Women carrying cocoa in Petit Bondoukou

Photo credit: E.Smith/World Agroforestry

CHAPTER 5

Evolutions and Innovations in the Cocoa Supply chain

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Highlights

- Evolution and innovation in the global cocoa industry is driven by a honeymoon and turbulence around sustainability priorities and initiatives.
- Strategies to effectively link productivity and sustainability tend to be disconnected and, in many cases, work against each other.
- Evolution from cocoa to chocolates, the type of stakeholders and partnership that plays significant roles in the products evolution and the information and knowledge that have been associated with the short-term boom-and-bust cycles can lead to a long-term boom-and-bust cycle with country-wide consequences.
- Different evolution trajectories of cocoa from the old world to the new world and West Africa have shaped the flavor patrimony of cocoa and innovative socio-technical systems needed for transformative change.
- We argue that such transformative change should be progressive by exploring new perspectives at various level (substitutions), review or revise the governance structure of existing socio-technical system centered on productivity-enhancing interventions and initiate a co-building and co-construction of the whole system by integrating emerging sustainability challenges.

1. Introduction

1.1. The origin of cocoa tree

The first time someone visit a cocoa farm, you will be amazed by the architecture of a cocoa tree. After all, its flower cushions where flowers emerge and are pollinated into fruits, the fruit starts as a cherelle (small fruit) and if not wilted (natural phenomenon that enables the cocoa tree to regulate its pod production) matures to a large round to oval-shaped pods hanging

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out of cocoa tree trunk. Naturally, cocoa is a forest tree. The cocoa tree (*Theobroma cacao* Linnaeus 1753) is a small tree that can be found growing wild in the Amazon basin and the tropical areas of South and Central America. There are more than twenty species within the genus *Theobroma*, but the cocoa tree is the only one cultivated widely. Although today we are interested in cocoa beans, ancient peoples are likely to have selected cocoa for its pulp. Inside the cocoa pod, its seeds (or call them beans) are surrounded by a white, sweet-tasting nutritious pulp. Thousands of years ago, a natural population of *T. cacao* was spread from the central part of the Amazon region to Guiana and Southern Mexico. During this journey, the cocoa tree diverged into two distinct subspecies:

Criollo in Central America and Forastero in South America[1] (Young 2007). Beans from Criollo are rounded and white in cross-section. Chocolate made from these beans is of very high quality: aromatic but lacking in bitterness. Unfortunately, Criollo trees are susceptible to a range of diseases, which has had a huge impact on its cultivation. So much so that Criollo cocoa has become scarce and currently represents less than 3% of the world's cocoa production (Young 2007). By contrast, the Forastero accounts for about 85% of world's cocoa production. Forastero varieties are hardy, vigorous, and more disease resistant than Criollo cocoa. They produce beans that are smaller and flatter, with violet-colored cotyledons, and although beans from these types possess a stronger flavor with higher fat content, the flavor is not generally considered to be of high quality (Zarrillo et al 2018).

The considerable trade between Brazil and West Africa in the 19th century and after Brazil gained independence from Portugal in 1822 led to Amelonado cocoa introduction from Bahia to the small island of Principe off the Central African Coast. From there, it spread to the islands of São Tomé in 1830 and Fernando Po in 1854 (Bisseleua 2019). Later in the 19th century, cocoa was taken from there to Ghana and Nigeria, forming the basis of cocoa cultivation in West Africa. Cocoa production in West Africa since 1960 is based largely on these cultivars, with more recent additions of new material from the Cocoa Research Unit at the University of the West Indies in Trinidad.

Approximately 70% of all cocoa production comes from West Africa, primarily Côte d'Ivoire and Ghana. The cocoa supply chain has a highly diffuse producer base, with millions of smallholder farmers producing cocoa on 2–3 ha. In contrast, the trader and manufacturing sectors are highly concentrated. The largest producer by far is Côte d'Ivoire, which produced 2,180,000 tons in 2019/2020, with Ghana's production at 850,000 tons. Cameroon and Nigeria produced 290,000 and 250,000 tons (ICCO 2020), respectively, in the same period.

This book chapter provides a comprehensive analysis of the different evolution, innovation processes and transformative pathways along the cocoa supply with special focus on West Africa cocoa-producing countries, Côte d'Ivoire, Ghana, Nigeria, and Cameroon.

1.2. Evolution of cocoa production systems

During recent decades we have seen a transformation of cocoa farming to more intensified systems by eliminating shade trees, increasing agro-chemical inputs, and selecting genotypes, all to increase short-term income (Asare and Raebild 2016, Bisseleua et al 2013). This has resulted in a broad range of cocoa plantation management, ranging from low input shaded plantations to high-input full sun plantations, some of which begin to approximate a monoculture production system (Djuideu et al 2020). Since independence and until very recently most farmers in West Africa have been clearing forests to establish plantations. Policies and agronomic practices towards higher yielding varieties and full sun cocoa have contributed to further deforestation. This was the case of Côte d'Ivoire when cocoa was introduced from the Fernando Do Po island in the mid-1900 and the country decided to go full sun with the aim to maximize yield using improved varieties that was called hybrids – this was based on recommendations by scientists that upper amazon hybrids are not shade tolerant and that yield is low with shade (Hatløy et al 2012). This new way of growing cocoa quickly spread from Côte d'Ivoire to Ghana and recently (i.e. starting in late 90s) to Central Africa including Cameroon. At that time scientists assumed that shaded plantations are less profitable and that yield, and profitability was lower for shaded systems. However, part of Ghana and Cameroon decided to continue growing cocoa in a "traditional" way by keeping a diversity of shade/companion trees in their farms and by gradually replacing the local cocoa varieties known in Ghana as "Tetteh Quashie cocoa" and in Cameroon as "German cocoa" with the hybrid varieties. A system which is known today as cocoa agroforestry system.

In Cameroon, for example, cocoa is grown under the shade of considerably larger trees. About 60% of such systems are more than sixty years old, and they are still being used by farmers (Bisseleua et al 2018). The shade comes mostly from native forest trees, thinned out to provide space for cocoa seedlings to be planted, or, to a lesser extent, from trees specially planted to provide shade (Sonwa et al 2005, Bisseleua et al 2009). Banana and/ or plantain is commonly used to provide temporal shade to young cocoa trees and as the trees mature, the native trees that are retained and the new, exotic trees planted, provide not just shade, but can also be used to provide extra income (Djuideu et al 2020). This mixture of shade trees and shrubs creates a multi-strata layers of canopy (Sonwa et al 2005). The result is a multi-species system similar in structure and function to a forest-like agroforest system grouped into four general types of cocoa agroforestry system, including full sun-like type cocoa with a diversity of fruit tree species, cocoa under heavy diversified shade, moderate and intermediate shade (Ambele et al 2018, Djuideu et al 2020). In these systems, cocoa is produced much longer than is possible under cocoa monoculture (Bisseleua et al 2019). Ultimately, cocoa farmers, like everyone else, need to make a living. They need to know that growing cocoa in an agroforestry system is going to pay. Research published in 2019 suggest that cocoa agroforestry in Cameroon is

profitable. Yield averages between 800-1680kg/ha of marketable dry beans. Furthermore, each farm can provide about 8.7m^3 of commercial volume timber; 68,000kg/ha of bananas and plantains, 4-5,000l/ha of oil palm, between 140-220kg/ha of fruits and 10-18kg/ha of non-forest products harvested every year and generate a net annual profit of between US$5,000 to 13,000 to farmers which can enable cocoa farmers to make a decent income to make a living (Bisseleua et al 2018, Djuideu et al 2020). For Ghana, a study of 200 cocoa farmers from the Western region found that medium-shade agroforestry was more profitable than no-shade, low-shade, and heavy-shade systems (Asare et al 2019). These findings suggest that promoting medium-shade cocoa agroforestry would be the right policy to ensure the welfare of cocoa farmers and enhancing environmental sustainability.

It is now well established that shade trees in cocoa agroforests are important for farmers' livelihoods and the conservation of natural resources. It is important to have a detailed assessment of the long-term effects of shade removal on cocoa yield. This could help anticipate and mitigate any climate effects as cocoa grown in agroforestry systems might be better able to cope with the changing environment (Laderach et al 2013). But today, establishing such biodiversity friendly farming practices such a cocoa agroforestry system will require public and private actors providing economic and financial solutions to enable smallholders to embrace the short-term transition to sustainable production models (Asare et al 2018).

1.3. Chocolate is a product of the cocoa tree

People inhabiting Mesoamerica 5,450 and 5300 years ago were using cocoa, probably as a drink suggesting that South America is the center of domestication of the cocoa tree (Zarrillo et al 2018). The cocoa drink was made from fermented and dried beans toasted and ground together with toasted corn and then mixed with water containing a foaming agent. As with the Mayans, flavourings such as vanilla and chilli were often added to the chocolate drinks. Chocolate drinks were taken unsweetened, quite unlike the way many of us would drink chocolate today.

Cocoa beans were also utilized to make chocolate confectionery. Chocolate may have been taken across the Atlantic by monks or nuns moving between Old World and New World monasteries, the first official shipment of cocoa beans was sent from Veracruz on the Mexican coast to Seville in Spain in 1585. In 1644 nuns in Mexico made chocolate sweets that were eaten at banquets in Baroque Europe along with various other sweet delights (Coe and Coe 2013). Chocolate made its way to England, France and Italy during the 17th century. Chocolate consumption in Europe increased greatly during the 17th and 18th centuries. In 1868, John

Cadbury's son George produced cocoa powder, which he called 'Cadbury's Cocoa Essence' and the first 'chocolate box' – a selection of chocolate sweets. Chocolate then became a big business, not just in Britain, but also in continental Europe and the USA.

Today, chocolate is a massive global business, worth billions of dollars annually. Four trading firms (Barry Callebaut, Cargill, Olam and ADM) control an estimated 60% of cocoa volume (Gayi and Tsowou 2016), and six manufacturers (Mondelēz, Nestlé, Mars Inc, The Hershey company, Ferrero, and Lindt) use about 40% of all cocoa produced (Fountain and Hütz-Adams 2015). In 2018, the market leader was Mars Inc, based in the USA, with net sales of $18 billion. Mondelēz International, a US-based company posted net sales in 2018 of $11.8 billion. The Hershey company netted sales of $7.7 billion in 2018, while sales for Nestlé SA of Switzerland were a bit lower but still very respectable $6.1 billion.

