TECHNICAL REPORT

STATE OF THE ART ON COCOA PRODUCTION IN BRAZIL

Netherlands
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CONSERVATION INTERNATIONAL Brazil

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SUMMARY

1. INTRODUCTION

Cocoa is one of the main global agricultural commodities, with production strictly limited to tropical regions. It is this juxtaposition between climatic suitability for the crop and areas of high biodiversity concentration that underscores the importance of reconciling production with conservation.

Brazil is a major producing country with a long history of sustainable cocoa production. Importantly, recent expansion of this crop has not occurred at the expense of forests and natural habitats, but rather by advancing into areas of low suitability and productivity for conventional agricultural practices. Currently, **cocoa agroforestry systems** (AFS) are being replicated to expand cultivation into degraded areas, adopting regenerative agricultural practices. Consequently, cocoa offers the country an opportunity to promote the bioeconomy and sustainable development in the tropics, serving as a model for the global sector.

The central motivation of this study involves is to compile key information about cocoa cultivation in Brazil. This includes aspects related to: productive parameters, technological profiles; financial viability of different arrangements; market characteristics (internal, external, and regional); socio-environmental attributes, such as the use of cocoa AFS for environmental liability remediation, the promotion of ecosystem services; the trade-offs and synergies between environmental conservation and production; job and income generation in the production chain; and available financing instruments and overall comparisons among different cocoa production models.

Since the Witches' Broom crisis in 1989, triggered by a fungal disease that compromised over 75% of Bahia's production, research has focused on developing more resistant varieties, modernizing agricultural techniques, and advancing knowledge for more sustainable production systems, such as agroforests, including the cabrucas, *the tradicional system in which cocoa replaces the understory of a thinned forest*. Although the quantity and rigor of existing information is significant and crucial for decision-making by various stakeholders in the cocoa value chain, these data are currently scattered across many sources and disaggregated across different aspects of the sector.

This compilation aims to showcase the evolution of Brazilian cocoa farming, focusing on the main producing regions: Southern Bahia, within the Atlantic Forest biome, and the North of the country, in the Amazon biome. This information is vital for achieving the goals of relevant action plans currently being implemented and guide investments to revitalize national production. In line with the expectations of an increasingly sustainability-conscious market, this study seeks to attract investors interested in commodities that contribute to biodiversity conservation, restoration, and production compatible with a demanding and environmentally aware global market.

The annual demand from the international market over the next 10 years is estimated to be one million tons. Brazil is uniquely positioned on the global stage: it is the fifth largest chocolate market in the world and the only producing country with a robust industrial park. This national industry has an annual processing capacity exceeding 275 thousand tons, yet internal production has not been sufficient to meet this demand fully. Consequently, the country has great potential to become a global leader in this scenario, moving away from being a net importer and securing its domestic supply. Furthermore, Brazil can significantly expand its contribution to the international market, meeting the demands of high-value markets requiring fine chocolate—that of superior quality and produced sustainably, thus commanding high aggregated value.

It is in this context that the compilation and systematization of accurate, public, and comprehensive information about cocoa AFS becomes important. This report can provide technical support to consumers, investors, and major buyers interested in acquiring cocoa of verified, responsible origin—free from deforestation and degrading conditions—that promotes the recovery of degraded areas, assists in socio-biodiversity conservation, and increases landscape resilience.

Our review highlights the historical importance of the cultural practices and knowledge of traditional communities and family farmers, who cultivate cocoa through AFS, integrating production with forest elements and promoting local economic development. The major challenge for the cocoa sector is ensuring a trajectory of consistent production growth, providing food security while maintaining socio-environmental sustainability. This challenge occurs amidst social pressure for a new development model capable of reconciling economic growth and environmental conservation, increasing the resilience of production systems, and reducing greenhouse gas emissions. However, it also presents an opportunity for the country to stand out globally as a place where productivity can be increased through the adoption of better practices and agroforestry models, and the expansion of cultivation into degraded areas, reducing its environmental liability.

In this scenario, planning actions for the adoption and enhancement of sustainable production technologies in the cocoa production chain face significant barriers and challenges, depending on the producer's technological profile and regional context. For family and small farmers, it is essential to overcome difficulties in logistics for commercialization and social organization for market access; difficulties in accessing quality propagation material; rural exodus due to generational issues; the high cost of implementation and maintenance; and the complexity of accessing resources and quality technical assistance. These barriers are also important challenges for medium-sized producers, with the addition of specific issues like the lack of qualified labor, climate risk, the need for genetic improvement, and the technification of agroforestry management practices.

The key to overcoming these challenges lies in diversifying the production system, which drives increased income, enhanced resilience, and the production of higher-quality, value-added cocoa. Achieving this requires a cohesive, multi-pronged strategy focused on expanding access to and awareness of crucial support programs. This includes scaling up the Payment for Environmental Services (PES) and leveraging emerging financial tools, notably carbon and biodiversity credits. Furthermore, success depends on strengthening producer organizations (cooperatives and associations) and ensuring improved access to high-quality technical assistance. This effort must be complemented by expanded uptake of established public programs, while simultaneously opening new market opportunities.

2. OBJECTIVE

The study aims to conduct a comprehensive literature review on the state-of-the-art cocoa AFS in Brazil, with a focus on Southern Bahia and the Amazon biome. It draws on both technical and academic sources and includes consultations with subject-matter experts for data collection and validation. The research also incorporates relevant information on existing initiatives, projects, and public policies designed to strengthen Brazil's cocoa production chain, particularly in terms of its productive, managerial, financial, and socio-environmental dimensions.

3. COCOA – FROM ITS ORIGINS TO THE CONQUEST OF THE WORLD MARKET

3.1. Center of Origin, Uses, and Dissemination of the Plant in the Americas

Between the use and domestication of the plant by the Indigenous peoples of the Americas and the commercial varieties currently disseminated globally, there is a range of historical information useful for understanding how this food was transformed into one of the main "commodities" in the agricultural international market.

Belonging to the Malvaceae botanical family, historical accounts indicate that Theobroma cacao L. — the scientific name of the plant — was consumed by the Indigenous peoples of the American region and was primarily associated with dietary and ritualistic habitats. In partcular, the Maya and Aztec people considered it to be of divine origin.

The term "Theobroma" itself, assigned as the genus of this species by the botanist Carl Nilsson Linnaeus in his work "*Species Plantarum*," published in 1753, literally means "Food of the Gods[1]." The epithet "cacao", associated with the species, is related to the word "kakaw(a)," widely spread among Mesoamerican languages with evidence suggesting this word originated in the Mixe-Zoquean linguistic family, distributed within or around the Olmec civilization in the Mexican region, which influenced the peoples who prospered after its decline, the Mayas and Aztecs (Kaufman & Justeson, 2007). Researchers have long sought to

[1] In Greek, "Theos" means God and "broma" means food.

understand the center of origin and dissemination of cocoa in the Americas. Despite being associated with the culture of Mesoamerican Indigenous peoples, some theories based on old anthropological research, carried out through archaeological and ethnographic evidence, already indicated that cocoa originated in South America and was subsequently introduced to Central America by man, as reported by Van Hall (1914), Cheesman (1944), and Schultes (1984).

More recently, new evidence regarding the use and domestication of cocoa by Indigenous peoples has emerged, now revealed by archaeogenomic and biochemical approaches. Using DNA found in ceramic residues from peoples of the Americas, Lanaud et al. (2024) point to the generalized use of cocoa in South America, with records extending back at least five thousand years, and not just in its area of origin in the Ecuadorian Amazon region (Zarillo et al., 2018), demonstrating cultural interactions between peoples occupying the Amazon and the Pacific coast.

Cheesman (1944) is a good reference for understanding the origins of the cocoa cultivars (genetic materials) used at the time. According to the author, cocoa has its center of origin in the moist tropical forests of the lower eastern equatorial slopes of the Andes in South America, in the Amazon region. He considers that the cultivated, semi-wild, and wild varieties belong to a single botanical species, *Theobroma cacao*. Other botanical nomenclatures, such as *T. pentagona* and *T. leiocarpa*, have previously been associated with the plant for exhibiting distinct phenological characteristics of the fruits. It should be noted that with the establishment of cocoa cultivation, different cultivar names also emerged based on fruit morphology and region of origin, including the Criollo, Forastero, and Trinitario varieties.

For Cheesman (1944), the Amazonian Forastero variety evolved in isolation from other varieties, occurring as wild and semi-wild along the main Amazonian rivers with considerable variation. The two most uniform populations reported by the author are the Nacional Cocoa of Ecuador and the Brazilian Forastero, which was also the variety present on the Gold Coast – the coastal region of the African continent, mainly in Ghana, where cocoa was taken for the formation of extensive cultivation, during the Second Cocoa Cycle, starting in 1920. The Criollo variety was associated with the original "cocoas" of Colombia, Venezuela, and Central American countries, with a history of ancient cultivation and high quality of its product. From the hybridization of the Amazonian Forastero variety with the Criollo from South America, a variety known as Trinitario arose. This formed highly heterogeneous populations, unknown in their wild state, but differentiated by vigor and high productivity.

More recently, research involving genetic markers has contributed to a better understanding of the center of origin and dissemination of cocoa. In this regard, Motomayor et al. (2002) reveal that individuals of the Old Criollo variety from Central America, previously classified as "wild," form a group closely related to individuals of the Old Criollo variety from South America. The Old Criollo trees were also closer to the Colombian-Ecuadorian Forastero variety individuals than the latter were to other South American Forastero individuals. Genetic analyses revealed a high level of homozygosity and significantly low genetic diversity within the Old Criollo group. The research results of Motomayor et al. (2002) imply recognizing that this group does not represent a separate subspecies and that it likely originated from a few individuals in South America that may have been disseminated by humans in Central America.

In summary, the long history of cocoa is closely linked to the geographic and cultural diversity of the groups where it thrived and evolved, with intense gene flows between remote *T. cacao* populations and the emergence of hybrid forms favorable to its adaptation to new environments where local human cultures adopted the crop (Lanaud et al., 2024).

3.2. The History of Cocoa Cultivation in Brazil

The Spanish were the first Europeans to consume cocoa, after invading the Aztec empire in Mexico in the 16th century. The Aztecs ground and beat the beans with water, corn, and other flavorings to make a drink, an early version of what is known today as chocolate. The word "chocolate" probably has its roots in a set of words of Nawa origin, "chokola:tl" (Kaufman & Justeson, 2007). The first evidence of a commercial shipment of cocoa to Spain was recorded in 1585 (Coe & Coe, 2013). Subsequently, the drink was disseminated to other European countries and consumed especially by the elites, but during the 17th and 18th centuries, it spread to more countries, becoming popular from the 19th century onwards, with industrialization and the use of new technologies to produce, besides chocolate, its derivatives cocoa butter and cocoa powder. The supply of European demand was met by the commercialization of growing production from the European colonies in the Americas.

In Brazil, the first attempts to implement cultivation for the commercial exploitation of cocoa began in Pará, in 1679, with authorization, by way of a Royal Charter[2], for colonizers interested in starting this type of economic activity to plant cocoa. This initiative by the Portuguese colonial administration aimed to reduce Portugal's dependence on cocoa bean production in Spanish America (Baiardi & Ribeiro, 2018).

