

# Cultivation, Processing and Economic Importance of Rubber

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**ABSTRACT:** Natural rubber (*Hevea brasiliensis*) was introduced to Nigeria from England around 1895, with the first rubber estate established in Sapele in the present day Delta State in 1903. By 1925, there were already thousands of hectares of rubber estate that were predominantly owned by Europeans in Southern Nigeria. Nigeria has a vast potential for rubber production especially in many of the Southern States in the country where the vegetative and climatic conditions are suitable for its production. Rubber can be grown extensively in Edo, Delta, Ogun, Ondo, Abia, Anambra, Cross River, Akwa Ibom, Imo, Ebonyi, nearly 52,000 more different products are made directly from rubber. The primary and major products of rubber latex (the milky, juice obtained from the rubber tree) is very useful as it contains about 25-45% rubber by weight and can be processed into secondary products such as crepe rubber, crumb rubber and sheet rubber for onward processing into finished goods. Apart from Latex, the rubber tree produces seeds and wood which are also of economic value to the farmers. The rubber seeds when processed produce oil alkyd resins used for paints, soaps, skin cream and hair shampoo. Rubber contributes significantly to the Nigerian economy by providing raw materials for agro-based industries, foreign exchange earnings and in the provision of raw materials, it should be noted that the uses to which rubber can be put is almost innumerable.

**KEYWORDS:** rubber, production, cultivation, processing, industries, economic, seeds, origin

## I. INTRODUCTION

*H. brasiliensis* is a tall [deciduous](#) tree growing to a height of up to 43 m (141 ft) in the wild, but cultivated trees are usually much smaller because drawing off the latex restricts the growth of the tree. The trunk is cylindrical and may have a swollen, bottle-shaped base. The bark is some shade of brown, and the inner bark oozes [latex](#) when damaged. The leaves have three [leaflets](#) and are spirally arranged. The [inflorescence](#) include separate male and female flowers. The flowers are pungent, creamy-yellow and have no petals. The fruit is a capsule that contains three large seeds; it opens explosively when ripe.<sup>[2]</sup> In the wild, the tree can reach a height of up to 140 feet (43 m). The white or yellow latex occurs in latex vessels in the [bark](#), mostly outside the [phloem](#). These vessels spiral up the tree in a right-handed [helix](#) which forms an [angle](#) of about 30 degrees with the horizontal, and can grow as high as 45 feet (14 m).<sup>[3]</sup> In plantations, the trees are generally smaller for two reasons: 1) trees grow more slowly when they are tapped for latex, and 2) trees are generally cut down after only 30 years, because latex production declines as trees age, and they are no longer economically productive. The tree requires a [tropical](#) or [subtropical climate](#) with a minimum of about 1,200 mm (50 in) per year of rainfall, and no frost.<sup>[4]</sup> If frost does occur, the results can be disastrous for production. One frost can cause the rubber from an entire plantation to become brittle and break once it has been refined.<sup>[5]</sup> The natural rubber tree takes between seven and ten years to deliver the first harvest.<sup>[6]</sup> Harvesters make incisions across the latex vessels, just deep enough to tap the vessels without harming the tree's growth, and the latex is collected in small buckets. This process is known as [rubber tapping](#). Latex production is highly variable from tree to tree and across clone types.<sup>[3]</sup> As latex production declines with age, rubber trees are generally [felled](#) when they reach the age of 25 to 30 years. The earlier practice was to burn the trees, but in recent decades, the wood has been harvested for furniture making.<sup>[3]</sup> The South American rubber tree grew only in the [Amazon rainforest](#), and increasing demand and the discovery of the [vulcanization](#) procedure in 1839 led to the rubber boom in that region, enriching the cities of [Belém](#), [Santarém](#), and [Manaus](#) in Brazil and [Iquitos](#), Peru, from 1840 to 1913. In Brazil, before the name was

