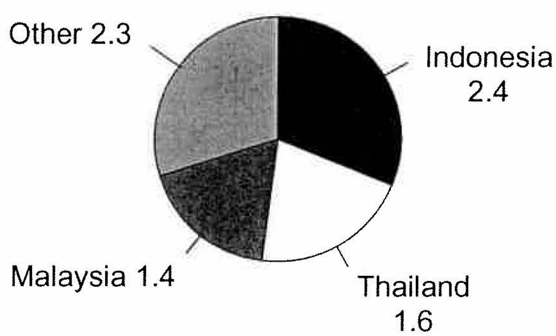
Rubber *Hevea brasiliensis*

Production	
Area Under Cultivation	7.7 million ha
Global Production	6.8 million MT
Average Productivity	888 kg/ha
Producer Price	$395 per MT
Producer Production Value	$2,688 million
International Trade	
Share of World Production	84%
Exports	5.7 million MT
Average Price	$680 per MT
Value	$3,876 million
Principal Producing Countries/Blocs (by weight)	Thailand, Indonesia, Malaysia, India, China, Vietnam, Sri Lanka
Principal Exporting Countries/Blocs	Thailand, Indonesia, Malaysia, Vietnam, Liberia, Côte d'Ivoire
Principal Importing Countries/Blocs	United States, European Union, Japan, China
Major Environmental Impacts	Effluents from processing in the plantations and in processing plants Conversion of primary forest habitat is an issue mostly in China
Potential to Improve	Good Very little expansion planting BMPs are known and address most impacts Few inputs are being used Effluents are a problem but there are known ways to reduce them

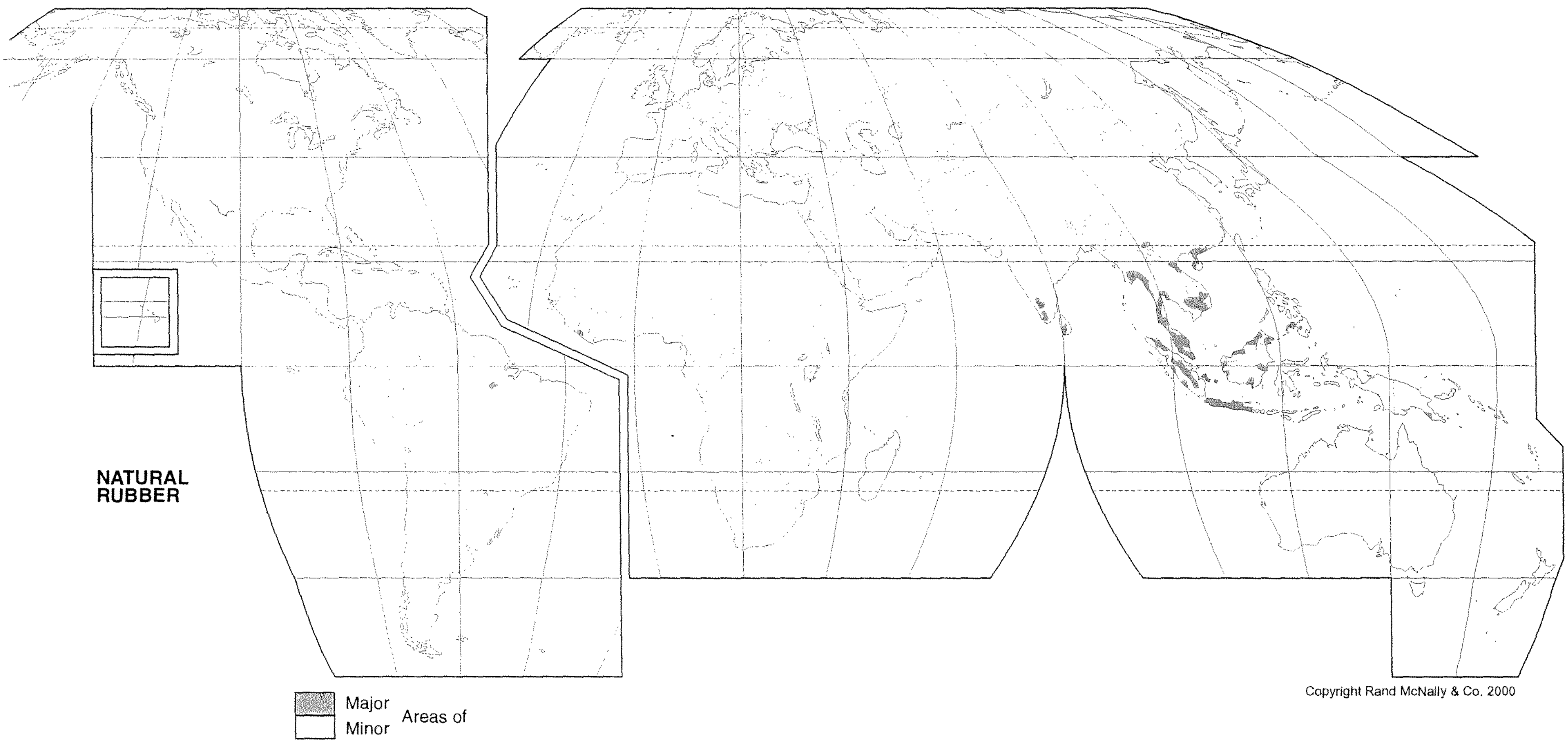
Source: FAO 2002. All data for 2000.