External stakeholders, including producing-and consuming-country governments, NGOs, and certifiers, also influence cocoa value chains.

Box 5.1

Innovation Systems

An innovation system is a collaborative arrangement that brings together several organizations and individuals working towards a desired change to interact and generate outcomes that benefit all stakeholders (Adekunle et al 2012). An innovation system incorporates the invention system (i.e. the technological and biological components generated from hard science and quantitative data 'hard facts' or hard system approaches), as well as the complementary economic processes required to turn invention into innovation and subsequent diffusion and utilization (Adekunle et al 2012). Innovation systems do not occur automatically; it is the problem situation that defines a particular innovation opportunity. Innovation systems are created for a purpose; they will change in content and patterns of interaction as the problem situation evolves and they are constructed at micro and macro levels (Adekunle and Fatunbi 2014). The most relevant innovation system is the one that is constructed (i.e. takes into account the social network, individual preference and history, culture, power, policy and economic opportunity) (these are generated from 'soft facts' or soft science) to address a particular problem i.e. context specific. Innovation is not just about developing a technology but requires taking into account the 'whole innovation systems' i.e. culture, power, institutions and policies as well as the actors themselves. For innovation to happen you need to integrate various knowledge systems as well as the dynamic and evolving nature of situations; therefore, the need to put emphasis on processes that can further 'social learning' i.e., the systematic learning process among multiple actors who together define a purpose related to the agreed necessity of concerted action at a variety of scales. This process of social learning includes cultural transformation, institutional development, and social change (Adekunle et al 2012).

1.4. Cocoa and chocolate under threats of pests and diseases

The multi-billion-dollar cocoa and chocolate industry is under threat. The cocoa tree is susceptible to the ravages of diseases and pests which cause serious problems for growers. Some diseases are endemic; however, as cocoa was disseminated from the Amazon rain forest to new cultivation sites it encountered new pathogens. Two well-established diseases cause the greatest losses: black pod rot, caused by several species of *Phytophthora*, and Cocoa Swollen Shoot Virus Disease (CSSVD) by cocoa swollen shoot virus. *Phytophthora megakarya* causes the severest damage in the main cocoa producing countries in West Africa, while *P. palmivora* causes significant losses globally. In West Africa particularly in Côte d'Ivoire and Ghana, CSSVD is rapidly spreading. In Côte d'Ivoire, the CSSVD infected area was estimated at 100,000 ha in 2017. In 2019, the Côte d'Ivoire government estimated that the disease had progressed by 8% for a total of 125,000 ha CSSV infected farms. Between 2014 and 2017, the government of Côte d'Ivoire was able to cut 21,000 ha of CSSV infected farms. In 2018 they cut about 32,000 ha of CSSV infected farms. They were targeting 35,000 ha by June 2020 to reach 88,000 ha from the 100,000 ha planned in 2017. They expected to complete the cutting-out campaign by May 2021 and to replant when the farmer and farm surveys are completed. In Ghana, Cocoa Health and Extension Division (CHED) of COCOBOD second country-wide surveys (2017) indicates that (23%) of Ghana cocoa tree stock is infected with CSSVD. CHED has planned to rehabilitate 91,400 ha of the 400,000 ha infected in the next 5 years.

Elsewhere main diseases are caused by *Moniliophthora perniciosa* responsible for the witches' broom disease and its sister basidiomycete species, *M. roreri* which causes frosty pod rot (Mareli et al 2019). Witches' broom was responsible of 80% production loss in the Bahia region of Brazil in 1988 forcing cocoa growing families to leave their farms for the city. The basidiomycete *Ceratobasidium theobromae* causing vascular-streak dieback occurs only in South-East Asia and remains poorly understood.

The insect pests include the cocoa mirids (*Sahlbergella singularis* Hagl, *Distantiella theobromae* Dist and Heliopeltis sp) and the cocoa pod borers (*Characoma stictigrapta* Hmps). In Southeast Asia, cocoa pod borer causes losses of $600 million per year. Climate is another threat resulting in the emergence of underground pests such as termites (*Odontotermes* spp *Ancistrotermes* spp, *Microtermes* spp and *Microcerotermes* spp.) which can cause more than 70% tree loss in severe conditions (Ambele et al 2018, Djuideu et al 2020). In unshaded situations, when the trees get beyond 25 or so years old, pod yields fall, and insect pests become problematic. These pressures often lead to farms being abandoned, and new areas of forest gets encroached. This has been called a short-term boom-and-bust cycle and has been a common practice in cocoa cultivation (Clough et al 2009). Unfortunately, the pest and pathogen problems associated with the short-term boom-and-bust cycles can lead to a long-

term boom-and-bust cycle with country-wide consequences. This happened in Brazil in the late 1980s, when pathogen problems turned the cocoa boom into a cocoa bust, resulting in a huge slump in production. A similar fate befell Malaysia a few years later, courtesy of cocoa pod borer. This could happen in West Africa with the combination of cocoa swollen shoot virus and termites' outbreaks. Researchers have suggested that large parts of cocoa producing areas in West Africa will become unsuitable for the production of cocoa in the future if the issue of pest and disease under the current climate variability is not taken seriously. This is a problem not just for the multinational companies that produce chocolate but also, and crucially, for the farmers who grow cocoa in the various regions across the humid tropics of West Africa.

1.5. Sustainability challenges and strategies in the cocoa supply chain

Strategies to effectively link productivity and sustainability tend to be disconnected and, in many cases, work against each other. Given the trend towards sustainable development and the need to minimize ecological footprints of economic activities, linking productivity and sustainability should be the basis for an alternative approach to targeting agricultural investments with more realistic, long-term expectations that meet societal demands sustainably-that is, no significant erosion of ecological functioning and preservation of natural capital and support farmer resilience.

Building sustainability into productivity and production gains will require paying simultaneous attention to the following eight overarching issues:

1. Closing yield gaps through sustainable intensification technologies such as agroforestry systems that combine production and preservation of ecosystems' essential functions or by providing farm-level support through individual, tailor-made Farm Development Plans and encourage the rehabilitation of cocoa farmland.
2. Identifying appropriate agro-ecological practices/ strategies, constraints, and policies in favour of biodiversity conservation trade-offs or synergies and support ecosystem services.
3. Paying attention to water conservation strategies, especially water use and re-utilization efficiency, and management of rainwater through appropriate practices and policies at scale.
4. Introducing policy reforms that restructure institutional arrangements that favour farmer-based organization, farmer professionalization, youth entrepreneurship, job creation including for women, strong investment in multi-stakeholder processes, and market-based change through improvements in institutions, tenure, and governance.

5. Ensure financial inclusion and financial literacy to enable access to, and using one or more, formal financial services (i.e. credit, digital financial services, loans, (micro) insurance, savings and payments) and investment in off farm activities
6. Introducing gender equality, women empowerment and child labour policies in agricultural practices as well as facilitating access to basic socio-economic infrastructures to farming communities.
7. Building on local knowledge, culture, and traditions while seeking innovations.
8. Investing in strengthening infrastructure for storage, transformation, and local market niche, development of post-harvest technologies, enhancing efficient logistics systems, as well as provision of the right institutional and policy environment to support production and distribution.

To address these issues, the cocoa sector has developed several strategies to improve the sector's image, and to contribute to its transition towards greater sustainability. The main initiatives include certification (Fairtrade, organic, Rainforest Alliance/UTZ) and the establishment of "corporate policies" and voluntary commitments (Amiel and Laurans 2019). These strategies, in addition to the Cocoa and Forest Initiative (CFI) and CocoaAction, aim to reduce deforestation and are vital in attempting to eradicate child trafficking and child labour in the chocolate industry. CocoaAction aims to boost productivity on environmentally suitable land and boosting farmer income while CFI aims to reduce the pressure for farmers to encroach into new forests i.e., 'to produce more cocoa on less land'.

The 4th World Cocoa conference held in Berlin in the early summer of 2018 recognized that the cocoa sector will be sustainable when all stakeholders develop and implement policies that enable cocoa farmers to earn a living income. In 2019 the Ivorian and Ghanaian governments supported by the cocoa industry announced an increase in the floor price for cocoa farmers, and levy an extra fee to cocoa buyers. These measures ensure that money goes to farmers to achieve a living income.

2. Continuous evolution of the cocoa value chain in West Africa

We describe here the different evolution trajectories of cocoa from the Old world to New world and West Africa. We provide readers on the evolution from cocoa to chocolates, the type of stakeholders and partnership that plays significant role in the products evolution and the information and knowledge generated to the cocoa boom and bust.

2.1. Geographical evolution of flavor and quality

2.1.1. What makes people to prefer cocoa from West Africa

Flavour places itself at the foundation of cocoa production in West Africa and consumers preference globally. Is West Africa making it cheap or they have a better flavour? However, if companies continue to come and buy cocoa from West Africa, it is because it tastes good! Several factors have contributed to place West Africa at the centre of cocoa and chocolate.

a. The West Africa Flavor profile

The flavour profile of West Africa takes its origin from Amelonado. As we mentioned in our introduction, Amelonado cocoa was introduced from Bahia, Brazil to Central African Coast in 1800 and later in the 19th century to Ghana and Nigeria, forming the basis of cocoa flavor in West Africa. Brazil is the source of the major structured group Amelonado that constitute the genetic basis for cocoa taken to West Africa.

Amelonado characteristic is its' flavor. It produces a very strong, clear, rich chocolate flavor and aroma which is not fruity, not floral and with no nutty nuts. This flavor is recognized as chocolate. The astringency and acidity is well balanced in chocolate. It has a more Zend effect that immerses you in chocolate and all you must do is to close your eyes and drift off into a *nirvana*. However, Amelonado completely lacks disease resistance against black pod, witches' broom, frosty pod rot or the cocoa swollen shoot virus disease. In short, Amelonado is susceptible to any cocoa disease which is the problem Ghana and Côte d'Ivoire are facing. This problem may continue to Nigeria and Cameroon.

The colonial masters the British and the French, except Nigeria, have created a landrace flavor through some hybridization with other materials. This resulted that the traditional flavor profile of Ghana, Côte d'Ivoire and Nigeria are slightly different from one another. Although it is true that intense chocolate is what is found in West Africa. Cameroon was very different in many respects from much of the rest of West Africa, Côte d'Ivoire, Ghana, and Nigeria (Table 5.1). The Belgium brought in Cameroon many other materials that created a more complex flavor (http://www.cocoaofexcellence.org/).

