Family reunion: cocoa and durian, both members of the Malvaceae family, meet in an Indonesia agroforest

Photo credit: Meine van Noordwijk/World Agroforestry

CHAPTER 26

Cocoa and coffee in Asia: contrasts and similarities in production and value addition

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Highlights

- Cocoa and coffee are major income sources for smallholder agro-foresters in Asian economies
- Supply and value chains of both crops change to more local processing as part of the Asian boom
- Optimal shade levels in agroforestry are part of risk management in changing climates and markets
- Disruptive, stepwise development efforts to rejuvenate production have backfired in cocoa
- Certification and geographical indication are efforts to capture value closer to the farmers/producers

1. Introduction

Cocoa and coffee are important components of many tropical landscapes, at the start of value chains that reach the vast majority of global citizens through a variety of beverages and consumables. Yet, the specific history and current modes of production differ between the three main tropical continents and need to be understood in their historical, ecological, social and economic context.

Cocoa and coffee are both strongly connected to colonial economies. Cocoa is a '1493' crop (Mann 2011) that spread rapidly from Latin America in the post-Columbus era when European trade connections disrupted the natural biogeography. In Asia, the Spanish link made the Philippines the first country where cocoa got a foothold (Clarence-Smith 2003). Coffee (Wrigley 1988) is an 'out of Africa' crop that, through the stepping-stone of Mocca on the

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Arabian peninsula, came to Asia with pilgrims bringing the crop to India before a colonial connection made 'Java' a globally recognized brand name. Coffee is a classic example of how value chains connect producer and consumer via various steps in which processing reduces the volume (with rest of the products generated as waste or utilsed for secondary use), but more than proportionally increases the market price and consumer willingness to pay (Figure 26.1).

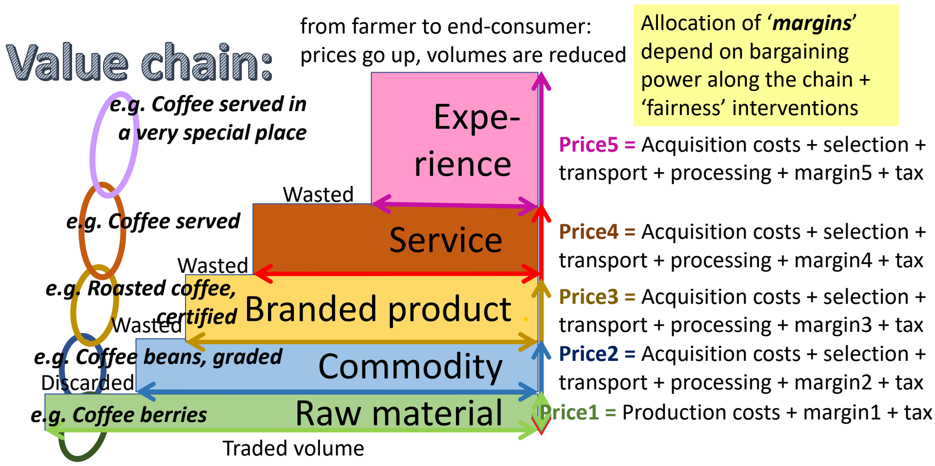

Figure 26.1: *The value chain from farm to consumer, with coffee as an example (van Noordwijk 2021)*

While most of this book is focused on the African experience so far, an account of the Asian experience can help in discussing way forward for African countries, as they may have to compete on quality, price, reliability or other aspects of appeal to consumers for the same market segments, and/or differentiate into other ones. Despite numerous similarities between coffee and cacao in their environmental requirements (Dewi et al 2017), architecture, physiology, compatibility with companion trees in agroforestry, post-harvest handling and global trade, there are important differences as well. Cacao is more restricted to humid tropical conditions, is almost completely geared to trading and processing elsewhere (while coffee is consumed locally) and tends to have more concentrated global trade channels (Mithöfer et al 2017a). For both crops, innovation and system change in supply and value chains can be part of 'development'. This chapter will touch on macro- (national economy), micro- (household production) and meso-scale (landscapes, geographic identity) patterns and processes, referencing more specialized literature on a wide range of topics. After a section on origin and trends in the production of both crops in Asia, a section will discuss the demand-side transformation of a colonial export commodity to the Asian consumption boom, domestic processing and value capture, before delving into production systems, germplasm and the track record of "tree crop rejuvenation" programs. The final section will discuss contrasts and similarities in comparing coffee vs cocoa and Asia vs Africa.

2. Origins and trends

Asia is relevant in global coffee production (van Noordwijk et al 2019a), with Vietnam, Indonesia, and India ranked 2nd, 4th and 6th, respectively, with 16, 7 and 3% of global production and the Philippines as a rising star; in cocoa, Indonesia was (until recently) ranked 3rd with 16% of total production (van Noordwijk et al 2019a). Asia represents the fastest-growing segment of global consumption for both commodities but is still a net exporter of coffee and a net importer of cocoa beans. Statistics for 2019/2020 (International Coffee Organisation 2020) indicate that Latin American countries supply 60% of global coffee export and 19.3% of its consumption, Asian countries 27% of global export and 22.1% of consumption, and African countries 9.2% of global export and 7.0% of consumption.