Despite its Amazonian origin, it was in Southern Bahia that commercial cocoa production notably became structured, starting in the mid-18th century, with the arrival of the first seeds of the Forastero variety (Amelonado group) in the city of Canavieiras, in 1746, and in Ilhéus, in 1752. The good adaptation of the crop to the local climate and ease of logistics for export contributed to encouraging the dissemination of the crop, which quickly gained market share with increasing exports stimulated by growing consumption abroad. Thus, throughout the 19th century, cocoa farms spread across the region, and exports advanced as chocolate consumption increased in Europe and the United States.

The late 19th and early 20th centuries marked a period of great prosperity for cocoa farming in Bahia, known as the "Cocoa Cycle," making it the state's main export product[3]. In the 1890s, Bahia produced over 3.5 thousand tons of cocoa beans, standing out in the global market with exports to the United States and Europe. It is estimated that Brazil, driven by the cocoa farms in Bahia, produced about 21 thousand tons in 1905, 45 thousand tons in 1915, and 64.5 thousand tons in 1925, continuing to grow production and reaching 100 thousand tons in 1935.

Despite maintaining steady growth, cocoa production entered a decline. The main reasons were the global economic crisis of 1929 and the strong competition from English colonies in Africa. These colonies used genetic material from Bahia's cocoa to establish their first cocoa plantations starting in 1822. This propelled West African countries to become the world's leading cocoa producers in the early 20th century (Santos et al., 2015). To give an idea of the size of the African market, production on the Gold Coast, now Ghana, reached 260 thousand tons in 1935, a volume 2.6 times greater than Brazil's at the time.

[2] The Royal Charter – in Portuguese, Carta Régia - was one of the most important and formal legal and administrative instruments of the Portuguese Crown during the colonial period of Brazil. It represented an official document issued directly by the King or Queen of Portugal (hence the term "Régia", relating to the monarch) and possessed the force of law.
[3] Available at: https://fsp.usp.br/eccco/index.php/2023/04/15/cacau-da-amazonia-para-o-mundo/. Accessed on August 15, 2025.

In Bahia, in addition to the "Common Forastero" or "Amelonado" variety, additional varieties were introduced between 1874 and 1876, also coming from the state of Pará, known as "Maranhão" and "Pará," from which spontaneous mutations were observed, generating varieties like "Almeida" and "Catongo," which produce white seeds (Vello et al., 1972; Santos et al., 2015). These varieties, along with clones of local and imported materials, were used in breeding programs to generate hybrid cultivars. The goal was to develop high-productivity plants with good-quality beans for the industry that were resistant to the P*hytophthora sp fungus*, which causes the so-called "black pod rot," the most common cocoa disease in Bahia until 1989. Starting that year, Witches' Broom disease, caused by the fungus *Moniliophthora perniciosa*, spread through the region, marking the second cocoa crisis.

The rapid spread of Witches' Broom is precisely associated with the strict genetic base of the founders and the recurrent breeding efforts to increase productivity, which further restricted the genetic diversity of the plantations in the Bahia region. This combination made the region's cocoa trees highly susceptible to the disease. A study by Santos et al. (2015) confirmed this information, showing that all Bahian cocoa trees descend from a very small number of *Forastero* individuals, the same ones introduced to the region more than 270 years ago. These original trees were selected for the superior quality of their fruits and ended up giving rise to all regional production. As reported in an interview with the **FAPESP Agency**[4] about the aforementioned study, while the low genetic diversity of the plants generated by selection guaranteed the quality of the fruit, it also made the entire cocoa population fragile due to the absence of varieties that could resist the threat of a pest, as Witches' Broom turned out to be. This is how Witches' Broom spread rapidly through the region and devastated entire plantations, causing a decline of more than half of the production.

The recovery of cocoa farming in Bahia, starting at the beginning of the 21st century, has occurred through the technological improvement of crop management and the adequate use of genetic resources. **The Executive Commission for the Cocoa Farming Plan (CEPLAC/MAPA)**, the main federal agency created in 1957 to technically support the crop, presented the adoption of mixed and/or cloned varieties with greater resistance as a strategy. In parallel, over the last two decades, there has been continuous growth in cocoa production in the Northern states of the country, especially in Pará, in the Amazon biome region.

The analyses presented in the following sections reveal the numbers and trends of cocoa farming in the country.

[4] https://agencia.fapesp.br/historia-genetica-do-cacau-no-brasil-e-descrita/24594#:~:text=O%20cacau%20chegou%20%C3%A0%20Bahia,as%20primeiras%20sementes%20em%20Ilh%C3%A9us

4. COCOA IN NUMBERS

4.1. Brazilian Cocoa Farming Statistics in the Last 20 Years

The **Brazilian Institute of Geography and Statistics (IBGE)** is the main body responsible for producing and disseminating statistical and geographical information about Brazil. Through the **IBGE Automatic Recovery System (SIDRA)**, it is possible to access information from the **Systematic Survey of Agricultural Production** regarding the planted and harvested area of cocoa (in hectares), production (in tons), and productivity (average yield in kilograms per hectare), with data available since 2006. This data was compiled considering the total for Brazil, as well as geographical breakdowns considering the administrative macro-regions and cocoa-producing federative units. Data from the **Food and Agriculture Organization (FAO)**, specifically available from the **FAOSTAT database**, were also used in this analysis to enable the recognition of the numbers presented by this international organization, as well as Brazil's position in relation to other cocoa-producing countries in the world. Some minor discrepancies can be observed between the data presented by IBGE and FAO due to the sources of information used. However, we observed a significant discrepancy with data provided by the **Brazilian Association of Cocoa Processing Industries (AIPC)**, an association representing major processing companies responsible for 95% of the cocoa purchasing and processing in the country. From the historical series of the cocoa production and harvest area in Brazil reported by IBGE for the last 20 years (2006-2025), a gradual increasing trend is observed between 2006 and 2014, reaching 760 thousand hectares of planted area and 698 thousand hectares of harvested area at the end of this period, subsequently undergoing a period of decrease in planted and harvested area that lasted until 2019, when 611 thousand hectares of planted area and 580 thousand hectares of harvested area were quantified, a reduction of

20% of the planted area (149 thousand hectares) and 17% of the harvested area (118 thousand hectares) during this 5-year period. According to a technical note published by the **CEPLAC/MAPA** for the 2015/2016 harvest[5], this drop occurred due to unfavorable climatic conditions, aggravated by two diseases, Witches' Broom and black pod rot. This scenario caused greater stress on the cocoa trees, resulting in less leaf and flower development in the off-season harvest over the last 30 years. The premature ripening of the fruits, in turn, negatively impacted the weight of the beans and the total production of the harvest. Since 2020, cocoa cultivation has once again increased in Brazil, currently occupying 641 thousand hectares of the country's agricultural areas with a similar harvest area value (Figure 1a).

[5] https://www.cnabrasil.org.br/storage/arquivos/8-ativos_fruticultura_0.85620200201514916988.pdffruticultura_0.85620200201514916988.pdf

Planted and Harvested Area of Cocoa in Brazil

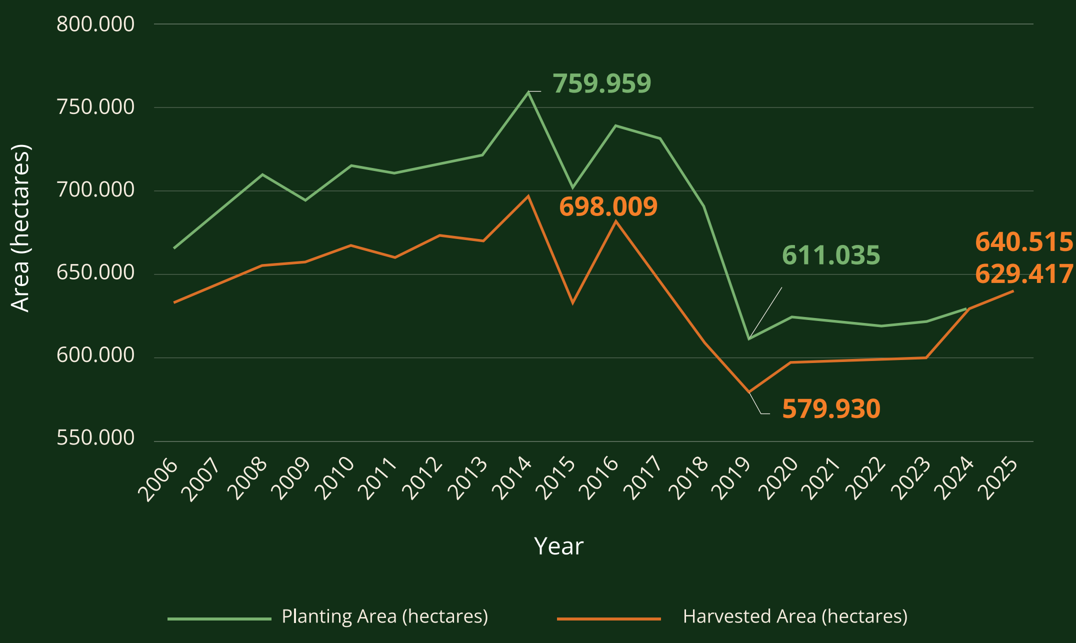


Figure 1a. Cocoa area planted and harvested in Brazil over the last 20 years (Data Source: IBGE - Systematic Survey of Agricultural Production, 2025[6]).

[6] IBGE - Levantamento Sistemático da Produção Agrícola. See at: https://sidra.ibge.gov.br/tabela/6588#notas-tabela. Accessed on August 15, 2025.

The cocoa production areas in the country are concentrated in the Northeast and North macro-regions, with Bahia being the sole state with an area of production in the Northeast. Pará leads the ranking of Northern states, with 95% of the total planted and harvested area in the region, which also includes production in the states of Rondônia, Roraima, and Amazonas. The Southeast, with plantations predominantly in the state of Espírito Santo but also some in Minas Gerais, and the Central-West, with crops only in the state of Mato Grosso, still appear with a very modest share (Figures 1b and 1c).

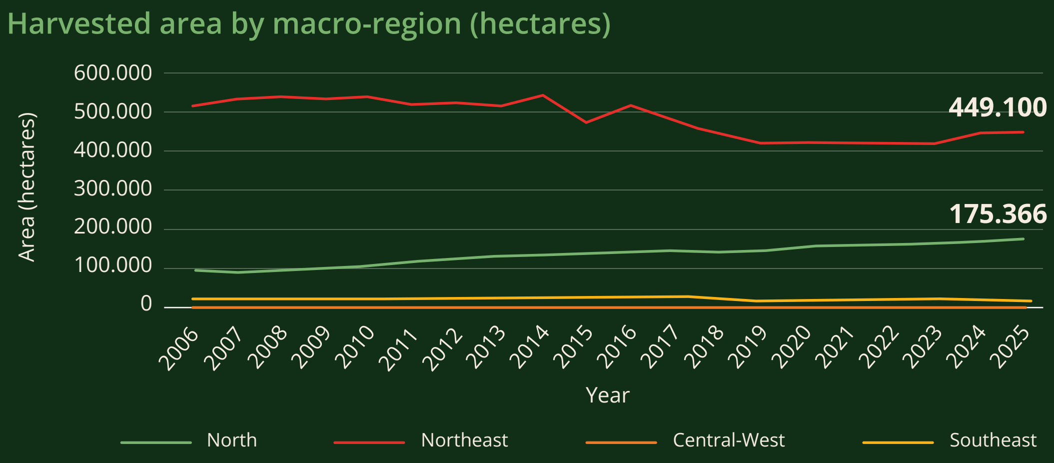


Figure 1b. Cocoa area planted and harvested by administrative macro-region over the last 20 years (Data Source: IBGE - Systematic Survey of Agricultural Production, 2025).