Table 5.1: The differences in flavor of West African cocoa

Country	Flavor profile
Ghana	The country is known for very clear and distinct chocolate flavor where the bitterness and astringency are balanced, and little bit on a lower side. Inherently Ghana cocoa has a lot of aroma that is very distinct. Sometime having a little bit of a rose note - a very slight flower rose note. It is all about aroma and how that aroma smell chocolate in the mouth when you chew and bite it. It melts and envelops in the mouth especially considering the modest bitterness and astringency. The Ghana flavor is very much like a symphony orchestra playing but a piece in which it is very light and airing. It is lot of violins and some flute. It is like handles water music and you must just listen! The flavor is not aggressive but invites you to immerse yourself in the flavor.
Côte d'Ivoire	Côte d'Ivoire flavor is a little bit lower with beans total intensity typically of a chocolate flavor. Côte d'Ivoire beans handle a floral roast which means developing more brown flavor which is viewed by consumers as chocolate – Brown like Brownies! The flavor is rich full roasted cooked flavor. It is a little bit higher in astringency than Ghana – bitterness is like Ghana, maybe a little bit more. But the chocolate flavor is a little bit more aggressive and come on quicker in the mouth but a little bit harder. While the Ghana chocolate flavor caused you to sink back in a chair and relax, the Côte d'Ivoire chocolate flavor makes you open your eyes a little bit and straight your shoulder and sit up a little bit. Good cocoa from Côte d'Ivoire sometimes has a very mild spicy note, specifically tobacco spice - the aroma of the tobacco itself. It is a little bit of the aroma complexity if you walk outside a tobacco shop where there is different tobacco.
Nigeria	The chocolate flavor of Nigeria has had the least of the changes of the inherit cocoa that was brought over. It has a higher bitterness, not a high astringency, is aggressive in mouth. According to Ed Seguine and international expert of cocoa flavor and the chairman of the International Cocoa Excellence (CoEX) group, in terms of cocoa intensity a pure Nigeria sample can be given a 10 over a 10-point scale while Ghana will be on 8.0 – 8.5 occasionally 9.0; Côte d'Ivoire will be on 7.5 or between 8.0 – 8.5. The Nigeria flavor is very much aggressive; its strength and full tolerance roast very well and incorporate these brown elements as well as the bitterness of a high roast into that wrong chocolate impression.

All these countries are offering very specific chocolate flavors which the globe recognize and like. The specific chocolate flavors are used by chefs worldwide to create and marry ingredients that is striking, memorable and desirable. A good chocolate can be created between Nigeria or Côte d'Ivoire or Ghana with all these richness elements and will make an outstanding desert liked by everybody depending on the skill of chocolate makers and the quality of the beans. Chocolate from these countries can also be used to make chocolate cakes, brownies, and chocolate cookies to name a few. This is the reason why West Africa cocoa has done well so far.

2.1.2. The cocoa butter content as precursor of flavor profile of West Africa cocoa

Cocoa butter in West Africa is one of the most valued product in the world, very well appreciated and liked by many master craftsmen. The best cocoa butter is Ghana with a nice upper end fat content ranging between 54.5 and 55%. Second on the list is Côte d'Ivoire butter with between 54 – 54.5% fat content. Ghana has historically been high in cocoa butter than Côte d'Ivoire and therefore has historically had a higher differential on the market than Côte d'Ivoire. However, if Côte d'Ivoire changes their flavor to fine flavor it will be massively below the current market value because that much of fine flavor cocoa does not have a home.

2.1.3. Colonial heritage of flavor profile

Ghana historically produced some of the cleanest cocoa in the world. By clean, we mean free from trash, stones, sticks, debris, pieces of woods and diseased beans all stocked together. This was originally created by the British which developed various inspectors and collectors based on rigorous standards. The British created a culture of cocoa quality in Ghana that is not parallel in any other country in the world. Ghana cocoa was the cleanest cocoa in the world, always beautifully well fermented. Nonetheless, in the last 20 to 30 years, all countries in West Africa have had a gradual and long slide in quality and today probably about 60% of cocoa from Ghana is close to the root of flavor and quality. The rest are marginal to one extent to another. Côte d'Ivoire has slide in flavor with the early Mercedes family trees having a very bad taste even when fermented carefully well.

2.1.4. Flavor profile of cocoa from other origins

These countries (Table 5.2) provide unique differences and diverse flavor profile.

Table 5.2: *Flavor profile from other origins*

Countries	Flavor Attribute
Madagascar	Produces fine flavor cocoa with fruit acidity and with some nut note. It is good for making some deserts that has some fruit elements like mango reduction or passion fruit reduction or chocolate soufflé.
Ecuador	It is a fine flavor producing country called *national* and is characterized by a moderate chocolate intensity on a Cocoa of Excellence (CoEX) scale from 5.5 to 6.5 or very low 7.0. The beans handle a green herbal and some floral note - flower odd blossom notes. The flavor is deep powerful and more powerful overtime as you keep it in the mouth as a conductor of a symphony. The way cool is to blend about 60% Ghana good smell aroma with 40% Ecuador. Spectacular! Imagine yourself closing your eyes and enjoying such chocolate!

Countries	Flavor Attribute
Trinidad	Historically the chocolate intensity on CoEX scale is 7.0 and sometime 8.0. the beans carry with it a raisin or long brown note that last long in a mouth. A blend of 50% Ghana and 15 to 20% Trinidad for that long brown note and the balance with the Ecuador for the floral and depth to have a flavor profile that is multidimensional crafted to your preferences just expanded in the mouth.
Peru and Venezuela	Peru has lot of diversity starting from the northern side and the Andean. The Peruvian cocoa has a more floral note. Andean cocoa is sold as premium. The Venezuela chocolate intensity is moderate, and the bean has a fruit note – a fresh fruit note.
Vietnam	The country has lot of diversity brought by the French in many phases. The bean has a very distinct toasted coconut rich chocolate note.

The good West Africa cocoa including Côte d'Ivoire has the capability of being the canvas upon which the chocolate making artists, craftsmen and chocolate companies can use with these fine flavors cocoa to create robust business. Those are the secret behind cocoa from West Africa. That is why people rush to West Africa for cocoa!

2.1.5. The political economy of flavor and chocolate

Big chocolate companies are interested on the flavor and want a flavor that is not particularly distinguished. They want a flavor that can handle a high roast, where they can add vanillin artificial flavor to make their chocolate. The commodity wants always to keep the price down. They do not want to see a 3,000$ tons/cocoa. This justifies the reason why the demand for chocolate is downright sensitive to the price of cocoa because cocoa is the only thing you can use to make chocolate. Because each human being will only consume a fixed amount of calory/ per day, candy bars, chocolate bars, chocolate desert and brownies compete with other discretionary foods for the consumers palais and stomach room which we call "Calory pie". The competitors are potatoes chips, corn chips, popcorn, crunchy foods, ice creams, and pressels. If the price of cocoa goes up too much, the price of the chocolate must go up, therefore the price of the candy bars must go up as well or make the bar smaller. In such condition, a candy bar vs a bag of potato chip will now have a different value relationship to the consumers. That is the reason why most companies do not want the cocoa price to go crazy! Company would like to keep the price down. They do not control the price, but they are happy when the price is down!

2.1.6. Downfalls in West African Flavor Quality

One of the downfalls is that quality has declined. Part of it is due to the type of drying infrastructure put in place by exporters around seaports. More and more beans are being bought wet and not well dried, long enough on the farm specifically during early seasons. Exporters have created a structure that tells farmers that quality does not matter.

Another important element of downfalls of quality is that flavor is ignored when breeding new varieties for resistance/tolerant to pest, diseases, and climate change. Flavor is the reason why West Africa produces more than 70% of the world cocoa. It is therefore important to West African producing countries to preserve their traditional flavor. Each country is responsible for their own flavor patrimony. It is a national treasure – it is a national heritage and the combination of all the work of millions of farmers over more than the last century that need to be respected and preserved.

Cocoa producing countries of West Africa should work and collaborate with buying and consuming countries to decide on which materials to plant in order to preserve this flavor patrimony and to avoid flavor drift or flavor shift that may drive chocolate buyers and consumers to other regions.

2.2. Evolution of stakeholders and partnerships: Who control what and since when?

West Africa is home to three quarters of the world's cocoa production. Côte d'Ivoire alone accounts for over half of this total (56 percent), with Ghana second (26 percent) and Cameroon and Nigeria third (7 percent each). But all these West African countries export mostly unprocessed beans, with earnings equivalent to less than a tenth of world chocolate sales, neither country captures the large returns higher up in the value chain (Thorklason 2018).

2.2.1. Stakeholders and partnerships in Ghana and Côte d'Ivoire

The cocoa market in the two main West African producing countries is, however, highly regulated. Domestically, both the Ivoirian and Ghanaian governments regulate their cocoa markets through their central regulatory agencies: The Ghana Cocoa Board (COCOBOD) in Ghana and the Conseil du Café et Cacao (le Conseil) in Côte d'Ivoire. Both agencies provide varied direct extension services to farmers, support programs in place to combat cocoa diseases, and supply of inputs and planting. Farmers receive the farm gate cocoa price regulated by the respective government. Both countries have cocoa marketing boards that pre-sell part of their harvest in the year before the harvest season starts. The Conseil in Côte d'Ivoire and the COCOBOD in Ghana determine a fixed price around October 1st, when the main crop season

begins. In Ghana, all major buyers are required to sell their product to COCOBOD, which either exports it or sells it to domestic processors. In Côte d'Ivoire, le Conseil determines the guaranteed minimum farm-gate price through the Programme of Average Anticipated Sales. Since Côte d'Ivoire does not have a single-purchaser system, international firms hold stronger market positions. In both cases, government income through price controls could enable these firms to invest in research and extension services. Both governments cover the costs of extension services by the price difference between farm-gate and export prices. However, extension services remain weak and smallholders receive prices lower than the world price with few extensions' benefits in return. In June 2019, the chocolate industry and the government of Ghana and Côte d'Ivoire agreed buyers to pay a USD 400/ton fixed premium, called a "living income differential" to be redistributed to farmers as bonuses when cocoa prices fall between USD 2,600 – 2,900 during the season. Drawing from recent data collected by KIT Royal Tropical Institute, an average cocoa farmer in West Africa may own between 2-4 hectares of land and produce roughly 400 kg/hectare. Under the proposed scheme, the average farmer would then earn between USD 1,456 – USD 3,640 per year, which falls short of proposed living income levels. Since farm-gate prices are set before the start of the season and do not account for fluctuations in either exchange rates or inflation, smallholders can lose real value even if prices rise relative to the previous season. Cocoa smallholders in Côte d'Ivoire and Ghana earn less than their counterparts in Indonesia, Nigeria, or Cameroon (Oomes and Tieben 2016). There is no official price differentiation for certified cocoa, and smallholders have limited access to higher-value markets.