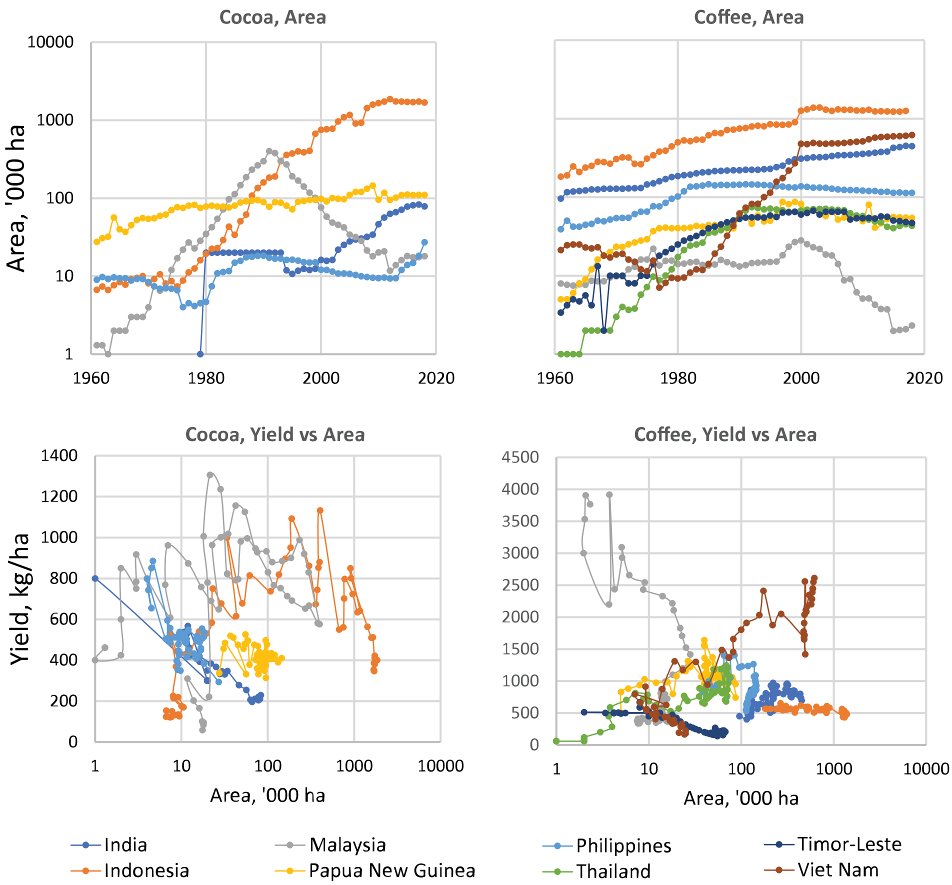

Figure 26.2: *Area and productivity data for cocoa and coffee in selected Asian countries; the yield versus area data span the 1960-2020 period (source: FAO-stat)*

Global production and trade data for cocoa and coffee at national scale (Figure 26.2) show generally increasing trends but remarkably country-specific patterns, such as a steep rise in the cocoa area in Indonesia and coffee area in Vietnam after 1980, both levelling off in 2010, while coffee area plateaued in 2000 in Indonesia after a more gradual rise. Rapidly declining production areas can be seen in cocoa in Malaysia after 1990 following three decades of exponential growth. While graphs of yield versus area would show rising diagonal lines for constant yields, the cocoa data especially are more varied and include patterns where area increase is accompanied by a decline in total yield as experienced in the Philippines and for coffee in Malaysia. A complete interpretation of all national patterns is beyond the scope of this chapter. However, it may be clear that countries in Asia have been on contrasting trajectories over the past decades.

Almost 70% of global coffee produced is *Coffea arabica (*mostly Latin America), 30% *C. canephora* (commonly named *robusta*, mostly Asia), and less than 2% *C. liberica (*mostly Asia). While Latin America has remained focussed on *C. arabica* and is leading its global production, after the spread of coffee leaf rust (*Hemileia vastatrix*) at the end of the 19th century, many Asian countries adopted *C. canephora*, from central and western sub-Saharan Africa as a less disease-sensitive species for lower elevations (Clarence-Smith and Topik 2003). Coffee leaf rust reached Brazil in 1970 and spread to other Latin American countries from there. In parts of Asia, *C. liberica* as an even-less-sensitive species for even lower elevations has been appreciated in local markets and is productive on coastal peat soils. It is native to western and central Africa from Liberia to Uganda and Angola and has become naturalized in Southeast Asia. It can be used as rootstock for grafting robusta coffee but also harvested as such. It has the lowest caffeine content of the three coffee species. Coffee leaves have a long history of use as ethnomedicine and “tea beverage” by locals from countries where coffee plants grow (Chen 2019). Recently, attention has been paid to their health benefits to human beings because of abundant bioactive components in coffee leaves (Saw et al 2015).

