

Ever since the late colonial period, the key challenge has been the development of more productive yet sustainable cultivation systems in the face of an ever-dwindling availability of primary forest. The doubling of average cocoa yields since the 1960s was no mean feat, but for several reasons it brought little reprieve for the forests of the main producer areas. Although technological innovations such as high-yielding hybrids, synthetic fertilizers, and pest control could, in principle, save thousands of square kilometres of primary woodland, in practice they have tended to encourage the spread of intensive full-sun farms that generate high net profits over the short to medium term.¹²³ Promoted by governments and leading chocolate companies as a means of boosting supply,¹²⁴ these unshaded hybrid systems rely on large inputs of fertilizer, pesticides, and (more recently) herbicides to achieve their high yields. In addition, they possess only a fraction of the biodiversity of the forest cover they replace, and are also far less varied than the mixed agro-forestry alternatives that were previously developed as a means of mimicking natural conditions and diversifying cocoa farmers' incomes. Although they do offer some scope for replanting old *amelonado* groves in parts of West Africa, these high-input techniques have not entirely offset the benefits of newly cleared forest. Cocoa trees still perform best on fresh soils, and this includes the vigorous new hybrid strains designed to respond to chemical inputs. As a result, tapping the forest rent has continued to give producers a competitive advantage wherever primary forest is available.¹²⁵

The recent history of cocoa shows few signs that this basic pattern will change, and even less indication that consumers will lose their appetite for chocolate.¹²⁶ As long as this remains the case, the forests of the tropical lowlands will continue to be mined for the 'brown gold' they can be made to yield.

3

Colonialism, Rubber, and the Rainforest

One of the chief ecological effects of global trade has been the large-scale transfer of plant species from one part of the world to another. Over the past several centuries, botanists, commercial entrepreneurs, and farmers have made enormous efforts to cultivate useful crops on different continents and to engineer host environments to accommodate these implants from afar. In tropical lands sugar cane was the trail-blazer, followed by coffee, various food crops, and of course cocoa. During the late nineteenth and early twentieth centuries, the most important addition to the list of globetrotter plants was the rubber tree.

Latex substances have been used in various parts of the tropics for many centuries, whether for waterproofing, illumination, games, or other rituals. Before the 1800s rubber was little more than a curiosity in Europe, since its tendency to soften in warm temperatures and to lose elasticity in the cold severely limited its utility. Two innovations in particular were crucial for the rise of a mass market for rubber: Charles Goodyear's vulcanization process (1837), which first made rubber durable enough for an array of applications from shoe soles to electrical insulation; and above all the development of the pneumatic tyre, first conceived in 1845 and perfected by John Boyd Dunlop in 1888. From 1875 to 1900 annual world rubber production rose from around 10,000 tons to over 50,000 tons, much of it spurred by the 'bicycle craze' of the 1890s. After around 1905 the growth of the automotive industry drove a further production boom that reached nearly 120,000 tons per year by the eve of the First World War.¹

Before the 1910s nearly all of this latex was collected in the wild from a small number of species scattered across the world's tropical lowlands. In South America the main sources were *Hevea brasiliensis* and *Manihot glaziovii*, both native to the Amazon basin. In Central America *Castilloa elastica* was most important, and among the various contenders in Southeast Asia, *Ficus elastica* led the way. In Africa the primary sources of latex were *Landolphia* vines and the towering *Kickxia* tree (*Funtumia elastica*). Of all these candidates *Hevea* yielded not only the most latex but also the highest-grade rubber, labelled Pará rubber (the standard on international commodity markets) after the coastal Brazilian state from which it was

¹ John Loadman, *Tears of the Tree: The Story of Rubber—A Modern Marvel* (Oxford: Oxford University Press, 2005), xxviii, 66; J. H. Drabble, *Rubber in Malaya, 1876–1922: The Genesis of the Industry* (Oxford: Oxford University Press, 1973), 222; Colin Barlow, *The Natural Rubber Industry: Its Development, Technology, and Economy in Malaysia* (Oxford: Oxford University Press, 1978), 10–16.

¹²³ See François Ruf, 'The Myth of Complex Agroforests: The Case of Ghana', *Human Ecology*, vol. 39 (2011), 373–88.

¹²⁴ See <http://worldcocoafoundation.org/wp-content/uploads/FINAL-CocoaAction-CDI-Press-Release-English_05202014.pdf>.

¹²⁵ Ruf, *Booms et crises*, 181–2, 262–3.

¹²⁶ Quite the opposite: surging demand for chocolate in Asia and parts of South America has led industry analysts to predict major shortfalls by 2020: see e.g. <<http://www.bloomberg.com/news/2014-05-28/cocoa-shortage-looms-as-growers-opt-to-farm-rubber-commodities.html>>.

shipped overseas. During the era of wild rubber, Amazonia accounted for the vast bulk of world exports.²

As demand for rubber continued to grow, governments and investors in Europe's tropical colonies began to set up plantations as the future basis of the industry. Ever since the 1870s botanists had been experimenting with a variety of latex-bearing species, among which *Hevea brasiliensis* emerged as the planter's favourite due to its high productivity, its ability to survive years of regular tapping, and its relatively straightforward cultivation requirements. *Hevea* could be grown throughout most of the world's humid tropical lowlands, especially where there was well-drained soil, little temperature variation, and consistent but not excessive rainfall (over 1,500 mm). The main prerequisites for establishing a rubber plantation were abundant supplies of forest land and adequate access to labour. Several of Europe's Southeast Asian colonies—above all parts of Malaya, Indonesia, Ceylon, and southern Indochina—had the necessary ingredients, and soon came to dominate world production.

The ensuing rubber boom marked a major ecological and social watershed across much of colonial Southeast Asia. From the 1900s to the 1930s, millions of hectares of some of the world's richest *Dipterocarp* rainforests were replaced by *Hevea* trees as waves of European planters were attracted by the promise of cheap land and big profits. Most of the heavy work on the estates was performed by thousands of migrant labourers whose arrival left an indelible imprint on the societies of the main producer areas. At the same time, the opportunities opened by rubber cultivation also brought changes for countless indigenous farming communities, expanding their engagement with the global economy and altering their systems of land use. By the 1930s, only three decades after the planting boom began, rubber had created a complex web of global linkages between the forests of Southeast Asia, the vulcanizing plants of the industrial world, and millions of consumers—especially motorists—throughout Europe and North America.

To date, the historical literature on the Southeast Asian rubber industry has focused mainly on its economic and commercial aspects.³ Rubber was, after all, a key ingredient of industrial society and one of the most important tropical commodities traded on world markets. Although studies have long recognized the importance of the region's natural endowments and the efforts of botanists to improve latex yields, they have paid far less attention to the broader socio-ecological parameters of the rubber boom, and certainly less than has been done for the

² See, generally, Barbara Weinstein, *The Amazon Rubber Boom, 1850–1920* (Stanford, Calif.: Stanford University Press, 1983); Warren Dean, *Brazil and the Struggle for Rubber: A Study in Environmental History* (Cambridge: Cambridge University Press, 1987).

³ The principal studies are heavily weighted towards Malaysia: Barlow, *Natural Rubber*; Drabble, *Rubber in Malaya*; John H. Drabble, *Malayan Rubber: The Interwar Years* (Houndmills: Macmillan, 1991); D. J. M. Tate, *The RCA History of the Plantation Industry in the Malay Peninsula* (Kuala Lumpur: Oxford University Press, 1996). Exceptions with an environmental focus are Michirake Aso, 'How Nature Works: Business, Ecology, and Rubber Plantations in Colonial Southeast Asia, 1919–1939', in Uekötter (ed.), *Comparing Apples*, 195–220 (on colonial Indochina); also Beinart and Hughes, *Environment and Empire*, 233–50.

Americas.⁴ The purpose of this chapter is to explore how the forest ecosystems of Southeast Asia and the rise of mass rubber production shaped one another.

Like all tropical crops, *Hevea* has a number of characteristics that influence how it is grown. First of all, planters must wait several years (usually five to seven) before the trees are mature enough to yield an income. Like coffee and cocoa, and unlike cotton or sugar, the business of rubber cultivation is therefore marked by relatively long cycles. Another important feature is that rubber has been successfully cultivated on widely different scales. In contrast to cocoa, which was increasingly dominated by smallholders during the colonial era, rubber was grown on vast, carefully engineered corporate estates as well as on countless smallholdings otherwise used primarily for subsistence agriculture. At the outset, rubber cultivation was mainly centred on large plantations, but over the course of the 1920s and 1930s the proportion of smallholder rubber steadily increased, and eventually outstripped estate production in the leading export regions of Peninsular Malaya and the Dutch East Indies. In effect, estates and smallholdings constituted two separate sectors of the rubber economy, both economically and ecologically. They differed not only in their cultivation techniques and organizational forms, but also with respect to their biophysical and social effects. Despite the strong ideological attachment to what colonial authorities regarded as 'modern' plantation techniques, the success of smallholders gradually opened up a range of alternative practices designed to mitigate some of the chief environmental problems associated with plantation rubber.

The colonial rubber industry thus evolved through a complex interaction between environmental circumstances, diverse cultural predispositions, and shifting ideas about the optimal management of resources. Ultimately, the expansion of the Southeast Asian rubber frontier was rooted in the exceptional suitability of the region's lowland forests for *Hevea* cultivation—a suitability that, as we will see, surpassed even that of its Amazonian homeland. But human choices were crucial, and within the limits of ecological feasibility, a variety of different outcomes was possible.

FROM PLUNDER TO PLANTATION: THE ORIGINS OF THE NATURAL RUBBER INDUSTRY

The surging demand for rubber in the late nineteenth century unleashed a headlong rush into the forests of the Amazon basin. At Belém, the capital of Pará state, European and American purchasing agents bought tons of latex from Brazilian merchants who shipped it downriver from the various trading outlets that lined the great river system. Much of it moved through Manaus, the epicentre of the rubber boom, which at its peak in the 1890s was one of the wealthiest cities in the world. Most of the trade was controlled by a small group of rubber magnates who drew

⁴ Dean, *Brazil*; Seth Garfield, *In Search of the Amazon: Brazil, the United States, and the Nature of a Region* (Durham, NC: Duke University Press, 2014); Mark R. Finlay, *Growing American Rubber: Strategic Plants and the Politics of National Security* (New Brunswick, NJ: Rutgers University Press, 2009).

their supplies from a network of local strong-men, or *seringalistas*, based in the Amazonian interior. As these local rubber barons carved out their fiefdoms in the jungle, they employed a swelling army of labourers—most of them immigrants from poverty-stricken areas, some of them indigenous people whose lands were seized, all of them tied to their employers by debt or the threat of violence—to tap the dispersed stands of wild *Hevea* that grew throughout the forest. The standard method for gathering the latex was to hack a gouge in the trunk and collect the sap in a bowl, which sometimes proved fatal to the tree. All things considered it was a cruel and inefficient system that relied on a constant influx of exploitable workers and a continual expansion of the extractive frontier. Nonetheless, it made Brazil the world's dominant rubber producer, accounting for nearly 90 per cent of global exports in the early 1900s.⁵

Most of the remaining latex supply came from Africa, where methods of wild rubber collection were broadly similar. In the forests of West and East Africa, rubber was mainly produced on a free trade basis whereby merchants purchased latex from tappers in the interior and hauled it to the coasts for export. Over time, traders essentially followed the tappers into the hinterlands as coastal forests became progressively depleted of latex-bearing plants. The rate of exhaustion, and thus of frontier expansion, varied according to several factors, above all the specific collection method, the degree of commercial competition, and the different target species. *Funtumia* trees were harder than sensitive *Landolphia* vines, which often died as a result of tapping. And whereas many tappers chopped down vines or removed large rings of bark to drain latex-bearing sap as quickly as possible, others made smaller incisions from which the plants could recover. As a general rule, however, the basic pattern was one of rapid pillage that mirrored the extraction processes in the Amazon.⁶

In the humid forests of Equatorial Africa the industry worked somewhat differently than in West and East Africa, and the effects were even worse. Here rubber production was dominated by a small number of concessionary companies with little reason to worry about competitors harvesting all of their latex before they got around to it. In principle, one might expect this more regulated commercial environment to reduce the incentives for the hasty plunder of the forests. In practice, most of the concession companies were determined to cash in on their investments as quickly as possible, and committed appalling atrocities while doing so. In the Congo Free State in particular, entrepreneurs oversaw a lethal system of delivery quotas that showed little more concern for human life than for the ravaged *Landolphia* vines on which their profits depended. As collectors were forced to

⁵ See, generally, Weinstein, *Amazon Rubber Boom*; Dean, *Brazil*.

⁶ Patrick Krajewski, *Kautschuk, Quantanähe, Krieg. Dhaushandel in Ostafrika 1880–1914* (Berlin: Schwarz, 2006), 150–62; Thaddeus Sunseri, *Wielding the Ax: State Forestry and Social Conflict in Tanzania, 1820–2000* (Athens, Oh.: Ohio University Press, 2009), 19–23; J. Forbes Munro, 'Monopolists and Speculators: British Investment in West African Rubber, 1905–1914', *Journal of African History*, vol. 22 no. 2 (1981), 263–78; Raymond Dumett, 'The Rubber Trade of the Gold Coast and Asante in the Nineteenth Century: African Innovation and Market Responsiveness', *Journal of African History*, vol. 12 no. 1 (1971), 79–101; Goucher, 'The Impact', 63; John Henry Holland, *Rubber Cultivation in West Africa* (London: 1901).

travel further and further to find supplies, they often cut down the vines or stripped their bark in order to bleed out the latex. Some even killed the vines deliberately in the hope that it would make the concession companies go away. Although the end of this notorious system in 1908 is usually credited to reform activists in Britain and Belgium, it was also partly due to the exhaustion of the latex supply itself, which had already thrown the industry into disarray by around 1906.⁷

The wild rubber collection systems in Amazonia and equatorial Africa were extreme examples of frontier exploitation, and they soon faced trouble on several fronts. The political scandals they sparked off—most famously 'red rubber' in the Congo Free State, but also the M'Poko investigation in the French Congo (1906/7) and the Putamayo Affair in Peru (1909–11)—were resounding indictments of the contradictions between the rhetoric of 'free' labour and realities on the ground.⁸ From an economic perspective, their long-term prospects were also dampened after the turn of the century by the stark incongruity between industrial-scale demand and primitive methods of supply. Although few feared an imminent collapse of wild rubber production—according to the most competent authorities there is no prospect of an exhaustion of rubber in the Amazon region', noted the botanist Otto Warburg in 1900⁹—rising prices highlighted the growing inability to keep up with demand. And although large areas of Amazonia were yet to be tapped, there were already ominous warning signs in West Africa, where exports plummeted from 94,301 tons in 1898 to only 18,486 in 1902.¹⁰ As a leading botanist put it at the time, the basic problem was that 'the European trader does not care about the source or mode of collection of the products that the native brings to his storehouse'.¹¹ No one expected merchants to halt the plunder since their primary concern was to generate profits. But as critics argued, any state that purported to be 'civilized' had a duty to ensure the welfare of its territory 'beyond short-term commercial success and temporarily high export revenues'.¹²

In response to the ongoing pillage, colonial governments introduced a range of measures to place rubber production on a more 'rational' footing. One was to prohibit the stripping of bark or cutting of vines and trees, though such prescriptions were scarcely enforceable on the remote extractive frontier. Throughout French

⁷ Robert Harms, 'The End of Red Rubber: A Reassessment', *Journal of African History*, vol. 16 no. 1 (1975), 73–88; E. D. Morel, *Red Rubber: The Story of the Rubber Slave Trade Flourishing on the Congo in the Year of Grace 1906* (London: T. F. Unwin, 1906); Adam Hochschild, *King Leopold's Ghost: A Story of Greed, Terror, and Heroism in Colonial Africa* (London: Macmillan, 1999), 158–224; Kevin Grant, *A Civilized Savagery: Britain and the New Slavery in Africa, 1884–1926* (London: Routledge, 2005), 39–78; Coquery-Vidrovitch, *Le Congo*, 164–86, 424–6.