Côte d'Ivoire has a more competitive and liberalized market structure than Ghana. In Côte d'Ivoire, farmers and cooperatives can sell cocoa to local intermediaries or to export cooperatives or companies which hold export licenses. In Ghana, farmers sell their cocoa to Licensed Buying Companies (LBC) that are authorized and approved by COCOBOD. The LBCs then sell cocoa sourced from smallholders to COCOBOD. Farmers receive a bonus payment if COCOBOD can market the cocoa at higher than anticipated prices. Farmers' lack of liquidity and knowledge asymmetries make them susceptible to intermediate traders who purchase cocoa at lower prices against direct cash.

According to a report by Bakhtary et al 2020, the aggregation and organization of cocoa farmers in West Africa is generally low. In Côte d'Ivoire, over 1,500 registered cooperatives represent 20-50 percent of farmers and are responsible for just over half of the total production. They also recognized that most of these cooperatives are not functioning properly, typically due to lack of capacity, knowledge gaps, funds, infrastructure, and mistrust. Most farmers in Ghana are not formally organized (85 percent according to Baah and Anchirinah 2011), though they are automatically registered with the Ghanaian Cocoa Coffee and Sheanut Farmers Association (GCCSFA). The GCCSFA is governed by a system of district and regional Chief

Cocoa farmers from the cocoa growing districts and regions. However, it is unclear whether farmers perceive to be represented by the GCCSFA (Bakhtary et al 2020).

The future of cocoa supply by West African countries is increasingly uncertain due to multiple challenges including aging cocoa tree stock, recurrent outbreaks of new pests and diseases, climate change with its effects on the changes in crop suitability areas and reduced soil fertility resulting in forest clearing; making cocoa one of the main imported food commodities that is linked with deforestation (Ambele et al 2018).

Major chocolate manufacturers and larger cooperate players are increasingly addressing sustainability issues directly within their supply chains, either via their own programs or addon programs to certification commitments through concerted actions with the aim to support production and productivity of West African cocoa. This includes engaging farmers certification (Fairtrade, organic, Rainforest Alliance/UTZ) programs, establishing with farmers "corporate policies" and voluntary commitments or engaging farmers in deforestation-related programs (Amiel and Laurans 2019; Bakhtary et al 2020). Other companies invest in traceability or implement smallholder engagement programs that offer inputs, training and access to finance. However, these efforts are often limited in scale.

Despite many local non-governmental organizations (NGOs) playing important role in supporting these sustainability initiatives, their implementation is not with a number of challenges including local pressures and priorities due to changing or inconsistent public policies, lack of tenure right policy, poor supply chain transparency and sharing of information.

2.2.2. Proliferation of sustainability initiatives and partnerships in the cocoa supply chain

Six manufacturing companies (Mondelēz, Nestlé, Mars Inc, The Hershey company, Ferrero, and Lindt) and one processing company (Barry Callebaut) control around 70% of the world's cocoa market. Their sustainability initiatives (Table 5.3) share a common attribute of focusing mainly on the means of agricultural production at the plot of origin. In addition to these voluntary commitments, these companies in addition to Blommer, Cemoi, SucDen, Touton, Cargill, Olam, and Ecom signed Framework for Actions of the Cocoa and Forests Initiative (CFI) during the COP 23 in 2017 in Bonn. CFI is a joint public-private partnership effort by the World Cocoa Foundation (WCF), the Sustainable Trade Initiative (IDH), and the Prince of Wales' International Sustainability Unit with the chocolate industry and the governments of Côte d'Ivoire and Ghana to collaborate in establishing zero-deforestation supply chains.

CFI focuses on forest protection and restoration, sustainable production and farmer's livelihoods, and community engagement and social inclusion. The CFI aims to end sourcing from protected areas and national parks, and to move towards zero-deforestation supply chains.

Table 5.3: *Chocolate and cocoa industry sustainability programs*

Company	Sustainability Programs objectives	Sustainability objectives
Barry Callebaut	Forever Chocolate https://www.barry-callebaut.com/en/group/forever-chocolate-our-planmake-sustainable-chocolate-norm	Launched in 2016, aims to "make sustainability the norm" with around four targets to be achieved by 2025: • Eradicate child labour from the supply chain; • Elevate 500,000 cocoa farmers out of poverty; • Become carbon neutral and forest positive; • Have 100% sustainable ingredients in all products. For objectives achievement, the program relies on direct action with producers, on efforts to work directly with specific suppliers
Nestlé	Nestlé Cocoa Plan https://www.nestlecocoaplan.com/	Launched in 2012 consist of a series of mainly social measures based on three pillars: • Better agriculture • Better lives • Better cocoa Aiming to increase farm productivity and cocoa quality, improve the standard of living of producers, eradicate child labour, and improve cocoa processing including access to education.
Mondelez	Cocoa Life program https://www.cocoalife.org/	Established in 2012, aims to support 200,000 producers by 2020, and focuses on five themes: • Farming • Community • Youth • Livelihood • Environment
Mars Inc	Cocoa for Generation	Launched in 2018 aiming to achieve 100% sustainable and traceable cocoa by 2025 around two pillars • A "short-term" program called Responsible Cocoa • A longer-term one called Sustainable Cocoa Tomorrow. • The first pillar is componentized by: children protection, forest preservation; and farmer income improvement. • The second pillar also has three objectives: to improve productivity; diversify income; and empower women and communities.

CocoaAction is another voluntary commitment launched in 2014 by Mars Incorporated, Mondelēz International, Nestlé, The Hershey Company, Barry Callebaut, Ferrero, Cargill, Olam and Blommer to tackle the issues of cocoa sustainability, including sustainable livelihoods for cocoa farmers. CocoaAction aligns these leading chocolate companies, the governments of Côte d'Ivoire and Ghana, and important stakeholders, on regional issues on cocoa sustainability. Their vision is to enable a sustainable and thriving cocoa sector where farmers prosper, cocoa-growing communities are empowered, human rights are respected, and the environment is conserved. According to Rick Scobey, President of the World Cocoa Foundation, the body which convenes CocoaAction, their most important target is to raise cocoa farmers above the poverty line of $1.90 per day.

However, in June 2019, Côte d'Ivoire and Ghana proposed a floor price of USD 2,600/ton for the 2020/2021 season, as the price paid to traders (farmers receive a lower price than this after additional fees and costs are considered) was a significant blow to CocoaAction which manages to agree a 'living income differential' of USD 400/ton fixed premium to be redistributed to farmers as bonuses when cocoa prices fall between USD 2,600 – 2,900 during the season with the goal to reach a minimum farm gate price and bonus payment of at least USD 1,820/ton.

In addition to the above voluntary sustainability initiatives, chocolate companies also have third party certifications which include Fairtrade, Rainforest/UTZ labels (Amien and Laurans 2019).

2.2.3. Stakeholder and partnership in finance

Smallholders in West African producing countries lack the expertise, technology, and finance to invest in climate smart cocoa. The vulnerability of their plantations and their lack of capital makes it impossible for many smallholders to engage in farm rehabilitation and tree stock renovation activities. With annual income estimated at $1,840 in Côte d'Ivoire and $1,807 in Ghana and average farm size at 3.5 hectares and 2.5 hectares, respectively, smallholders are hardly able to finance the rehabilitation of a single hectare of cocoa. Considering the high opportunity costs of Rehabilitation and Renovation (R&R) investments – cocoa trees take approximately three to five years to produce their first crop of economic value – replanting further compromises smallholder incomes and their ability to make loan payments. Smallholders' capital is held mostly in physical assets, making it difficult to self-finance costly R&R or other farm investments. Some R&R interventions, like replanting, carry high initial costs and a loss of income for several years, further increasing the need for financial support. However, smallholders are often excluded from formal financial systems. Financial institutions have difficulty reaching smallholders in remote regions and perceive them as a risky prospect because smallholders often lack a financial history or collateral. Where credit is available, it often carries high interest rates and focuses only on short-term loans. Such credit is unsuitable

to R&R and smallholders are reluctant to apply. Technology and mobile-based solutions hold great potential in better reaching smallholders, lowering transaction costs, creating digital credit histories, enhancing financial literacy, offering better interest rates due to reduced risk, and in offering financial products aside from loans, such as savings accounts and insurance. It is important for smallholders to receive financial management training. Smallholders should have a solid understanding of the financial implication of R&R on their personal incomes and household finances. Only when access to finance is paired with sound financial management will R&R have a chance to result in long-term gains for smallholders and the sector at large. Financial training could form part of smallholder coaching that combines an assessment of R&R and agronomic needs with a strategy on how to finance the recommended action.

Financial inclusion enables smallholders to access a wider variety of financial products. Smallholder farmers should be supported to access innovative technologies and partnerships with local finance institutions through which specialized financial products can be offered and financial planning can be enhanced. They can be supported to establish cooperatives and local finance organizations through which financial services are delivered. Specialized financial institutions such as Advans, including microfinance, social entrepreneurs, or FinTech companies may partner with farmer-based organizations (FBOs). Supply-chain companies can combine financial services with off-take agreements to accelerate the inclusion of smallholders into financial markets.

In Côte d'Ivoire, IDH and the Conseil Café Cacao are piloting an experience of transformation of cocoa farming as a business for the farmers and their organization. With the development of the Farm and Cooperative Investment Program (FCIP) by facilitating farmers and their cooperative access to finance, IDH and the Conseil Café-Cacao aim to create a viable investment environment within the cocoa sector with the support of the local financial institutions and agribusinesses and the support of IDH FarmFit Fund in Côte d'Ivoire. This program focuses on demonstrating that farmers and their organizations can do better investment in their activities including alternative income sources through diversification if they have better access to financial products and digital services. It also proves that financial investment can better serve farmers and their organizations if they improve their professionalism. A combination of improved access to financial products and digital services can improve profitability at farm level and therefore better income and better living labor conditions for farmers.