Theobroma cacao is widely distributed from south-eastern Mexico to the Amazon basin, but the start of domestication has probably taken place in the upper Amazon regions of Peru and Ecuador, where the fruits were initially selected for their edible pulp (Clement et al 2010) -- just like their family member, the Durian tree in southeast Asia (see cover photo for this chapter). Many semi-domesticated lines, with Criollo and Amelonado as better known ones, have been traced back to preceding the European devastation of the human population. Other *Theobroma* species are still cultivated for edible fruits, such as the cupuassu (*Theobroma grandiflorum*). Current cocoa cultivation is primarily (95%) the Forastero variety, less than 1% Criollo (most aromatic, mild and slightly bitter) and about 5% the Trinitario type, a hybrid of the other two, with fine flavours, but less intense than Criollo. The recent interest in more refined flavours is reflected in market prices differentiation by variety.

3. From colonial export commodity to Asian consumption boom, domestic processing and value capture

In the 19th century, coffee production on Java became directly associated with colonial history, as forced cultivation of coffee (along with sugarcane in the lowlands) became a major part of revenue collection for the colonial state (Clarence-Smith 1994, Whitten et al 1996). Coffee was introduced to Vietnam by French missionaries in the 1850s. Beyond family farms, the colonial governments in Southeast Asia allowed larger-scale plantations to emerge under European management on land concessions (leased). In Indonesia, however, these are mostly focused on tea at a higher elevation. After independence, part of the large-scale enterprises was claimed and occupied by smallholders, and another part was nationalized. Their focus on export production remained, mostly providing 'bulk' coffee to the global markets that sourced high-quality arabica coffee and speciality cocoa elsewhere. Expansion of smallholder coffee in Indonesia was closely linked to world market prices, with only one period of high prices (in the mid-1950s) missed. Probably due to political chaos at that time, the drastic shift in exchange rates during the Asian financial crisis in the late 1990s led to a further wave of expansion, especially into the mountains of Sumatra where control over forest lands had become weak (Verbist et al 2005).

After the reunion of North and South Vietnam in 1975, the area under smallholder, irrigated cultivation of robusta coffee without shade trees increased by a factor of 10 in the central highlands, representing 60% of the national production (D'haeze et al 2005). The increase in production had an impact on the global balance between coffee supply and demand. A study (Luong and Tauer 2006) of investment decisions by Vietnamese coffee growers found that producers, with variable costs of 0.42 USD/kg and total cost of 0.65 USD/kg, entered coffee production at a coffee price of 1.04 USD/kg and exited at a coffee price of 0.31 USD/kg. Thus, Vietnamese growers were sufficiently efficient to continue producing coffee even at relatively depressed global market prices. With decreasing coffee prices, cacao has become an attractive alternative in the central highlands of Vietnam (Ha and Shively 2005), but Vietnam did not (yet) become a major player in the global cacao market.

Dependence on global markets has gradually weakened, and in the COVID-19 pandemic, the stress on global exports can at least partly be offset by domestic markets. Post-independence coffee consumption gradually became part of the local culture, mostly associated with 'talk-shops' for (older) men. In the last 10-20 years, more urban and younger segments of consumers, particularly interested in higher-quality coffee, emerged. In chocolate consumption, Asia is the globally fastest-growing destination, linked to a rapidly growing middle class.

Singapore and Malaysia were the first countries in Southeast Asia to move up in the value chain and be involved in cocoa processing. In Malaysia, that shift coincided with a decline in production, but neighbouring Indonesia was available as a basis for imports. In the 1990s, cocoa boomed in Indonesia, especially in Sulawesi (Ruf et al 1996), around the same time that robusta coffee production was scaled up in Vietnam (Meyfroidt et al 2013). Ironically, Indonesia's rapid development of cocoa processing capacity (Neilson et al 2020) also coincided with a decline in domestic production, making Indonesia suddenly a major importer of cocoa beans, especially from the Ivory Coast and Ecuador. While designed to reverse the negative trend, a failed national 'revitalization' program failed due to a combination of technical design issues (see below) and challenges in the cross-scale implementation. At the policy level, this created the challenge Malaysia faced before (Yudyanto and Hastiadi 2019): protecting the processing industry through a tax on exporting cocoa beans (depressing farmgate prices) or supporting the growers by maintaining these prices.

4. Underplanting in forests, complex and simple agroforestry or monoculture?

Both coffee and cocoa can be grown in a wide range of production systems (Martin et al. 2020; Figure 26.3). In Asia, the historical patterns differ between countries and may interact within a country. For example, an analysis (Meyfroidt et al 2013) of land use and cover changes in the coffee-growing area in Dak Lak and Dak Nong provinces in Vietnam over the 2000–2010 period found direct evidence for displacement into the forest margins of swidden cultivation with annual crops by local ethnic minorities and poor migrants, pushed by market crops expansion where capital-endowed migrants of the dominant ethnic group took over already deforested lands to grow coffee (Doutriaux et al 2008).