Rubber

Area in Production (MMha)



NATURAL RUBBER



Chapter 14

Rubber

Overview

Rubber from *Hevea brasiliensis* dominates all other sources of natural rubber and is synonymous with what is now called rubber. Rubber was first known and used by Indians in the Brazilian Amazon. Exports of natural rubber collected in Brazil began in the eighteenth century. As far back as the early 1800s there were reports of rubber-covered slickers and boots being used by fishermen in the New England cod industry.

The development of vulcanized rubber in the late 1800s stimulated demand that led to the rubber boom. Instant millionaires were made in the Amazon, Indians were enslaved to gather rubber, and the poor from Brazil and all over the world were induced to move to the Amazon in the search for rubber. From 1890 to 1910 so much money was made that local elites sent their laundry to Europe where it could be done in clean water. An opera house was built in Manaus that rivaled any in the world. Tens of thousands of paving stones around the building were replaced with rubber "bricks" at the equivalent of $10 each so that carriages would be silent as they passed. European opera stars came to the Amazon, but many died of fevers and never left.

But the boom was not to last. Rubber was the object of one of the most publicized cases of alleged "biopiracy" in the world. In 1876 rubber seeds were taken from Brazil by Henry Wickham to Kew Gardens in England (smuggled or legally exported, depending on one's point of view). After addressing propagation problems, seedlings were shipped to British colonies in Asia, in particular Malaysia and Ceylon (now Sri Lanka) but also Indonesia. Production began in earnest around 1910, and the monopoly of wild Amazonian rubber was broken. The price plummeted.

By 1910 plantations had expanded tremendously; 245,000 hectares were being cultivated in Indonesia alone. Research in Indonesia during the early twentieth century led to the development of bud-grafting, a propagation technique that greatly raised productivity. At this time rubber was still largely a plantation crop with only 8,100 hectares grown on small farms. However, with the new easy-to-learn propagation technology, that quickly changed. By 1940, 1.3 million hectares of rubber were grown by small-scale farmers compared to only 0.6 million hectares on plantations. By 1990 the balance had shifted even more with 2.6 million hectares grown by small-scale farmers and 0.5 million hectares on plantations (Burger and Smit 2001).

Only during World War II was wild Amazonian rubber highly sought again, and that was because the Japanese occupied all the rubber plantations in Southeast Asia. The Amazon was unable to provide the quantities of rubber necessary for the war effort. The Allies searched the Amazon for natural stands but also invested in research to develop synthetic substitutes. After the war production from the Amazon proved, once again, not to be competitive with rubber produced on plantations. After 1947 rubber ceased to be exported from the Amazon in commercial quantities.