⁸ On the Putamayo, Michael Edward Stanfield, *Red Rubber, Bleeding Trees: Violence, Slavery, and Empire in Northwest Amazonia* (Albuquerque: University of New Mexico Press, 1998), 131–78; on M'Poko, Coquery-Vidrovitch, *Le Congo*, 177–84; on 'red rubber' in the Congo, see n. 7.

⁹ Otto Warburg, *Die Kautschukpflanzen und ihre Kultur* (Berlin: KWK, 1900), 12.

¹⁰ Auguste Chevalier, *La Situation agricole de l'Ouest Africain: enquête* (Dormfont: Senen, 1906) 4–5, 7. The figures reflect the combined exports from Gambia, Sierra Leone, Gold Coast, Lagos, and Niger.

¹¹ Chevalier, *La Situation agricole*, 4.

¹² Louis Hoff, 'Die Kautschuk- und Guttaperchafrage in den deutschen Kolonien', *Verhandlungen des deutschen Kolonialkongresses 1905* (Berlin: Reimer, 1906), 604–17, here 616–17.

West Africa, German East Africa, and the Congo Free State, legislative bans probably did more to encourage denunciation and blackmail than to conserve latex resources. Another method was to mandate replanting in worked-out areas. In the Congo, collectors were ordered to plant fifty seedlings for every 100 kg of raw rubber they delivered, though once again enforcement was impractical despite the threat of imprisonment.¹³

For most observers, the future of the rubber industry lay in plantations rather than wild collection. Around the turn of the century, British and American entrepreneurs tried to establish concentrated *Hevea* estates in Amazonia where the tree grew naturally. But none of them were successful, partly because of commercial obstacles, but mainly due to an ecological problem: the South American leaf blight (*Microcyclus ulei*), a fungus endemic to the Amazon basin and the principal disease threat to *Hevea* trees. Over thousands of years, *Hevea* had co-evolved with the fungus in the Amazonian rainforest, surviving through a strategy of thin dispersal (generally no more than a few per hectare) among many other tree species. As a result, any attempt to cultivate a dense mono-crop of *Hevea* trees removed this natural defence and created a veritable smorgasbord for the leaf blight to attack. Despite years of effort, plant pathologists were never able to control the disease on plantations.¹⁴ In the late 1920s, none other than Henry Ford tried to establish concentrated *Hevea* stands in Pará, but even his highly capitalized 'Fordlandia' estate proved no match for the humble fungus and eventually became a cattle ranch after its sale to the Brazilian government in 1945.¹⁵

Planters fared much better in Southeast Asia, where climate and soils were suitable, land and labour were readily available, and where, most importantly, there was no leaf blight. The absence of *Hevea*'s primary disease created the conditions for what biologists call 'ecological release', or the rapid expansion of a population into new ecological niches unchecked by the competitive constraints of its previous habitat. These environmental advantages played a crucial role in the emergence of Southeast Asia as the world's main rubber-producing area, and also in the choice of *Hevea* as its main cultivar.

Given the eventual dominance of Southeast Asian *Hevea* on rubber markets, it is worth emphasizing that neither of these outcomes was inevitable or obvious to contemporaries. Before the 1910s, planters experimented with a range of different latex-bearing species in many parts of the tropical world. French officials, nervously eyeing the planting boom in Malaya and the Dutch East Indies, were determined 'not to let themselves be outstripped by foreign efforts'.¹⁶ By the early 1900s there were several small plantations growing *Hevea* in French Guinea and *Manihot* in Gabon. In Equatorial Africa, concessionary companies opted for *Manihot* over *Hevea* due to its superior ability to cope with the dry season there.¹⁷ In Indochina,

¹³ Hoff, 'Die Kautschuk', 608–13; Coquery-Vidrovitch, *Le Congo*, 424–5.

¹⁴ Dean, *Brazil*, ch. 4, esp. 58–9.

¹⁵ Grandin, *Fordlandia*; Dean, *Brazil*, 72–84.

¹⁶ Henri Jumelle, *Les Plantes à caoutchouc et à gutta dans les colonies françaises* (Paris: Challamel, 1898), vi.

¹⁷ Jumelle, *Les Plantes*, 77–123; M. du Vivier de Sireel, *La Culture en Afrique Équatoriale Française* (Coulommiers: Dessaint, 1917), 32–4; Coquery-Vidrovitch, *Le Congo*, 428–31.

the only French colony ever to become a significant player in the world rubber economy, many regarded *Ficus elastica* as the most suitable cultivar for the region. It was only in 1906/7—three decades after *Hevea* was initially introduced there—that the first *Hevea* plantations of any size were established around Saigon.¹⁸

In the meantime, German firms in Cameroon likewise set up a string of rubber plantations, which mainly grew native *Funtumia* trees after trials with Central American *Castilloa* had to be abandoned due to beetle attacks.¹⁹ Around the turn of the century, as German entrepreneurs turned their attention to East Africa, botanists initially recommended that they plant indigenous *Funtumia* or *Landolphia* vines rather than *Hevea*, though in the event the Amazonian *Manihot* tree became the favourite among estate directors.²⁰ In the late 1900s rising latex prices triggered a rash of planting in German East Africa, which resulted in around 45,000 ha of rubber by 1914. The timing could hardly have been worse. After 1910 the flood of cheap Malayan rubber onto world markets rendered the colony's *Manihot* plantations commercially unviable before they even began production. In 1914 Germany's rubber imports from its own colonies still covered only around one quarter of its needs—a strategic failure that ultimately helped launch the world's first large-scale synthetic rubber industry during the First World War.²¹

By the early 1910s the plantations of Southeast Asia had forever transformed world rubber markets. From 1910 to 1914 their combined output rose from around 11,000 to 76,000 tons, surpassing wild rubber production (which peaked in 1912) for the first time. By 1917 Southeast Asian estates outstripped wild rubber production by a ratio of nearly four to one (214,000 tons to 57,000 tons), and over the following years the quantities of wild rubber on world markets also shrank in absolute terms as falling prices made it increasingly unprofitable. By the end of the 1920s over four-fifths of world rubber exports came from Malaya and the Dutch East Indies alone.²² It was a resounding success for the investors and planters involved, and it seemed to banish once and for all the threat of inadequate supplies for the burgeoning automotive tyre industry. But behind the

¹⁸ Camille Spire and Andrié Spire, *Le Caoutchouc en Indo-Chine: étude botanique industrielle et commerciale* (Paris: Challamel, 1906), 204–7; J. Cardot, *Note sur la production du caoutchouc en Indochine* (Paris: Agence Economique de l'Indochine, 1929), 3; Jean Vaxelaire, *Le Caoutchouc en Indochine* (Hanoi: Imprimerie d'Extrême-Orient, 1939), 7; E. Girard, *Notes sur la culture de l'hevea en Cochinchine* (Saigon: Ardin, 1918).

¹⁹ Paul Preuß, 'Über Pflanzenschädlinge in Kamerun', *Der Tropenpflanzer*, vol. 7 no. 8 (Aug. 1903), 345–61.

²⁰ A. Zimmermann, 'Anzapfungsversuche mit Kicksia elastica', *Der Pflanze*, vol. 1 (1905), 182–7; Franz Ranniger, 'Unsere Kautschuk-Plantagen und deren Zukunft', *Der Pflanze*, vol. 3 (1907), 113–22; Dr Eduardoff, 'Über Kautschukindianen-Anpflanzungen', *Der Pflanze*, vol. 4 (1908), 177–82; Eduard Markwald and Fritz Frank, 'Der Kautschuk-Plantagebau in seiner Bedeutung und seinen Gefahren für die deutsche Kolonialwirtschaft', *Der Pflanze*, vol. 7 (1911), 247–54.

²¹ Richard Deeken, *Die Landwirtschaft in den deutschen Kolonien* (Berlin: Süsserott, 1914), 22–6; O. Warburg, 'Der Krieg und die koloniale Landwirtschaft', *Der Tropenpflanzer*, vol. 21 no. 1 (Jan. 1918), 7–8; *Kautschuk und die deutschen Kolonien* (Berlin: KWK, c. 1917), 2–3; Eduard Markwald, and Fritz Frank, 'Der Kautschuk-Plantagebau in seiner Bedeutung und seinen Gefahren für die deutsche Kolonialwirtschaft', *Der Pflanze*, vol. 7 (1911), 247–54, here 250–1.

²² Barlow, *Natural Rubber*, 53; Drabble, *Rubber in Malaya*, 220; Drabble, *Malayan Rubber*, 264.

profits and production figures lay one of the largest bouts of forest clearance ever witnessed in the tropical world.

FROM FOREST TO RUBBER FARM: THE SOUTHEAST ASIAN PLANTING BOOM

The journey of *Hevea* from Amazonia to Southeast Asia began in 1873 when Clements Markham—an India Office geographer who was also responsible for the first transplantation of cinchona (quinine) trees from Peru to India in 1860—convinced Sir Joseph Hooker of Kew Gardens to sponsor an expedition to the Amazon to collect seeds. Although only six seedlings from this cohort reached their destination in Calcutta, where they promptly died, officials in India were sufficiently interested to finance a follow-up expedition. In 1876 the British explorer Henry Wickham sent (or smuggled)²³ some 70,000 *Hevea* seeds to Kew, 2,400 of which germinated into seedlings and were subsequently sent to Ceylon to be planted at Henerathgoda Gardens in Colombo. Over two-thirds of the seedlings survived the trip, and in June 1877 twenty-two of them were transported to Singapore Botanical Gardens, nine of which were then taken to the garden of the British Resident in Perak, Sir Hugh Low. According to Henry Ridley, director of the Singapore Botanical Gardens from 1888 to 1911, this tiny handful of seedlings formed the basis for over 75 per cent of the *Hevea* that was later planted in Malaya.²⁴

The first Malayan rubber plantations were established in 1896 in Malacca and Selangor. They soon attracted the attention of Chinese and European planters eager to find a substitute for coffee amidst the spread of the dreaded coffee rust fungus, and especially after the surge of Brazilian coffee production sent prices plunging.²⁵ At first, rubber was usually inter-planted with tapioca, gambier, or other crops as a supplemental source of income, but as the *Hevea* saplings matured most planters soon shifted to monoculture.²⁶ Acreage grew slowly in the beginning, expanding from 140 hectares in 1897 to 2,914 in 1902. But as prices continued to rise, they triggered a veritable explosion of planting throughout the Malayan states of Perak, Selangor, and Negri Sembalan. By 1910 rubber covered around 220,000 hectares in Malaya, and over the next four years it doubled to more than 445,000 hectares. Although much of the growth was driven by British firms (e.g. Guthries, Harrisons, and Crosfield, Barlow & Co.), by 1914 around 200,000 hectares were also in Asian hands, a third of them worked by smallholders

²³ Wickham's purported act of bio-piracy has long been a matter of debate and embellishment; at the time there was no Brazilian prohibition on the export of seeds: see Loadman, *Tears*, esp. 92–3; cf. the more stylized account in Joe Jackson, *The Thief at the End of the World: Rubber, Power and the Seeds of Empire* (London: Duckworth, 2008).

²⁴ See Loadman, *Tears*, 82–97.

²⁵ On the coffee rust, McCook, 'Global Rust Belt'.

²⁶ Barlow, *Natural Rubber*, 25.

who had entered the rubber bonanza several years after the first plantations were set up.²⁷

Meanwhile, a parallel rubber frontier opened in the Netherlands Indies. Although the Dutch laid claim to the world's oldest rubber plantation (a small stand of *Ficus elastica* established in 1864 in West Java), most East Indies estates were created around a decade after large-scale planting got under way in Malaya. In 1914 rubber covered an estimated 245,000 hectares in the East Indies, rising to over 405,000 hectares in 1919.²⁸ At the beginning of the boom over half of this acreage was on Java, where (as in Malaya) coffee planters initially grew it as a catch-crop in the face of collapsing prices and the spread of the coffee rust epidemic.²⁹ By the mid-1910s, the focus of East Indies rubber planting shifted to the Outer Isles, above all to the Dutch *cultuurgebied*, or plantation belt, on the north-east coast of Sumatra (Fig. 3.1).

The rich volcanic soils in the Deli area around the town of Medan had already attracted an influx of European planters in the 1870s and 1880s, most of them eager to cultivate the famous 'Deli leaf' tobacco that fetched a premium on world markets. By 1890 planters had cut down vast swathes of forest in the belief that the fancy wrapper tobacco could only be grown for one season on freshly cleared land, most of which was quickly abandoned to invasive *alang grass* (*Imperata cylindrica*) after the harvest. As the tobacco frontier spread beyond the most suitable soils (mainly situated between the Wampu and Ular Rivers), planters experimented with a variety of tree crops as substitutes for tobacco, usually starting with coffee before eventually turning to *Hevea*.³⁰ In the hinterlands of Medan alone, rubber acreage rose from 22,000 hectares in 1909 to 173,000 in 1924. By 1927 Sumatra's plantation belt accounted for 49 per cent of East Indies rubber production, around half of which was shipped directly to the USA, a fifth to Britain, and a quarter to Singapore or Penang for trans-shipment to Europe or North America.³¹

In the East Indies and Malaya alike, the key prerequisite for rubber production was access to suitable forest land, which governments doled out to planters on decidedly generous terms. The first areas to be bought up were generally near the main lines of communication or existing areas of settlement. In Malaya the initial hot-spots lay along the roads that already served the tin mines in Perak and Selangor

²⁷ Drabble, *Rubber in Malaya*, 216; Barlow, *Natural Rubber*, 30–3, 308.