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changed to 'Seringueira' the initial name of the plant was 'pará rubber tree', derived from the name of the province of [Grão-Pará](#). In Peru, the tree was called 'árbol del caucho', and the latex extracted from it was called 'caucho'. The tree was used to obtain rubber by the natives who inhabited its geographical distribution. The [Olmec](#) people of [Mesoamerica](#) extracted and produced similar forms of primitive rubber from analogous latex-producing trees such as [Castilla elastica](#) as early as 3,600 years ago. The rubber was used, among other things, to make the balls used in the [Mesoamerican ballgame](#).<sup>[7]</sup> Early attempts were made in 1873 to grow *H. brasiliensis* outside [Brazil](#). After some effort, 12 seedlings were germinated at the [Royal Botanic Gardens, Kew](#). These were sent to [India](#) for cultivation, but died. A second attempt was then made, some 70,000 seeds being smuggled to Kew in 1875, by [Henry Wickham](#), in the service of the British Empire.<sup>[8]:55[9][10]</sup> About four percent of these germinated, and in 1876, about 2,000 seedlings were sent, in [Wardian cases](#), to [Ceylon](#) (modern day Sri Lanka) and 22 were sent to the botanic gardens in [Singapore](#).

Once established outside its native country, rubber was extensively propagated in the British colonies. Rubber trees were brought to the botanical gardens at [Buitenzorg](#), Java, in 1883.<sup>[11]</sup> By 1898, a rubber plantation had been established in [Malaya](#), with imported Chinese field workers being the dominant work force in rubber production in the early 20th-century.<sup>[12]</sup>

The cultivation of the tree in South America (Amazon) ended early in the 20th century because of indigenous [blights](#) that targeted the rubber tree.<sup>[4]</sup> The blight, called South American leaf blight, is caused by the [ascomycete Pseudocercospora ulei](#),<sup>[13][14][15]</sup> also called *Microcyclus ulei*,<sup>[16]</sup> or *Dothidella ulei*. Rubber production then moved to parts of the world where it is not indigenous, and therefore not affected by local plant diseases.<sup>[17]</sup> Today, most rubber tree plantations are in [South](#) and [Southeast Asia](#), the top rubber producing countries in 2011 being Thailand, Indonesia, Malaysia, India and Vietnam.<sup>[18]</sup>

The toxicity of arsenic to [insects](#), [bacteria](#), and [fungi](#) has led to the heavy use of [arsenic trioxide](#) on rubber plantations, especially in [Malaysia](#).<sup>[19]</sup>

The majority of the rubber trees in Southeast Asia are clones of varieties highly susceptible to the South American leaf blight—*Pseudocercospora ulei*. For these reasons, environmental historian Charles C. Mann, in his 2011 book, 1493: Uncovering the New World Columbus Created, predicted that the Southeast Asian rubber plantations will be ravaged by the blight in the not-too-distant future, thus creating a potential calamity for international industry.<sup>[20]</sup>

*H. brasiliensis* produces [cyanogenic glycosides](#) (CGs) as a defense, concentrated in the seeds. (Although effective against other attackers, CGs are not very effective against [fungal pathogens](#). In rare cases, they are even detrimental. This is the case for *H. b.*, which actually suffers worse from *Pseudocercospora ulei* if the rubber tree produces more CGs. This may be because cyanide inhibits the production of other defensive metabolites. This results in significantly divergent subpopulations with selection for or against CGs, depending on local likelihoods of fungal or non-fungal pest pressure.) The carbon and nitrogen in CGs are recycled for growth and latex production if needed, and the ease of doing so makes them an attractive nitrogen store - especially if the plant is light-deprived and storage in photosynthesis proteins would thus be unhelpful. The [α-hydroxynitrilases](#) are likely contained in the [cytoplasm](#). [Linamarin](#) is [hydrolyzed](#) by an accompanying [linamarase](#), a [β-glycosidase](#). *H. b.* linamarase does act upon linamarin because it is a [monoglucoside](#), while it does not for [linustatin](#) because it is a diglucoside - in fact, the production of linustatin inhibits linamarase cleavage of linamarin. This allows intra-plant, post-synthesis transport of linustatin without risking premature cleavage.<sup>[21]</sup>