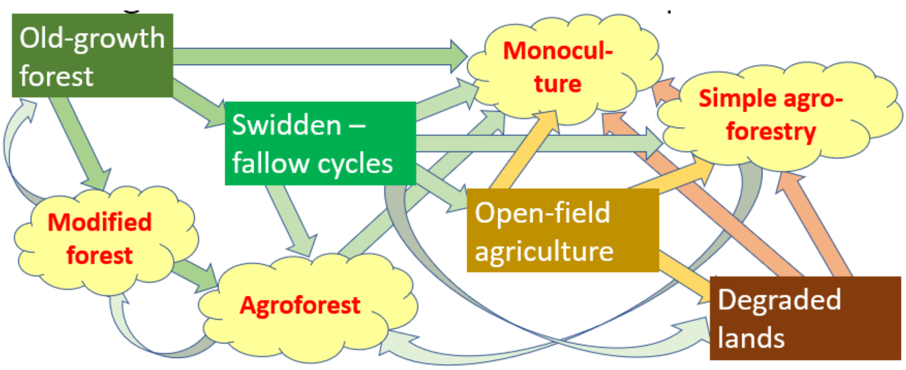

Figure 26.3: *Pathways of land-use change that can lead to a range of coffee and cocoa production systems (van Noordwijk 2021)*

Both coffee and cocoa are forest understory trees that tolerate shade in their natural environment. The easiest way of growing coffee is to 'interplant' it into an existing forest, gradually clearing surrounding vegetation and reducing the upper canopy. In the countries with the earliest coffee expansion, Indonesia and India, such systems still exist. This establishment pattern targeted natural forests when the crops first arrived in Asia and has been replicated with the *Pinus* plantations established across the mountains of Java by the forest service and now allow smallholder coffee as understorey (Cahyono et al 2020). Greater clarity in comparing the various production systems may depend on operational definitions of the terms used. Operational definitions may use the fraction that the focal commodity forms of the total tree basal area, and the tree species diversity in standard-sized plots. On this basis, monocultures, simple and complex agroforestry systems, and agroforests can be distinguished (Figure 26.4).

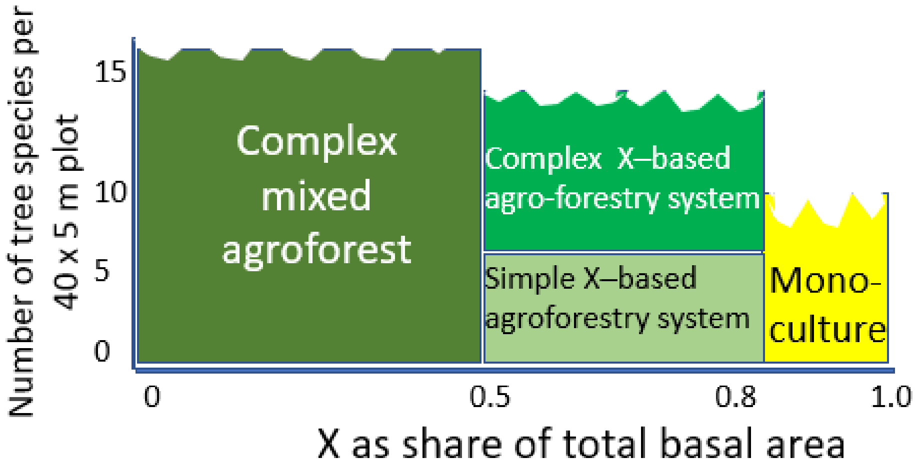

Figure 26.4: *Operational definitions for the various tree crop production systems based on tree diameter and tree diversity surveys (van Noordwijk 2021)*

Another way to achieve low-establishment-cost plantations is to introduce seedlings into 'swiddens' before they are abandoned in 'fallow' vegetation. Various other trees can be grown alongside the coffee and cocoa or tolerated and managed when established through natural regeneration. The tree diversity on coffee and cocoa agroforest is partly due to differences in tree preferences by male and female farmers (Mulyoutami et al 2015, Sari et al 2020) and the relevance of a range of functions, including products (Nguyen et al. 2020). Some of these other trees may become the economic driver of the system, as happened in the damar (*Shorea javanica*) agroforests of Krui (W. Lampung, Indonesia) that started as 'shade coffee' systems (Budidarsono et al 2000) or the durian dominated agroforests in various parts of Indonesia that may include some coffee. On the other extreme, we see monoculture coffee systems, without any companion trees, as was the basis for the rapid growth of robusta coffee in Vietnam (D'haeze et al 2005). Less known than the robusta coffee in the Central Highlands of Vietnam, Arabica coffee has been grown in northwest Vietnam in recent decades on sloping land in intensive, full sun monocultures. As these are not sustainable in the long term and has negative environmental impacts, there is an urgent need to reverse this negative trend (Nguyen et al 2020) by promoting good agricultural practices, including agroforestry. A survey among farmers from three indigenous groups showed that most farmers were aware of the benefits of trees including for soil improvement, shelter (from wind and frost), and the provision of shade and mulch. Still, farmers had limited knowledge of the impact of trees on coffee quality and other interactions amongst trees and coffee. Farmers ranked the leguminous tree species *Leucaena leucocephala* as the best for incorporating in coffee plots because of its coffee services. Tree species richness in agroforestry plots was much higher for coffee (48 tree species in 100 ha surveyed) compared to non-coffee plots (22 tree species in 60 ha surveyed), partly due to intercropped fruit trees, especially where the proximity of farms to a main road secured good market access (Nguyen et al 2020). Further from the roads, timber trees (both native and commercially promoted) were more prominent. Combinations of coffee and durian (see the cover photo of the chapter) are increasingly popular.