²⁸ Drabble, *Rubber in Malaya*, 219.

²⁹ In 1914 the vast majority of rubber in central and eastern Java was still inter-planted with *Robusta* coffee, though most Javanese rubber estates were established on the southern coast, where *Hevea* grew better due to the less persistent west-monsoon season: W. J. van de Leemkolk, *De Rubber-Cultuur en de Rubber-Handel van Nederlandsch-Indië* (Batavia: Ruygrok, 1914), 9, 17–18; *Rubber in the Netherlands East Indies* (Weltevreden: Landsdrukkerij, 1925), 2, 10.

³⁰ Karl Peltzer, *Planter and Peasant: Colonial Policy and the Agrarian Struggle in East Sumatra 1863–1947* (The Hague: Nijhoff, 1978), 19–23, 51–4; N. L. Swart and A. A. L. Rutgers (eds), *Handboek voor de Rubbercultuur in Nederlandsch-Indië* (Amsterdam: de Bussy, 1921), 47–53; *Rubber in the Netherlands East Indies*, 10; Pieter Honig, 'Agriculture in the Netherlands Indies', in Pieter Honig and Frans Verdoorn (eds), *Science and Scientists in the Netherlands Indies* (New York: Board for the Netherlands Indies, Surinam and Curaçao, 1945), 175–80, here 179.

³¹ T. Volker, *Van Oerbosch tot Cultuurgebied: een Schets van de Beteekenis van de Tabak, de andere Cultures en de Industrie ter Oostkust van Sumatra* (Medan: Deli Planters Vereeniging, 1928), 77, 151.

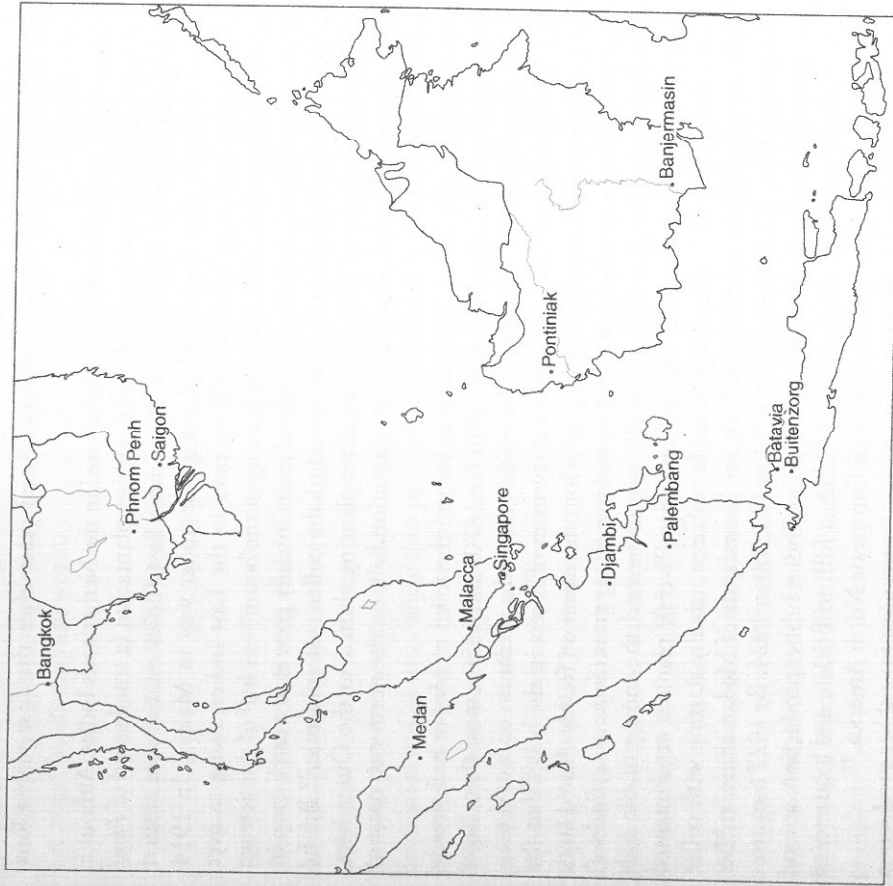


Fig. 3.1. Map of colonial Southeast Asia, covering the main rubber-producing districts.

(see Chapter 4). In the late 1890s and early 1900s parcels of forest in these areas were available on long-term lease for next to nothing. Even after land rents were hiked in 1906, the price of uncleared land was still negligible in relation to profit forecasts; moreover, former estate land that had reverted to government ownership was even cheaper than forested parcels. In an attempt to streamline the process of land acquisition still further, the government of the Federated Malay States even gave the individual state Residents the authority to permit clearing before an application was formally approved.³²

In north-eastern Sumatra, access to land was technically in the hands of the autonomous Malay sultans indirectly controlled by Batavia. In the wake of the new Agrarian Law of 1870, which terminated the state monopoly on East Indies export

³² Barlow, *Natural Rubber*, 28–9; J. B. Carruthers, 'Rubber', in Arnold Wright and H. A. Cartwright (eds), *Twentieth-Century Impressions of British Malaya: Its History, People, Commerce, Industries, and Resources* (London: Lloyds, 1908), 345–502, here 348, 352.

crops, these local rulers sought to enrich themselves by granting large areas of vacant land to concessionary companies on highly attractive terms. But the manner in which supposedly 'unused' land was defined and distributed created deep resentment among local Batak and Simalungen cultivators, who found themselves excluded from much of the land they had long used for swidden agriculture. In response to their protests, the East Indies government introduced a 'model contract' in 1878 that set aside four bouws (2.8 hectares) of land for each household residing within concession boundaries, but this was only around a quarter of what they actually required for subsistence. Although subsequent amendments in the 1880s and 1890s went some way towards improving land access and collection rights for indigenous people, 'squatters' were continually reported on the concessions from 1900 onwards, and in the 1930s the extent of unlawful occupancy had reached such proportions as to disrupt estate operations. By 1941 virtually all the acreage that foreign corporations wanted—some 10,000 km² of the best alluvial land in the Deli region—had been granted on long-term concession.³³

The supplanting of forests by *Hevea* estates was not a smooth or continual process, but rather advanced in fits and starts as market conditions changed and new areas opened up. The first big slow-down came in the early 1920s as the effects of wartime stockpiling and post-war economic dislocation temporarily depressed prices. In 1922 the British tried to organize a producers' cartel—the so-called 'Stevenson Scheme'—in a bid to shore up prices through planting restrictions, but the Dutch refusal to participate in the scheme undermined it from the start (indeed, the main result was to allow the East Indies to catch up with Malayan production by the end of the decade). As prices subsequently recovered in the mid-1920s, planters once again rushed into the forest. In Malaya the total rubber surface rose to just under 1.25 million hectares by 1930, roughly double that of 1920. In the East Indies, over 500,000 hectares were planted between 1925 and 1930 alone.³⁴

Although this second wave of planting was in some ways a resumption of pre-war trends, it nonetheless differed from the earlier phase in several important respects. For one thing, indigenous farmers accounted for much of the increase. In the East Indies in particular, it was impossible to know exactly how much smallholder rubber had been planted, though no one doubted that the area was vast. On Sumatra, smallholder production spread rapidly across central and southern parts of the island, and on Borneo it also took off along the southern and western coasts.³⁵

At the same time, a whole new planting frontier also opened in Indochina as French companies sought to gain a firmer foothold in the global rubber economy. The newfound (or belated, according to some contemporaries) French determination to boost Indochina's rubber production was not only a response to the rising prices of the late 1920s; it also reflected the increasingly autarkic direction of

³³ Pelzer, *Planter and Peasant*, 71–85; Ann Laura Stoler, *Capitalism and Confrontation in Sumatra's Plantation Belt, 1870–1979*, 2nd edn (Ann Arbor: University of Michigan Press, 1995), 2, 23–5.

³⁴ Drabble, *Malayan Rubber*, 308; T. A. Tengwall, 'History of Rubber Cultivation and Research in the Netherlands Indies', in Honig and Verdoorn (eds), *Science*, 344–51, here 349–50.

³⁵ See generally Bambang Purwanto, *From Dusun to the Market: Native Rubber Cultivation in Southern Sumatra, 1890–1940* (Ph.D. Thesis, SOAS, 1992), esp. 212–14.

French trade policy and the expanding reach of the colonial state. Before the 1920s a small number of plantations had been established on the so-called 'terres grises' (grey soils) to the east and north of Saigon, where labour was readily accessible but where production was hampered by fertility and drainage problems. Far more promising were the basaltic 'terres rouges' (red soils) situated between southern Cambodia and southern Annam.³⁶ Although a handful of estates had been set up on the fringes of this region before the war, large-scale planting on the more remote plateaus had to await the completion of a major post-war investment in transport infrastructure. As roads gradually penetrated the area in the mid-1920s, the colonial state granted huge concessions to planting firms, most of them comparatively large and well capitalized, and all of them French owned: Michelin, Caoutchoucs d'Indochine, Plantations de Kratié, Caoutchoucs du Mékong.

By the 1930s, over two-thirds of Indochina's rubber area was controlled by only twenty-seven companies, and much of the latex they exported came from a small number of mega-plantations over 1,000 hectares in size.³⁷ The underlying rationale for this policy was twofold: first, to 'do at the scale of 1,000 to 10,000 hectares what the (English and Dutch) neighbours did at the scale of 100 to 1,000'; and secondly to ensure that 'France will be able to consume French rubber, thereby removing all economic dangers in this area'.³⁸ Indochina's rubber industry was far more centralized and exclusive than elsewhere in the region. Unlike in Malaya or especially the East Indies, French land and labour policies ensured that indigenous farmers never accounted for more than a tiny fraction of Indochina's rubber production. Furthermore, as the plantations expanded in size (from 18,000 hectares in 1925 to around 127,000 hectares in 1937), they increasingly encroached on land used by shifting cultivators, especially once the frontier advanced into the highlands. Although special land grants were established for the 'Moï' groups that were most directly affected, the spread of rubber plantations and the influx of tens of thousands of labourers from Tonkin and Annam was nonetheless a constant source of tension.³⁹

The environmental consequences of all this rubber planting were vast. From northern Sumatra to southern Indochina, the dramatic spread of *Hevea* estates came predominantly at the expense of mature forest. The basic method varied little from place to place. After a site was chosen and small pathways were cut through the undergrowth, clearing was generally done in parcels of 1 to 4 hectares depending on the thickness of the cover. The standard procedure was to cut out most of the vegetation and then pile the brush around the base of any trees too large to fell with axes, arranging the debris in such a way as to ensure a continuous burn across

³⁶ Yves Henry, *Terres rouges et terres noires basaltiques d'Indochine: leur mise en culture* (Hanoi: Gouvernement Général de l'Indochine, 1931).

³⁷ Four of these estates even exceeded 5,000 ha: Charles Robequain, *The Economic Development of French Indo-China*, trans. Isabel A. Ward (London: Oxford University Press, 1944), 207.

³⁸ Pierre Michaux, *L'Hévéaculture en Indochine: son évolution* (Paris: Exposition Internationale, 1937), 4, 14.

³⁹ René Mingot, and J. Canet, *L'Hévéaculture en Indochine* (Paris: Exposition Internationale, 1937), 27–9; Robequain, *Economic Development*, 181–6, 213–18.

the surface. After several months—and preferably on a dry day with light wind—a fire was lit on one side of the clearing and was gradually fanned across until all the wood was consumed.⁴⁰ Although it was a seemingly simple process, a good 'burn' was crucial for releasing nutrients back into the soil and minimizing the amount of decaying material that could harbour detrimental fungi. 'The future of a rubber plantation', remarked one contemporary, 'depends in large part on a good initial clearing'.⁴¹

Felling these mature tropical forests was extremely arduous work. Apart from some of the largest estates in Cochin China, where clearing was often aided by machinery, it was generally carried out by hand, usually by locals working on contract.⁴² Given the considerable costs and effort this involved, some of the earliest planters avoided forest plots in favour of previously cleared land, such as former tobacco estates, abandoned coffee land, or even degraded *lalang* areas.⁴³ There were benefits and drawbacks either way. Although cleared parcels were by and large cheaper to prepare for planting, they often yielded less well than forest plots. Moreover, getting rid of the pernicious *lalang* grass often required repeated deep-ploughing (called 'chunkling' in Malaya) and/or multiple doses of leaf poison (usually sodium arsenite, a carcinogenic toxin that is still used in herbicides today).⁴⁴ It is debatable whether the application of such chemicals or the clearing of additional woodland was ecologically worse. At the time, it was a moot point, since the sheer scale of rubber planting in the region meant that most estates were inevitably carved out of the forests.

Those who witnessed the razing of forested plots were not entirely insensitive to what was being lost in the process. In contemporary accounts, the scene after a major burn often evoked a feeling of ambivalence: 'The fire had been violent, and now only smouldering black stumps remained. The aspect of the land was desolate. The great trees had toppled down, tearing up the soil and making deep pits. All the landscape was soiled with ash and soot. Smouldering trunks lay everywhere'.⁴⁵ But despite such pangs of melancholy, most viewed the clearings as little more than pinpricks amidst the vast expanse of the region's forests. 'The plantations that seemed so large, looked, as I now saw them, like little deserts in a limitless oasis,' noted the French planter and novelist Henri Fauconnier, who worked in Malaya throughout the boom years.⁴⁶ This sense of being surrounded by an endless wilderness led many planters to regard themselves as nothing less than heroic conquerors of the unknown. In the words of one of Fauconnier's protégés, 'from the moment I set foot in Malaya I felt like a planter, with the morale of a conquistador'.⁴⁷ Few if any perceived the destruction as anything other than the justifiable cost of progress.

⁴⁰ Swart and Rutgers (eds), *Handbook*, 25–34, 36–8; Carruthers, 'Rubber', 348–50.

⁴¹ Vaxelaire, *Le Caoutchouc*, 16.

⁴² Robequain, *Economic Development*, 208–9.