2.3. Evolution of knowledge and information

Significant scientific, technical, and institutional innovations have been developed by improving and conserving the cocoa genetic resource, the management of emerging pests and diseases threats including climate change, developing sustainable strategy to improve soil fertility and

nutrient management with positive impact in yield and producing countries flavor patrimony and to support local processing and consumption.

2.3.1. Preservation of cocoa genetic diversity

The global cocoa industry is becoming increasingly aware of the importance of cocoa genetic resources for a sustainable cocoa economy and the urgent need to secure stable long-term support for international genebanks which preserve and protect them. Currently, the genebanks are under-resourced with future funding uncertain and at high risk, jeopardizing the survival of the wild cocoa types that have been collected and transferred over some 80 years into the International Collections. These are the essential materials that cocoa breeders need to develop improved planting materials, preserve the flavor patrimony with the agronomic performance needed by farmers and the diverse quality characteristics required by the chocolate industry. Although some stakeholders in the chocolate industry, universities and international research institutions and parts of the traders are already contributing to support cocoa genetic resources, there is an urgent need to broaden the funding base to secure stable long-term support.

Representatives from the World Cocoa Foundation, Cocoa Research Association and individual companies in the cocoa sector have been actively involved in global efforts to understand better the status of cocoa genetic resources and the action required to ensure they remain accessible for use in breeding programs today and long into the future (Table 5.4). A global network for cocoa genetic resources, CacaoNet, was launched in 2006 and has been coordinated by the Alliance CIAT Bioversity International with member representatives from various cocoa research institutes and organizations which support cocoa research.

Table 5.4: *Company initiatives to preserve the genetic diversity of cocoa*

Initiative	Objectives	Achievements
CocoaAction Launched in 2014 by WCF and the Governments of Ghana and Côte d'Ivoire	Improve the sustainability of cocoa farming in West Africa and substantially scale up effective supply and delivery models of improved planting material to farmers to allow farm rehabilitation and productivity increase	• Develop and demonstrate the effectiveness of clonal grafting techniques, led by Mars in Côte d'Ivoire. • Develop and demonstrate the effectiveness of somatic embryogenesis techniques, led by Nestlé in Côte d'Ivoire. • Develop and demonstrate the effectiveness of commercial production and distribution systems, led by Mondelēz International in Ghana

Initiative	Objectives	Achievements
African Cocoa Initiative phase I (ACI I) Launched in 2012 by WCF, the cocoa industry members, the Dutch Sustainable Trade Initiative (IDH), USAID, and government institutions in Cameroon, Côte d'Ivoire, Ghana and Nigeria.	Support sustainable productivity extension and upgraded food security on diversified cocoa farms in West and Central Africa.	Activities have resulted in the increase of cocoa farm household revenues by 180% i.e. from $2,250 to $4,050, which is well on course to WCF/ACI I goal of doubling cocoa productivity and an accompanying increase in incomes by 150-200% for 100,000 cocoa farm households (https://www.worldcocoafoundation.org/program/wcf-african-cocoa-initiative/).
African Cocoa Initiative Phase II (ACI II) Launched in 2017 by WCF, the cocoa industry members, USAID, and government institutions in Cameroon, Côte d'Ivoire, Ghana and Nigeria.	Sustainably increase cocoa productivity among smallholder farmers in West Africa	• Increasing production and the use of quality cocoa planting material; • Increasing the provision of financial services in support of the cocoa value chain; and • Improved flavor quality of cocoa.

2.3.2. Management of emerging threats

Besides humans, insects and diseases also like cocoa. Among the most damaging in West Africa are the mirids, the stemborers, the mealybugs vector of the cocoa swollen shoot virus disease and since 2016, termites. The global cocoa industry in collaboration with Universities, national and international research institutions have implemented cocoa Integrated Pest Management (IPM) programs targeting mirids, stemborers, mealybugs and termites. The IPM programs integrate a range of practices for economic control of pests. It aims to suppress pest populations below the Economic Injury Level (EIL). It emphasizes on the use of pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations, encourage natural pest control mechanisms, and keep pesticides to economic levels to reduce or minimize risks to human health and the environment. Synthetic pesticides are used only where and when these natural methods fail to keep pests below damaging levels.

Cocoa Swollen Shoot Virus Disease (CSSVD) is the major threat to West African cocoa, causing defoliation and dieback of the plant with severe losses to yields. The virus is spreading rapidly in Côte d'Ivoire, Ghana, Nigeria, and Togo. In 2018, the governments of Côte d'Ivoire and Ghana announced a joint control effort to combat CSSVD. They described the threat posed by CSSVD as "comparable to natural disasters like tsunamis and earthquakes" and urged producers to allow their farms to be treated (https://www.worldcocoafoundation.org/blog/

early-detection-can-eradicate-cocoa-diseasein-west- africa/). The virus has already infected 23.5% of Ghana's cocoa areas (more than 400,000 ha) and the government is planning to invest an estimated US$ 140 million of a US$ 600 million loan from AfDB on CSSVD control efforts in the country. The government of Côte d'Ivoire has started cutting more than 100,000 ha of infected cocoa farms in the next three years, thus, costing about US$ 19 million.

When a cocoa tree is infected, it takes a while for symptoms (swelling of shoots and red ban vein on young leaves or flushes) to manifest and three years for the tree to completely die. As a result, the disease can be spread through farmers inadvertently sharing infected planting materials or through grafting and transferring infected germplasm. This is the main cause of the rapid spread of the virus in Côte d'Ivoire, Ghana, Nigeria and Togo. The only known cure is cutting and destroying infected trees, hence the high cost of national CSSVD control programs. WCF believes that the key to CSSVD eradication is early detection, both in planting material, before seedlings reach farms, and on existing trees, before symptoms appear. This should be part of an integrated approach to identification, management, cutting out of infected farms, replanting, and diversification. Therefore, WCF (through ACI II and CocoaAction) has developed an early detection tool which has the potential to safeguard the livelihoods of millions of farmers in the region.

This early detection tool combines real-time polymerase chain reaction (PCR) and DNA-based genetic testing (a plant is declared diseased if the DNA of the virus is present). A handheld PCR device is used to screen samples in the field, and only a few samples are sent to a specialized laboratory for DNA testing. This process requires a robust sampling protocol for farms and nurseries to ensure proper analysis of the disease presence and its spread (Figure 5.1). Discussions are underway with various institutions in Côte d'Ivoire about what might be an acceptable process going forward to deploy the tool on a commercial basis.

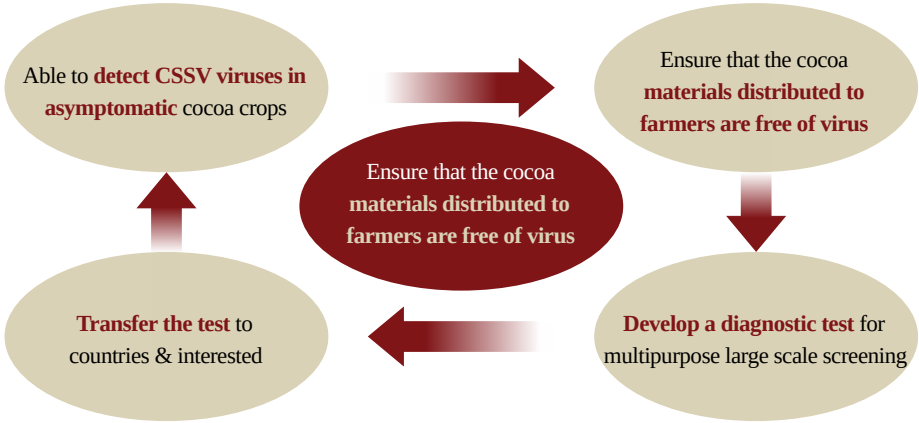

Figure 5.1: *Steps in using the early detection tool against CSSVD*

2.3.3. Nutrient and soil fertility management

There is a broad agreement across the cocoa industry that the addition of nutrients to cocoa farmers is beneficial to crop production, maintains and builds soil fertility, and is part of a holistic approach to achieving a sustainable crop. We also know that the status of cocoa crop nutrition knowledge is far behind other crops and is preventing the creation of robust and scientifically supported fertilizer recommendations. However:

1. We do not know the best fertilizer for each cocoa cropping system.
2. We do not know what effect any fertilizer or blend of nutrients will have.
3. We do not know if fertilizer addition will bring value for investment.
4. We do not know if the available quantity of SOM in existing cocoa farms could enhance the effect of any fertilizer

A vital part of cocoa sustainability that is sometimes overlooked is soil management. Soil's continued ability to stay fertile is inherent to the success of any farm. Several approaches and techniques to manage cocoa and nutrients are implemented to include a combination of bio and organic fertilizers or the combination of organic/bio and inorganic fertilizers with mitigated results.

CocoaSoils program (https://cocoasoils.org/) launched in 2018 with funding from Norwegian Agency for Development Cooperation (NORAD) through IITA aims to increase by 30% productivity of cocoa farms and efficient use of agricultural inputs; improved rural livelihood of 90,000 farmers while avoiding deforestation. CocoaSoils target 4 groups: (1) smallholder cocoa farmers that will benefit through enhanced cocoa productivity, and improved livelihoods, (2) national research agents who will gain skills, knowledge and tools, (3) policymakers who will be empowered in supporting the cocoa farmers and (4) the society as a whole because they will benefit from avoided deforestation. The program consists of a Research for Development (R4D) component, that involves (scientific) research on various program elements such as understanding the cocoa physiology, climate change effects, and forest and biodiversity monitoring. The other component, Partnership for Delivery (P4D), works on the dissemination of the research results by training, capacity building, and policy adjustments.

2.3.4. Preservation of flavor patrimony

Preserving the traditional flavor of West Africa is key in preserving the leadership of West Africa in the global cocoa economy. ACI II with funding from the American Agency for International Development (USAID), implemented and equipped the sensory quality laboratory (FQ-lab) at CNRA of Côte d'Ivoire, CRIG, CRIN and IRAD to ensure that flavor quality, which is the reason chocolate makers include cocoa from specific origins in their recipes, is not lost in the

pursuit of those other desirable traits. The FQ Lab ACI II provides the tools to enable national cocoa research institutes to integrate flavor characteristic into their cocoa breeding programs. The flavor laboratories also make liquor from cocoa beans for the training of cocoa extension staff and subsequently cocoa farmers on the effects of harvest and post-harvest practices on flavor development.