While intensive monoculture coffee farms quickly expanded in Yunnan Province (China) in the 1990s and 2000s, local authorities in the main coffee producing areas in the province initiated a large-scale conversion program of these farms towards coffee-agroforestry systems in 2012 to promote "ecologically-friendly coffee" (Rigal et al 2018). A study documented a high level of tree species diversity at farm and landscape levels despite the previous dominance of intensive coffee monoculture and the government's large-scale distribution of a limited number of shade tree species. A total of 162 tree species were encountered during farm inventories, mostly 'invisible' in official statistics or recommendations, with ample opportunity to provide a wide range of ecosystem services.

5. Production ecology and ecosystem services

The level of shade influences microclimate around the coffee and cocoa canopy, modifying the pest and disease pressure. Intermediate light levels (30-70%) may be the best if product quality and quantity are considered. Coffee pollination (especially in robusta coffee; arabica coffee can be self-pollinated; Boreux et al 2013) and production may be compromised in monocultures. Additionally, coffee planted closer to the edges can benefit from pollinators with year-round access to other food sources (Olschewski et al 2006). Shade trees, banana culms and litter are relevant for breeding opportunities of the midges (little flies) that are important as cocoa pollinators (Kaufmann 1975, Toledo-Hernández et al 2017). Research has established direct positive relationships between the moisture content of litter and cocoa pollinators as midges can complete their lifecycle in that environment (Bravo et al 2011). However, the relationship between pollination and fruit yield is also influenced by other production factors (Bos et al 2007a,b).

Inefficient use of irrigation water is reported to constrain coffee flowering and production in Vietnam (Amarasinghe et al 2015), especially from January to April, when rainfall only provides 25% of the potential evapotranspiration rate and frequent irrigation may seem to be attractive. However, water stress in this period is needed to release flower buds from dormancy and induce flowering after rewetting. Better irrigation control at 70% of officially recommended rates can increase coffee production (up to 4 Mg/ha) beyond current levels, if other inputs are adjusted and a knowledge-intensive management system is followed (Byrareddy et al 2020).

Plant-parasitic nematodes are a major problem in coffee gardens, with the presence of grass strips to control erosion, aggravating problems of 'rhizovores' (Wiryadiputra and Tran 2008). Interestingly, a commonly used leguminous shade tree (*Gliricidia sepium* – its common names suggest it kills rats) has been shown to control nematodes (Barrios et al 2018). This may explain why farmers have found it beneficial (it is also called the 'mother of cocoa' in Latin America, where both mother and daughter originated).

The wide range of production systems that include at least some coffee and/or cocoa in some cycle stage can be a challenge when coffee yield data are expressed in national statistics. When the total coffee yield is divided by the area on which some coffee grows, a low national average yield per unit area is the result, and an opportunity (or even 'need') for intensification (often involving specialization) is indicated. Such intensification, however, may reduce other products and services currently produced, including fruits, timber, firewood, C-stocks (van Noordwijk et al 2002), plant biodiversity (Gillison et al 2004) and bird biodiversity (O'Connor et al 2005; Philpott et al 2008). A more comprehensive performance measure is the Land Equivalent Ratio (Khasanah et al 2020).

Although coffee trees can be relatively deep-rooted compared to other trees in the same environment (Wrigley 1988, Hairiah et al 2020), most (60-80%) of its roots are normally in the top 50 cm of the soil. A study in Costa Rica found 92% of coffee root biomass in the top , 1.5m, and the rest to a depth of 4m (Defrenet et al 2016). Frequent shoot pruning may induce a shallower rooting pattern, as noted in other tree species (van Noordwijk and Purnomosidhi 1995). Combining coffee or cocoa with other trees helps to stabilize the soil on slopes and generate a permanent litter layer that protects the soil surface from erosion (Hairiah et al 2006). Soil physical conditions in cocoa and coffee agroforestry are not as favourable as in a secondary forest but better than those in monocultural plantations (Gusli et al 2020, Saputra et al 2020, Rigal et al 2020).

The conservation community realizes that agroforestry systems, where crops such as cocoa and coffee are grown under the shade of or in association with native forest trees, sustain rural livelihoods and support high amounts of biodiversity (Schroth et al 2004). A study of the rich biodiversity in the Western Ghats region of India, known for its high-quality arabica coffee (Garcia et al 2010), found that a deeper understanding of land-owner strategies within the existing legal context is needed to maintain the balance of productivity and biodiversity (Clough et al 2011). Native coffee agroforestry in the Western Ghats of India maintains higher carbon storage and tree diversity than exotic agroforestry based on *Grevillea robusta* (Guillemot et al 2018). Combining biodiversity and agricultural productivity is, however, not without challenges. In the Western Ghats, the combined effects of high elephant density and major landscape changes due to the expansion of coffee cultivation cause human-elephant conflicts to intensify (Bal et al 2011).