By the 1980s plantation rubber production was in trouble. Synthetic rubber had eroded the market for natural rubber; today natural rubber makes up only 29 percent of the market. However, there are certain products that cannot be made with synthetic rubber. Airplane tires are 100 percent natural rubber, and automobile tires are 35 to 40 percent natural rubber. These two industries alone account for 70 percent of the natural rubber market. In the age of AIDS (acquired immunodeficiency syndrome), natural rubber is indispensable. Neither surgical gloves nor condoms can be made inexpensively from synthetic rubber. For the short term, anyway, natural rubber will have a market, although it is losing market share to synthetic rubber every year.

Rubber trees can be sold for timber once they have passed their productive life. The wood is a semihard, light-colored timber. It has a pleasant grain and can be used in wooden utensils, furniture, flooring, and chipboard making. Commercial exploitation has been rapid, and the timber currently commands a high value. In part, the value is related to the ease of harvest associated with any plantation-grown tree. While any rubber trees can be sold for timber, plantation trees are easy to harvest and transport, many trees of harvestable age are located in a confined space, and plantations produce straight logs with few branches close to the ground.

Producing Countries

By 2002 there were 7.7 million hectares of rubber in production, excluding the vast areas of natural rubber that are harvested in the Amazon. The countries with the most area planted to rubber trees include Indonesia (2.4 million hectares), Thailand (1.6 million hectares), and Malaysia (1.4 million hectares). These three producers account for 70 percent of all land planted to rubber trees and 67 percent of the 6.8 million metric tons produced annually. Côte d'Ivoire, Mexico, and the Philippines have the highest average yields at about double the global average of 888 kilograms per hectare. Thailand's average per-hectare yield is twice the level of either Indonesia or Malaysia (FAO 2002).

Thailand and Indonesia combined account for 57 percent of the world's supply of natural rubber. These two countries, together with Malaysia, India, China, Vietnam, and Sri Lanka, are the top seven producers and account for 80 percent of global production.

Brazil continues to produce rubber, but the vast majority of its rubber now comes from established plantations rather than from the wild. Most rubber plantations are monocultures, but some are intercropped with other species. All plantations in Brazil have been established outside of the Amazon in the states of Bahia, São Paolo, and Mato Grosso. These areas have shown higher productivity than natural rubber stands in the Amazon, and are outside of the range of the disease vectors found within the Amazon. Even with the plantations, Brazil has rarely exported rubber since shortly after the end of

World War II. Ecuador, Guatemala, and Colombia also produce a small amount of rubber for local use (FAO 2002).

Consuming Countries

World consumption of rubber is dominated by the United States, China, the European Union (especially Germany), Japan, and India. Imports of natural rubber are dominated by the United States, the European Union, Japan, and China (FAO 2002).

Production Systems

While rubber originated in the Amazon and the wild rubber trees of that region dominated trade in the nineteenth century, today all globally traded rubber is produced from planted trees. Plantations are established by clear-cutting tropical forests and then planting monocrop stands of rubber trees on a grid pattern to facilitate harvesting. On small-scale plantations, trees may be interplanted within agroforestry systems. After the initial planting within monocrop plantations, other vegetation is removed until the seed bank in the soil is exhausted or until the branches of the rubber trees extend to close the canopy and shade out other growth. Even though they originated in the Amazon, rubber trees do best where the water table is 1 to 1.2 meters or more below the surface (Goldthorpe 1993). This assures good soil aeration and the development of good root systems.

Planted trees are productive for thirty years or more. This means that virtually the entire rubber demand of the twentieth century was met by only three generations of rubber trees. As rubber prices have declined, mature or aged rubber plantations in Malaysia and Indonesia have been converted to other tree crops such as cocoa, pulp, or, more commonly, oil palm. The fact that former rubber plantations support new crops without intensive renovation suggests that the plantations did not cause a lot of soil erosion or soil degradation.

Most small farmers in countries like Indonesia use the traditional "jungle rubber" system of production. Smaller numbers of trees are planted in thinned natural forests or forests that are gradually converted to agroforestry orchards, depending on the amount of land owned.