⁴³ Volker, *Van Oerbosch*, 77; Pelzer, *Planter and Peasant*, 51.

⁴⁴ Swart and Rutgers (eds), *Handbook*, 42–4; Carruthers, 'Rubber', 353.

⁴⁵ Madelon Lulofs, *Rubber*, trans. G. J. Renier and Irene Clephane (Singapore: Oxford University Press, 1987), 63 (first published in Dutch as 'Rubber' in 1931).

⁴⁶ Henri Fauconnier, *The Soul of Malaya*, trans. Eric Sutton (Singapore: Oxford University Press, 1990), 36 (originally published in French as 'Malaisie' in 1930).

⁴⁷ Raoul Chollet, *Plantations en Indochine française* (Paris: pensée universelle, 1981), 9.

The entire purpose was to carve 'a piece of civilization' from the wilderness: 'There would be a fine head-quarters with short cropped lawns and a wealth of cultivated flowers. The road would be metalled, and later, when the motor lorries arrived to fetch the latex for the factory, then he would be able to point to it all and say: "This is the piece I have reclaimed and planted. I have taken it from the forest"'.⁴⁸

As this last remark indicates, the destruction of the forest was the nucleus of a wider set of environmental impacts that rippled across the landscape, including transport infrastructure, new settlements, and a whole range of subsidiary economic activities. The plantations required huge amounts of labour, far more than local populations could generally provide. In Malaya, British authorities recruited tens of thousands of impoverished south Indian 'foreign natives' to work on the rubber estates. In East Sumatra, where autochthonous groups were generally disinclined to work on the plantations, most of the manual labour was carried out by Javanese and Chinese 'coolies' working under slave-like conditions. In all of the main rubber districts, the human population grew as rapidly as the estates themselves. In Deli, the number of inhabitants rose from around 100,000 in 1880 to 1.5 million in 1930, most of them newcomers to the area.⁴⁹ Furthermore, feeding and housing such a large labour force generated a host of secondary effects. To take one example, the Snoul estate in southern Cambodia drained a nearby marsh in order to create a 33-hectare farm that produced between 3 and 5 tons of vegetables per day for its 3,000 Tonkinese workers. It also kept 500 cattle, 800 pigs, as well as herds of sheep and goats that browsed on the surrounding forest (and that occasionally attracted unwanted predators, including tigers).⁵⁰ Besides food, estates also required significant amounts of fuel and construction timber, which was usually obtained from nearby sources to avoid the costs of buying it in.⁵¹

Unlike the densely populated and long-established agrarian centres of Java or Tonkin, Southeast Asia's rubber belts were essentially frontier societies peopled mainly by restless entrepreneurs and migrant labourers. Few had any ties to the land, and they treated it accordingly. Most Europeans were there to get rich before returning home, the majority of them working as estate managers and supervisors rather than as independent planters. Many of the workers who toiled under the brutal labour regime could only be kept on the estates through the threat of extreme violence for breaching their contracts (though conditions in Malaya were significantly better than in the East Indies).⁵² 'Here everything and everybody was merely transient,' wrote Ladislao Székely, who began work as a planter in Deli in the late 1910s. 'It was a question of making money and getting away again. No one dreamed of settling down here; neither a Chinaman nor a European ever thought

of that, nor even the Malays who came from the other islands. The country was still too young.'⁵³

Domesticating this raw landscape was the basic aim of European planters and officials, and it had both an economic and a cultural logic. Establishing a rubber estate was an expensive undertaking. In Malaya it cost around \$550/hectare for the initial phase of clearing, planting, and maintenance, followed by a wait of five or six years before the first income was generated.⁵⁴ Broadly speaking, European planters brought with them an 'orchard' model of cultivation that emphasized orderly rows, low tree density, weeding, and straight-edged drainage ditches wherever needed. Getting the planting right was deemed crucial. Early spacing norms of around 3 metres soon increased to 4, 5, or even 7 metres in parts of Indochina as it was discovered that yields were a function of tree girth, and that girth was inversely related to planting density.⁵⁵

On the face of it, the methodical systems applied on the estates were designed to maximize productivity and profits. Beneath the veneer of economic rationality, however, they also served as an expression of European mastery over nature, of the 'aesthetic colonization' of the land. Székely's description of Medan in the 1910s and 1920s suggestively captures the symbolic importance of strict agronomic order amidst the untamed chaos of tropical nature: 'Forest, swamp, lianas, monkeys, jungle, thicket, stillness, dark pieces of water. Suddenly, as if marked out with a ruler, a huge clearing... Everything one saw was carefully tended, almost exaggeratedly ordered.' Indeed, this zeal for neatness reflected not only the logic of operational efficiency but also the role of estates as metaphorical guardians of colonial order against the aboriginal forces of disarray: 'The virgin forest had disappeared. As far as the eye could see, young rubber trees stood in straight lines, like soldiers.'⁵⁶

Such vast, serried ranks of *Hevea* rarely failed to impress onlookers, though they occasionally conjured mixed feelings. Driving the 200 kilometres from Goenoe Malajoe to Medan, a Swiss forester in the mid-1930s was amazed by 'the endless rubber forests that appear as monochromatic walls along both sides of the road'.⁵⁷ It was highly debatable whether these were still 'forests' at all, containing as they did only a tiny fraction of the botanical diversity of the woodlands they had displaced (which, on Sumatra, was around 420 plant species per hectare in undisturbed forest).⁵⁸ Such a radical standardization of plant cover inevitably had repercussions for animal life too. A former health minister in Indochina fittingly referred to the rubber plantations as 'forests without birds'—that is, forests without the many

⁵³ Ladislao Székely, *Tropic Fever: The Adventures of a Planter in Sumatra*, trans. Marion Saunders (Singapore: Oxford University Press, 1979), 60–1 (first English publication in 1937).

⁵⁴ Barlow, *Natural Rubber*, 29.

⁵⁵ Carruthers, 'Rubber', 354; Drabble, *Rubber in Malaya*, 44; Chollet, *Plantations*, 131.

⁵⁶ Székely, *Tropic Fever*, 29, 274.

⁵⁷ F. Schneider, 'Tagebuch einer Reise in Nord-Sumatra', in Honig and Verdoorn (eds), *Science, 289–95*, here 290.

⁵⁸ P. A. Sanchez, 'Science in Agroforestry', in Fergus L. Sinclair (ed.), *Agroforestry: Science, Policy and Practice* (Dordrecht: Kluwer, 1995), 5–55, here 33.

⁴⁸ Lulofs, *Rubber*, 15–16.

⁴⁹ Volker, *Van Oerboch*, 25; Pelzer, *Planter and Peasants*, 61–3; Stoler, *Capitalism and Confrontation*, 3; T. Bauer, *The Rubber Industry: A Study in Competition and Monopoly* (London: Longmans, 1948), 217–22.

⁵⁰ Chollet, *Plantations*, 85–92.

⁵² Bauer, *Rubber Industry*, 221–4.

⁵¹ Swart and Rutgers (eds), *Handbook*, 25–34.

fruiting trees that sustained bird populations.⁵⁹ Numerous mammal species were also pushed out as jungle gave way to *Hevea* mono-crops, and many of those that remained were subsequently treated as pests. The progressive loss of habitat and familiar forage areas often drove large herbivores into the plantations, where they helped themselves to the tender rubber saplings and whatever else was on offer in the employees' gardens and orchards. On some estates the damage from elephants and deer ran into many thousands of trees and tens of thousands of dollars per year. Despite the concerns among conservationists about the effects of rubber cultivation on wildlife, it remained legal to shoot any animals that destroyed crops, and planters did so enthusiastically.⁶⁰

Once the plantations were up and running, much of the work consisted of tapping, weeding, and general maintenance. Tapping, like planting, was systematized over years of experimentation. By the 1900s the basic method—devised largely by Henry Ridley at Singapore Botanical Gardens—was much as it is today, and involved the removal of a small sliver of bark with a special knife that cut just deep enough to sever the latex vessels without wounding the tree. After a specified interval (which varied according to prices, climate conditions, and different tapping regimes), another sliver was removed from the edge of the preceding cut, and the process was repeated at a controlled rate—initially in a herringbone pattern but later in spirals around the trunk—to ensure that the rate of bark usage did not exceed the rate of regrowth.⁶¹ A skilled tapper could cut up to 350 trees per day with this method. Weeding, too, was thoroughly systematized, and was usually carried out at three-week intervals to ensure the removal of unwanted grass species before they went to seed.⁶² Madelon Lulofs's portrayal of life on Deli's plantations conveys a clear sense of the mania for rationalizing such tasks: 'The days succeeded one another monotonously: tapping, weeding, tapping, weeding. The old rubber plantations needed no other attentions. But the tapping and the weeding were done to perfection. For a year, the inspectors had had nothing to do except think out new systems, and the assistants nothing to do except apply them. Everything went with the simplicity of well-oiled machinery.'⁶³

The machinery analogy is fitting, for in many ways the corporate estates were more like factories than orchards, let alone forests. Like most plantations the world over,⁶⁴ in essence they were carefully designed production systems instrumentally geared towards maximizing the production of a single output. Yet for all their industrial affectation they were more than mere 'machines in the garden', technological systems intruding onto the natural landscape. The fact that they remained fundamentally based on biological processes meant there was always an element of

the 'garden in the machine' as well.⁶⁵ Managing these processes was more complicated than controlling the cogs in an engine. There were many more variables at work, innumerable organisms and physical processes interconnected in an intricate web of life. Moreover, many of these organisms and processes were not very well understood. Despite the attempt to isolate and manage the various factors of production, the methodical systems employed on the rubber estates often achieved no more than the illusion of human control.

THE ECOLOGY OF RUBBER PLANTATIONS

To put the point differently, the corporate plantations created not only a new rubber economy in the region but also a new rubber ecology. Recognizing this fact, and managing the estates accordingly, were among the keys to long-term success. Few, however, saw things this way during the rubber bonanza of the early twentieth century. As planters converted huge tracts of jungle into orderly rows of *Hevea*, they unleashed a series of unanticipated ecological effects. Many of the management practices they introduced proved ill suited to the humid lowland environment, and often damaged the productivity of the land and the plantations themselves.

Among the worst offenders were the clean-weeding systems that prevailed during the early years. Removing all unwanted vegetation was standard agricultural practice in northern Europe, and was common on coffee and cocoa estates throughout the tropics. During the early rubber boom most European planters employed it almost unthinkingly, and in Malaya it continued to be 'the gospel of efficiency in estate management' until at least the mid-1920s.⁶⁶ But some observers challenged the conventional wisdom. In Malaya, the Director of Agriculture J. B. Carruthers repeatedly enjoined planters to leave some form of ground cover to hold the soil and prevent the leaching of nutrients. Although his warnings were mostly ignored at the time, they were eventually vindicated as severe erosion began to afflict many estates, especially those situated on sloping land where the formation of gullies and the exposure of roots reduced latex yields and sometimes killed entire stands.⁶⁷ Planters in the East Indies encountered similar problems, but were by and large less beholden to the doctrine of clean-weeding. On Java in particular, where intensive rice cultivation tended to push rubber onto hillsides, planters quickly abandoned the practice in the face of disastrous soil erosion during the

⁶⁵ Leo Marx, *The Machine in the Garden: Technology and the Pastoral Ideal in America* (Oxford: Oxford University Press, 1967); Edmund Russell, 'Introduction: The Garden in the Machine: Toward an Evolutionary History of Technology', in Susan R. Schrepfer and Philip Scranton (eds), *Industrializing Organisms: Introducing Evolutionary History* (New York: Routledge, 2004), 1–16.

⁶⁶ Quote from A. W. King, 'Plantation and Agriculture in Malaya, with Notes on the Trade of Singapore', *Geographical Journal*, vol. 93 no. 2 (Feb. 1939), 136–48, here 139.

⁶⁷ J. B. Carruthers, 'Report of the Director of Agriculture of F.M.S. for 1907', *Agricultural Bulletin of the Straits and Federated Malay States*, vol. 8 (Singapore: GPO, 1908), 523–48; *Report by the Right Honourable W. G. A. Ormsby Gore on his Visit to Malaya, Ceylon, and Java during the Year 1928* (London: HMSO, 1928), 30.

⁵⁹ Michitake Aso, 'Rubber Plantations, Ecology, and Colonial Rule: Industrial Agriculture and the Spread of Ecological Thinking', paper presented at the Rachel Carson Center for Environment and Society, July 2011, 4.

⁶⁰ Jeyamalar Kathirithamby-Wells, *Nature and Nation: Forests and Development in Peninsular Malaysia* (Honolulu: University of Hawaii Press, 2005), 197–8.

⁶¹ Drabble, *Rubber in Malaya*, 8–9; Bauer, *Rubber Industry*, 254–6.

⁶² Swart and Rutgers (eds), *Handbook*, 133–6.

⁶⁴ On the basic attributes of the 'global plantation', see Uekötter, 'Rise, Fall, and Permanence', 7–25.

rainy season'.⁶⁸ On Sumatra too, clean-weeding was increasingly frowned upon by the mid-1920s, though it took many years for its after-effects to subside. Pedological studies throughout the inter-war period showed that rubber plantations were still a major source of erosion in the Deli region despite the modification of weeding practices.⁶⁹

The impact of all this eroded soil ranged far beyond the estates themselves. Much of it inevitably ended up in the rivers draining the rubber districts, many of which became choked with silt and far more likely to burst their banks during heavy rains. As riverbed levels rose, the effects on downstream paddy farmers were occasionally severe. In the Malacca River valley, for instance, around 2,800 hectares of paddy were abandoned in the 1930s because of erosion from rubber estates.⁷⁰ On the east coast of Sumatra, silt repeatedly clogged irrigation works, caused rivers to flood low-lying fields, and in some localities raised water tables to just below the surface. In the worst affected areas, the resultant waterlogging was so severe as to create 'dying lands'.⁷¹ As for the riverine environments themselves, Malayan reports of declining fish-catches in the 1920s were blamed in large part on cleaning of the rubber estates, along with the erosion caused by the mining industry (see Chapter 4). In 1939 it was estimated that erosion from rubber plantations in Peninsular Malaya amounted to 33 million tons annually, or 1.1 billion tons since 1905 (to give some sense of scale, 33 million tons is around three times as much earth as was removed by the entire Channel Tunnel project, including all three tunnels).⁷² In sum, many of the costs of corporate rubber production were passed on to others downstream, generally to groups such as paddy farmers or fishermen who were less powerful than those causing the mess.