As discussed in this chapter (Arifin et al 2021), coffee production in Indonesia has not been a global front runner in certification of compliance with environmental and/or social standards. However, a number of different programs have been and still are active in coffee and cocoa

Box 26.1

Contested watershed functions in a coffee agroforestry landscape in Sumberjaya (Indonesia)

Government-sponsored and spontaneous migration from densely populated Java brought farmers to the mountainous part of neighbouring Sumatra, where soils and climate are suitable for coffee production (Van Noordwijk et al 2019b). Part of the watershed protection forest in the mountains became converted to coffee gardens. When forest authorities became aware, farmers were evicted, coffee plants uprooted, and fast-growing exotic trees planted to reclaim the forest. One of these areas became a well-known hotspot of conflict after a hydropower facility was built that raised complaints about the sediment load of the river and that could not operate at the planned capacity, causing blackouts in the province. This raised the question of whether or not coffee production can be reconciled with the watershed functions expected for the area and, if so, how the conflicts between local people, forest authorities, the hydropower company and local government could be transformed into ways of cooperation, within existing legal frameworks. The ‘Negotiation Support’ approach that the World Agroforestry Centre and partners developed for this landscape provided positive answers to both questions (Leimona et al 2015). In a phased approach, tenurial security for farmers shifting from monoculture to agroforestry coffee systems in the contested protection forest zone was the first focus, supporting stewardship through agroforestry. Specific actions to reduce the sediment load of the river followed, as did support for the marketing of environment-friendly coffee. A key finding in the analytical phase was that the profitability of multistrata coffee agroforestry is actually higher than that of monocultures, provided that relatively low discount rates are used. High discount rates, typical of high uncertainty, drove farmers to the short-term gains of monocultures, fearing evictions. The case shows that landscapes are coupled with social-ecological systems and that solutions require integrated approaches, combined with trust building between former adversaries.

(Mithöfer et al 2017b). A number of studies (Astuti et al 2015, Ibnu et al 2015) have evaluated certification from the perspective of farmers, traders, consumers and government agencies (Neilson 2008). As there are several challenges to existing global standards (Leimona et al 2018), the alternative of 'geographical indication' of locally defined 'branding' of products (varieties) with a recognisable origin has received attention (Neilson et al 2018).

6. Germplasm selection, grafting or seed-based propagation

The productivity and quality of cocoa and coffee are inextricably interlinked with the genetic resources deployed in the production systems. Environmental conditions and other inputs being consistent, the genetic material deployed determines the upper limits of yield and the productivity of those other inputs (Dawson et al 2014). The germplasm sourced by smallholders or in any tree planting program needs to be suitable for local biophysical conditions to provide high yields of good quality, but also protect against pests, diseases and the uncertainty about future conditions that climate change brings (Roshetko et al 2018). Farmers actively select among the variation they observe among their trees (and those of the neighbours or relatives they might visit) and are also the recipients of improved germplasm selected in research stations and provided by extension and development assistance. The challenge is to make this not an 'either/or' choice but combine the best of both tree improvement pathways (Jamnadass et al 2019). Such combinations are easier to achieve in vegetative propagation (grafting of selected scions on rootstocks in a nursery setting or in situ, on existing trees as is common in robusta coffee; Figure 26.5) than in seed-based reproduction.

Grafting is a vegetative propagation technique that shortens the juvenile non-productive period and provides an opportunity to assure the productivity or pest/disease resistance of the plant by using scions of known genetic and physiological quality. Grafting is not complicated, it requires materials and tools that are available and familiar to farmers, and is easy to learn for most farmers. It is a common propagation technique with cocoa and (robusta) coffee. Cocoa and coffee seedlings are grafted during nursery production, although there is always a risk of spreading the virus along with the grafts (Asman et al 2019). In the field, coffee is often top-grafted to improve the productivity of mature or young trees by using scions of superior genetic quality. Grafting is adopted by some farmers and communities, but not all, demonstrating the continued need for intense training and extension to strengthen smallholder cocoa and coffee production.

In Indonesia and (possibly to a lesser extent), Vietnam farmers still have limited access to diverse and improved germplasm. Cash investments are prioritized for fertilizers and other agricultural inputs over germplasm (Chapman 2014). While many farmers still propagate coffee from unselected or low-quality genetic material, subsequent in-situ grafting can bring in more productive material, and coffee farmers can increasingly name the clones promoted and used. Smallholder propagation of cocoa in Indonesia is similar. Farmers often multiply their cocoa seedlings from locally available material of low genetic diversity, likely resulting in narrow selections and inbreeding over time (Zhang and Motilal 2016). Farmers' preference for large pods with large beans, rather than total yield, contributes to this situation (Dinarti et al 2015). Narrowing the on-farm gene pools through limited access and preference of productivity over genetic diversity increases smallholder systems' vulnerability to pests, diseases, and climate change.