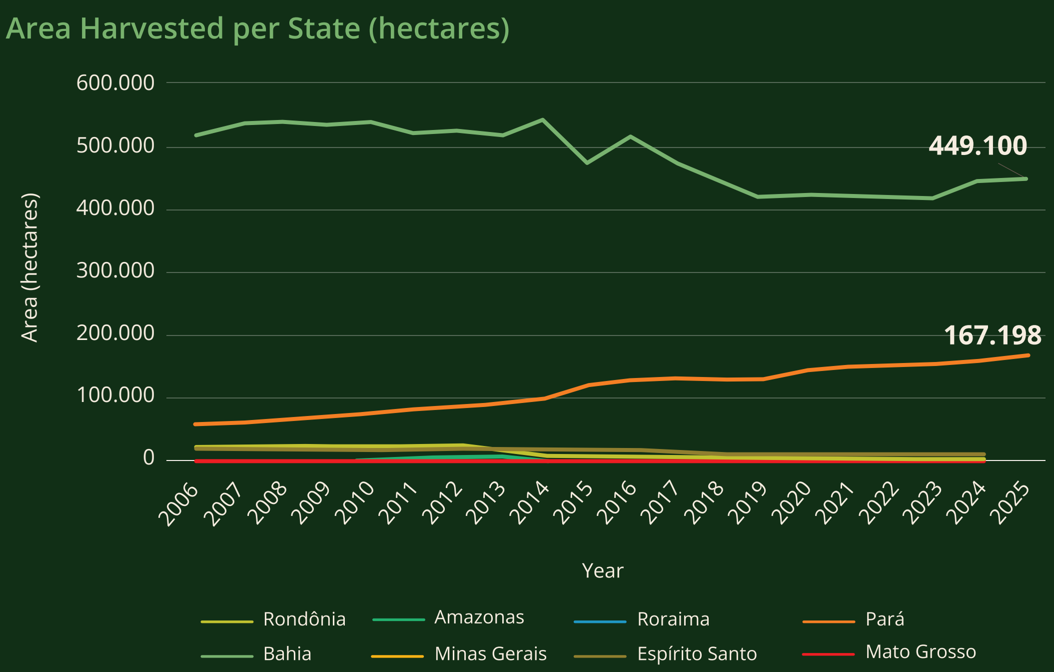


Figure 1c. Cocoa area planted and harvested per state over the last 20 years (Data Source: IBGE - Systematic Survey of Agricultural Production, 2025).

Bahia, historically the main producing state in the country, was responsible for the observed shrinkage of planted areas nationwide between 2014 and 2019. After a period of ascent, in 2014, it began a drastic reduction in planting areas, going from 543 thousand hectares that year to 420 thousand hectares in 2019 (a 23% reduction), with a slight recovery in subsequent years, now occupying 449 thousand hectares of the state.

A different situation was observed in Pará. Throughout the 20-year period analyzed, cocoa production areas have increased gradually and consistently, with an annual average of 5.5 thousand hectares per year, rising from 57 thousand hectares in 2006 to 157 thousand hectares in 2025. The other producing states reported by IBGE have maintained a a smaller share. For example, during this 20-year period, the state of Espírito Santo went from 20.8 thousand hectares in 2006 to 15.8 thousand hectares in 2025.

According to IBGE, in the current ranking of states with the largest production area in the country, we have: Bahia (70.1%), Pará (26.1%), Espírito Santo (2.5%), Rondônia (1.1%), and the other states (Amazonas, Roraima, Minas Gerais, and Mato Grosso) collectively accounting for less than 0.3% of the national total.

A striking phenomenon in Brazilian cocoa farming since 2014 has been the sharp gain in yield. Even with the reduction in the planted area between 2014 and 2019, total production in tons increased significantly in 2016 (Figure 2a). In 2020, production exceeded the volume of 2014 — the year with the largest planted area — and reached its peak in 2022, maintaining the trend of productivity growth until 2025 (Figure 2b). In 2016, the average productivity was 360 kg/ha, reaching the mark of 481 kg/ha in 2022, a gain of 33.6% in productivity over the 7-year period.
This increase in productivity during this period was primarily due to the employment of more sophisticated planting techniques and improvements across all processes of the production chain, from the area to be cultivated and the choice of seedlings to planting care, cultivation, and the final product.

Planted and harvested area x Total Cocoa production in Brazil

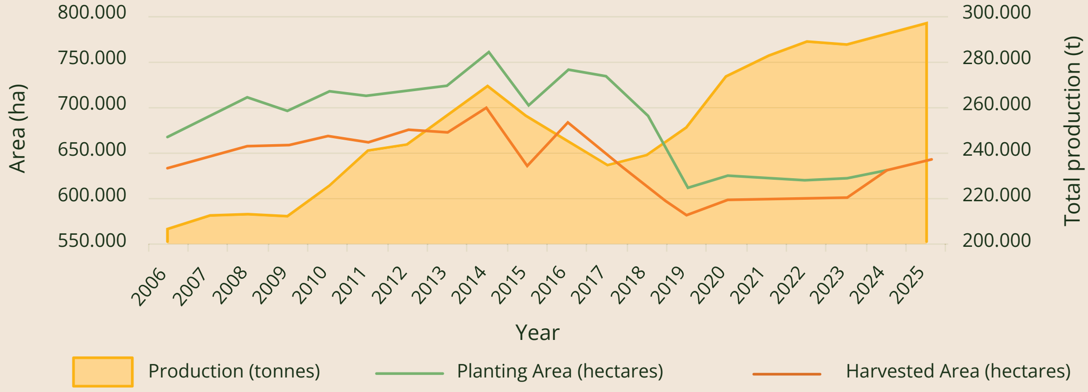


Figure 2a. Total production, planting areas, and cocoa harvest area in Brazil in the period 2006–2025
(Data Source: Adapted from IBGE - Systematic Survey of Agricultural Production, 2025)

Planted and harvested area x Total Cocoa production in Brazil

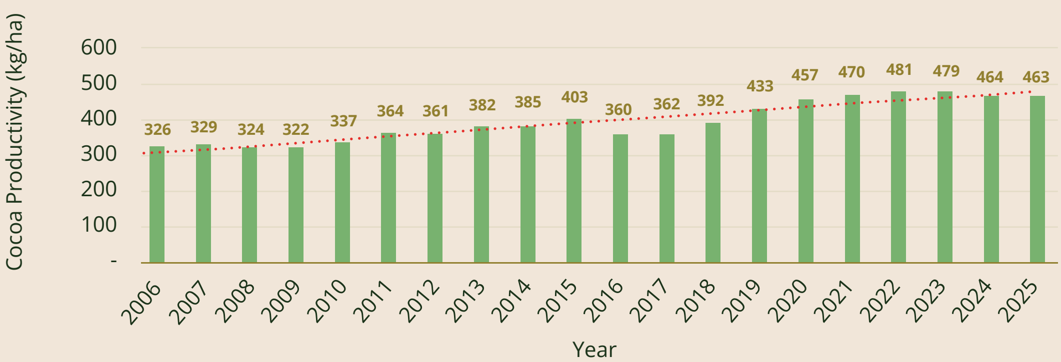


Figure 2b. Variation in cocoa productivity in Brazil in the period 2006–2025
(Data Source: IBGE - Systematic Survey of Agricultural Production, 2025)

It is important to consider that the increase in national productivity is due to the contribution of other states besides Bahia. While the productivity of the Northeast, exclusively represented by Bahia, remained stable, with small fluctuations between 244 and 307 kg/ha, productivity in the Northern states increased considerably, rising from 615 kg/ha in 2006 to 921-951 kg/ha from 2020 onwards. This growth is mainly due to the states of Pará, Roraima, and Rondônia, which achieved productivity levels more than three times that of Bahia. Roraima and Rondônia stood out even more in the last two years, exceeding the mark of 1250 kg/ha. The only Northern state with declining productivity was the Amazonas. In the Southeast, Espírito Santo and Minas Gerais also maintained good productivity, ranging between 640 and 770 kg/ha from 2020 (Figures 2c and 2d).

Productivity of cocoa by macro-region (kg/ha)

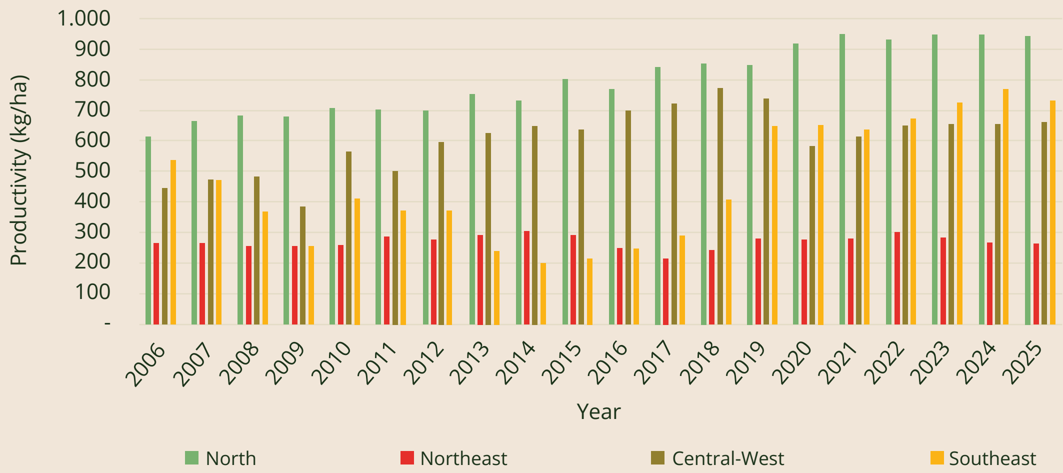


Figure 2c. Variation in cocoa productivity in the country's macro-regions in the period 2006–2025 (Data Source: IBGE - Systematic Survey of Agricultural Production, 2025)

Productivity of cocoa per State (Kg/ha)

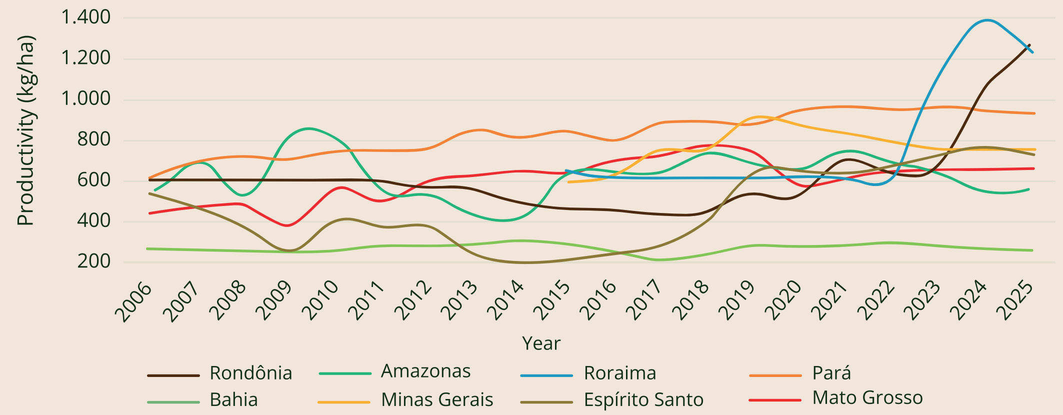


Figure 2c. Variation in cocoa productivity in the country's macro-regions in the period 2006–2025 (Data Source: IBGE - Systematic Survey of Agricultural Production, 2025)

It is important to highlight that there are other sources of information regarding cocoa production in Brazil besides the previously mentioned data from IBGE (Brazilian Institute of Geography and Statistics). In this regard, information from the **Brazilian Association of Cocoa Processing Industries** (AIPC) is relevant.