Governments introduced a variety of remedies to mitigate the damage. In the Federated Malay States, a series of enactments from 1917 onwards empowered state authorities to take action against landowners who allowed eroded material from their property to enter rivers or neighbouring land. In the East Indies, officials called for a more stringent application of 1874 laws mandating terraces on sloping terrain. In neither colony, however, was such legislation widely enforced.⁷³ In the long run, a more effective solution was to promote better soil conservation, above all through the construction of silt pits, bunds, and contour drains designed to retain loose soil.⁷⁴ Despite the extra labour costs they entailed, such devices were fairly standard on new estates by the 1920s. The retention of non-invasive weed cover—or, better still, the planting of leguminous cover crops—was also broadly recommended. On Java such cover crops were all but universal on rubber estates, and on Sumatra they were also widely used despite the need for

⁶⁸ Tengwall, 'History of Rubber', 34.

⁶⁹ C. H. Edelman, *Studiën over de Bodemkunde van Nederlandsch-Indië* (Wageningen: Veenman, 1947), 285, 288–9.

⁷⁰ Sir Lewis Leigh Fermor, *Report upon the Mining Industry of Malaya*, 3rd printing (Kuala Lumpur: Government Press, 1943), 154.

⁷¹ Edelman, *Studiën*, 289.

⁷² Fermor, *Report*, 152–4.

⁷³ S. Robert Aiken et al., *Development and Environment in Peninsular Malaysia* (Singapore: McGraw-Hill International, 1982), 122–3; Edelman, *Studiën*, 294.

⁷⁴ Swart and Rutgers (eds), *Handbook*, 38–42.

phosphate fertilizer inputs.⁷⁵ On Indochinese estates as well, leguminous cover plants were a common feature of the 'sarclage de bande' technique, whereby workers clean-weeded only a 1-metre strip in which the trees grew while leaving the intervening spaces uncleared.⁷⁶ By contrast, planters in Malaya were slow to adopt cover plants out of fear of root competition with young trees, despite the repeated assurances of agronomists that they had little to fear.⁷⁷ The reason for this discrepancy between Malaya and neighbouring colonies is unclear, though for what it is worth, Sir Frank Stockdale surmised that Dutch planters were more likely than their British counterparts to have undergone proper agronomic training at the National Agricultural College at Wageningen before leaving Europe. Judging from a career guide for would-be Malayan rubber planters, which listed as the main prerequisites for success a 'sound physique, an aptitude for controlling native labour and a readiness to dispense with the superfluities of life', he may well have been right.⁷⁸ In any event, the lower rates of sediment loss on most East Indian and Indochinese rubber estates offered compelling evidence that erosion in Malaya was 'an evil that might have been avoided' (Fig. 3.2).⁷⁹

Soil loss was only one of many unintended consequences. The environmental conditions on the rubber plantations also provided an ideal habitat for all manner of pathogens. Human diseases ranging from hookworm to dysentery were rife on the estates, but the biggest health problem of all was undoubtedly malaria. In Malaya, which first introduced malaria controls in 1901, mortality rates of 50/1,000 among estate workers were by no means uncommon in the 1900s and 1910s despite heavy doses of quinine. In 1911, the worst year for malarial deaths in Malaya, mortality rates reached 63/1,000, and in certain hotspots they were several times higher than that. In the state of Negri Sembilan, nearly one in five Indian estate workers died in 1911.⁸⁰ Disease problems of this magnitude were not only appalling from a humanitarian perspective, they also posed a serious obstacle to the growth of the rubber industry. As news of malarial deaths circulated in the colony, workers tried to avoid the most unhealthy estates, or at least demanded higher wages as compensation for working on them. In the words of Malcolm Watson, the physician who pioneered the anti-malaria measures in Malaya, 'the labour problem is nothing but the malaria problem, and... the solution of the malaria problem will also be the solution of the labour problem'.⁸¹ But solving the malaria problem took time, and methods had to be modified as the rubber frontier advanced into different types of terrain.

⁷⁵ *Report by Sir Frank Stockdale on a Visit to Malaya, Java, Sumatra and Ceylon 1938* (London: Colonial Office, 1939), 17–19.

⁷⁶ In addition, leguminous cover crops performed better on the red soils of Indochina than on the more acidic soils of western Malaya: Michaux, *L'Hévéaculture*, 14–18; Vaxelaire, *Le Caoutchouc*, 18–22.

⁷⁷ Eric Macfadyen, *Rubber Planting in Malaya* (London: Malay States Information Agency, 1924), 29–32; Drabble, *Rubber in Malaya*, 120.

⁷⁸ Quoted from E. Macfadyen, *Rubber Planting in Malaya* (London: Malay States Information Agency, 1924), 54; see also *Report by Sir Frank Stockdale*, 69.

⁷⁹ *Report by the Right Honourable W. G. A. Ormsby Gore*, 30.

⁸⁰ Tamils were generally thought to be more susceptible than Chinese or Malays: Barlow, *Natural Rubber*, 51–2.

⁸¹ Sir Malcolm Watson, *The Prevention of Malaria in the Federated Malay States*, 2nd rev. edn (London: Murray, 1921), 365.



Fig. 3.2. Flat terraces on sloping terrain at a Hevea plantation in East Sumatra, 1921–6. By permission of the Nationaal Museum van Wereldculturen, coll. no. 60014052.

Watson's major innovation was to employ an 'ecological' rather than a medical approach to malaria—that is, to focus not on the bodies of infected humans but on the vectors that spread the disease. In the low-lying coastal plain where the earliest estates were located, the chief mosquito vector was *Anopheles umbrosus*, which tends to breed in stagnant pools under heavy cover. To combat this species Watson recommended a programme of swamp drainage and brush clearance, which proved sufficiently effective for planters to continue employing it as they advanced into the ravines of the foothills. As they did so, however, they found that the drainage methods designed for the lowlands were counter-productive in hilly areas, where they created ideal breeding grounds for another malaria vector, *A. maculatus*, which thrives not in heavy jungle cover but in clear water under full sunlight. These were precisely the conditions created on newly cleared estates. Drainage channels, silt pits, root holes, and the like provided *A. maculatus* larvae with a perfect habitat. The most effective remedy against this vector was the installation of subsoil drains, but this was prohibitively expensive. A cheaper and more common alternative was to leave the jungle cover intact around hilly streams to keep them shaded, though the most widely used practice of all was to douse breeding areas with kerosene or mineral oil.⁸²

⁸² Generally, Watson, *The Prevention*, 354–65; also Foong Kin, 'The Role of Waterborne Diseases in Malaysia', in Peter Boomgard (ed.), *A World of Water: Rain, Rivers and Seas in Southeast Asian Histories* (Leiden: KITLV, 2007), 281–95.

As a result of such measures, mortality rates on Malayan plantations gradually declined over the course of the 1910s and 1920s, and finally dipped below 10/1,000 in 1930. In the meantime, medical officers in the East Indies and Indochina adopted many of Watson's vector-based control methods.⁸³ Morbidity rates in the *terres rouges* of Indochina were particularly high, sometimes reaching almost 600 per cent in the latter 1920s (i.e. an average of six bouts of malaria annually per worker); one plantation in the Thu Dau Mot province even reported a staggering 45 per cent mortality rate among its workers in 1927.⁸⁴ Given the severity of the problem, the Institut Pasteur d'Indochine pursued a dual ecological-medical approach, including the elimination of standing water within 1,200 metres of settlements, the regular treatment of all ditches and drains with larvicide, along with copious amounts of quinine. By the late 1930s infection rates dropped to around 5 per cent.⁸⁵

Besides human diseases, the estates created breeding grounds for plant pathogens as well. Although Southeast Asia's *Hevea* trees remained unmolested by the leaf fungus that ravaged them in their native Amazonia, the huge single-species blocks nonetheless invited other problems. The most serious by far was the spread of root fungus (especially *Fomes lignosus*) from old diseased stumps or roots that had been left over from the original forest cover. Infections could spread quickly once *Hevea* stands matured and their shallow root systems intertwined, starving the trees of nutrients and eventually killing them if left untreated. By 1914 root fungus was already causing significant losses in east Sumatra, where planters tried to control it by removing all decaying vegetation from new planting areas. In Malaya too, alarm at the losses from root fungus, ants, and beetles led to an Agricultural Pests Enactment in 1913, which gave inspectors the authority to mandate sanitary measures on estates. Various forms of bark and stem canker, mostly caused by various fungi, were also problematic.⁸⁶ In this respect the estates of Indochina enjoyed an unanticipated advantage over their counterparts in Malaya and the East Indies. The annual dry season across much of the colony, which was initially seen as a drawback for *Hevea* cultivation, eventually proved beneficial for reducing the incidence of fungal disease.⁸⁷

To some extent such maladies were unavoidable in the perennially moist conditions of western Malaya and Deli, but they were undoubtedly exacerbated by the practice of mono-cropping. Once again, as with the practice of clean-weeding, early warnings from agronomists went unheeded. 'Though the sight of an immense area planted with rubber trees only is impressive, and calls forth an expression of appreciation for the energy and foresight displayed, yet there is something one

⁸³ G. Grijns and G. W. Kiewiet de Jonge, *Plantage-Hygiene* (Batavia: Javasche Boekhandel, 1914), 134–55.

⁸⁴ Michitake Aso, 'Patriotic Hygiene: Tracing New Places of Knowledge Production about Malaria in Vietnam, 1919–75', *Journal of Southeast Asian Studies*, vol. 44 (2013), 423–43, here 427.

⁸⁵ Mingot and Canet, *L'Hévéaculture*, 51–4, 73–4; Chollet, *Plantations*, 211–20.

⁸⁶ Van de Leemkolle, *De Rubber-Cultuur*, 31–2; Drabble, *Rubber in Malaya*, 119–20; Barlow, *Natural Rubber*, 154–6; generally Harold Hamel Smith, *Notes on Soil and Plant Sanitation on Cacao and Rubber Estates* (London: Bale, 1911).

⁸⁷ Cardot, *Note sur la Production*, 4; Michaux, *L'Hévéaculture*, 27–8.

does not altogether like,' remarked Herbert Wright, editor of the *India-Rubber Journal*, in 1908. 'The system is an unnatural one—that may or may not enable planters to get better results than if they strictly imitated nature—and strikes the visitor as being dangerous from the plant sanitation standpoint.'⁸⁸ Despite continued disease losses, mono-cropping remained standard practice. It was more a matter of luck than design that none of the rubber pathogens reached the epidemic proportions that witches' broom or swollen shoot assumed on many cocoa farms. In the late 1910s and early 1920s the most acute problem for the rubber estates was in fact human-made: namely 'brown bast', a bark disorder caused by excessive tapping, which reduced or stopped the flow of latex on up to 30 per cent of the trees on some estates.⁸⁹

As disease and fertility problems mounted on the estates, the planter community instinctively put its faith in modern agronomic science to find solutions. In some ways it proved to be a successful partnership. With the help of botanists and mycologists, most planters learned from at least some of their mistakes and generally managed to keep their estates working. But keeping their estates profitable was another challenge, and in this respect the main threats were not soil wash or pathogens—important though these were in commercial terms—but rather the vagaries of international markets and the mounting competition from smallholders. Ultimately, smallholders were the more important of the two, for the threat they posed was not only economic. It was one thing that their apparently simple cultivation methods produced rubber at low cost. But the fact that they also brought other advantages posed a more fundamental challenge to the ideology of the modern scientific agro-estate.

NATURE, CULTURE, AND SMALLHOLDER RUBBER

Although the ever-rising prominence of smallholder rubber alarmed the plantation community, in many respects it was entirely unsurprising. Throughout much of the region indigenous cultivators had long engaged in commodity production for distant markets. During the nineteenth century small-scale planters in the lowlands, many of them Chinese, threw themselves into pepper, gambier, and tapioca production. Even swidden cultivators in the remote uplands busily traded resins (especially gutta-percha) and spices with outside merchants. What was new about the rubber boom was not the active participation of Southeast Asian smallholders in international commodity markets, but rather the growing scope of their involvement. After the turn of the century the voracious global demand for rubber outstripped anything the region had witnessed before. In stark contrast to colonial cotton cultivation, the main problem for peasants and small-scale planters was not that they were coerced into producing rubber for

⁸⁸ Herbert Wright, *My Tour in Eastern Rubber Lands* (London: McLaren, 1908), 30.

⁸⁹ Drabble, *Rubber in Malaya*, 150–3, 202; Badlow, *Natural Rubber*, 154–6; Tengwall, 'History of Rubber', 347–8.

international markets, but rather that colonial elites sought to cut them out of the profits.⁹⁰

Smallholders near the main planting districts were generally quick to spot the opportunities presented by the rubber boom. In most localities, planting seems to have commenced around three to five years after the establishment of foreign-owned estates. Cultivation techniques were broadly similar across Malaya and the East Indies, though the distribution and ethnic profile of rubber smallholdings differed significantly between the two colonies. Whereas Malayan smallholdings were mostly concentrated in the western areas of the peninsula, in the East Indies they were more widely distributed, including not only the hinterlands of Medan but also central and southern Sumatra (Palembang, Djambi) as well as western (Pontiak) and southern (Banjermasin) Borneo. Patterns of ownership were also noticeably different. In Malaya around half of all medium-sized and small rubber groves were owned by ethnic Chinese or, to a lesser extent, Indian immigrants, many of them absentee proprietors; furthermore, a large proportion of the nominally 'Malay' smallholders were Javanese. By contrast, immigrants played a much smaller role on Sumatra and Borneo, where the bulk of smallholdings were planted and maintained with local labour. This difference was reflected in the official definitions of 'smallholdings' versus 'estates' in the two colonies. In Malaya the key criterion was size; anything over 100 acres (40.5 hectares) was classified as an estate and anything under 100 acres as a smallholding (though medium-holdings ranging from 15 to 100 acres accounted for up to half of the acreage in this category). During the inter-war period around 40 per cent of Malayan rubber acreage was on small- or medium-holdings, and 60 per cent on large estates (three-quarters of it owned by Europeans, with most of the balance in Chinese hands). In the East Indies the categories were more closely aligned to size and ethnic ownership. Estates of over 100 acres were broadly coterminous with European or American ownership, smallholdings with 'native rubber'. Official statistics for the inter-war period attributed 46 per cent of East Indies acreage to estates and 54 per cent to smallholdings, but native rubber was almost certainly underestimated in such calculations.⁹¹

⁹⁰ Michael R. Dove, *The Banana Tree at the Gate: A History of Marginal Peoples and Global Markets in Borneo* (New Haven: Yale University Press, 2010); Jeyamalar Kathirithamby-Wells, 'Attitudes to Natural Resources and Environment among the Upland Forest and Swidden Communities of Southeast Asia during the Nineteenth and Early Twentieth Centuries', in Richard H. Grove, Vinita Damodaran, and Satpal Sangwan (eds), *Nature and the Orient: The Environmental History of South and Southeast Asia* (Delhi: Oxford University Press, 1998), 918–35; Lesley M. Porter, 'A Forest Product out of Control: Gutta Percha in Indonesia and the Wider Malay World, 1845–1915', in Peter Boomgard, Freek Colombijn, and David Henley (eds), *Paper Landscapes: Explorations in the Environmental History of Indonesia* (Leiden: KITLV, 1997), 281–308.