ACI II has collaborated with the Ed Seguine Lab (@seguinecacao.com), Guittard chocolate (https://www.guittard.com/) and CocoaTown (https://cocoatown.com/) to provide sensory analysis and liquor preparation and tasting to flavor and quality with scientists from Ghana, Côte d'Ivoire and Cameroon and to train farmers and extension staff form cocoa extension services in Ghana, Côte d'Ivoire and Cameroon on post-harvest practices, fermentation and drying that preserves their "Saveur du Terroir". For instance, in Ghana ACI II assisted CRIG to acquire larger scale equipment to expand the labs' capacity from 30kg of samples per week to close to 100kg, which will enable CRIG to produce enough cocoa liquor to train all cocoa farmers in Ghana on flavor quality. Already, in 2019, CRIG trained more than 442 cocoa extension, 647 quality control staff and 5,359 farmers, including 1,661 women, in Ghana. Three farmers who benefited from the flavor quality training in Ghana were recognized at the 2019 edition of the International Cocoa Awards in Paris in October 2019 by the CoEX (http://www.cocoaofexcellence.org/). It is anticipated that this impact of increased capacity will be expressed in the inclusion of more samples from Ghana in the top 50 at the International Cocoa Awards in 2021.

2.3.5. Supporting sustainability: breaking with the past or continuing business as usual

Technical, scientific, organization and institutional innovation initiatives in the global cocoa industry contributed to strengthening of actors' capacities to drive innovation while accounting for complexity of innovation processes. The global cocoa industry (government of producing countries, NGOs, the chocolate industry, including private firms and farmers' organizations) supported actors to innovate by facilitating interactions for the co-production of knowledge, co-design of technologies, and identification of new institutional arrangements around productivity, quality and sustainability priorities.

Quality priorities aims to develop quality standards and to improve the national capacity in post-harvest practices, fermentation and drying following the sensory analysis standards and protocols of the International Standards for the Assessment of Cocoa Quality and Flavour (ISCQF) (Figure 5.2); and to enable a clear communication throughout the value chain (cocoa producers, bean buyers/traders, chocolate makers and other users), using a common language: (1) to identify the intrinsic flavour attributes and characteristics (flavour potential) of the

beans when beans are converted into chocolate and (2) to unlock the value of cocoa beans and empower producers and buyers so that users can decide how to use the beans through targeted marketing flavour customization to meet customers' needs.

The industry was able to harmonize their practices with the international standards and protocols for cocoa quality and flavour assessment to include details on physical bean quality assessment (using recently revised and published material), as well as preparing samples (powder, liquor and chocolate) for flavour assessment; it also listed the principal considerations for sensory panel training, executing tasting sessions, and handling data to improve and optimize current processes and achieve product and process control.

Clonal material from CNRA experimental farm

Bad practices observed (up) vs good practices (down) during pods breaking

Weigh beans from each pod. 750g net for microfermenting in 5 different mother heaps MH1, ..., MH5

Positioning microferment nets in mother heaps. Insertion of data logger in nets and in mother heaps to track temperatures during fermentation

Covering microferment nets with beans from mother heaps

Closing of mother heaps with banana leaves

Photos: Herve Bisseleua/World Cocoa Foundation

Figure 5.2: *Appropriate steps from harvest to fermentation of cocoa beans during sensory analysis*

It is worth mentioning that buyers of cocoa beans seek different quality and flavour profiles as discussed above, and as such there is an opportunity to tap into the value and flavour potential of different cocoa cultivars from different regions, which would enable farmers to present the value proposition to potential buyers, and also facilitate communication among sellers, buyers and consumers of cocoa and chocolate. To achieve this, WCF with financial support from USAID and the Ed Seguine Laboratory has established two tasting panels – one in Ghana and the second at Côte d'Ivoire. WCF is planning to establish a third and fourth tasting panel in Nigeria and Cameroon in the course of 2020. These tasting panels and FQ labs will establish accepted, credible, quantifiable, and verifiable protocols for assessing and communicating about cocoa quality attributes, facilitate comparison among samples, and generate feedback to improve fermentation and drying processes for different cocoa genetics in certain regions (or 'terroirs') in West Africa.

Sustainability priorities aims at zero deforestation from cocoa production. National governments, chocolate companies, farmers, and other stakeholders view agroforestry as a crucial opportunity for landscape restoration and avoiding further deforestation in West Africa. With this momentum, these global stakeholders are collecting the current state of agroforestry as it exists now and aligning the approach for the transition to this production system under their respective sustainability initiatives. While agroforestry promises a range of important benefits – including enhanced resilience, income diversification, improved productivity, and long-term regeneration of soil and forests – transitioning from the current state of the landscape via agroforestry requires greater understanding, investment, and alignment over the existing models, challenges, and solutions.

Recent analysis shows that climate change will likely impact land suitability in West Africa for growing cocoa. As land becomes less suitable, cocoa expansion may put additional pressure on forested areas. In Ghana, innovation initiatives are supporting farmers to be more climate resilient with training in climate smart cocoa (CSC) best practices. CSC farming takes into account climate change adaptation, including a focus on intensification, shade trees, food security and diversification, resulting in more sustainable cocoa farming and more resilient and prosperous cocoa farmers. Ghana's government is currently developing a national CSC standard in collaboration with WCF and chocolate companies. WCF is currently working with companies, government partners and technical experts to develop CSC training materials for Côte d'Ivoire. For Cameroon, with some CSC activities focusing on agroforestry and diversification, more innovation initiatives around CSC may rupture the existing market system which is yet to finalize its standards on quality and sustainable cocoa. The best approach will be reconciling the different pillars of sustainability as described above.

The World Bank and Climate Focus (https://www.climatefocus.com) suggested 8 priority areas to rapidly advance CSC intervention at scale and align all stakeholders. They include: 1. Operationalize cocoa sector action plans; 2. Agree on common operational principles and definitions; 3. Establish multi-stakeholder engagement and action platforms; 4. Develop integrated smallholder support packages; 5. Develop a financing strategy; 6. Deliver finance and support to smallholders; 7. Monitor impact and link to zero-deforestation agenda and 8. Strengthen governance.

It is important to note that all these innovation initiatives towards sustainability requires profound changes, restructuring and rebuilding production systems, markets and also the governance and institutional systems to drive transformative change as defined since Rio 92 and 2002. It is not just a question of adding one pillar after another. It is really seeing how to move towards an adapted socio-technical system that is aligned with sustainability goals. These transformative changes are the result of tensions linked to power relations between all stakeholders in the global cocoa industry around sustainability. This will only be possible if the existing socio-technical system is accepted by all players including the consumers.

3. The honeymoon and turbulence era of cocoa in West Africa

In cocoa value chain, as in the whole agricultural sector, priorities of development are moving since the past years towards sustainability and progressively integrating a diversity of objectives which could be controversial as they concern economic, social, environmental or institutional domains (Dobermann et al 2013). Thus, compromises should be identified. Sustainability issue includes progressive complexity regarding the designing of adapted support policies for the cocoa value chain based on these multiple priorities (productivity, quality and sustainability). In this section, we intend to analyze with the West Africa lens how the type of support and socio-technical change affect priorities when challenges as discussed above, and complexity progressively come on board.

3.1. Productivity, technological innovation, and diffusion model: the honeymoon of cocoa production in Africa

The development of cocoa sector in Africa has been clearly influenced by strong productivity and production orientations. Cocoa as a cash crop is viewed as a privileged source of foreign currencies for cocoa-producing countries. Increasing productivity and production is therefore a priority. This priority will be exacerbated by the independences, particularly in Côte d'Ivoire and Ghana. In the case of Cameroon, this increase in production will come rather at the time

of liberalization, which will stimulate the arrival of new operators in cocoa production. The growth in production will depend on orientations to increase production including production factors, technological and technical changes. We observed an expansion of cultivated areas in the early 1970s in Côte d'Ivoire (a sixfold increase in cultivated areas between 1977 and 2017). The emblematic quote of President Houphouët-Boigny "the land belongs to the one who cultivates it" reflects this approach. Similar trend was observed in Ghana in the mid-1990s (FAOSTAT). In both countries this land expansion was supported by better use and improvement of these production factors. The result was development of monoculture full sun cocoa systems and a considerable increase in yields. One of the pinnacles of this massive intensification was the development and use of new varieties of cocoa which are resistant to diseases and are more productive. These changes were followed by a "diffusionist" approach, i.e. based on research - extension agents - producers tryptic. During the first stage, research identified ways of optimizing production (production system, resistant varieties with high yield potential). The second stage included extension agents being deployed in the field to distribute improved seedlings and to disseminate new production technologies to producers. This approach was supported by strong delivery services (supply of inputs, sanitary control, distribution of phytosanitary products, access to equipment, etc.) and regulatory bodies such as the stabilization fund (e.g. STABEX fund in Cameroon).

We could see here at inception a strong alignment of the socio-technical system (Geels and Schot 2007), i.e. between the political priority (productivity) for the sector with the social and technical orientations to significantly increase cocoa production in Africa.

3.2. Standards on quality, organizational innovation, and complicated models: starting of the turbulence era

After this honeymoon period, the fall in cocoa prices in the 1990s created a growing awareness from countries in some qualitative differentiation of the cocoa they produce. Some countries such as Madagascar and Sao Tome and Principe moved in this direction. They managed to develop standards on quality to be well appreciated by the cocoa industry and chocolate manufacturers and to position themselves in these niche markets. The biggest producers on the other hand started discussing on ways to have standards on quality that will help preserve their flavor patrimony by building on their socio-technical systems around production and post-harvest management. In these countries, standards on quality puts to test the construction of specific production and market systems around les 'Saveurs du terroir" and the capacity building of key actors along their supply chain including farmers on these standards. In West Africa we observe two tendencies towards standards on quality. The first tendency is to preserve the traditional flavor of West Africa with high added value based on labels such as geographical indications, organic certification, or specific labels guaranteed by NGOs,

international organizations, or cocoa industries such as premium cocoa or cocoa excellence standard (https://www.cocoaqualitystandards.org/). This involves organizational innovation leading to the structuring of a specific value chain coexisting with the dominant socio-technical system. Another tendency is the development of monitoring and local purchasing by exporters to ensure that practices confer with the quality of cocoa. The second movement has led to the development of organizational innovations essentially based on contractualization with the use of supply contracts specifying the quality characteristics and the related prices or premiums with limited standards on quality as we have described above under the downfall of quality in West Africa. The first movement is leading in restructuring technical innovations around harvest and post-harvest operations (fermentation, drying, storage and transportation etc.) with the aim to develop standards on quality that will restore and conserve the organoleptic and physical quality of West African cocoa which is highly recognized by consumers and master craftsmen worldwide.