In this context, IBGE data from 2024 indicates that production in Brazil was 291,920 tons, with Pará responsible for 51.5%, Bahia 41.2%, Espírito Santo 4.4%, Rondônia 2.5%, and other producing states for 0.4%.

AIPC data on ANNUAL COCOA RECEIPT in 2024[7] indicates a total of 179,431 tons of cocoa received by Brazilian producers, with Bahia responsible for 59%, Pará 37%, Espírito Santo 3%, Rondônia 1%, and other producing states for 0.01%.

4.2. Brazil's Cocoa in Relation to World Production

Data systematized by FAO since 1961, reveals the change in Brazil's cocoa "status" compared to the world's producing countries. At the beginning of this historical time series, Brazil was the 3rd largest country in terms of cocoa production area, with 474 thousand hectares. This represented 10.8% of the production areas worldwide (4.403 million hectares), with Nigeria (700 thousand hectares) and Ghana (1.756 million hectares) the top countries in terms of production area. Compared to Latin American countries, Brazil's estimated production area by the FAO was at least double the area of the second place, Ecuador (220 thousand hectares), and well ahead of other countries such as the Dominican Republic (75 thousand hectares), Venezuela and Mexico (70 thousand hectares), Colombia (33 thousand hectares), and Costa Rica (29 thousand). Brazil's peak participation in area of cocoa production occurred between the early 1980s and the early 1990s, when it maintained more than 12% of the world's production area dedicated to this crop. During this same period, many other countries, mainly African, built incentive policies and began to feature cocoa as one of the main agricultural commodities, significantly entering the international market for this product. Since 2017, Brazil's representativeness in terms of planted area has been around 5.0-5.3% (Figure 3a).

These same variations are observed in relation to the country's total production (Figure 3b). Brazil, which reached 23.7% of all world production in 1983, has seen its participation reduced to an average of only 5.1% in the last 20 years, varying between

[7] Available in: https://aipc.com.br/estatisticas/recebimento/#pll_switcher

4.6% and 5.8%. Currently, the African countries Côte d'Ivoire and Ghana hold the position of the largest producers in the world, with 2,377,442 and 653,700 tons in 2023, respectively. This position is maintained even considering the drastic drop in Ghana's annual production in recent years, which has already exceeded a loss of more than 400 thousand tons/year. Together, these two countries are responsible for 55% of world production, which was 5.6 million tons in 2023.

Area of cocoa production in Brazil (hectares)

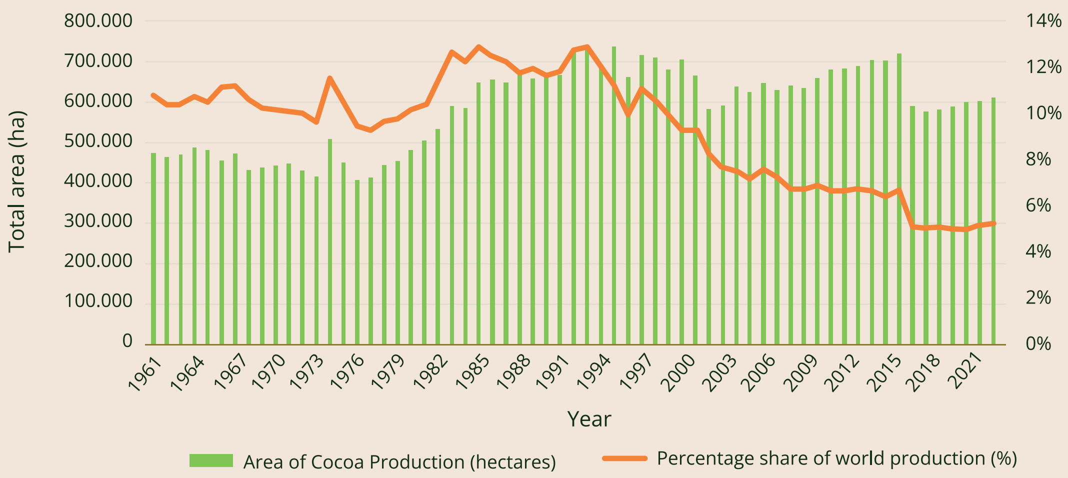


Figure 3a. Cocoa area planted and harvested in Brazil from 1961 to 2023 (Source FAOSTAT, 2025[8]).

Production of cocoa in Brazil (ton)

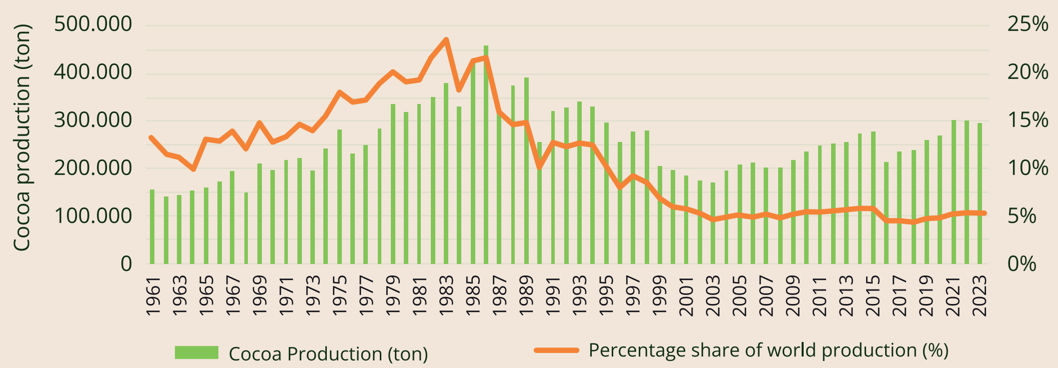


Figure 3b. Total cocoa production in Brazil between 1961 and 2023 and its percentage share of world production (Source FAOSTAT, 2025)

[8] IBGE, 2025 - Levantamento Sistemático da Produção Agrícola. See at: https://sidra.ibge.gov.br/tabela/6588#notas-tabela. Accessed on August 15, 2025.

Cocoa productivity (kg/ha)

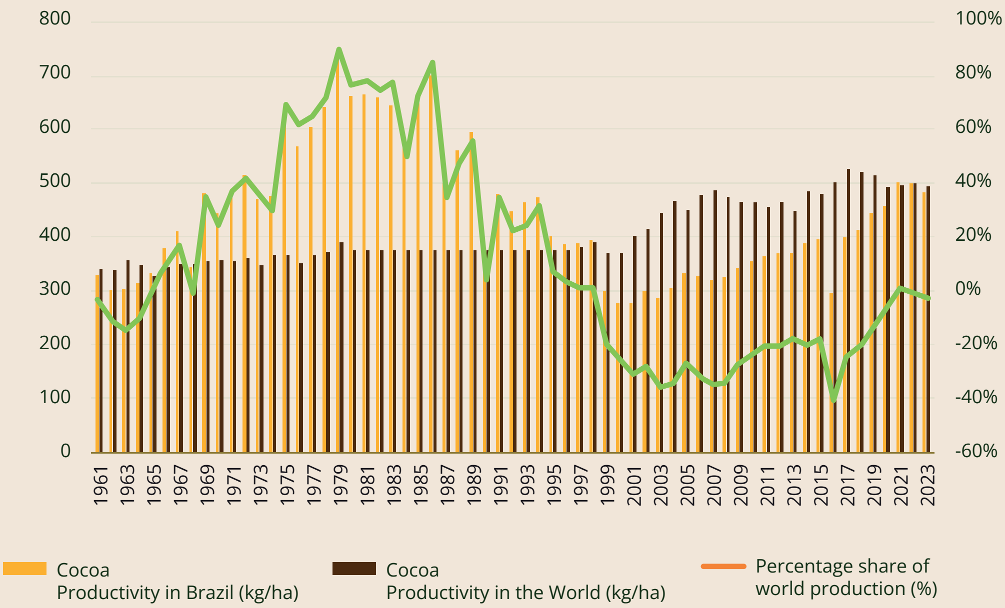


Figure 3c. Cocoa productivity in Brazil and the world between 1961 and 2023 and the position of countries relative to world productivity (Source FAOSTAT, 2025)

Considering the average productivity from 2019 to 2023 at 478 kg/ha, Brazil ranks 22nd in the world, led by countries such as Thailand (2849 kg/ha), Guatemala (2560 kg/ha), and Fiji (1998 kg/ha). However, Brazilian cocoa productivity is not far from the productivity of the world's largest producers: Ghana (average of 550 kg/ha over the last 5 years of FAO data), Côte d'Ivoire (506 kg/ha), and Indonesia (464 kg/ha). In Latin America, according to FAO data, the countries with higher productivity than Brazil are Peru (average of 870 t/ha), Ecuador (621 t/ha), Nicaragua (594 t/ha), Bolivia (564 t/ha), Cuba (551 t/ha), Mexico (525 t/ha), and Haiti (489 t/ha).

4.3. World Market – Commercialization Price

The **International Cocoa Organization (ICCO)** is an intergovernmental organization since 1973, operating under the auspices of the United Nations. Operating within the framework of successive International Cocoa Agreements, it is composed of 51 member countries, 22 of which are cocoa exporters and 29 of which are importers, with Brazil being one of the organization's members. Together, these member countries represent 86% of global cocoa exports and 72% of global cocoa imports.

The ICCO has tracked the commercialization prices of the product in the international market since 1995. Based on the available data, the annual average value of quotations over this 40-year historical series was calculated (Figure 4a). The average values throughout the year were also systematized to identify the price variation based on the month of sales, jointly presenting the variation in the estimate through the 90% probability Confidence Interval (Figure 4b).

Average annual price of cocoa beans (US$/ton)

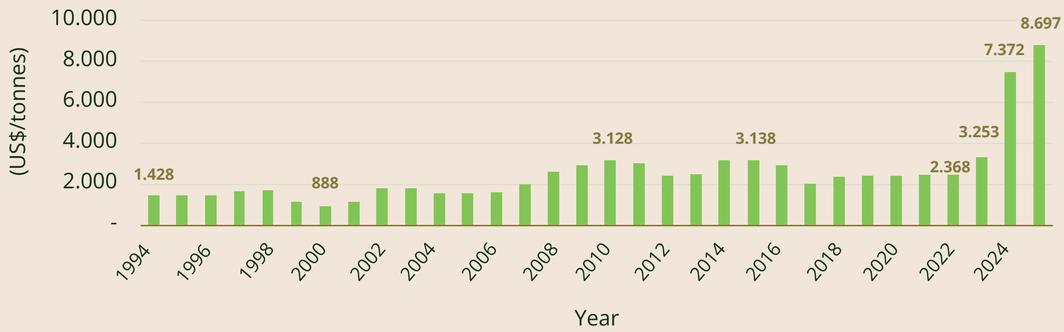


Figure 4a. Annual average of the ICCO daily price for cocoa beans, in US$/ton. (Data Source: ICCO, 2025[9]). The ICCO daily price for cocoa beans is the average of the quotations of the three nearest active futures months on ICE Futures Europe (London) and ICE Futures US (New York) at the time of the London closing.