Government agencies, research institutions and the private sector produce improved germplasm of diverse genetic origin; however, it often does not reach farmer producers. The availability of this genetic material is restricted by quantity, location, and pathways. The demand from the farmers' sector typically exceeds the supply of improved material once interesting material has been promoted. Many smallholder communities in coffee and cocoa producing areas are remote with limited infrastructure. Farmers have weaker connections with germplasm supply pathways than the government agencies, research institutions, and the private sector (Harwood et al 1999). Yet, the farmer-to-farmer spread of in situ grafting, especially in robusta coffee and cocoa, shows that gradual rejuvenation and improvement is possible (Figure 26.6, 26.7).

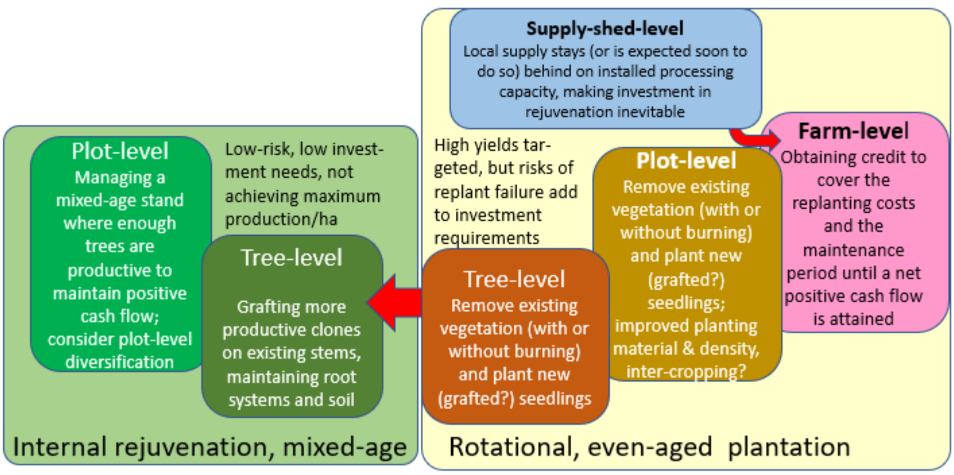

Figure 26.6: *Tree crop rejuvenation options at plot to supply-shed level (van Noordwijk 2021)*

Figure 26.7 *At harvest time of the fast-growing timber species (Falcataria moluccana) some damage to coffee is unavoidable, but farmers use this to graft existing coffee stumps with new clones of (supposedly) higher productivity (Kali Konto, East Java, Indonesia – Meine van Noordwijk/Brawijaya University)*

7. Gradual versus stepwise, disruptive development pathways

"Regional boom-and-bust cycles are the rule in global cocoa production: after initial forest conversion to cocoa agroforests, sustaining production is difficult due to dwindling yields as trees age, and pest and disease pressure increases. The failure to revitalize plantations often leads to a shift of cocoa production to other regions." (Clough et al 2009) Soil quality decline, especially in monocultures, may aggravate the problems farmers face.

To counter the expected loss of smallholder cocoa production by aging and diseased cocoa trees, the Indonesian government invested in a major (70,000 ha) cocoa rejuvenation program from 2009-2011. A modern plant propagation technique, somatic embryogenesis (SE), was used for mass production of selected clones, based on the claimed success in the laboratory of this new technology and small-scale field trials as reported in the literature (Goenaga et al 2015). However, the results did not meet expectations. In fact, the National Cocoa Program became a dramatic failure. A journalistic report from the field in 2012 (Pardomuan and Taylor 2012) called attention to poor yields and general disappointment at the farmer level after about 74 million specially developed seedlings had been distributed to farmers across a tenth of the growing nationwide area of 1 million hectares. Despite rapid early growth, the SE material failed to develop a normal taproot and stem, and after five years, only 1.3 % of plants were still alive, according to survey data (Gusli, pers. comm.). Several reasons have been put forward to account for the failure, ranging from an inflexible top-down project management culture in which early warning signals from farmers were ignored to the rapid scaling up of the SE technology without testing at scale. Although the five clones used in the program are favoured by farmers when grafted onto existing rootstocks, they do not have a track record as whole plants and possibly do not invest enough in their roots.

While annual cocoa yields had been around 1000 kg ha^{-1}, the failed revitalization program left yield levels to crash to 400 kg ha^{-1} (Figure 26.2). Meanwhile, the farmers who had durian or other trees that yielded commercial commodities in their cocoa gardens did well. The approximately 100,000 farmers reached by the program responded in various ways, looking for any locally available planting material to replace the 'improved-but-failed' planting material they had received, shifted to grafting where they still had established plants or switched to other crops. As embarrassing as the failure of the program was, there has not been a formal evaluation of the causes and – more importantly – lessons to be learned on how to avoid such failure. A comparison (Table 26.1) between the attributes of large-scale replanting programs, such as the Indonesian National Cocoa Revitalization Program and the more stepwise approach of farmers suggests that the risk profiles are indeed different. In fact, the more gradual approach that is taken in coffee intensification has had more effect than the 'big leap forward' attempted in cocoa in Indonesia, with lessons yet to be properly analyzed (as many of the agencies involved have been reluctant to do so).