Trees on plantations are planted in densities of 250 to 450 per hectare. Trees are tapped for their sap a couple of times each week. Productivity declines as trees get older, but if tapped properly the process does not threaten the tree. Some researchers in Brazil have suggested that tapping reduces seed productivity, however. While this is an important issue for wild trees, it is not important in plantations where all tapped trees have been planted.

Traditionally, some trees from previous plantings are left standing when plantations are cut down after 30 years or so or even when the rest of the plantation is cut because of declining rubber prices. These remnants are kept in reserve to meet immediate financial needs or to give producers an edge if rubber prices increase. Traditional trees take eight to fifteen years to mature before they can be tapped, and they are not as productive as new, input-intensive clonal varieties.

Through the 1990s, with the price of rubber generally declining and the price of food (mostly rice) increasing, small farmers were finding it increasingly difficult to cover their costs of living. Rubber came to supply only 75 to 90 percent of their income. Increasingly, up to 20 percent of their income was coming from paid labor on plantations of either oil palm or pulp (Penot and Ruf 2001).

In the 1970s rubber was one of the first perennial crops for which highly productive, vegetatively propagated planting materials became available to replace seed-grown stock. Bud-grafted, clonal varieties improved production and increased income, particularly to small farmers who relied on family labor. While only 15 percent of small farmers were using clonal varieties by the late 1990s, 86 percent were planning to plant or replant clonal rubber (Penot and Ruf 2001).

Clonal varieties offer several advantages over traditional varieties. They begin to produce within five years, tend to produce two to three times as much rubber, and generate 50 to 100 percent more net income (Gouyon 1999 as cited in Penot and Ruf 2001). While some clonal varieties are susceptible to leaf blights that reduce production by 30 to 50 percent, many of the clonal varieties perform better than traditional varieties on poorer soils, degraded areas, and areas with higher rainfall. The ability to use these varieties on degraded areas more than quadrupled the price of degraded land in parts of Indonesia between 1997 and 1999 (Penot and Ruf 2001).

At this time, many small farmers are diversifying their production. They are increasing their plantings of clonal rubber, but they are also planting oil palm. Producers do not see these crops as substitutes for one another. Rather, they are complementary aspects of an overall strategy to ensure reliable income. Most small farmers are also planting fruit trees. The fruit can be used both for consumption and for sale on local markets. Many of the small farmers cannot afford to plant input-intensive clonal rubber, so they are intensifying their agroforestry systems. If local roads and/or local fruit-processing facilities improve, then many small farmers are likely to increase their fruit plantings.

Over time, producers have learned how to plant and care for rubber plantations. The oldest plantations in Asia are just now on their fourth generation. As production practices have come to more closely mimic natural forests (and with the absence of diseases native to the Amazon), production has risen from 250 kilograms per hectare per year to 2,500 kilograms per hectare per year (Goldthorpe 2003).

Processing

Processing rubber begins with its harvest from the tree. Tapping rubber to collect the sap consists of making incisions in the bark, collecting the sap from the incision in a cup, and emptying the cup into a container. In plantations, new incisions are made about three times per week or some 120 times per year during the tapping season. Sap is collected every 4 to 5 hours throughout the period between incisions. The sap collected in the daytime is of higher quality and is coagulated by adding ammonia which maintains the higher quality rubber. During the night the sap is exposed to bacteria that cause natural coagulation but create rubber of a lower quality. The collector visits each of twenty to thirty trees and pours the sap from each cup (about 500 milliliters) into a 15-liter container. When the container is full, a solution of ammonia (5 percent by volume) is added at the rate of 40 milliliters per liter of sap (Sonetra 2002).

The coagulated sap (latex) is then transferred to a tanker, which transports it to a rubber factory. At the factory, the latex is discharged into a holding tank. The latex contains about 25 to 30 percent "dry rubber"; water is added to the holding tank to dilute the latex to about 16 to 18 percent dry rubber content. The pH is usually about 6.6 to 6.9, and formic acid is added to reduce the pH to about 5 (Sonetra 2002).