Average annual price of cocoa beans (US$/ton)

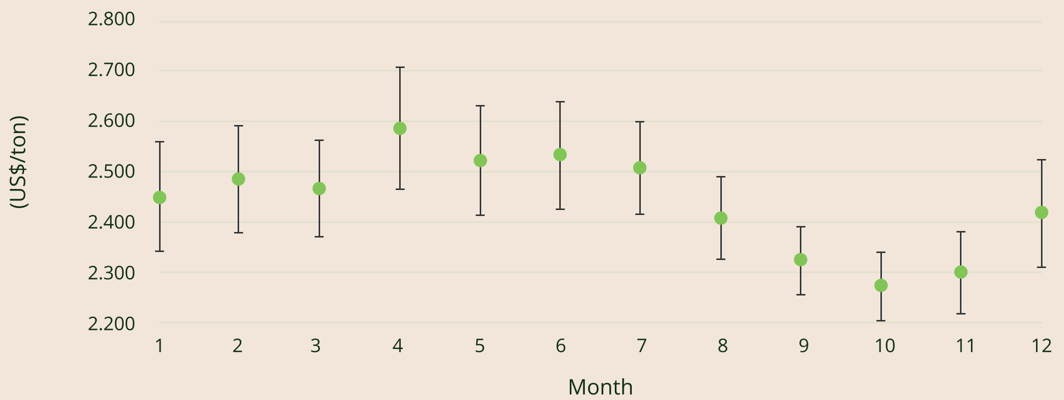


Figure 4b. Variation of the average daily price throughout the months of the year (Data Source: ICCO, 2025). Vertical bars represent the dispersion of the average of each month, expressed by the 90% probability Confidence Interval.

[9] ICCO, 2025. See at: https://www.icco.org/statistics/. Acessed on August 18, 2025.

The lowest commercialization price in the last 40 years occurred in 2000, with an average of US$888.00/ton. The years 2010 and 2015 were high, with the average price around US$3,130.00/ton. However, there was a significant drop in the following five years, with a devaluation of 1/3 in the price. In 2017, the price reached US$2,030.00/ton, in the same year that global production increased by 9.5%, going from 4.78 to 5.23 million tons.

Throughout these 40 years, no change in the cocoa market has been as expressive as that of recent years. In 2022, the average bean price was US$2,368.00/ton. In 2023, it rose to US$3,253.00/t, jumping to US$7,372.00/t in 2024. In 2025, the average price was already at US$8,697.00 (arbitrated in August 2025). This means that, in less than four years, the value of the cocoa bean increased by 367%. According to Trading Economics[10], the price of cocoa hit the historical negotiation mark of US$12,906.00/t in December 2024. Figure 4c illustrates this variation in the world average price of cocoa over the last five years.

Figure 4c. Prices paid for cocoa over the last 5 years (Source: Trading Economics.[11]).

[10] Available at: https://pt.tradingeconomics.com/commodity/cocoa#:~:text=O%20cacau%20subiu%20para%208.228,00%20em%20dezembro%20de%202024. Accessed on August 18, 2025.

[11] Available at: https://pt.tradingeconomics.com/commodity/cocoa

Thus, when it comes to prices paid for cocoa, the market is presenting a period of great volatility and record prices due to a combination of global scarcity, driven by poor climatic conditions and diseases in West African producing regions[12]. World cocoa production, clearly controlled by African producing countries, suffered a sharp drop of 11% between the 2022/23 and 2023/24 crop years, going from 5.04 to 4.49 million tons, according to ICCO estimates. This atypical scenario pressured prices to historical levels, affecting chocolate production and leading to an increase in demand for working capital among dealers. Price stabilization now depends on factors such as the evolution of climatic conditions, the increase in stocks, and consumer demand.

Despite the drop in production, worldwide cocoa grindings remained relatively stable in 2023/24, leading to a significant reduction in final stocks. The stock-to-grinding ratio is projected at 27%, the lowest level in the last 46 years, further pressuring international cocoa prices (CNA, 2025)[13]. The growing demand for chocolate, especially in emerging markets, also increases pressure on an already reduced supply.

Brazil has an important role in the global cocoa market, with a promising future due to its high-quality production. The highlight is the production of **fine cocoa**, a product with unique flavor and aroma that is traded separately with a premium — a value above the market price. This premium reflects market demand for high-quality raw materials. In this scenario, risk management is essential to deal with market volatility. Although the global crisis is challenging, it can also represent an opportunity for Brazil.

Furthermore, it can be observed that the selling price of cocoa varies throughout the year (Figure 4b). This seasonality concerns the variation in production over the months of the year, given that production and supply are concentrated in certain months of the year, with consequences on the prices received by producers, transportation, storage, and processing costs (Zugaib et al., 2015)[14]. On average over the 40 years of observations, the peak commercialization value occurs in April, with an average of US$2,600.00 ± US$121.10/t, with the lowest price observed in October, with an average of US$2,272.00 ± US$67.50/t. This demonstrates that these commercialization values remain more stable during low periods than during high periods.

[12] Ghana is facing its weakest harvest in over two decades, with production estimated at only 530,000 tons for 2024–25, hampered by disease and aging trees. Meanwhile, the American company Cargill Inc. halted grinding operations in Côte d'Ivoire, as adverse weather hurt the mid-crop, resulting in smaller, poorly dried beans, and unprofitable processing.

[13] See at: https://www.cnabrasil.org.br/storage/arquivos/pdf/ativos-fruticultura-abril2025-cacau.pdf

[14] See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/revista-agrotropica/artigos/2015-DOI-10.21757/0103-3816-2015v27n3p267-280.pdf

4.3.1. The Volume of the Cocoa Market and the Influence of Europe on Current and Future Projections

The global cocoa bean market, valued at US$14.40 billion in 2025, is expected to grow to US$17.30 billion by 2030 (Modor Intelligence, 2025a)[15]. Europe is the world's largest importer of cocoa, including beans, paste, butter, and powder. In 2024, it led with 45% of the world cocoa bean market value. This reflects the fact that the continent is also the largest producer and exporter of chocolate in the world, according to CBI. The European chocolate market was estimated at US$49.28 billion in 2025 and is expected to reach US$61.55 billion by 2030, with a Compound Annual Growth Rate (CAGR) of 4.55% during the period (Modor Intelligence, 2025b)[16].

Worldwide, and especially in Europe, the demand for fine chocolate — that of better quality and produced more sustainably — is growing. Aware that many commodities imported by the bloc's countries contribute to deforestation and the climate crisis, in 2019 the **European Union (EU) Commission** launched the **European Green Deal**. The goal is to make the continent climate-neutral. This commitment is binding under the umbrella of the **EU Climate Law**, which includes a goal of reducing emissions by at least 55% by 2030. The Pact also considered other non-binding legal instruments, such as the UN Sustainable Development Goals (SDGs). In this broader global context, the EU created regulations to address human rights and environmental degradation in agricultural supply chains, such as the European Union's Regulation on deforestation-free products (EUDR), which is likely to have a major impact on cocoa imports by the bloc's countries (CBI, 2025)[17].

[15] Sigla em holandês para Centrum tot Bevordering van de Import uit ontwikkelingslanden, ou em inglês, Centre for the Promotion of Imports from developing countries.
[16] See at: https://www.mordorintelligence.com/industry-reports/europe-chocolate-market. Accessed on: 09/10/2025
[17] See at: https://www.cbi.eu/market-information/cocoa/what-demand. Accessed on: 09/10/2025

COCOA IN NUMBERS

According to data from the **EU Commission**, supported by Naranjo et al. (2023), cocoa accounts for 7% of the deforestation produced by commodities imported by Europe, a percentage similar to coffee. Between 2001 and 2015 alone, cocoa was associated with the loss of one-third of Ghana's forest area and one-quarter of Côte d'Ivoire's, countries which together held 55% of the world's export volume in 2023. This situation generated great concern on the part of the industry and producing countries about the economic impact caused by the new European Union rules in these countries. Thus, the bloc's cocoa processors began investing in **traceability systems** to comply with deforestation regulations, while implementing agricultural solutions based on Artificial Intelligence (AI) to increase productivity in climate-vulnerable regions (Mordor Intelligence, 2025).

In this race to meet the growing global demand for more sustainable cocoa beans, the governments of producing countries have received support from the European Union and sought to implement programs to enhance production with a focus on sustainability requirements, including the well-being of farmers and environmental protection. Since 2024, the government of Côte d'Ivoire has proposed allocating US$16.75 million annually over four years to support small producers facing difficulties in obtaining financing from local banks, in the expectation that the country's annual bean sales capacity will more than double. Similarly, the government of Malaysia also allocated US$2.13 million in 2024 to revitalize cocoa projects, to increase local cocoa bean production, and strengthen its position in the global cocoa market.

4.4. Market and Domestic Demand for Cocoa in Brazil

Brazil currently represents the fifth largest chocolate market in the world in terms of consumption and is the only producing country with a consolidated industrial complex dedicated to cocoa processing. It is estimated that the chocolate supply chain is responsible for 300 thousand direct and indirect jobs, from planting to the retail market. The demand for beans considers the capacity of the grinding industrial park installed in the country, with large, medium, and small processing industries, in addition to more than 300 chocolate brands located in the various producing regions that directly use the bean to manufacture their products from bean-to-bar and tree-to-bar. This national industrial park has an annual processing capacity exceeding 275 thousand tons, but domestic production has not been sufficient to meet this demand. According to **AIPC**, the average amount of beans ground in the country over the last five years was 218 thousand tons/year, and the national supply fell short of this, at only 166 thousand tons. This imbalance between internal supply and demand aggravates the idleness of this industrial park, which has been offset by the importation of beans, mainly from African countries (Figure 4d).

Importation

Figure 4d. Importation of cocoa beans and derivatives over the last 7 years (Source: AIPC, 2025[18]).

In current values, in the 2022/23 crop year Brazil needed to import US$113.8 million in cocoa, acquiring about 40 thousand tons of the product from abroad, with an average acquisition price of US$2,845.87 per ton. For the 2023/24 crop year, this value increased to more than US$253.2 million for the acquisition of similar quantities, but with the average price per ton reaching US6,330.38. The forecast for 2025 indicated a deficit of 20 thousand tons, which representd an estimated import need of US$173.9 million, considering the average quotation of US$8,697.00 per ton[19]. These numbers demonstrate the degree to which the internal market is still unsaturated and reinforce the opportunity for Brazilian producers to expand their participation in the supply chain, both in national supply and as a strategy for insertion into the foreign market, whose international market demand over the next 10 years is estimated at 1 (one) million tons per year.

[18] See at: https://aipc.com.br/estatisticas/importacao/
[19] Average price in August 2025.

The increase in production could allow the country to regain its prominent position as an exporter of cocoa beans and derivatives, expanding business to other markets. To achieve this goal, it is essential that the country not only increases its productivity but also expands its production area. It is important to highlight that in Brazil, this expansion of the cultivated area can be achieved by recovering extensive degraded areas, by implementing highly desired regenerative agriculture practices. At the same time, the country needs to overcome the challenges that limit the competitiveness of the sector. These bottlenecks include factors directly linked to production, such as the lack of technical assistance and limited access to credit, as well as logistics. In fact, the logistics remain a significant bottleneck for the competitiveness of Brazilian cocoa, especially in the North and Northeast regions. Examples such as the BR-163 in Pará and the infrastructure of the ports of Ilhéus (Bahia) illustrate the obstacles. Investments in roads, storage, and river transport are essential to reduce losses and costs.