Table 26.1: *Attributes of large-scale replanting versus gradual in situ grafting*

CLEAR and REPLANT	IN SITU GRAFTING, INTERPLANTING
• Clearing all cocoa, coffee and other trees,	• Gap-level management: harvest and replant (or allow to regrow),
• Accept temporary soil disturbance and erosion risks,	• Avoid disturbance of soil and belowground root networks,
• Planting with 'superior' new germplasm,	• Stepwise introduction of selected clones by in situ grafting,
• Using optimized plant density and spacing of companion crops,	• Gradually modify plant density and spacing of companion crops,
• Accepting considerable 'income gap', waiting for new production,	• Avoid 'income gap', using trees as 'insurance' for cash needs,
• Predictable results for agricultural credit providers,	• No need for agricultural credit providers; focus on farmer skills
• Benefits for 'agro-industry' at large.	

Beyond changes in total production, shifts in the way decisions are made, and benefits shared between and within households are an important aspect of 'development'. A recent study in Vietnam documented the gender differentiation in the management of coffee agroforestry. As harvesting coffee is considered labour intensive, both men and women are involved, but marketing is performed by men alone, while for fruits, both harvesting and marketing are tasks usually performed by women (Catacutan and Naz 2015). These gender relations can, however, shift when explicit attention is paid. As documented by Simelton et al (2021), active gender and finance training translated to real changes in gender dynamics, and membership of a Village Savings and Loans Association also helped women improve their financial literacy and improve their negotiating abilities. Husbands in the study also began to reconsider gender roles and shift towards equal sharing of responsibility and decision-making with their wives.

8. Contrasts and similarities: coffee vs cocoa, Asia vs Africa

Our quick tour of the patterns and trends in coffee and cocoa production, processing and trade in Asia has revealed both similarities and differences between the two crops. Coffee has become more deeply rooted in local cultures and economies, being compatible with many other trees depending on climate, elevation and soils. It also has become a preferred beverage in both rural and urban areas, with local processing becoming common; in cocoa, in contrast, consumption has depended on industrial-scale processing of the beans and primarily urban in reach. Periods of high world market prices have triggered expansion by migrant farmers moving into forest frontiers and establishing coffee farms – but under average or below-average world market prices, farmers are better off with diverse rather than specialized production systems.

Participation in 'certification' programs is appreciated for the access to information and trading networks it can provide, rather than expectations of price premiums. Cocoa still has a boom-and-bust dynamic, with efforts to revitalize the sector in a bust phase by large-scale replanting vulnerable to failure. A major trend in cocoa in Southeast Asia has been the shift from the export of cocoa beans to local processing for higher-end products. Unfortunately, it has coincided with a decline in cocoa bean production that challenges the viability of the industry with its import dependence while depressing the farmgate process by export tariffs. Policy-wise the cocoa example is seen (Neilson et al 2018) as a resurgence of resource-based industrialization (RBI) policies that may also appear to be attractive to African governments seeking to capture a larger share of the value chain for their agricultural commodities. The main lesson here is that effective RBI policies require enhanced attention to the sustainability of domestic resource supplies and a fair farmgate price in support of that (Yudyanto and Hastiadi 2019, Dewanta 2019). With labour being around 50% and land rent around 30% of production costs for cocoa beans, and fertilizer costs being only 5% and seed only 1%, Policy Analysis Matrix data show a 40% effective reduction of input prices for farmers, compared to world market prices (Fahmid et al 2018).

Agricultural policies towards coffee mirror those towards palm oil with interest in establishing national sustainability standards for coffee to reduce dependence on 'externally controlled' certification that challenges Indonesian sovereignty (van Noordwijk et al 2017). Of course, the key question is whether or not such standards would be relevant for the overseas consumers who care about the social and environmental conditions under which production takes place (Mithöfer et al 2017a).

The historical Asia-Africa connection through colonial powers, where African crops for European markets (coffee, oil palm) could be produced at lower cost in Asia, has shifted to one where Asian economies are a major engine of global growth and commodity demand. The challenge for African countries to be competitive producers in a global market that is more prominently Asian is increasing rather than decreasing. Just as some Asian countries (including Malaysia, Indonesia) did before, African countries may try to capture a larger share of the value chain by moving into cacao processing, as discussed in *chapters 5* and *chapters 14* of this volume. Where there is a growing middle-class demand for the products, there will be a higher more chance than where the targets are European or North American market segments. Opportunities for value chain development in coffee may be larger for African countries than those in cocoa, as regional and domestic demand is growing.

9. Conclusions

1. Cocoa and coffee are major income sources for smallholder agroforesters in Asian economies, with coffee grown in a wider range of elevations and climatic conditions than cocoa.
2. Supply and value chains of both crops change towards more advanced local processing as part of the Asian boom in consumer demand.
3. Optimal shade levels in agroforestry are part of risk management strategies in changing climates and markets, with the economic value of timber or fruit-producing companion trees (rather a pure supporting role of shade trees) depending on geographical context.
4. Disruptive, stepwise development efforts to rejuvenate production have backfired in a major cocoa program in Indonesia, providing lessons yet to be evaluated in detail.
5. Certification and geographical indications are efforts to capture value closer to the farmers/producers as part of dynamic value chains that require a full understanding of the administrative requirements and collective actions at the producer level.

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