3.3. Developing integrated models of innovation to tackle sustainability

3.3.1. Go beyond diffusion approaches to integrate complexity

The issue of sustainability is increasingly emerging in the cocoa sector as an inevitable trajectory to follow. However, this trajectory must lead to a rethinking of the ways in which support for the sector can be conceived in a more integrative and inclusive manner. We showed that the diffusionist approach that dominated the cocoa sector at inception is not in line with this trajectory. Producing countries are pushing to reactivate these support tools in the same way as before, but they are also aware that they are not adapted to a sustainable trajectory. Today, priorities have changed or to some extent have been reoriented, more and more actors are joining the cocoa sector and we see more power struggle between the producing countries, the cocoa and chocolate industry and the consumer countries. Consequently, it is becoming difficult to implement policies as they were done previously. The sustainability initiative for sustainable cocoa production will be based on willingness to apply innovation models based on:

1. participatory approaches including the diversity of stakeholders in the sector to collectively define the principles of sustainable cocoa production and responsible consumption
2. implementation based on a good understanding of the contexts (no generalized standardization)
3. integration of innovations that are not only technical or technological but also institutional and organizational, and finally

4. genuine sector approach with (re)construction of supply in relation to demand (i.e. sustainable production vs responsible consumption).

The main point here is no longer just a question of leaving the burden of technological or technical changes to the cocoa farmers but envisage gradual transformations at different sociotechnical levels (Nkott et al 2019). Sustainability should be tackled with a transdisciplinary lens where innovation is seen as processes that benefit from knowledge and expertise from all actors (e.g. public and private) in the sector (Vogel et al 2020).

Box 5.2

Socio-technical system

In evolutionary economy, the emergence of innovations depends on the strong role of socio-technological system. A socio-technical system (STS) is a stable cluster of social and technical elements including institutions (regulations, norms, rules), user practices and markets, cultural meaning, networks of actors, infrastructures, and technologies (Geels 2004). STS is a key determinant of successful innovations by influencing the selection of innovations. The selected innovation is not necessarily the best, but it is the most appropriate because it successfully emerges in each STS and corridor where technology trajectories could exit. However, such system may create lock-in effects due to socio-technical path dependency (Crespo et al 2014) when a set of conditions presents in the STS, it makes the development of an innovation impossible or very unattractive to actors (e.g. high cost, performance yield). This may lead to innovations being constrained to evolve within a narrow corridor.

The transformation of an existing STS or the transition to a new STS is a long-term and multi-dimensional process with the co-evolution of all the elements of the system (Geels and Schot 2007). During this transformative process, institutions as driving forces should coordinate activities and perceptions of actors and support reproduction of the different elements of the STS to generate its stability and avoid divergent behavior within the existing STS. STS is therefore made of a 'dominant' network integrating actors and flows (knowledge, technological interdependencies, human capital mobility, subcontracting, alliances). The resilience and transition capacity of STS is concomitant with the capacity of the network structure to bring about order (conservation) while maintaining resource reorganization capacities (release and organization). A transition process of a STS is therefore similar to a deformation/reformation process of a network structure. The growth and capacity of a new network or new actors to impose themselves on markets and society will go through a process of ossification of its network structure, around leading actors capable of attracting and coordinating many actors to impose standards and norms. The transition from one STS to another depends on the ability of key actors to connect with emerging and peripheral actors within the network. The transition towards sustainability of STS in the cocoa sector is not only a question of introducing new technologies. It requires creating conditions to replace old technologies (Stegmaier 2018), establishing institutions that encourage actors to adopt behaviors to support sustainability and foster their capacity to become central in the STS network.

3.3.2. Where innovation is necessary for transformational change

Transformational change for the cocoa sector will include a set of transformations around the ongoing sustainability initiatives. The first thing to do could be to discontinue the already established socio-technical system (Stegmaier 2018). As discussed above, cocoa sociotechnical system has been established on production and productivity priorities particularly for Côte d'Ivoire, Ghana, Cameroon, and Nigeria. However, these priorities are gradually abandoned or enriched with additional priorities such as child labour, farmer's income and deforestation. Therefore, the transformational change should be progressive through various steps: (1) exploring new perspectives at various level (substitutions), (2) review or revise the governance structure of existing socio-technical system centered on productivity enhancing interventions and (3) initiate a co-building and co-construction of the whole system by integrating emerging challenges such as child labour, farmer's living income, deforestation and sustainability norms and standards.

The first step consists of exploring new perspectives or alternatives at various levels for farms, household, community, landscape and beyond. This may include farmers organization level, the value chain level and the institutional context level to embrace modernization of farms (mechanization), professionalization of farmers and farmer organizations, diversification of farms including agroforestry, land tenure and nutrition at the household and community level. As discussed in previous paragraphs, some of these initiatives are well advanced under chocolate company voluntary commitments, third party certifications, CocoaAction, FCIP, CocoaSoils and CFI. Others are yet to be implemented such as Children First in cocoa, a significant public-private partnership to eradicate child labour and advance children right in the cocoa supply chain. The founding members of this partnership include the United Nations Children's Fund (UNICEF), the International Labour Organization (ILO), the Government of Côte d'Ivoire, the Government of Ghana, the International Cocoa Initiative (ICI), representing its membership of key non-profit and for-profit stakeholders, and the World Cocoa Foundation (WCF), representing the cocoa industry.

The second step of the transformational change will consist of processes to review or revise the existing socio-technical system, which is more focussed on production priority to include other sustainability priorities. The idea is to revisit the mission and vision of existing institutions and organizations to include emerging sustainability challenges. We acknowledged that governing such processes in the current context of changes in priorities and policies in the cocoa sector is quite challenging with existing constellation of actors. Such revision might create resistance of these stakeholders. Identifying a passionate and consensual convenor to engage in active policy dialogue with each of the actor will be key to the success of such processes. The third step is to co-build and co-construct with key actors the new socio-technical system that includes

emerging sustainability challenges. This third step will happen when the first two are achieved. This third step could be a long process or could be quicker if the suitable convenor is identified and appropriate policy dialogue is implemented.

4. Concluding remarks

Evolution and innovation in the global cocoa industry has been driven by a honeymoon and turbulence around sustainability priorities and initiatives.

We have provided in this chapter the different evolution trajectories of cocoa from the Old world to New world and West Africa. We have navigated readers through the journey of flavor, quality and standards of cocoa and chocolate in West Africa, the type of stakeholders and partnership that plays significant role in the products evolution and the information and knowledge generated to drive a new and innovative socio-technical system needed for transformative change. This includes going beyond diffusion approach to integrate complexity. We argue that such transformative change should be progressive by exploring new perspectives at various level (substitutions), review or revise the governance structure of existing socio-technical system centered on productivity enhancing interventions and initiate a co-building and co-construction of the whole system by integrating emerging challenges such as environmental sustainability, tackling poverty and child labour, ensuring gender equality and strengthening cocoa farmers' organizations. Such revision should lean on two key principles when designing a process to negotiate partnership agreement between the consumers and cocoa producing countries which include a deliberate process for decision-making and building on what is there.

The transformative change should include the following components as pillars of a new bilateral partnership agreement between the consumers and cocoa-producing countries:

1. Putting in place a multi-stakeholder dialogue in West African producing countries with special focus on Ghana and in Côte d'Ivoire
2. Putting in place a multi-stakeholder dialogue in the consumers' countries
3. Collectively developed, locally managed, sustainable landscape management plans
4. Ensuring companies pay Living Income Differential
5. Financing a sustainable transition
6. Monitoring and enforcement mechanism

The pillars listed above are essential, in our view, for a sustainable transition of the cocoa sector. However, many of the activities described in this chapter already exist in various sustainability initiatives. A multi-stakeholder partnership agreement with the consumers' countries can make

things happen that have so far proved intractable by developing a legally binding enforceable agreement. This will need the creation of enforceable roadmaps for producer countries and the consumers' countries and enforcing implementation of the roadmap on due diligence for companies and financing mechanisms: price rewards, increased investments, tariff adjustments, or pre-season finance interest adjustments or conditionalities. Implementation of the roadmap should be jointly enforced by institutions (e.g. EU, United States Customs Office) in the consumers' countries and the country governments of producing countries.

The journey may take time, but the cocoa sector and stakeholders are heading in the right direction, as they bring together the levers of consuming country due diligence legislation, producing country sustainability standards, voluntary collective action in public-private partnerships, and increased aid/trade flows to support financing gaps. Let's all watch the space of the various ongoing sustainability priorities and initiatives!

References

Adekunle AA, Fatunbi AO. 2014. A new theory of change in african agriculture. *Middle-East Journal of Scientific Research* 21(7): 1083-1096.

Adekunle AA, Ellis-Jones J, Ajibefun I, Nyikal RA, Bangali S, Fatunbi O, Ange A. 2012. Agricultural innovation in sub-Saharan Africa: experiences from multiple-stakeholder approaches. Forum for Agricultural Research in Africa (FARA), Accra, Ghana.

Ambele FC, Bisseleua DHB, Babalola OO, Ekesi S. 2018a. Soil-dwelling insect pests of tree crops in Sub-Saharan Africa, problems and management strategies—A review. *Journal of Applied Entomology* 142: 539–552.

Ambele FC, Bisseleua DHB, Ekesi S, Akutse KS, Djuideu CT, Meupia MJ, Babalola OO. 2018b. Consequences of shade management on the taxonomic patterns and functional diversity of termites (Blattodea: Termitidae) in cocoa agroforestry systems. *Ecology and Evolution* 8:11582–11595.

Amiel F, Laurans Y. 2019. For a cocoa without deforestation: performance of labels and company actions. IDDRI, Issue Brief N°10/19.

Asare A, Ræbild A. 2016. Tree diversity and canopy cover in cocoa systems in Ghana. *New Forests* 47:287–302 https://doi.org/10.1007/s11056-015-9515-3

Asare R, Afari-Sefa V, Osei-Owusu Y, Pabi O. 2014. Cocoa agroforestry for increasing forest connectivity in a fragmented landscape in Ghana. *Agroforestry systems* 88:1143–1156.