## II.DISCUSSION

Rubber tapping is the process by which [latex](#) is collected from a [rubber tree](#). The latex is harvested by slicing a groove into the bark of the tree at a depth of one-quarter inch (6.4 mm) with a hooked knife and peeling back the bark. Trees must be approximately six years old and six inches (150 mm) in diameter in order to be tapped for latex.<sup>[1]</sup>

Rubber tapping is not damaging to the forest, as it does not require the tree to be cut down in order for the latex to be extracted. Jungle rubber is essentially old secondary forest, strongly resembling the primary forest. Its species' richness

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is about half that of the primary forest. Michon and de Foresta (1994) found that sample jungle rubber sites contained 92 tree species, 97 lianas, and 28 epiphytes compared with 171, 89, and 63, respectively, in the primary forest, and compared with 1, 1, and 2 in monoculture estates. Thiollay (1995) estimated that jungle rubber supports about 137 bird species, against 241 in the primary forest itself. Jungle rubber is expected to resemble primary forest in its hydrological functions.<sup>[2]</sup> Mono culture rubber tree plantations have far less of an environmental impact than other crops, such as coffee or especially [oil palm](#).<sup>2</sup>

Each night a rubber tapper must remove a thin layer of bark along a downward half spiral on the tree trunk. If done carefully and with skill, this tapping panel will yield [latex](#) for up to five hours. Then the opposite side will be tapped, allowing this side to heal over. The spiral allows the latex to run down to a collecting cup. The work is done at night or in the early morning before the day's temperature rises,<sup>[3]</sup> so the latex will drip longer before coagulating and sealing the cut.

Depending on the final product, additional chemicals can be added to the latex cup to preserve the latex longer. Ammonia solution helps prevent natural coagulation and allows the latex to remain in its liquid state. Plastic bags containing a coagulant have replaced cups in many plantations in Malaysia. This form of latex is used as the raw material for latex concentrate, which is used for dipped rubber products or for the manufacture of ribbed smoke sheet grades.

Naturally coagulated latex, sometimes referred to as cup lump, is collected for processing into block rubbers, which are referred to as technically specified rubbers (TSRs). The serum left after latex coagulation is rich in [quebrachitol](#), a cyclitol or cyclic polyol.<sup>3,4</sup>

Intensive tapping is done to older trees during its last years just before it is cut. It involves collecting maximum amount of latex by tapping frequently, making double cuts, using yield simulants, etc. [Slaughter tapping](#) refers to the destructive tapping that was done in late nineteenth century to extract large quantities of natural latex.

## III.RESULTS

Rubber, whether natural or synthetic, arrives at processor (fabricator) plants in large bales. Once the rubber arrives at the factory, processing goes through four steps: compounding, mixing, shaping and vulcanizing. The rubber compounding formulation and method depends on the intended outcome of the rubber fabrication process.<sup>5,6</sup>

### Compounding

Compounding adds chemicals and other additives to customize the rubber for the intended use. Natural rubber changes with temperature, becoming brittle with cold and a sticky, gooey mess with heat. Chemicals added during compounding react with the rubber during the vulcanizing process to stabilize the rubber polymers. Additional additives may include reinforcing fillers to enhance the properties of the rubber or non-reinforcing fillers to extend the rubber, which reduces the cost. The kind of filler used depends on the final product.

The most commonly used reinforcing filler is carbon black, derived from soot. Carbon black increases rubber's tensile strength and resistance to abrasion and tearing. Carbon black also improves rubber's resistance to ultraviolet degradation. Most rubber products are black because of the carbon black filler.<sup>7,8</sup>

Depending on the planned use of the rubber, other additives used could include anhydrous aluminum silicates as reinforcing fillers, other polymers, recycled rubber (usually less than 10 percent), fatigue-reducing compounds, antioxidants, ozone-resisting chemicals, coloring pigments, plasticizers, softening oils and mold-release compounds.

### Mixing

The additives must be thoroughly mixed into the rubber. The high viscosity (resistance to flow) of the rubber makes mixing difficult to accomplish without raising the temperature of the rubber high enough (up to 300 degrees

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Fahrenheit) to cause vulcanization. To prevent premature vulcanization, the mixing usually takes place in two stages. During the first stage, additives like carbon black are mixed into the rubber. This mixture is referred to as a masterbatch. Once the rubber has cooled, the chemicals for vulcanization are added and mixed into the rubber.<sup>9,10</sup>

## Shaping

Shaping rubber products occurs using four general techniques: extrusion, calendaring, coating or molding, and casting. More than one shaping technique may be used, depending on the final product.