On more rustic rubber plantations or small farms, one of the most important things producers must do to aid the processing of rubber is to add formic acid to the sap tapped from the trees to stimulate the coagulation of latex. Formic acid is one of the few costs to such producers. This process is sometimes referred to as prevulcanization. Once this coagulation has occurred, producers transport the treated latex either to the processing plants directly or, more often, to pickup points. The highest-quality rubber is treated with ammonia and then acid and processed within 24 hours of collection. This is one of the advantages of plantations: not only is the collection and prevulcanization of rubber cheaper and easier to control, but it is also easier to transport the product to processing plants.

Further processing of rubber generally takes place off the plantation. The primary stage consists of processing latex and coagulum into sheets, crumb rubbers, or latex concentrate, and creates large quantities of effluent. In general 25 to 40 cubic meters of wastewater is produced for each metric ton of rubber produced. After the primary stage comes the process known as vulcanization. In 1839 Charles Goodyear invented this process, which uses sulfur, lead, or zinc oxide and heat to stabilize natural rubber by preventing it from turning brittle when cold and sticky when hot (Chapman 2002).

Substitutes

In 2000 the amount of natural rubber produced was 6.8 million metric tons (FAO 2002). Synthetic rubber production now amounts to more than 10 million metric tons per year, and so it exceeds the production of natural rubber. Most synthetics are petroleum-based. Because petroleum is readily available, most synthetics are cheaper for most applications than natural rubber. However, when synthetics must have the exact same elasticity and durability of rubber, then they are more expensive. This is why natural rubber still dominates some markets. Production of synthetic rubber is dominated by the United States, Japan, Russia, China, France, Germany, and Brazil. Consumption is dominated by these same countries (FAO 2002).

There are other plants that produce a form of latex than can be used for rubber. In fact, one of the major incentives for King Leopold of Belgium to occupy central Africa in the end of the nineteenth century was to coerce local residents to harvest wild latex from a long spongy vine of the *Landolphia* genus. In just over a decade an estimated 10 million Africans lost their lives either producing the rubber, being killed for not producing their quotas, or dying from the elements as they tried to escape King Leopold's occupying forces. Since the end of the nineteenth century, however, other rubber-producing plants have not proven as successful as plantation crops as *Hevea brasiliensis* (Hochschild 1999).

Market Chain

Rubber has one of the more simple market chains, and as a consequence the primary end users have periodically made efforts to vertically integrate rubber production. Henry Ford and others failed miserably in their attempts to establish rubber plantations in the Amazon during World War II. The Pirelli tire company had about the same amount of success in the Amazon. In West Africa, Firestone, Pirelli and others did successfully establish plantations, only to see them taken over or made unsafe as the countries were caught up in revolutionary movements in the latter part of the twentieth century.

In general, the trend is for small-scale farmers to produce more and more of the rubber in the world. The rubber is then sold to capital-intensive processing plants that have the capacity to handle the rubber produced from a very large region. After the rubber is processed and graded, it can either be sold or stored indefinitely before it is ultimately purchased and used by a manufacturer.

Market Trends

From 1961 to 2000 total natural rubber production increased by 221 percent, from 2.1 million metric tons to 6.8 million metric tons. Exports increased by 151 percent over the same time period. Prices declined by 82 percent (FAO 2002). The price of rubber has generally declined over the past 50 years. In 1995 the price was U.S.$1.60 per kilogram and by 1997 it had fallen to $1.30. Prices have continued to drop, so that by 1998 it was $0.60 and by 1999 it was only $0.55 per kilogram (Penot and Ruf 2001). By mid-2002 the price of rubber had bounced back to $0.87 per kilogram. While the currency collapse in Southeast Asia tended to protect rubber producers from price declines in the late 1990s (especially in Indonesia), the rising price of labor and rice made traditional rubber less attractive to plantation owners. As a result, many shifted their production to palm oil, cocoa, or pulp (Penot and Ruf 2001).

Penot and Ruf suggest that there are three main causes of price declines. First, world supply has increased by 4 percent while demand has risen only 3.5 percent. In addition, China, a major importer, has slowed its purchases after stepping up its domestic production. By the end of 1996 global stocks had recovered to some 2 million metric tons, which also depressed prices.