According to the **Inova Cacau 2030 Plan** (BRASIL, 2023)[20], Brazil has the capacity to double its production in the coming years, with the official goal of exceeding 400 thousand tons annually by 2030. This advance, projected in the plan, should be made possible through the expansion of production with the implementation of cocoa AFS on degraded lands, especially those occupied by low-productivity pastures; investments in technical assistance and rural credit; promotion of research and innovation (CEPLAC/MAPA); valorization of fine and regional cocoa; and infrastructure and logistics policies integrated into the sector. In this context, due to the great difficulty of small and family cocoa producers in accessing rural credit, the role of resources derived from new financing arrangements is crucial to leverage sustainable cocoa production, especially in Bahia. More details on financing mechanisms will be described in section 8 of this report.

Thus, the **Inova Cacau 2030** Plan is expected to increase the gross value of production with wealthy generation in the states involved, avoiding imports and their inherent phytosanitary risks, and strengthening producers and the national industry. Furthermore, by expanding the use of improved harvesting, post-harvest, and processing practices, improving bean quality, and supporting certification and traceability, this plan will contribute to an increase in exports of fine flavor cocoa and its derivatives, contributing to the surplus in

[20] BRASIL (2023). Plano Inova Cacau 2030: estratégias para fomentar o desenvolvimento sustentável das regiões produtoras de cacau no Brasil. Ministério de Agricultura e Pecuária. Secretaria de Inovação, Desenvolvimento Rural e Irrigação. Comissão Executiva do Plano da Lavoura Cacaueira – Brasília – DF: MAPA/SDI/CEPLAQ, 2023. 36 p. See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/inova-cacau-2030/inova-cacau-2030.pdf. Accessed on: 20/08/2025.

the Brazilian trade balance and bringing international recognition for the quality of Brazilian cocoa.

Economic viability studies of cocoa production, such as the one carried out in 2021 by **CocoaAction, Instituto Arapyaú, and WRI Brasil**[21], in partnership with other institutions, show that productivity levels above one thousand kilograms per hectare (an estimate of 1,275 kg of dry beans per hectare), in cabruca areas with low density of shade plants (known as "cabruca rala"), would generate an income of about R$5,700,00 (~US$1,060.00) per hectare for the producer, with a cocoa sales price, at the time, of R$12.07/kg (~US$2.24). Considering the appreciation of the product in recent years, with the sales price quotation around R$25.00 (~US$4.65) and R$31.00/kg (~US$5.76)[22], this return would currently be at least two times more than estimated by the study, making the investment quite attractive.

Cocoa cultivation in Brazil plays an important role in the economic development of regions such as Southern Bahia and Pará state, which accounted for approximately 95% of the national planted area and production. In part, this history occurs due to the good adaptation and development of planting cocoa in AFS, playing a significant role in the conservation of the Atlantic Forest and the Amazon, generating benefits such as soil health, biodiversity, and water resource conservation, in addition to carbon removal and stock in the system.

In the state of Pará, although productivity is well above the national average (970 to 1,000 kg/hectare), there is genetic material[23], technology, and areas in the region available to expand this production sustainably, with a practically guaranteed market. In fact, the area cultivated with cocoa in this state has been increasing in recent years, especially in the Transamazônica region. There is, however, difficulty in mapping this expansion due to the diversity of the production systems involving cocoa cultivation in the region. Venturieri et al. (2022)[24] state that mapping and monitoring cocoa plantations using optical sensor images is a challenge due to the botanical and arboreal characteristics that are normally confused with areas of

[21] WCF, Arapyaú e WRI. Viabilidade econômica de sistemas produtivos com cacau Cabruca, Pleno Sol e Sistemas Agroflorestais nos estados da Bahia e do Pará. Informativo técnico, 47p. See at: https://arapyau.org.br/wp-content/uploads/2021/11/viabilidade-economica-de-sistemas-produtivos-com-cacau.pdf. Accessed on: 20/08/2025

[22] Cocoa price in Brazil for September 26, 2025. See at: https://www.noticiasagricolas.com.br/cotacoes/cacau/cacau-mercado-do-cacau. Accessed on: 26/09/2025.

[23] Ceplac (Comissão Executiva do Plano da Lavoura Cacaueira) has been active in the Amazon region since the 1960s and maintains the largest genetic bank of Theobroma cacao in the world in Pará, with more than 53,000 plants.

[24] See at: https://www.scirp.org/pdf/jgis_2022062814555132.pdf

capoeira (secondary vegetation) and forest, as cocoa is usually cultivated in the understory, shaded by the forest. It is important to note that the study shows that cocoa mostly does not advance into new forest areas but rather occupies already degraded areas and the understory of forests that have not been completely deforested.

In Bahia, where cocoa is predominantly cultivated in traditional AFS — the so-called cabrucas — the cocoa situation is quite distinct. Although the state is still the largest producer in the country, productivity is relatively low, mainly after the dissemination of Witches' Broom that decimated plantations in the 1990s and continues to be one of the main limiting factors to increase production and productivity. This collapse in the production of cocoa in Bahia was essential in explaining the country's drop from the second largest cocoa producer in the world, with a production of 460 thousand tons in 1986, to the current fifth position in that ranking, with annual production around 300 thousand tons. The planted area in Bahia has seen a small retraction in recent years, with productivity remaining stable and still low compared to the other producing states, with an average of 280 kg/ha over the last five years.

However, to achieve the production goal of over 400 thousand tons annually of cocoa, proposed in the Inova Cacau 2030 Plan, it is necessary to carefully assess the investment costs and the expansion area required for each production model. Based on surveys by the **Campo Futuro Project (CNA, 2025)**, simulations were carried out considering the different productivities of the analyzed systems and the respective area expansion needs. The four production models are distinguished due to significant variations in cost (US$) per weight (1 @ = *15kg*), productivity, and gross revenue.

The Altamira models show how the degree of technology directly influences performance: while the low-tech system reached 66.66@/ha (~990kg/ha), the medium-tech model achieved 148.14@/ha (2,200kg/ha). In Eunápolis, with a high-tech system and a third-party labor regime, productivity reached 150 @/ha (2,250kg/

ha), similar to the medium tech system. On the other hand, the Ilhéus model, operating in a low-tech cabruca system within a partnership arrangement, obtained only 12@/ha (180kg/ha). This demonstrates the immense potential to increase the productivity of differentiated systems in Brazil, such as cabrucas and other AFS, with investments in technical training and assistance, cost-reduction and management, and system modernization, without the need to expand the area to increase production and productivity and, consequently, reduce the need for imports.

Table 4a below presents the locations, highlighting the necessary investment per hectare, the estimated area of expansion, and the total capital required to enable the increase in cocoa production in Brazil. The data presented indicate that the values necessary to expand cocoa production vary significantly according to the adopted production model. High-productivity systems, such as those in Eunápolis and Altamira (medium), demand a smaller area and, consequently, less total capital. On the other hand, less efficient systems, such as the Cabruca in Ilhéus, require significantly larger areas, reflecting higher investments.

However, in this same study, the necessary investment per hectare, the estimated area of expansion, and the total capital required to enable the increase in production, considering the cabruca productivity at 66@/ha (990kg/ha) through improved management, were also simulated. This scenario was named Ilhéus (potential) in the study. It is noted that, with increased productivity in the cabruca system, the investment needed to increase production is 82% lower when compared to the cabruca system with productivity of only 12@/ha (180kg/ha).

Table 4a. Investment Estimate to Double Cocoa Production in Brazil.

Local	Intensification level	Type of System	Productivity *(kg/ha)*	Investment *(R$/ha)*	Expansion area *(ha)*	Investment required *(R$)*
Altamira	Low	Full-sun	976.23	110,707.00	190,019.00	21,036,433,643.36
Altamira	Medium	Full-sun	2,176.3	110,707.00	85,500.00	9,465,448,500.00
Eunápolis	High	Full-sun	2,203	102,685.00	84,444.44	8,671,177,111.78
Ilhéus	Low	Cabruca	176	58,882.81	1,055,555.56	62,154,079,861.11
Ilhéus (potencial)	Low	Cabruca	970	58,882.81	191,919.19	11,300,741,792.93

Adapted from CNA, 2025; 1@=~15kg.

High productivity in cabruca systems is perfectly viable and corroborated by the study "Economic Modeling of Cabruca," carried out by Instituto Arapyaú (2019)[25]. The study considered family farmers (≤ 5 hectares), small (≤ 20 hectares), and medium (≤ 100 hectares) producers, who together represent more than 90% of the cocoa production in the region. For the small and medium producer models, an initial productivity of 150kg/ha with a density of 300 plants/ha was assumed, and the projection was to reach a productivity of 1,500kg/ha with a density of 1,000 plants/ha. In the case of family farmers, despite reaching the same density, a productivity expectation of 1,050kg/ha was adopted. The study demonstrated that cabruca cocoa production, with high productivity, is economically viable. Furthermore, it can be observed that among the three

[25] See at: https://arapyau.org.br/wp-content/uploads/2019/05/Cabruca_FINAL_reduzida-1.pdf

producer profiles, the family farmer is the one who presents the greatest vulnerability due to small variations in price and productivity.

These estimates reinforce the importance of strategies focused on level of technology and the adoption of more efficient agricultural practices, reducing costs and optimizing territorial occupation. The choice of an adequate production model and the planning of expansion are determining factors for enabling the sustainable growth of Brazilian cocoa production. Thus, some labor-related challenges reinforce this recommendation, mainly due to the intensive management of cocoa, rural exodus, the inverted age pyramid with the advanced age of the base, and the competition between social benefits and job formalization.

In addition to the numbers highlighted previously, it is fundamental to emphasize the profile of cocoa producers in Brazil. Thus, more detailed analyses can be performed regarding the economic, environmental, and social impacts, both regional and global, on Brazilian production and market. Thus, the average size of cocoa-producing properties in Brazil is 6.5 ha, totaling about 93,314 properties, with 53% of them having up to 10 ha and another 16% having only between 10 ha and 20 ha. Therefore, 70% of cocoa-producing properties in the country have less than 20 ha, being associated with family and small-holder farming.

5. CHARACTERISTICS OF COCOA PRODUCTION SYSTEMS IN BRAZIL

Different moments in Brazil's history allow us to understand the advancement of cocoa as a striking element in the agricultural sector in some regions in the country. From the use and propagation by Indigenous peoples to the resurgence of cocoa farming after the crisis caused by the spread of Witches' Broom, each moment was relevant for the advancement of knowledge and techniques employed in cocoa cultivation until the present day.

Each producing region in Brazil tended to create and adopt models adapted to its realities, considering the social, economic, and environmental aspects of each locality. The development and adoption of differentiated models among regions also depend on factors such as the availability of resources and technologies, climate conditions, soil and relief characteristics, as well as the performance of **Technical Assistance and Rural Extension (ATER)** agencies in the dissemination of technologies, knowledge, and best practices to producers. These factors that differentiate the production systems of cocoa farms are presented, discussed, and compared below, which allow inferences about relevant, positive, and negative points.

5.1. Concept of Production Systems – Composition and Functionality

There are three main production systems, with variations occurring within each one: (a) monoculture models of sun-grown cocoa, (b) shaded-cocoa under simple or more complex AFS, and (c) cabrucas, which are is also considered AFS, but with a difference in their initial formation (Figure 5a).

In Brazil, cocoa is grown under a variety of arrangements

Full-sun cocoa

Cocoa-agroforestry

Cabruca system

For illustration purposes only. Generated by AI.