⁹¹ Indeed, the first systematic survey of smallholdings in the East Indies was only carried out 1937: Bauer, *Rubber Industry*, 3–8; Drabble, *Malayan Rubber*, 1; Jeroen Touwen, 'Entrepreneurial Strategies in Indigenous Export Agriculture in the Outer Islands of Colonial Indonesia, 1925–38', in Peter Boomgard and Ian Brown (eds), *Weathering the Storm: The Economics of Southeast Asia in the 1930s Depression* (Leiden: KITLV, 2000), 143–70, here 149–50, 158–9; Purwanto, *From Dusun to the Market*, 184–9, 216–18; D. H. Grist, *Nationality of Ownership and Nature of Constitution of Rubber Estates in Malaya* (Kuala Lumpur: Caxton Press, 1933).

The great attraction of rubber among smallholders was based on two main factors: its profitability, and the fact that it could be neatly folded into existing patterns of swidden cultivation. The conventional hill rice or 'ladang' system that was practised across much of the region essentially consisted of forest clearance followed by one or two dry rice crops before the patch was given over to natural regrowth or 'blukar' successor species. To introduce rubber into this system, farmers planted *Hevea* seeds in relatively dense concentrations on freshly cleared *ladang* plots along with the first rice crop. After the second harvest the rubber seedlings were already over a year old and therefore had a head start over the natural *blukar* successor species, quickly forming a crown that suppressed undergrowth and that consequently minimized maintenance.⁹² After another three to five years all that was needed was to slash the low-lying undergrowth for access to the mature rubber trees. In the words of P. T. Bauer, one of the most astute observers of the colonial rubber economy, 'To add rubber to this system costs nothing in effort, cash or displaced alternatives.'⁹³ In many ways the establishment of rubber smallholdings mirrored the dominant mode of indigenous cocoa planting in West Africa. In both cases the key was the remarkable compatibility of an exotic cash crop with existing agrarian systems, though smallholders in Southeast Asia were, if anything, even less likely to over-commit themselves to a single commodity and even more insistent on maintaining their subsistence activities.⁹⁴

The differences between smallholdings and estates therefore went far beyond the question of size or ownership. They also reflected more fundamental distinctions over the ways in which land resources should best be used. In accordance with the Ricardian doctrine of 'comparative advantage', the large plantations specialized solely on rubber. They clear-cut forest, intercropped rarely if at all, and opted to import most of their basic needs rather than withhold any land from latex production for the purpose of growing food. By contrast, smallholdings generally grew rubber alongside rice, fruit, and other crops as a means of spreading risks. To some extent the discrepancies reflected contemporary notions of a 'dual economy' that distinguished between a dynamic, export-oriented European sector and a conservative, subsistence-based indigenous sector, each of which served quite different economic and social needs.⁹⁵ But if the theory was correct in highlighting the differences between European and indigenous approaches to land use, it failed to recognize that subsistence-oriented

⁹² A. van Gelder, 'Bevolkingsrubbertcultuur', in C. J. J. van Hall and C. van de Koppel (eds), *De Landbouw in de Indische Archipel*, vol. 3 (The Hague: van Hoeve, 1950), 427–75; here 446–9; V. A. Taylor, and John Stephens, *Native Rubber in the Dutch East Indies* (London: Rubber Growers' Association, 1929), 3–4; Purwanto, *From Dusun to the Market*, 114–16, 202–3.

⁹³ P. T. Bauer, *Report on a Visit to the Rubber Growing Smallholdings of Malaya, July–September 1946* (London: HMSO, 1948), 17.

⁹⁴ Michael R. Dove, 'Rice-Eating Rubber and People-Eating Governments: Peasant versus State Critiques of Rubber Development in Colonial Borneo', *Ethnohistory*, vol. 43 no. 1 (1996), 33–63, here 34–5.

⁹⁵ These ideas, associated above all with Julius Herman Boeke, were particularly influential during the 'ethical' period of development in the Netherlands Indies: Susanne M. Moon, 'Development and the Dual Economy: Theories of Colonial Transformation in the Netherlands East Indies, c.1920', in Benedikt Stuchey (ed.), *Science across the European Empires, 1800–1950* (Oxford: Oxford University Press, 2005), 129–47.

rubber growers actually produced a large and growing proportion of colonial latex exports, and indeed did so at much lower cost. Estates needed high outputs to pay for their overheads and to recoup their investments in roads, drainage ditches, processing buildings, and the like. Smallholders needed little of this, and most of the tapping was carried out by family labour or on a sharecropping basis. In the mid-1920s it was estimated that smallholders in the Outer Isles of the East Indies invested only £5–6 per mature acre (0.4 hectare) of rubber compared to £60–80 per acre for European estates.⁹⁶

Little wonder, then, that colonial officials and estate owners grew increasingly concerned about the threat this posed to the rubber plantations. The rivalry between these two modes of production, and the extent to which governments should intervene to control it, was a perennial source of controversy. In Malaya there were already attempts to inhibit smallholder planting before the First World War. The Malay Lands Act of 1913, which prevented sales of rice-growing land to non-Malays, was ostensibly designed to protect indigenous peasants from the effects of speculative land purchases, but it also explicitly prohibited rubber cultivation within reserve boundaries.⁹⁷ It was mainly the price slump of the early 1920s that first drew attention to the 'problem' of smallholder rubber. The 1922 Stevenson Scheme, which imposed a system of export quotas based on purportedly 'normal' production figures, strongly favoured the large estates by underestimating the amount of smallholder output. Among the various reasons why the Dutch refused to participate in the Scheme were the political risks and the practical difficulties of suppressing smallholder cultivation. They were right to do so, for over the long term the Scheme proved spectacularly counter-productive. Instead of slowing the growth of rubber acreage to keep prices stable, the maintenance of higher prices encouraged a surge of East Indies smallholder planting that merely swelled the flood of latex onto world markets after the controls were lifted in 1928.⁹⁸ Indeed, the timing could hardly have been worse for the industry, for many of the smallholder rubber groves reached maturity precisely during the trough of the Depression.

As prices plummeted after 1930, colonial administrations tried to protect the plantations in a number of ways. In Indochina, planters benefited from generous price guarantees that funnelled rubber earnings in France back to exporters in the colony.⁹⁹ In Malaya, the government issued an indefinite ban on land alienation in 1930, which scarcely affected the estates since most had ample reserves of uncleared forest land. Following the price collapse, colonial authorities in the region also agreed a temporary suspension of tapping. Although the ban was dutifully observed

⁹⁶ Bauer, *Rubber Industry*, 68; Touwen, 'Entrepreneurial Strategies', 158; Drabble, *Rubber in Malaya*, 100.

⁹⁷ Though the ban was widely ignored: Lim Teck Ghee, *Peasants and their Agricultural Economy in Colonial Malaya 1874–1941* (Kuala Lumpur: Oxford University Press, 1977), 50–1, 74; Drabble, *Malayan Rubber*, 104–10; Bauer, *Report on a Visit*, 39–40, 87–9.

⁹⁸ Ghee, *Peasants*, 106–16, 143–54; Batlow, *Natural Rubber*, 57–62; Touwen, 'Entrepreneurial Strategies', 159.

⁹⁹ Marianne Bouchet, 'Les Organisations de planteurs de caoutchouc indochinois et l'état du début du XXe siècle à la veille de la seconde guerre mondiale', in Bonin, Hodeir, and Klein (eds), *L'Esprit économique impérial*, 715–33, esp. 729–32; Robequain, *Economic Development*, 205–6.

by most estates, it was completely disregarded by smallholders in the East Indies. In 1934, in response to the ongoing slump, the governments of Britain, France, the Netherlands, India, and Siam signed an International Rubber Regulation Agreement, which once again underestimated smallholder production for the purpose of setting quotas. But despite all these discriminatory measures, smallholders continued to expand their market share.¹⁰⁰

For many observers it was literally incomprehensible that indigenous farmers were able to out-compete some of most modern, well-capitalized and scientifically advanced agro-estates in the entire tropical world. Among European planters it was a worrying and downright subversive state of affairs, and it soon gave rise to a series of hopeful rationalizations.¹⁰¹

One was the idea that smallholder rubber was of poor quality and was often adulterated, but there was little evidence to support this. Indeed, the process of coagulating, mangling, and rolling the latex was simple enough to enable smallholders to produce smoked sheets comparable to those made on the estates (Fig. 3.3).¹⁰² There was also the common accusation, echoing forestry discourses of the era, that smallholders' extensive cultivation methods made 'wasteful' use of the land by destroying more forest than necessary. Estates had a moral investment in this line of thinking since the alleged profligacy of swidden cultivation was one of the main arguments in favour of granting large concessions to foreign firms in the first place. But before the effects of new high-yielding varieties were eventually felt in the 1940s and 1950s, the thicker tree density on smallholdings meant that their per hectare yields were generally higher than those on estates—around one-quarter higher in Malaya and up to twice as high in the East Indies.¹⁰³

Moreover, the accusation that smallholders destroyed vast swathes of virgin forest was based on a misunderstanding of how indigenous rubber was planted. Surveys in the East Indies showed that the integration of rubber into the *ladang* hill rice cycle nearly always occurred on *blukar* (secondary growth) land that had long been used for itinerant cultivation. Generally speaking, smallholders were not clearing large areas that would otherwise have remained untouched; in fact, plantations were more likely to do this.¹⁰⁴ Over time, the conversion of more and more *ladang* land into rubber groves inevitably pushed peasant cultivation into new areas, but this happened far more slowly than the early Cassandra calls suggested.

Once the high yields on smallholdings were grudgingly acknowledged by colonial planters, a common explanation was that they resulted from tapping too deeply and too frequently. The 'squandering of bark reserves' at an unsustainable rate would soon lead, many thought, to the degradation of trees and a marked decline in yields. But this suspicion was totally unwarranted, and smallholder yields

¹⁰⁰ Bauer, *Rubber Industry*, 370–5.

¹⁰¹ See also Dove, 'Rice-Eating Rubber', 40–2.

¹⁰² Bauer, *Rubber Industry*, 72–3, 200–2.

¹⁰³ Barlow, *Natural Rubber*, 76–7, 444–5; Drabble, *Malayan Rubber*, 253–4.

¹⁰⁴ Tayler and Stephens, *Native Rubber*, 3–4.

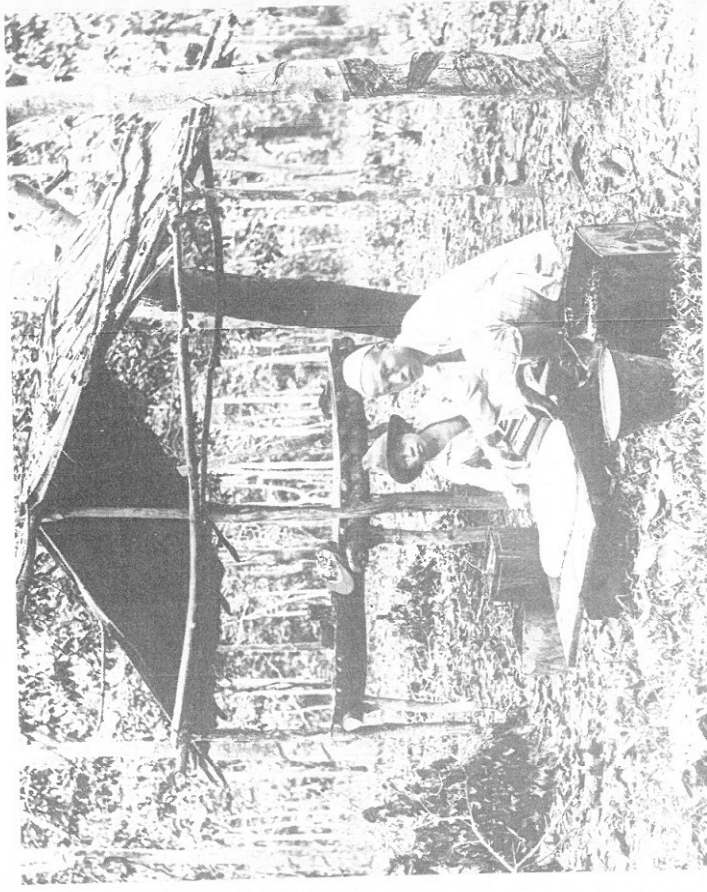


Fig. 3.3. Rolling out coagulated latex sheets on a smallholding in Palembang, Sumatra, 1920–6. By permission of the Nationaal Museum van Wereldculturen, coll. no. 10012718.

stubbornly failed to confirm such wishful thinking. An extensive investigation launched by the Malayan government in 1931–3 found no evidence of over-tapping on smallholdings, and in fact discovered that bark renewal remained well ahead of consumption. Indeed, it was soon established that bark renewal rates were actually faster on smallholdings than on estates due to their denser planting distribution and higher humidity levels.¹⁰⁵ None of this evidence, however, completely removed the suspicion of unsustainable tapping.¹⁰⁶

Perhaps the most common accusation of all was that the unkempt native rubber gardens were incubators of disease. This was a source of great anxiety amidst the ongoing problems with fungal root infections and white ants, which many estate owners were quick to blame on nearby smallholdings. Yet once again, extensive studies in the 1920s and early 1930s found—much to the consternation of the estate lobby—that smallholdings actually suffered significantly fewer disease problems, largely due to the existence of weedy ground vegetation. For decades, the advocates

¹⁰⁵ H. D. Meads, *Bark Consumption and Bark Reserves on Small Rubber Holdings in Malaya* (Kuala Lumpur: Kyle, Palmer & Co., 1934), esp. 39–42; Bauer, *Rubber Industry*, 34–41; Purwanto, *From Diusun to the Market*, 247–9.

