yielding planting materials in future breeding programs. In hybridization programs, the common practice is to produce progenies with suitable characteristics that would contribute to a more productive plant. There is an additional gain in widening the genetic base for crop improvement, where inter-specific crosses are involved. In other natural rubber producing countries, crop improvement programs often incorporate attempts to produce a hybrid between *H. brasiliensis* and *Hevea* species, to develop immunity towards leaf diseases (Schultes, 1990). However, the interspecific hybrids developed between commercial planting materials and other *Hevea* species are discouraging due to the low latex production and severe infection by the South American Leaf Blight (SALB). Although SALB is not present in Asia, Malaysia also embarked on several trials involving inter-specific hybrids in the 1970s (Gilbert *et al.*, 1973; Tan and Subramaniam, 1976; Tan, 1987).

VI. CONCLUSION

The selection of productive planting materials to produce vigorous trees capable of producing higher latex quantities has become crucial for Malaysian smallholdings, plantations, and rubber growers. For commercial and large-scale planting, the preferable planting materials should generate high latex yield, healthy leaves and canopies, smooth and soft bark surface for tapping, fast bark renewal rate after tapping, straight stem and trunk, vigorous girth growth and high survival rate of rootstock-scion compatibility. Besides, characteristics such as bark thickness, number of laticifers, number of stomata, leaflet position, seeds, and photosynthetic rates were the primary concerns in *Hevea* improvement. The characteristics that should be found in suitable rubber planting materials and approved by the rubber growers are as follows: (1) High latex yield production; (2) Smooth and soft bark surface; (3) Low susceptibility to leaf diseases; and (4) High tolerance to wind damage. Currently, rubber plant breeders are still trying to improve rubber-planting materials with all the right characteristics into a single model or "Ideotype", while at the same time considering minimizing the effect of “Inbreeding depression” when breeding for a new rubber planting material for commercial planting. Inbreeding depression ought to reduce the vigorous growth and latex yield production with a narrow genetic base. Therefore, *Hevea* improvement programs necessitate to incorporate broader genetic resources with a selection of materials that includes commercial rubber planting materials derived from *H. brasiliensis* and other *Hevea* species that are compatible with crossing or hybridization. The highlights from this research aim to provide opportunities to employ the potential rubber species and genetic resources to select desirable characteristics with the urge to utilize a new source of rootstocks in bud-grafting and multiplication of planting materials in the future.

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