Historically, the *cabruca* is the most traditional cultivation system, which has existed for more than two centuries and is still under production in the states of Bahia and Espírito Santo, in the Atlantic Forest biome. The name cabruca comes from the term *brocar*, which popularly means "to thin" or "to open" the forest. In practice, cabruca is a system in which cocoa plants replace the original understory of the forest, maintaining a portion of the native trees to fulfill the function of shading the cocoa trees. Over time, part of these native species is generally replaced by exotic species of commercial, food, or cultural value. This system can be seen as relictual due to possible infringements due to the legal protection provisions of the Atlantic Forest biome – the only one among the Brazilian biomes with specific legislation (Federal Law No. 11.428/2006). In addition to the cabrucas, part of the cocoa AFS in Southern Bahia were formed by the method of complete clearcutting (called **"derruba total"**) of the native secondary and primary vegetation, or even old cabrucas, when, in the 1970s, CEPLAC/MAPA presented the proposal to renew cocoa by encouraging the conversion of these ecosystems into a simplified consortium between cocoa, banana (temporary shading), and Erythrina sp individuals – a tree species from the legume family that, in addition to providing permanent shade, would also increase the nitrogen supply in the soil. Other common consortia of species found in the region is cocoa, rubber trees, palm oil (dendê), and açaí.

According to Braga (2022)[26], AFS are "productive systems where there is the management of plants with different characteristics, agricultural and forestry, that interact with each other in a temporal process of directed succession, according to the farmer's objectives". Thus, different species are planted in the same area, including short-cycle crops, such as corn, rice, beans, pumpkin, cassava, along with others and perennial tree species, which will occupy different positions in the vertical stratum in the system and fulfill different functions.

Shaded cocoa farms, which have the species as the flagship of the model's production, are classified as cocoa AFS. These AFSs show great variability in composition and structural complexity, distinguished by the composition of shading species and their abundances (number of individuals), vertical stratification, and percentage of crop shading. Within these arrangements, the cocoa AFS model proposed by the Instituto Arapyaú in southern Bahia and developed by the company **Symbiosis Investimentos**, as part of its Verra-registered carbon project, stands out as a noteworthy example. The project applies the carbon increment modeling, which envisions the establishment of these cocoa AFS on degraded pasturelands for large, medium, and small producers.

[26] See at: https://admin.imaflora.org/public/media/biblioteca/cartilha_cacau_v1_florestas_de_valor_imaflora_2022_1.pdf

This model has enormous potential to scale and transform Southern Bahia into a major hub for sustainable tropical timber production, along with cocoa. In this case, cocoa AFS are composed of 416 trees/ha of two native species and 833 cocoa trees/ha, with a rotation cycle of 40 years for the carbon component.

In the full-sun cocoa system, the seedlings are planted in a monoculture system without the shading of another tree species. This highly intensive production mode relies heavily on chemical inputs and pesticides and is designed to maximize productivity while facilitating management. Generally, full-sun systems require irrigation, which makes the system more expensive in its implementation and maintenance, less climatically resilient, and more economically vulnerable. In both agroforestry and full-sun systems, there is great variation in terms of the genetic material used and the form of propagation (i.e., seeds, clones, and grafts) of seedlings and the use of technologies applied in weed control operations, pest and disease management, and soil corrections and fertilization. Full-sun cocoa planting is comparable to other practices applied to monocultures, generally conceived to simplify the productive system through variable reduction, with the application of predefined agronomic protocols that include massive recommendations of chemical fertilization and agrochemicals.

The cabruca system, recognized as a productive model that contributes to the conservation of natural resources, has been the focus of policies that aim to protect and maintain this system, including initiatives supported by international organizations. For example, since 2023 **FAO**[27] has been executing a **Global Environment Facility (GEF)** project called "Conservation of the Atlantic Forest through the sustainable management of cocoa agroforestry landscapes (GEF-Cabruca)". The project

[27] See at: https://www.gov.br/agricultura/pt-br/assuntos/noticias/projeto-de-conservacao-da-mata-atlantica-e-fortalecimento-da-producao-de-cacau-atende-3-mil-produtores-rurais-do-sul-da-bahia

involves more than 3000 beneficiary families and has the goal to strengthen the cabruca system, revitalize cocoa farms in Southern Bahia, conserve the Atlantic Forest, and promote sustainable production. The project also aims to increase the productivity and profitability of cocoa farming, encouraging access to differentiated cocoa markets and improving the quality of life of local communities.

In other regions of the **Legal Amazon** - a political and administrative jurisdiction comprising nine Brazilian states harboring the Amazon Biome - cocoa has been planted mainly in two ways: under the shade of secondary forests (*capoeiras* - forests in the initial stage of succession); and in already deforested areas, usually occupied by degraded pastures. When cocoa is planted in capoeira, trails (rows) are generally opened in the still young vegetation, interspersing cocoa plants with banana trees. In subsequent management stages, the farmer selects native tree species regenerating naturally that are desirable to maintain within the system to form the permanent shade canopy. Non-selected species are removed to minimize competition with the cocoa crop. Empirically, farmers' choices are made based on the potential of a certain native species to provide products, timber or non-timber, that will be part of the agroforestry management of the system. In the absence of species of economic use, it is common to enrich the system with the planting of other desirable species that have commercial value for their products to generate income.

When cocoa advances over degraded areas in the Legal Amazon, such as unproductive pastures, the implementation process is very intensive. In general, soil preparation involves the use of machinery, control of competing invasive plants (particularly exotic pasture grasses), soil acidity correction through liming, and fertilization to enhance soil fertility. Both synthetic and organic fertilizers may be applied, along with leaf-cutting ant control and, when resources allow, irrigation during planting. In these cases, cocoa is typically planted in full sun, accompanied by temporary shade species such as banana, cassava, or green manure crops. These species may later be replaced by other desirable, long-lived perennial trees that will form the system's productive structure.

5.2. Density and Diversity of Intercropped Species in AFS

The adopted AFS depends on the characteristics of each region and reflects the personal choices and management skills of each farmer. Simplified systems most often contain species of commercial interest that can be annual or perennial. Banana has been widely used as a first-shade species, which will provide favorable conditions for the growth of cocoa and other species such as açaí, rubber, and andiroba. Species are generally chosen according to the productive vocation of the region and already established supply chains. In the Transamazônica region, in Pará, the cultivation of cassava, corn, and pigeon pea *(guandú)* is common for temporary shading (Brasil, 2020)[28]. In Linhares-ES in the Atlantic Forest biome, the most used species are banana (41.2%), coconut (11.8%), and rubber (35.3%), according to a study carried out by INCAPER[29].

In contrast, cocoa AFS can contain numerous species, whether these are providers of commercial products or simply species of ecological interest for fulfilling some functionality, such as herbaceous short-cycle nitrogen-fixing legumes (crotalarias, jack bean, dwarf pigeon pea), shrub semi-perennials (common pigeon pea), or perennial arboreal plants (different species of Inga and Erythrina).

[28] Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Cartilha de boas práticas na lavoura cacaueira no estado do Pará / Ministério da Agricultura, Pecuária e Abastecimento, Secretaria de Inovação, Desenvolvimento Rural e Irrigação, Comissão Executiva do Plano da Lavoura Cacaueira. – Belém: Mapa/CEPLAC, 2020. 64 p. See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/outras-publicacoes/cartilha-do-cacaueiro-com-ficha-catalografica.pdf.
[29] See at: https://biblioteca.incaper.es.gov.br/digital/bitstream/item/4248/1/Livro-cadeiaprodutivadocacau-Incaper.pdf

Complex AFS require greater attention and management experience, usually demanding more labor and presenting limitations for the mechanization of operations. On the other hand, they are more like natural forest formations, being more expressive in promoting ecosystem services and more resilient and adapted to climate change. Short-cycle species, such as different types of corn, beans, cassava, pineapple, and cucurbits in general, function as initial forage in the system, producing biomass that, consequently, after the process of deposition and decomposition of accumulated residues in the litter, contributes to increasing the soil organic matter content, helping to improve its physical characteristics and fertility, with increased activity of soil biota organisms, in addition to reducing the risks of erosive processes and increasing water retention. These short-cycle species are also responsible for generating financial revenue in a very short term, helping to accelerate the return on investment *(payback)* used in the implementation of the system. Semi-perennial species, such as banana and papaya, are used with the ecological function in the system of creating the initial shading, favoring perennial crops like cocoa and other associated species that benefit from this partial shading condition for establishment, also bringing in short-term revenues.

Finally, the perennial species used in consortium with cocoa are trees that promote some type of service or generate revenue, which can be, individually or jointly, the following functions:

• Windbreak;
• Shade;
• Organic matter for fertilization and soil cover;
• Fauna attraction;
• Acceleration of the ecological succession process;
• Fruit production;
• Nut and oilseed production;
• Timber production.

5.3. ShadeSystems

Theobroma cacao is a shade-tolerant species with relatively high photosynthetic rates at sufficient light levels that favor its growth and productivity (LOBÃO et al., 2023). At the same time, cocoa is a plant with high water demand and requires an environment with low daily temperature and humidity variation. Agroforestry systems utilize shading to maintain the microclimate and reduce water demand. In these systems, the recommended shading percentage for cocoa cultivation varies depending on the stage of the plants. It is recommended that, in the first stages of seedling development, 25 to 50% light entry be allowed. As the plants develop, the amount of light should be increased to 70%, which should be done by thinning and pruning the species used for shading (SENAR, 2025)[30]. In the case of shading greater than this percentage, the planting tends to have lower productivity rates. However, studies conducted in Southern Bahia indicate that well-managed cabrucas can present double the regional average (585 kg/ha) with shading levels of up to 55% (Shroth et al. 2014). Undoubtedly, it is necessary to adjust the shading with the main objective of promoting thermal and environmental comfort for the cocoa tree, aiming to increase productivity. However, this intervention should not compromise the products and environmental and ecosystem services provided by the cocoa farm.

In cocoa AFSs in Pará, the most used shading species are generally providers of non-timber forest products (NTFPs), such as oilseeds and fruit trees. Among the oilseeds, *andiroba (Carapa guianensis), copaíba (Copaifera spp), cumarú (Dipteryx odorata*) predominate, and in the production of nuts and fruits, there are Brazil nut *(Bertholletia excelsa)*, *cajá* or *taperebá (Spondias mombin)*, acerola *(Malpighia emarginata)*, guava *(Psidium guajava)*, açaí *(Euterpe oleracea)* and peach palm *(Bactris gasipaes)*. Timber species are also found in the production arrangements, including yellow ipê *(Tabebuia serratifolia)*, Brazilian mahogany *(Swietenia macrophylla)*, freijó *(Cordia alliodora)*, tatajuba *(Bagassa guianensis)*, paricá *(Schyzolobium amazonicum)*, but also some exotic tropical timber species, such as African mahogany (*Khaya grandifoliola* and K. *senegalensis*) and teak *(Tectona grandis)*.

[30] Serviço Nacional de Aprendizagem Rural – SENAR. Cacau: produção, manejo e colheita / Serviço Nacional de Aprendizagem Rural – Brasília: Senar, 2018. 145 p; il. 21 cm (Coleção Senar, 215). ISBN: 978-85-7664-197-1. See at: https://www.cnabrasil.org.br/assets/arquivos/215-CACAU.pdf.