¹⁰⁶ e.g. Tayler and Stephens, *Native Rubber*, 6–7.

of clean-weeding thought that the removal of undergrowth would hinder the progress of root disease by denying subsurface contact points through which it could spread. As it turned out, the opposite was true. In 1932 plant pathologists at the Rubber Research Institute of Malaya found that clean-weeding promoted rather than inhibited the spread of *Fomes lignosus*. Whereas the shallow interlacing roots of *Hevea* mono-crops presented ideal conduits for the spread of underground rhizomorphs, the thick mat of small roots resulting from dense ground cover helped to block such contacts.¹⁰⁷ Moreover, the fact that most smallholder rubber was planted on secondary-growth land also lowered disease problems, for as Dutch observers recognized in the 1920s, *blukar* land that had previously been cleared and then left to fallow contained fewer fungal carrier roots or stumps left over from the primary cover.¹⁰⁸

One of the few remaining sources of consolation for estate owners was the assumption that modern science and technical innovation would enable them to prevail over smallholders in the end. The main problem, however, was that rubber cultivation presented few economies of scale and little scope for mechanization, leaving the plants themselves as the only target for further capital investment. The development of high-yielding *Hevea* strains was therefore crucial. Attempts to select and propagate seeds from the most prolific trees reached back to the early stages of the industry, though cross-pollination made it difficult to isolate them genetically from poor yielders. The solution lay in vegetative propagation, or grafting the buds of high-yielding trees onto ordinary rootstocks, which was first successfully carried out in 1916 by Dutch botanists at Buitenzorg. During the 1920s researchers at the AVROS¹⁰⁹ experiment station and the Rubber Research Institute of Malaya carried out a series of long-term bud-grafting trials, and by the late 1930s they managed to produce strains capable of yielding up to 1,200 kg per hectare, or around four times more than average trees. But because of the planting restrictions imposed by the International Rubber Regulation Agreement, the proportion of high-yielding trees grew slowly. In 1936 the new strains accounted for only 6.5 per cent of acreage in Malaya and 11.1 per cent in the East Indies (but 35.4 per cent in Indochina, reflecting another latecomer advantage).¹¹⁰ Significantly, all of this high-yielding acreage was on estates, which were anxious to keep the benefits of the new varieties from leaking into the smallholder sector. The failure to supply smallholders with improved planting material was symptomatic of the fact that rubber research in the colonies was geared towards the needs of plantations.¹¹¹

While plant breeders in the research stations were busily seeking new ways to manipulate nature, others began to advocate a rather different approach. By the

¹⁰⁷ Bauer, *Rubber Industry*, 58–9, 257–8.

¹⁰⁸ Van Gelder, 'Bevolkingsrubercultuur', 449; Tayler and Stephens, *Native Rubber*, 8. Readers may note the contrast to cocoa, which suffered fewer rather than more disease problems on nearly cleared land.

¹⁰⁹ Sumatran Rubber Growers' Association: Algemeene Vereniging van Rubberplanters ter Oostkust van Sumatra.

¹¹⁰ Michaux, *L'Hévéiculture*, 4; François Graveline, *Des Hévéas et des hommes: l'aventure des plantations Michelin* (Paris: Nicolas Chaudun, 2006), 70–81.

¹¹¹ Bauer, *Report on a Visit*, 42–9; Bauer, *Rubber Industry*, 275–85.

early 1930s there were growing calls within colonial agronomy and forestry circles to shift away from intrusive 'agricultural' practices—clearing ground, sowing seeds, clean-weeding—towards low-intervention 'forestry methods', which essentially managed the existing vegetation in such a way as to favour desirable species over others. What this approach entailed, more specifically, was threefold: planting *Hevea* trees at higher densities (500+/acre), leaving much of the natural ground cover intact, and removing only the most injurious species such as *alang* grass. Although trials in the early 1930s resulted in smaller average tree size and less latex per tapping, they also raised yields per hectare and, perhaps most importantly, they dramatically reduced operating costs.¹¹²

To some extent this move towards low-intervention methods reflected the harsh commercial imperatives of the Depression years. As rubber prices collapsed in the early 1930s, the labour-intensive weeding and maintenance regimes that had long been criticized on agronomic grounds now became economically suspect as well. Planters who found themselves squeezed by the price slump certainly became more open to the idea of abandoning such methods, along with the Indian labourers whom they had paid to carry them out. By the end of 1932 the average costs of upkeep for a hectare of mature rubber in Malaya dropped to only one-sixth of 1929 levels.¹¹³

But the point was not just to make an agronomic virtue of commercial necessity. In Southeast Asia as elsewhere, the attempt to improve tropical agriculture also reflected the influence of ecological approaches and the emergence of new understandings of the natural environment.¹¹⁴ As one forester put it, although *Hevea* was classified as an agricultural crop, 'a rubber plantation is none the less a forest and the ecological problems that arise in it are of general silvicultural significance'.¹¹⁵

For the advocates of forestry methods, the advantages of a less intrusive cultivation regime were not merely (or even primarily) to be found in lower costs and higher factor productivity. They also promised to improve exhausted soils and to maintain long-term fertility on plantation lands. The existence of perennial ground cover and the continual deposition of vegetable debris not only retained nitrates in the soil, it also reduced erosion. In turn, good soil husbandry would enable planters to replace ageing rubber stands at little cost, either by coppicing or by allowing *Hevea* trees to regenerate naturally from falling seeds, as foresters at the Sungei Buloh reserve in Malaya had already shown.¹¹⁶ Although supporters presented this as a coherent cultivation system, certain elements were more readily accepted than others. Although most planters still harboured doubts about the benefits of natural regeneration, which deprived them of the ability to switch to high-yielding varieties, the damage caused by previous weeding regimes was

¹¹² J. N. Oliphant, 'Rubber Forestry Again', *Malayan Forester*, vol. 3 (1934), 3–6; 'Ecology and Rubber-Growing', *Malayan Forester*, vol. 4 (1935), 75–7; Drabble, *Malayan Rubber*, 54–5; King, 'Plantation and Agriculture'.

¹¹³ Bauer, *Rubber Industry*, 367.

¹¹⁴ See, more generally, Tilley, *Africa*, ch. 3; also Aso, 'Rubber Plantations'.

¹¹⁵ J. G. Watson, 'Foresters and Rubber Forestry', *Malayan Forester*, vol. 4 (1935), 78–9, here 79.

¹¹⁶ 'Natural Regeneration of Rubber', *Malayan Forester*, vol. 3 (1934), 206–10.

broadly acknowledged. By 1934 even the Rubber Research Institute of Malaya recommended 'controlled natural ground cover' tailored to different soil and climate conditions.¹¹⁷

In sum, the new emphasis on low intervention and adaptation to local conditions was, in the approving words of the *Malayan Forester* journal, 'just what the ecologist would expect'.¹¹⁸ Interestingly enough, it was also remarkably similar to what indigenous producers had long practised. From the perspective of 'rubber forestry', the advantages of the dense planting arrangements and minimal weeding regimes on 'native' rubber holdings went far beyond the question of cost, for they also minimized erosion and leaching, aided decomposition and humus formation, stabilized soil temperature and moisture, and even reduced disease.¹¹⁹ Dutch agronomists were perhaps the first to recognize the wider benefits of indigenous cultivation practices, noting as early as 1925 that 'the native intuitively took the correct path, while the European rubber planter gradually has learned to change his operations that were initially far too intensive'.¹²⁰ A small number of commercial planters—one in Malacca, another at Tjigoegoer on Java—had also been experimenting with cultivation methods that were broadly similar to those used on smallholdings.¹²¹

Clearly, there were some striking parallels between 'rubber forestry' and existing smallholder practices. But the promotion of low-intervention techniques had less to do with the incorporation of local knowledge than with the application of evolving principles within colonial forestry circles. Although the shift towards forestry methods encouraged more openness towards indigenous environmental knowledge, the idea that 'the native intuitively took the correct path' still implied that the results were more accidental than intentional. As the journal *L'Agronomie coloniale* noted (in typically social-evolutionist terms), there was something profoundly ironic about large corporate estates having 'to abandon intensive cultivation with its carefully perfected processes devised by progress, because they are too expensive, in order to go back (*revenir en arrière*) to extensive cultivation with its primitive processes as practised by the natives'.¹²² Such analyses misunderstood the rationale behind the new forestry-based techniques, which represented less a backwards retreat than a sideways attempt to rethink the wisdom of the intensive, 'agricultural' model on which the rubber plantations had been based since the very beginning.

Despite the growing scientific sanction for low-intervention methods, they still met with widespread scepticism among planters, especially in Malaya. One reason was the sheer force of habit among the planter community; another was the fact

¹¹⁷ W. B. Haines, *The Uses and Control of Natural Undergrowth on Rubber Estates* (Kuala Lumpur: Rubber Research Institute, 1934); Bauer, *Rubber Industry*, 258–9.

¹¹⁸ 'Ecology and Rubber-Growing', *Malayan Forester*, vol. 4 (1935), 75–7, here 76.

¹¹⁹ 'Kautschukkultur als Forstwirtschaft', *Der Tropenpflanzer*, vol. 35 no. 7 (July 1932), 292–4; Bauer, *Rubber Industry*, 58–9.

¹²⁰ A. L. Rutgers, 'De toekomst van de bevolkingsrubber in Nederlandsch-Indië', *Indische Mercur*, vol. 48 (1925), quoted from van Gelder, 'Bevolkingsrubbercultuur', 449.

¹²¹ 'Kautschukkultur als Forstwirtschaft', 293–4; 'Natural Regeneration of Rubber', 206–10.

¹²² 'Culture forestière de l'Hévéa', *L'Agronomie coloniale*, vol. 21 no. 180 (Dec. 1932), 225–6, here 226.

that foresters tended to calculate with longer timeframes than entrepreneurs who were primarily concerned with the bottom line. But perhaps the most important factor was a deep-seated anxiety about any blurring of the racialized hierarchies associated with different forms of cultivation. Although the supporters of 'rubber forestry' presented it as a pragmatic means of ensuring the future sustainability of the plantations, both commercially and ecologically, for many observers it seemed nothing short of a capitulation to the smallholder competition. Writing in 1931, the American rubber economist H. N. Whitford noted the powerful sense of aversion towards anything that smacked of primitive and disorderly 'Asian methods'. Some planters, he reported, 'claim forestry methods are not aristocratic, implying that if the European has to go native to compete with the native, the European has no business to be in... rubber planting'.¹²³ In a sense this was absolutely correct, for as the British Under-Secretary of State for the Colonies had previously warned Malaya's planter community, 'the only justification for the present complicated and expensive mechanism of directors, agent firms, visiting agents, managers, and shareholders is the application of greater intelligence and skill than the native can reasonably be expected to acquire'.¹²⁴ In this context, any admission of being out-thought by 'natives' raised unsettling questions about why Europeans were there at all.

Why did a plantation sector that prided itself on deploying the latest agronomic knowledge prove so ill disposed towards this specific piece of scientific counsel? The question is revealing in itself, for what it highlights is the importance of cultural dispositions and expectations in shaping people's interaction with the environment. Ultimately, the sprawling nexus of rubber research institutes and agro-estates in Southeast Asia mirrored the wider ideological underpinnings of the imperial enterprise, which claimed to spread the benefits of European knowledge to other parts of the world by mobilizing their resources for human ends. The fact that smallholders were actually more 'efficient' (by nearly all definitions) at producing rubber did little to undermine this conviction. Indeed, the persistent faith in Europe's technical superiority long served to obscure the facts, even after certain members of its scientific priesthood had repeatedly verified them. Undoubtedly this devotion to the modern plantation was partly a reflection of European economic interests, not to mention government concerns about giving the colonies a bad name with investors. But the power of the ideology itself should not be underestimated. Given that most of the contemporary rationalizations for smallholders' success were factually wrong, and demonstrably so, suggests that they functioned not just as a ploy to discredit a commercial rival or as a pretext to justify greater state intervention in the rubber industry. They also served as a myth, a cultural response to a phenomenon that was beyond comprehension for many concerned.¹²⁵

¹²³ Drabble, *Malayan Rubber*, 55.

¹²⁴ Report by the Right Honourable W. G. A. Ormsby Gore, 141.

¹²⁵ I am drawing here on Dove, 'Rice-Eating Rubber', esp. 52–3.

WAR, DECOLONIZATION, AND THE WORLD RUBBER ECONOMY

When the first *Hevea* plants were brought to Southeast Asia in the late nineteenth century, few could have imagined the changes that would eventually result. From 1900 to 1940 around 4 million hectares—an area roughly the size of the Netherlands—of rainforest were razed and converted to rubber stands. In 1939/40 Malaya and the East Indies alone accounted for over 3.25 million of these hectares (roughly the size of Belgium), and produced the bulk of the 1.1 million tons of rubber absorbed on world markets.¹²⁶ Nearly all of this output was destined for the industrial world, with around two-thirds of it going into car, bus, and truck tyres. Although few motorists were aware of the connection, the degradation of the rainforests was crucial for keeping their wheels turning. The continual flow of latex into the industrial economies represented a vital resource subsidy from the ecosystems of the tropics, one that underwrote the radical economic and social transformations of the automobile age. By the late 1930s, rubber was far and away the dominant export crop in Southeast Asia. And for the industrial powers, no other tropical commodity was of greater strategic importance as they contemplated the possibility of a war in the Pacific.