Asare R, Asare RA, Asante WA, Markussen BO, Ræbild A. 2017. Influences of shading and fertilization on on-farm yields of cocoa in Ghana. *Experimental Agriculture* 53: 416–431.

Asare R, Markussen B, Asare RA, Anim-Kwapong G, Ræbild A. 2019. On-farm cocoa yields increase with canopy cover of shade trees in two agro-ecological zones in Ghana, *Climate and Development* 11(5):435-445, DOI:10.1080/17565529.2018.1442805

Auld G, Gulbrandsen LH, McDermott CL. 2008. Certification schemes and the impacts on forests and forestry. *Annual review of environment and resources* 33:187-211.

Baah F, Anchirinah V. 2011. Looking for convergence: Stakeholders' perceptions of cocoa extension constraints in Ghana. *Journal of Science and Technology (Ghana)* 30(3). http://www.ajol.info/index.php/just/article/view/64626.

Bakhtary et al 2020. Company progress in engaging smallholders to implement zero deforestation commitments in cocoa and palm oil. Climate Focus 57 pp.

Bisseleua, DHB, Idrissou L, Ogunniyi A, Atta-Krah K. 2018. Diversification and livelihood strategies in the cocoa belt of West Africa: The need for fundamental change. *World Development Perspectives* 10: 73–79.

Bisseleua DHB, Missoup AD, Vidal S. 2009. Biodiversity conservation, ecosystem functioning, and economic incentives under cocoa agroforestry intensification. *Conservation biology* 23: 1176–1184.

Bisseleua HBD, Fotio D, Missoup AD, Vidal S. 2013. Shade tree diversity, cocoa pest damage, yield compensating inputs and farmers' net returns in West Africa. *PloS one*, 8:e56115.

Clough Y, Faust H, Tscharntke T. 2009. Cacao boom and bust: sustainability of agroforests and opportunities for biodiversity conservation. *Conservation letters* 2(5):197-205.

Coe SD, Coe MD. 2013. *The true history of chocolate*. Third Edition. London, UK: Thames & Hudson. p.134

Crespo J, Suire R, Vicente J. 2014. Lock-in or lock-out? How structural properties of knowledge networks affect regional resilience. *Journal of Economic Geography* 14(1): 199-219.

Djuideu TCL, Bisseleua DHB, Kekeunou S, Meupia MJ, Difouo FG, Ambele CF. 2020. Plant community composition and functional characteristics define invasion and infestation of termites in cocoa agroforestry systems. *Agroforestry Systems*, 94: 185–201.

Dobermann A, Nelson R, Beever D, Bergvinson D, Crowley E, Denning G, Giller K, d'Arros Hughes J, Jahn M, Lynam J. 2013. *Solutions for sustainable agriculture and food systems*. Sustainable Development Solutions Network.

Fountain A, Hütz-Adams F. 2015. Cocoa Barometer (USA edition).

Gayi SK, Tsowou K, eds. 2016. *L'industrie du cacao: intégrer les petits exploitants dans la chaîne de valeur mondiale*. United Nations.

Geels FW, Schot J. 2007. Typology of sociotechnical transition pathways. *Research policy* 36(3):399-417.

Geels FW. 2004. Understanding systems innovation : a critical literature review and a conceptual synthesis. System innovation and the transition to sustainability. In: Elzen B, Geels FW, Green K, eds. *System innovation and the transition to sustainability: theory, evidence and policy.* Cheltenham: Edward Elgar, p. 161–16.

Läderach P, Martinez-Valle A, Schroth G, Castro, N. 2013. Predicting the future climatic suitability for cocoa farming of the world's leading producer countries, Ghana and Côte d'Ivoire. *Climatic Change* 119(3):841–854.

Marelli JP, Guest DI, Bailey BA, Evans HC, Brown JK, Junaid M, Barreto RW, Lisboa DO, Puig AS. 2019. Chocolate under threat from old and new cacao diseases. *Phytopathology* 109(8):1331-1343.

Nkott, ALN, Mathé SA, Temple L. 2019. Analyse multi-niveaux des freins à l'adoption de la certification du cacao au Cameroun. *Économie Rurale* 370: 81.

Oomes N, Tieben, B. 2016. Market concentration and price formation. SEO Amsterdam Economics.: http://www.seo.nl/uploads/media/2016-79_Market_Concentration_and_Price_Formation_in_the_Global_Cocoa_Value_Chain.pdf

Sonwa DJ, Nkongmeneck BA, Weise SF, Tchatat M, Adesina AA, Janssens MJ. 2007. Diversity of plants in cocoa agroforests in the humid forest zone of Southern Cameroon. *Biodiversity and Conservation*, 16:2385–2400.

Sonwa DJ, Weise SF, Adesina A, Nkongmeneck AB, Tchatat M, Ndoye O. 2005. Production constraints on cocoa agroforestry systems in West and Central Africa: The need for integrated pest management and multi-institutional approaches. *The Forestry Chronicle* 81(3):345-349.

Sonwa DJ, Weise SF, Nkongmeneck BA, Tchatat M, Janssens MJ. 2017. Structure and composition of cocoa agroforests in the humid forest zone of Southern Cameroon. *Agroforestry systems* 91(3):451-470.

Sonwa DJ, Weise SF, Nkongmeneck BA et al. 2017. Structure and composition of cocoa agroforests in the humid forest zone of Southern Cameroon. *Agroforest System* 91:451–470. https://doi.org/10.1007/s10457-016-9942-y

Sonwa DJ, Weise SF, Schroth G, Janssens MJ, Shapiro HY. 2019. Structure of cocoa farming systems in West and Central Africa: a review. *Agroforestry Systems* 93(5):2009-2025.

Stegmaier P. 2018. Discontinuity of socio-technical regimes–A typology of pathways and governance. Energy Systems in Transition–The Role of Actors in Regional Change Processes 2018.

Tchoundjeu Z. 2014. Farmer attitudes and intentions towards trees in cocoa (Theobroma cacao L.) farms in Cote dIvoire. *Agroforestry Syst*. doi: http://dx. doi. org/10.1007/s10457-014-9677-6.

Vogel C, Geitzenaeur M, Mathé SA, Ndah HT, Sieber S. Bonatti M, Lana M. 2020. Stakeholders' perceptions on sustainability transition pathways of the cocoa value chain towards improved livelihood of small-scale farming households in Cameroon. *International Journal of Agricultural Sustainability* 18(1): 55-69.

Young AM 2007. The chocolate tree. A natural history of cacao. University Press of Florida, Gainesville, FL, USA. p 15

Zarrillo S, Gaikwad N, Lanaud C, Powis T, Viot C, Lesur I, Fouet O, Argout X, Guichoux E, Salin F, Solorzano RL. 2018. The use and domestication of Theobroma cacao during the mid-Holocene in the upper Amazon. *Nature ecology & evolution* 2(12):1879-1888.

Endnotes

i. In Mesoamerica, cocoa cultivation started in the 17th century in regions that are hot and humid with high annual rainfall. But, in 1746 the first plantings were made in the State of Bahia in Brazil by French planter who brought the cocoa beans from the State of Para. These seeds are thought to have been derived from wild Amelonado (a Forastero type cocoa from the Lower Amazon) cocoa in the Guianas and gave rise to the type of cocoa known as Comum in Bahia.

ii. However, Cameroon was an exception, although Amelonado cocoa became the dominant type grown in West Africa. In the mid-1880s, Cameroon was a German colony and during this period Trinitario cocoa was imported from South America and the West Indies. As a result, different Trinitario cultivars

became established, especially in the east of the country, where Trinitario and Amelonado cocoa were interbred.

iii. Cameroon remains the only country with shaded farms. Almost 70% of the farms in Cameroon are shaded farms.

iv. Certifiers refer to the NGO or multistakeholder groups that set standards and verification approaches to assure a product meets specific sustainability requirements (Auld, Gulbrandsen, & McDermott 2008).

v. The building blocks for a sustainable financial inclusion may include: Strengthening farmer professionalization through the inclusion of financial and digital literacy in training curriculums and farm business services; Organize target beneficiaries into savings groups and build their capacity; Link savings groups to financial institutions and co-design financial products; Implementing of Digital Financial Services.

vi. The world market price for cocoa is determined as an average price for cocoa futures in the New York and London commodity exchanges. Traders pay a slightly different price depending on quality requirements and country of origin. Historically, cocoa prices have been volatile and subject to shocks ranging from oversupply, pests and disease, weather patterns, and civil war. While the farm gate price in most cocoa producing countries reflect the fluctuating world market price, cocoa pricing in Ghana and Côte d'Ivoire is different.

vii. According to recent data by KIT Royal Tropical Institute, an average cocoa farmer in West Africa may own between 2-4 hectares of land and produce roughly 400 kg/hectare. Under the proposed scheme, the average farmer would then earn between USD 1,456 – USD 3,640 per year, which falls short of proposed living income levels.

viii. The CRA is a not-for-profit UK based Scientific Research Association working, in particular, on conservation of cocoa genetic resources. It was initially created with a legacy from a member of the Cadbury family and is supported by generous regular contributions from Mars Wrigley, from Mondelez International and from ICE Cocoa Futures Europe.

ix. CocoaSoils is a collaboration between IITA, Wageningen University & Research and IDH, the National Agronomic Research Centres are represented by CRIG (Ghana), CRIN (Nigeria), IRAD (Cameroon), and CNRA (Côte d'Ivoire), the international Research Centres are represented by UNEP-WCMC, CIAT, and ICRAF, and the industry partners involved in the program are Mondelēz, Mars, Yara, Nestlé, Barry Callebaut, ICL, Olam, Cargill and the World Cocoa Foundation.

x. Productivity priorities included making available improved and affordable planting materials and tree nursery systems; facilitating access to good agricultural practices that includes pruning, pest and disease management; providing appropriate techniques and practices for nutrient management by supporting the use of bio and organic fertilizer to restore soil organic matters before inorganic fertilizer is applied. Priorities also included renovation and rehabilitation of aged and diseased tree stock, and a fundamental shift toward intensification of production and away from extensification with the aim to enable farmers to breathe new life into abandoned lands and put an end to the destructive pattern of expansion into forests in search of fertile "new ground" for cocoa.

xi. https://www.cocoaqualitystandards.org/