With production increasing faster than consumption, prices will continue to decline. Much of the increases in production have resulted from trees planted during the past twenty years. Among the factors leading producers to plant more trees are the growing awareness of AIDS and the speculation on the part of producers that this will spur increased markets for natural rubber through increased use of condoms and surgical gloves. Many of the trees in these recent plantations are only now becoming fully productive, so this is adding to the increases in production. A fair amount of planted rubber goes into production or is abandoned depending on the price of rubber. If prices continue to decline, some rubber plantations will be abandoned or converted to other crops.

While considerable effort and investment has been made to find substitutes for natural rubber, synthetic rubber cannot be fully substituted for natural rubber in many products at this time. However, given the size of the natural rubber market and the price of natural rubber relative to synthetic substitutes, it is likely that efforts to develop new substitutes will continue. Furthermore, as in the past, it is likely that substitutes will be found for an increasing number of uses to which only natural rubber can currently be put. This will reduce further the market for natural rubber.

Environmental Impacts of Production

Rubber trees are long-lived. Because of the longevity of the trees and because synthetic substitutes have been developed for many of the products, expansion of rubber plantations has not been significant globally. The one notable exception is China, where natural habitat in the more tropical, southern part of the country was being cleared until very recently in order to establish rubber plantations. There have also been a number of quite large failed experiments to establish rubber plantations in the Amazon basin, but all of these efforts succumbed to disease after the native forests were destroyed.

The ongoing impacts of rubber production, then, are mostly linked to processing. Converting the liquid sap that is collected directly from the tree to latex produces considerable amounts of effluent. Some of the chemicals in the effluent are highly toxic. In addition, the conversion of sap to solid latex requires a fair amount of energy (either fuelwood or electricity) to separate it from the water after coagulation. Finally, the vulcanization of latex into rubber also releases effluents that are highly toxic in the environment. In many countries, the emission of effluents from rubber processing and vulcanizing plants are not well regulated.

Habitat Conversion

A consequence of creating rubber plantations is the clearing of natural forests for the establishment of monocrop plantations. In addition, the timber is often stacked and burned. This results in a loss of the vast majority of forest species including those that live in the soil, which are exposed directly to sun and heat as well as rainfall and cannot survive the fluctuating heat and moisture levels. Soil exposure leads to erosion and the leaching of nutrients. Once rubber trees are planted, regrowth of any other vegetation is killed until the seeds in the soil are depleted or until the canopy is closed. Once rubber plantations are established they are recolonized by subsoil microorganisms as well as by small succulent and shrubby plants. While rubber plantations recreate some of the ecosystem functions of a natural forest, they harbor only a tiny proportion of the original biodiversity.

The area of the most active conversion of natural habitat to rubber plantations recently has been in China where rubber is considered a strategic crop (one that is so important that a country does not want to depend on others for it). Unfortunately, rubber is a tropical crop, and China does not have very much land that is suited for rubber cultivation. What is particularly unfortunate about this conversion is that much of China's land in tropical areas is quite hilly and subject to erosion. This leads to other environmental impacts, not only for China but also for those countries through which the Mekong River flows. For example, soil erosion alone has large impacts on drinking water, aquatic life, and siltation. In addition, the stripping of natural habitat tends to accentuate runoff during the rainy season as the water is no longer absorbed. This can contribute to flooding.

Pollution from Processing Rubber

One of the main environmental concerns with rubber production is the effluent from the initial stages of processing that most often occur in or near the plantations. The volume of effluent from rubber processing is twenty-five to forty times greater than the volume of rubber that is produced. There are two main types of effluents—the serum from the coagulation process and the water used to wash the rubber. The serum contains dissolved organic solids that readily oxidize and so create a significant biochemical oxygen demand (BOD) when they are dumped into water bodies. The washing effluent contains proteins, sugars, and other organic materials as well as inorganic chemicals. It also has high BOD, which can cause fish kills and harm other aquatic species in rivers and streams. In addition, some of the chemicals that remain in the sap after the latex is coagulated can be toxic (which is not surprising, as some serve the role of protecting the tree from pests).