The outbreak of the Pacific war in 1941 brought enormous changes to the world rubber economy. The Japanese occupation of Malaya and the East Indies severed at a stroke the all-important trade links that had hitherto sustained the heartland of the industry. As the main consumer markets in Europe and North America faced a sudden crisis of supply, the chief production zones experienced an abrupt collapse in output. On most plantations, tapping and maintenance quickly ground to a halt. With market outlets cut off there was little revenue (or need) to pay wages to estate workers, and with no hands to tend them, rubber stands were invaded by *lalang* grass and other unwanted species. As food supplies dwindled in the plantation belts, a growing number of 'squatters', many of them former estate labourers thrown out of work, converted large swathes of rubber to rice production, including around 53,000 hectares in Malaya and a similar area in East Sumatra.¹²⁷ The Japanese occupiers had little incentive to intervene. The small dribble of latex from Malaya, Sumatra, and Borneo to the Home Islands was in any event impeded by the Allied shipping blockade, and Japan was still able to acquire sufficient rubber supplies from Vichy-ruled Indochina and the Moluccas. As a result of wartime dislocations, world production of natural rubber fell by around three-quarters to a mere 254 million tons in 1945.¹²⁸

Such a dramatic collapse in the supply of such a key industrial resource was a major concern for planners in Europe and North America. Governments had already taken steps against the threat of a strategic rubber shortage as part of their

war preparations, mainly by stockpiling it up until December 1941. In addition, some states also tried to diversify their supply base by boosting production capacity in other parts of the world. In 1938 German authorities launched an ambitious programme to improve the latex yields of the *Kok-Saghyz* plant, or Russian dandelion, and after the invasion of the Soviet Union they forced farmers behind the Eastern Front to grow it, though with little success.¹²⁹ From 1941 onwards the British government tried to boost exports from Ceylon and India (the only colonies in the region that escaped Japanese occupation) as well as West Africa. French rubber firms that lost control over their Indochinese supplies encouraged latex harvesting in Côte d'Ivoire, while US authorities turned their attention to Firestone's estates in Liberia.¹³⁰

But stockpiling and supply diversification could offset only part of the wartime rubber shortfall. In the event, most of it was covered by the synthetic rubber industry. During the First World War, Germany produced modest amounts of methyl rubber from butadiene in order to mitigate the effects of the Allied blockade. By 1926 German chemists were able to synthesize more durable types of polymerized rubber, which were soon developed into IG Farben's famous 'Buna' product in 1929. After a series of further improvements, Buna rubber became sufficiently hard-wearing for use in automobile tyres, and eventually played an important role in the German war effort (production peaked at 115,000 tons in 1943). In the meantime, several US firms were also working on synthetic rubber, most notably Du Pont, Firestone, and Standard Oil (which held a portion of the patent rights to IG Farben's Buna product). After Pearl Harbor they were the target for massive government investment, and by 1945 the production of styrene-based GR-S rubber reached 866,000 tons, enough to meet the United States' own wartime requirements as well as most of Britain's.¹³¹

The rise of synthetics during the Second World War forever changed the global rubber economy. After 1945, most industrialized states were eager to develop their synthetic capacity as a means of circumventing the British dominance of world rubber markets. The sharp rise in demand fuelled by post-war reconstruction, and above all the explosive growth of automobile ownership, drove an unprecedented upsurge in world rubber production after the war, from 1.67 million tons in 1946 to 10.8 million tons in 1973. The bulk of this increase—7.3 million tons—came from the expansion of synthetic rubber, which accounted for two-thirds of overall rubber output in the early 1970s.¹³²

In many ways this was good news for the forests of Southeast Asia, since the growth of synthetic rubber reduced the amount of woodland that would otherwise have been converted to single-species *Hevea* stands during the post-war boom.

¹²⁹ Susanne Heim, *Plant Breeding and Agrarian Research in Kaiser-Wilhelm-Institutes 1933–1945*, trans. Sorcha O'Hagan (Dordrecht: Springer, 2008), 102–53.

¹³⁰ Bauer, *Rubber Industry*, 303–8; James Fenske, 'The Battle for Rubber in Benin', *Economic History Review*, vol. 67 no. 4 (2014), 1012–34; Graveline, *Des Hévéas*, 91–3; on Firestone, Tucker, *Insatiable Appetite*, 248–58, 262.

¹³¹ Bauer, *Rubber Industry*, 287–96; Tucker, *Insatiable Appetite*, 261–5.

¹³² Barlow, *Natural Rubber*, 408, 412.

¹²⁶ Bauer, *Rubber Industry*, 380, 392.

¹²⁷ Barlow, *Natural Rubber*, 75; Stoler, *Capitalism and Confrontation*, 97.

¹²⁸ On rubber in the Second World War, William G. Clarence-Smith, 'The Battle for Rubber in the Second World War: Cooperation and Resistance', in Jonathan Curry-Machado (ed.), *Global Histories, Imperial Commodities, Local Interactions* (Houndslow: Palgrave, 2013), 204–23.

But the news was not all good. For one thing, synthetic rubber was not a universal substitute for its natural competitor. Various products ranging from surgical gloves to aeroplane tyres were still primarily made from plant-derived latex due to its high tack and superior resistance to cuts and shearing; even modern radials for automobiles contained a significant proportion of natural rubber. Moreover, the huge rise in overall demand meant that natural rubber output continued to grow despite the relative dominance of synthetics. Between the mid-1940s and the early 1970s natural rubber production rose fourfold, reaching 3.5 million tons in 1973. Over two-thirds of it—a total of 2.375 million tons—still came from Peninsular Malaysia and Indonesia alone.¹³³ Furthermore, demand for natural rubber surged anew after the oil shocks of the 1970s, which dramatically raised the price of petroleum feed-stocks for synthetic latex. By 2014 world output of natural rubber exceeded 12 million tons, over ten times more than in 1939/40, and continued to gain ground on the 16.7 million tons of synthetics produced at the time.¹³⁴

So despite the enormous growth of synthetics after the war, the rubber growers of Southeast Asia essentially took up where they had left off in 1941. The trees themselves were more or less unaffected by the wartime lack of maintenance and the invasion of undergrowth, which once again confirmed the futility of cleaning. Most of Malaya's estates recovered within a year or two; neighbouring smallholders likewise resumed tapping shortly after the war.¹³⁵ In East Sumatra the Dutch 'police action' of June 1947 returned the majority of foreign-owned estates to their proprietors, while smallholders elsewhere on the Outer Isles continued to fold *Hevea* into their cultivation cycles.¹³⁶

But if the post-war recovery initially seemed like a return to business as usual, over the following years the Southeast Asian rubber economy was transformed in several respects. First of all, much of the production growth in the 1950s and 1960s came from the spread of high-yielding varieties that had first been developed before the war. This was especially the case on large estates, whose efforts to boost productivity mainly came to fruition in the post-colonial period. In Malaysia in particular, the development of new cloned varieties—some of which could surpass 2,000 kg of latex per hectare—enabled plantations to outstrip the average smallholder yield by around 50 per cent in the early 1970s.¹³⁷ These high-yield clones, like the growth of synthetic rubber, helped reduce the pressure to clear new land, all the more so given that they were often planted on old rubber acreage. But even so, the intensification of estate production could not entirely offset further forest clearance in the context of ever-rising demand. Malaysia's rubber area continued to expand, albeit slowly, from 1.37 million hectares in 1946 to 1.77 million in 1965 (after which it levelled off and gradually declined). By contrast, Indonesia's rubber

¹³³ Barlow, *Natural Rubber*, 410.

¹³⁴ Data from *Rubber Statistical Bulletin*, April–June 2015, cited in India Rubber Board, *Rubber Statistical News, Review of the Year 2014–15*, 4, available at: <<http://www.rubberboard.org.in/PDF/RSNMay2015E.pdf>>.

¹³⁵ Barlow, *Natural Rubber*, 76–8.

¹³⁶ Scoles, *Capitalism and Confrontation*, 112–14.

¹³⁷ Barlow, *Natural Rubber*, 76–7, 115–27, 444–5.

frontier lost none of its dynamism. After first overtaking Malaysia in the 1960s, it continued to grow to around 2.4 million hectares by 2000.¹³⁸

This reflected another important post-war change. Unlike the early phases of rubber expansion, smallholders were now the primary drivers of growth. By 1980 they accounted for two-thirds of the acreage in Malaysia, 80 per cent in Indonesia, and no less than 95 per cent in Thailand (the chief new competitor, with 1.24 million hectares of rubber in 1980).¹³⁹ In some ways this triumph of the smallholder represented a continuation of pre-war trends, but it was also reinforced by the altered political environment.

Whereas colonial governments had generally been unsupportive or at best ambivalent towards 'native rubber' cultivation, post-colonial regimes actively encouraged it as a tool for economic development and poverty reduction. In Malaysia, the independent government incentivized rural smallholders to open up new lands through the Federal Land Development Authority (FELDA), which included Sarawak and Sabah after their merger with the Peninsular states in 1963. Although palm oil eventually surpassed rubber as the country's main export crop, *Hevea* remained one of the chief cultivars on government schemes. To promote smallholdings still further, Malaysian authorities also subdivided 146,000 hectares of foreign-owned rubber estates into smaller parcels, many of which were purchased in the 1960s and early 1970s by ethnic Chinese landlords who leased them out to tenants.¹⁴⁰ In Indonesia too, Sukarno's government redistributed large amounts of foreign-controlled estate land as the original leases expired, and eventually confiscated the remaining Dutch estates in 1957. Although General Suharto's 'new order' reopened the doors to foreign investment after 1965, the relentless growth of Indonesian rubber was still overwhelmingly the work of smallholders.¹⁴¹ Only in southern Vietnam did plantations continue to dominate post-war rubber production, albeit with considerable difficulty. From the late 1940s onwards their operations were regularly disrupted by Viet-Minh forces, and by the mid-1960s the majority of European managers had to abandon their estates for the relative safety of Saigon.¹⁴² Most of the plantations went into state ownership after 1975, though smallholder production gradually took root under the reformist experiments of the 1990s, and has been expanding ever since.

Since the demise of colonialism, the development of Southeast Asian rubber has in many ways been a story of trade-offs. For starters, there was a difficult balance to strike between the social and ecological benefits of different modes of production.

¹³⁸ Barlow, *Natural Rubber*, 444–5; FAOSTAT: <<http://faostat.fao.org>>.

¹³⁹ Figures from FAOSTAT (<<http://faostat.fao.org>>); Barlow, *Natural Rubber*, 444–5; Enzo R. Grilli et al., *The World Rubber Economy: Structure, Changes, and Prospects* (Baltimore: Johns Hopkins University Press, 1980), 16–20.

¹⁴⁰ John H. Drabble, *An Economic History of Malaysia, c.1800–1990* (Houndmills: Macmillan, 2000), 216–24; M. C. Ricklefs, *A History of Modern Indonesia* (London: Macmillan, 1981), 215–16, 296.

¹⁴¹ Generally, Adrian Vickers, *A History of Modern Indonesia*, 2nd edn (Cambridge: Cambridge University Press, 2013), 137–45, 162, 165–73.

¹⁴² Graveline, *Des Hévéas; also Planteurs d'hévéas en Indochine, 1939–1954* (Amicale des Planteurs d'Hévéas, 1996), 109–44.

Although the victory of smallholders over estates has enabled a broader spectrum of the population to share in the proceeds, there can be little doubt that it resulted in higher rates of forest clearance. As plantations became more productive after the early 1950s, they were able to squeeze significantly more output from existing acreage than their smaller competitors. This yield discrepancy points to a second juggling act, namely between the interests of investors and the wider public good. Much of the research that went into the high-yield varieties was paid for by large estates and their commercial associations, which understandably sought to profit from the competitive advantages conferred by these new technologies by denying them to their rivals. In order to minimize forest clearance, the most promising strategy was to make such planting material available to smallholders (a policy most systematically pursued in Thailand), but this carried the risk of undermining future yield gains by removing the incentives for research. Herein lies yet another trade-off, for it is by no means clear that the replacement of multi-strata, low-intensity 'jungle rubber' by more input-intensive high-yield techniques is a more ecologically desirable outcome, regardless of who is doing it. As is so often the case when weighing up the advantages of different cultivation systems, growers are frequently exchanging one set of drawbacks (more forest clearance) for another (the accumulation of fertilizers and other agrochemicals).¹⁴³

The environmental implications of synthetic rubber are similarly ambiguous, at least when viewed at a global rather than regional level. Although petroleum-based rubber production has undoubtedly spared forests in Southeast Asia, it is nonetheless a manifestly unsustainable industry that requires around ten times more energy per unit of elastomer than natural rubber.¹⁴⁴ Of course, the alternative—a doubling (or more) of rubber acreage—may seem far worse, especially against the backdrop of decades of rampant forest clearance for oil palm, timber, and wood pulp. But as far as tropical crops go, rubber cultivation can be done on a relatively sustainable basis. In contrast to most other agricultural systems, research has shown that mature *Hevea* stands with ample ground cover are essentially self-supporting with respect to biomass and nutrient cycling.¹⁴⁵ At the end of a typical thirty-year cycle, rubber parcels can usually be harvested for valuable timber. If competently managed, they are also sufficiently fertile to allow replanting with another generation of rubber or with a range of other crops. Moreover, in the mid-1990s it was estimated that the worldwide stock of *Hevea* fixed around 90 million tons of carbon dioxide per year, leading some to applaud the growth of the industry as 'a carbon dioxide fixing factory for the sustained production of timber'.¹⁴⁶

¹⁴³ Eric Penot, 'From Shifting Cultivation to Sustainable Jungle Rubber: A History of Innovations in Indonesia', in Malcolm Cairns (ed.), *Voices from the Forest: Integrating Indigenous Knowledge into Sustainable Upland Farming* (Washington, DC: RFF, 2007), 583–605; Eric Penot and A. F. S. Budiman, 'Environmental Aspects of Smallholder Rubber Agroforestry in Indonesia: Reconcile Production and Environment', International Rubber Conference (1998): <<http://www.worldagroforestrycentre.org/seal/publications/files/report/RP0056-04/RP0056-04-1.PDF>>.

¹⁴⁴ Loadman, *Tears*, 274.

¹⁴⁵ Jason Clay, *World Agriculture and the Environment* (Washington, DC: Island Press, 2004), 344.

¹⁴⁶ Loadman, *Tears*, 275–6.

From the vantage point of the twenty-first century we might well view rubber cultivation as a relatively benign form of land use, at least in comparison to most of the alternatives. From a socio-economic perspective too, rubber has tended to bring more benefits to cultivators in the tropics than many other export crops such as sugarcane, bananas, or cotton. Yet any attempt to understand its historical development must also take account of the huge costs that were incurred. From the early phase of expansion through the colonial boom years, rubber destroyed enormous swathes of lowland forest across Southeast Asia. It brought hundreds of thousands of labourers into previously remote jungles, many of whom died from disease and maltreatment. In some of the main producer areas it displaced local cultivators from the best agricultural land and consigned them to a life of material and cultural poverty. As the planting frontier raced into the rainforests it eroded soils, damaged rivers, destroyed the habitat of countless species, and radically diminished local biodiversity. Although many of the rubber groves gradually stabilized as cultivation practices improved and political frameworks shifted, the woodland and soil that was lost would never come back.

Like the story of colonial cocoa, the development of Southeast Asia's rubber industry reminds us that the effects of commodity production are not culturally or ecologically predetermined. Instead, they are the result of a continuous interaction between material and social factors, which together shape the choices people make. Rubber was, and still can be, produced in different ways, on different scales, with different outcomes. The ecology of rubber has always been the historically contingent product of how it is grown, who grows it, and what it replaces. The nature of the *Hevea* tree defines the possibilities, but the trade-offs are up for grabs.