Extrusion consists of forcing highly plastic rubber through a series of screw extruders. Calendaring passes the rubber through a series of increasingly smaller gaps between rollers. The roller-die process combines extrusion and calendaring, producing a better product than either individual process.

Coating uses the calendaring process to apply a coat of rubber or to force rubber into fabric or other material. Tires, waterproof cloth tents and raincoats, conveyor belts as well as inflatable rafts are made by coating materials with rubber.<sup>11,12</sup>

Rubber products like shoe soles and heels, gaskets, seals, suction cups and bottle stops are cast using molds. Molding is also a step in making tires. The three primary methods of molding rubber are compression molding (used in making tires among other products), transfer molding and injection molding. Vulcanization of the rubber occurs during the molding process rather than as a separate step.

## Vulcanization

Vulcanization completes the rubber-production process. Vulcanization creates the cross-connections between the polymers of rubber, and the process varies depending on the requirements of the final rubber product. Fewer cross-connections between the rubber polymers creates a softer, more pliable rubber. Increasing the number of cross-connections decreases the elasticity of the rubber, resulting in harder rubber. Without vulcanization, rubber would remain sticky when hot and brittle when cold, and it would rot much more quickly.

Vulcanization, originally discovered in 1839 by Charles Goodyear, required adding sulfur to rubber and heating the mixture to 280 F for about five hours. Modern vulcanization, in general, uses smaller amounts of sulfur combined with other chemicals to reduce the heating time to 15 to 20 minutes. Alternate vulcanization techniques have been developed that don't use sulfur.<sup>13,14</sup>

## IV. CONCLUSIONS

Uncured rubber is used for cements; for adhesive, insulating, and friction tapes; and for crepe rubber used in insulating blankets and footwear. [Vulcanized rubber](#) has many more applications. Resistance to abrasion makes softer kinds of rubber valuable for the treads of vehicle tires and conveyor belts, and makes hard rubber valuable for pump housings and piping used in the handling of abrasive sludge.<sup>15,16</sup>

The [flexibility](#) of rubber is appealing in hoses, tires and rollers for devices ranging from domestic clothes wringers to printing presses; its elasticity makes it suitable for various kinds of shock absorbers and for specialized machinery mountings designed to reduce vibration. Its relative gas [impermeability](#) makes it useful in the manufacture of articles such as air hoses, balloons, balls and cushions. The [resistance of rubber to water](#) and to the action of most fluid chemicals has led to its use in rainwear, diving gear, and chemical and medicinal tubing and as a lining for storage tanks, processing equipment and railroad tank cars. Because of their [electrical resistance](#), soft rubber goods are used as insulation and for protective gloves, shoes, and blankets; [hard rubber](#) is used for articles such as telephone housings and parts for radio sets, meters, and other electrical instruments. The coefficient of [friction](#) of rubber, which is high on dry surfaces and low on wet surfaces, leads to its use for [power-transmission belting](#),<sup>17,18</sup> highly flexible couplings, and for water-lubricated bearings in deep-well pumps. Indian rubber balls or [lacrosse balls](#) are made of rubber. Around 25 million tonnes of rubber are produced each year, of which 30 percent is natural. The remainder is synthetic rubber derived from petrochemical sources. The top end of latex production results in latex products such as surgeons' gloves, balloons, and other relatively high-value products. The mid-range which comes from the technically specified natural

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rubber materials ends up largely in tires but also in conveyor belts, marine products, windshield wipers, and miscellaneous goods. Natural rubber offers good elasticity, while synthetic materials tend to offer better resistance to environmental factors such as oils, temperature, chemicals, and ultraviolet light. "Cured rubber" is rubber that has been compounded and subjected to the vulcanisation process to create cross-links within the rubber matrix.<sup>19,20,21</sup>

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