The vulcanization of rubber is considered by people in the industry to be one of the most toxic industrial processes on the planet. Either lead or zinc oxide is used in the vulcanizing process. Even though zinc is probably the least toxic of the heavy metals, it is still quite toxic (even in very small doses) to invertebrates and many freshwater and marine species. These heavy metals can contaminate water bodies if the effluent is dumped into streams, and they are also released as rubber products are used or as they degrade. At this time, there is no way to reduce the heavy metals either in production effluents or in degraded products. Many people believe that the reason sneaker manufacturers moved to Southeast Asia is because of lower labor costs. In fact, it is probably equally important that the countries where shoes are now manufactured do not have stringent pollution control or worker health and safety measures.

The extent of heavy metal pollution from the degradation of rubber products is more than one might expect. It is estimated that more than 3,000 metric tons of zinc are released into the environment per year from tire wear alone. This represents about 25 percent of the anthropogenic release of zinc into surface waters (Chapman 2002). The European Union uses about 100,000 metric tons of zinc per year in the manufacture of rubber products. In order to reduce pollution from this manufacturing, the European Union has proposed standards of 1 to 3 milligrams per liter of zinc in effluent and 0.5 milligrams per cubic meter in stack emissions (Chapman 2002).

Better Management Practices

At this time, most of the better management practices focus on increasing the productivity and life of existing rubber plantations. Several methods have been developed to maintain or increase soil quality. These include terracing steep hillsides, contouring on slopes, constructing bunds (earthen embankments constructed to reduce erosion), and installing silt pits. In addition, the use of ground cover, cover crops, and intercropping can all reduce soil erosion on rubber plantations, increase productivity, and reduce the need for costly inputs.

Most of the improvements to processing and wastewater management take place off farm and are more likely to occur when they are regulated by law. If standard end-of-the-pipe treatment measures are in place, effluents are not a problem. It is doubtful, however, that such treatments are common in processing plants in any of the less developed countries that are the primary producers of natural rubber. At best, the effluent can be captured and put back onto the rubber plantations. This will reduce the pollution of freshwater ecosystems and thus reduce the damage to freshwater biodiversity. In general, processors find that they use fewer chemical inputs and water when they are required to ensure cleaner effluent. In the end, this saves them money.

Reduce Soil Erosion

Several techniques can be employed to reduce soil erosion. Each of these practices also helps to build organic matter, maintain soil nutrients and soil structure, retain water, and support microorganisms that benefit the maintenance, nutrient cycling, and building of soil. On steep, hilly terrain, rubber trees should be planted on the contour to prevent soil erosion; this process is known as contouring. Terraces do an even better job of reducing erosion, but these require considerable investments to build (Goldthorpe 1993).

Soil erosion along terraces and on gentle slopes can be minimized by digging silt pits and constructing bunds. Silt pits trap the soil particles that are carried in runoff; they also hold some of the rainfall on site so it has time to sink into the ground. Bunds are earthen embankments that check the flow of water during heavy rains (Goldthorpe 1993). Planting bushy materials on the bunds can further minimize erosion after the bunds have settled.

Keeping the ground covered is one of the best ways to minimize erosion. Natural vegetation like ferns, grasses, and shrubs should be encouraged to rapidly cover the exposed soil surface during planting. In the absence of natural vegetation, rapidly spreading creeping legumes can be sown as cover crops around the young rubber trees. Legumes increase nitrogen in the soil and reduce the need for chemical fertilizers. Equally important, they reduce erosion and exposure to the elements and increase organic matter.

Mulch around the base of rubber trees prevents soil exposure and holds nutrients and moisture, which is especially important during the establishment of plantations. Mulch also reduces chemical runoff. Mulch can be created from clearing the undergrowth in the plantations or from trimmings cut from the trees themselves. Mulch is most important during the early years of plantation establishment, before the canopy closes, when both of these sources are more plentiful.

Another way to reduce soil erosion after the planting stage is intercropping, growing other plants between the rubber trees. Intercropping has been used effectively with cacao and coffee in the Philippines, with tea and cacao in Indonesia, and with hearts of palm in Brazil. However, intercropping has not been widely practiced with rubber except by some integrated farms with multiple product lines. Most plants are shaded out by mature rubber trees. For about three months per year, however, rubber trees shed their leaves, leaving the understory with sufficient sunlight for other crops to grow. Short-lived legumes could be planted during this period to rejuvenate the soil provided there is enough moisture (often the trees lose their leaves during the dry season). Intercropping provides the additional benefit of supporting greater biodiversity, especially in plantations that have been cleared and replanted.

Research suggests that the biomass of the mature rubber plantation at 450 metric tons per hectare, while somewhat less than the biomass of 475 to 664 metric tons per hectare for Malaysian forests, compares favorably to the 295 to 475 metric tons per hectare for forests in Brazil, Papua New Guinea, and Thailand. Rubber plantations also perform well from the point of view of canopy cover and the production of leaf litter (Goldthorpe 1993). Sivanadyan and Moris (1992) conclude that a mature rubber plantation is a nutritionally self-sustaining ecosystem unlike other agricultural systems. Research in India has suggested that mature rubber plantations with closed canopies generate and recycle more nutrients and biomass each year than are harvested.

Rubber plantations can actually be useful for rehabilitating degraded agricultural areas and bringing them back into productive use. The leaf litter generated on rubber plantations provides organic matter that improves the physical properties of the soil (porosity, moisture absorption and retention) (Goldthorpe 1993). This could help to reduce agricultural conversion of natural habitat

Improve Processing and Wastewater Management

There are several different practices that can be used to treat effluent from rubber factories prior to release or use as a soil amendment. In countries such as Malaysia, treatment before release into natural waterways is required and increasingly enforced. A number of different treatments have been development. For example, rubber factory effluents can be treated in an anaerobic pond system, in oxidation ditches, or in algae pond systems. However, the most common effluent treatment technology, which is the use of settling ponds, has a few drawbacks—not the least of which is that it takes sixty days (Goldthorpe 1993). That means that a considerable volume of water has to be held over time for treatment. Creating the treatment ponds requires a large area of land, construction expenses, and time.

Increasingly, effluent is tested and processing plants are required to reach certain levels of quality before they are allowed to release the material. Many rubber producers prefer to apply the effluent to their plantations as a soil amendment rather than to treat it to the level required before legally releasing it into rivers and streams. Good results have been reported from the experimental application of this effluent either through furrow irrigation by gravity, piped irrigation with sprinklers or trickle nozzles, or spray guns from tankers (Goldthorpe 1993).

Prior to application, however, the rubber particles need to be removed. This can be done through rubber traps or by allowing the effluent to sit for three days so the particles settle out. The effluent has a foul odor, but this can be mitigated by adding microorganisms that partially decompose the compounds. One experiment has shown that the effluent can be concentrated into a slurry with up to 60 percent solids or further concentrated into a powder. Both make effective fertilizers (Panfilo Tabora, personal communication). Apparently, such applications do not result in a build-up of toxic substances in the soil.

Outlook

In the past, rubber has been an important cornerstone for industrial development because of its many uses, especially its overall importance to transportation (not only for tires but also for hoses for motors of all kinds). As a result it has been considered a strategic crop.

At this time, synthetic substitutes exist for the vast majority of the original uses of rubber. In other instances, such as automobile tires, the proportion of natural rubber has been cut dramatically. Even so, there are some uses for which there are no affordable substitutes. The growth in these uses, to date at least, has been offset by the development of synthetic substitutes for other rubber uses. So long as these trends continue to offset each other, then rubber production will be sufficient to meet global demands. No major increases in rubber demand are expected at this time.

Resources

Web Resources

www.rubberstudy.com/
www.rubberboard.org.in/
www.irrdb.com
www.lgm.gov.my/rubberlinks/rubberlinks.html

Additional resources can be obtained by searching on "rubber" on the WWF International Intranet:
http://intranet.panda.org/documents/index.cfm

Contacts Within the WWF Network

No one within the WWF network has been identified as working on this commodity. Please contact Jason Clay at WWF-US (jason.clay@wwfus.org) for suggestions of contacts outside the network.

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