In the cabruca systems in the state of Bahia, according to Sambuichi (2002), the shading species mainly include cajá *(Spondias mombin)*, angico *(Pithecelobium polycephalum)*, ingá *(Inga affinis)*, and cedar *(Cedrela odorata)*. Other publications point to the high occurrence of vinhático *(Plathymenia reticulata)*, jackfruit *(Arthorcarpus heterophyllus)*, louro *(Nectanda sp)*, and embira-de-sapo *(Lonchocarpus sp)* (LOBÃO et al., 2023). Faria and Cassano (2024)[31], in a publication by the Arapyaú Institute, cite a compilation of floristic surveys in cocoa cabrucas, recording the occurrence of a total of 304 tree species in the cabrucas. The authors pointed out that 60% of tree species detected in cabrucas were native species, and of these, 25 species represented more than 72% of all observed trees. These include rare species such as vinhático *(Platymenia reticulata)*, rose cedar *(Cedrela fissilis)*, and pau-sangue *(Petorocarpus rohnii)*, and among the exotic species, jackfruit *(Arthorcarpus heterophyllus)*, rubber trees *(Hevea brasiliensis)*, erythrina *(Erythrina spp)*, and cajá *(Spondias mombin)* were the four most abundant.

According to Braga (2015) in his master's thesis that evaluates cocoa production systems as a tool for the rehabilitation of degraded areas in the municipality of São Félix do Xingu, Pará state, cocoa AFSs are characterized according to their age and shading. In this case, there are systems with **Initial Shade (IS)**, which are areas between 3 and 5 years old, established on pastures ranging from 3 to 13 years of use, intercropped with annual and perennial crops. During this stage, farmers selectively retain some regenerating trees and guide their growth over time. Another arrangement is the **Secondary Shade (SS)** system, consisting of areas 6 to 13 years old, which may have been established on former cropland or pastures. In these cases, naturally regenerating trees that have become established reach the canopy and surpass the height of the cocoa trees. At this stage, banana planting is gradually reduced, leading to the formation of the secondary shade.

[31] Faria, D.; Cassano, C. R. (2024). Biodiversidade, serviços ecossistêmicos e produtividade nas cabrucas: os tradicionais sistemas agroflorestais de cacau do sul da Bahia. Instituto Arapyaú, 42. See at: biodiversidade_nos_sistemas_agroflorestais_cabrucas.pdf. Accessed on: 20/08/2025.

5.4. Propagative Material – Seeds, Clonal Seedlings, Grafting, or Budding

Much has been discussed about propagative material to ensure productivity, phytosanitary safety, ease of propagule, durability of seedlings, pruning management, and early production. Today, different materials are available for propagation, some in greater numbers due to being historically more frequently used and having a low acquisition cost. Below is a comparative table described by the **Ministry of Agriculture, Livestock, and Food Supply (MAPA)**, in a document titled "Diagnosis of Cocoa Seed and Seedling Production in Brazil," within the scope of the **INOVA CACAU 2030 Program**, "Strategies to promote the sustainable development of cocoa-producing regions in Brazil.[32]"

Clonal materials are propagated through cuttings or grafting onto rootstocks derived from hybrid seeds. These materials can originate from a genetically narrow base due to intense and continuous selection. Marchiori and Miller (2025) emphasize that "the combined use of clonal and seed-derived cacao materials can help reconcile productivity, quality, and adaptive capacity to biotic and abiotic stresses". They recommend that seed-derived and clonal materials be planted in equal proportions within a production unit to ensure both the system's adaptive capacity and productivity, cautioning that relying solely on clonal materials may be risky in the face of climate change and phytosanitary challenges.

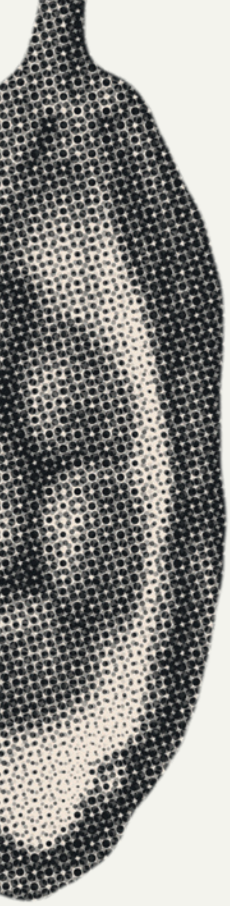
According to Flores and Serra (2023), for CEPLAC/MAPA, the advantages of productivity gains come from the uniformity of plant architecture and the bean pattern in clones; however, the use of these materials does not outweigh the risks of this endeavor. Considering issues related to production and the resilience of production systems to pests and diseases, there is a clear lack of nurseries capable of propagating grafted and clonal genetic materials, as well as a shortage of consistent research guiding the use of grafting, rootstocks, or propagation through cuttings. This contrasts with the seed-derived materials provided free of charge by CEPLAC/MAPA in all cocoa-producing regions.

[32] See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/outras-publicacoes/diagnostico-da-producao-de-sementes-e-mudas-de-cacau-no-brasil.png/view

The logistics for the distribution of seedlings in the Amazon region are a relevant point in the decision-making regarding the type of propagule used. Currently, the production and distribution of seedlings, with the existing structures, is a key bottleneck to be overcome. Bahia and Espírito Santo states, on the other hand, have numerous nurseries with mechanized production and a good road network for seedling distribution. Seminal propagation is more efficient from a logistical, phytosanitary, and varietal point of view, and is undoubtedly today the strategy with the greatest scientific backing, given several decades of study and the formation of seed production orchards carried out by CEPLAC/MAPA.

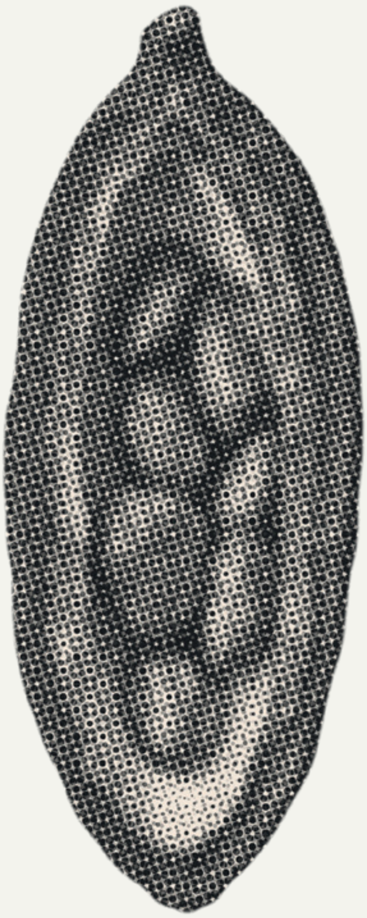
5.5. Harvesting and Processing Technologies

Cocoa production on the farm is a complex, multi-stage process. In most traditional agroforests, such as cabrucas, mechanization is virtually non-existent at all stages, mainly due to factors like high plant density, spatial irregularity of plants, and sloped terrain. In some situations, it is possible to use machinery for mowing and input application in these agroforests, but stages like pruning and harvesting are essentially manual. Breaking the fruits and separating the beans is still done manually. Although there is equipment to perform this operation, its use remains incipient. The beans are then transported to wooden boxes *(cochos)* where fermentation occurs for 5 to 8 days, depending on the climate. The beans are moved or transferred



between boxes daily to help the fermentation achieve uniformity. Some fermentation specialists are studying the possibility of using additives to accelerate fermentation or to enhance certain bean characteristics. Drying is carried out in the sun on patios *(terreiros)*, barges, or greenhouses, with the time varying by region or climate, ranging from 5 to 14 days. Forced drying methods are not recommended as they can damage key quality characteristics of the product.

In new, high-tech farms, especially those using the full-sun system, it is possible to mechanize a significant part of the production process. Machinery developed for other crops, such as coffee, is applied to ground preparation and the planting of cocoa seedlings. However, once planted, it requires intensive manual pruning in the first 3-4 years. Correct planting spacing allows machinery access for mowing and input applications, but the harvesting stage is still performed manually. The post-harvest stages of the beans, which also take place on the farms, already use specific machinery, from pulping, which separates the pulp from the bean to fermentation and drying.



In summary, the stages of harvesting, processing, and storage are:
• Harvesting fruits with cutting equipment.
• Breaking of fruits with a machete.
• Separation of beans from the shell and other internal parts of the fruit.
• Fermentation in wooden boxes (cochos), turned daily.
• Drying of the beans in greenhouses, barges, or wood-fired dryers.
• Bagging and storage.

Cocoa classification in Brazil is regulated by Normative Instruction (IN) No. 38/2008 of the **MAPA**[33], which establishes that the bean must be evaluated regarding physiological development, health, cleanliness, moisture, and percentage of defects such as mold, insects, and breakage. The harvesting and post-harvest process is key for the cocoa seed to be classified as a cocoa bean.

[33] See at: https://sistemasweb.agricultura.gov.br/sislegis/action/detalhaAto.do?method=visualizarAtoPortalMapa&chave=250964455

It is primarily during the fermentation and drying process that the bean loses or gains sensory notes and compounds. During these stages, not only are the precursors of the characteristic flavor of cocoa products generated but also compounds that will no longer undergo modifications and will contribute to that flavor (EFRAIM, et al, 2010). The same author also states that the greatest losses of phenolic compounds, which are naturally present in high quantities in cocoa seeds, occur during the fermentation and drying stages.

According to Ferreira (2017), the best cocoa is always the one that pleases the consumer market, which ultimately defines the desired quality. Market demands for good quality cocoa vary depending on the buyer and type of use, but follow certain determined standards such as:

- Having a pleasant, natural aroma, free from smoke and abnormal or strange odors.
- Uniform bean dimensions, full, thick beans, with air spaces inside the beans.
- Completely fermented and dried cocoa, with a predominant brown coloration.
- Beans free from any adulteration.
- Whole beans, without fragmentation and shell pieces.

5.6. Water requirement and Irrigation

Cocoa production demands a lot of water and is sensitive to water deficits. This is one of the main reasons explaining the choice of specific locations with satisfactory average rainfall for the establishment of cocoa farming. Rainfall for the cocoa tree should be greater than 1,200 mm per year to be considered sufficient for production, and the ideal rainfall should range between 1,800 and 2,500 mm per year (Olegário et al., 2022), with additional irrigation being necessary in regions with rainfall below 1,200 mm per year (Carr and Lockwood, 2011).
For irrigation, Müller and Valle (2007) indicate a demand of about 30 to 50 liters of water per day for an established adult plant in the Southern Bahia region. The quantity of 31.5 liters is also cited as the daily water consumption of an adult cocoa plant by SENAR (2018)[34]. Following Bouix et al. (2013), these values are the same indicated by Bessa Leite (2013), who calculated the crop Evapotranspiration (ETC) equal to 3.5 mm/day for cocoa trees aged 6 years, occupying an individual area of 9m² in the municipality of Ilhéus – BA.

[34] Serviço Nacional de Aprendizagem Rural. Cacau: produção, manejo e colheita (Coleção Senar, 215) / Serviço Nacional de Aprendizagem Rural – Brasília: Senar, 2018. 145 p. See at: https://www.cnabrasil.org.br/assets/arquivos/215-CACAU.pdf

There is no consolidated data on the area of irrigated cocoa plantations in Brazil, but it is clear that this represents a growing segment of the country's cocoa sector, particularly in intensively managed full-sun systems and in low-rainfall regions where cultivation has expanded, such as northern Minas Gerais, western Bahia, and the **MATOPIBA**[35]. Irrigated cocoa AFS also exist, notably in the state of Espírito Santo, where a large portion of production occurs along the banks of the Doce River, with AFS supplied by sprinkler or drip irrigation. Among the most used irrigation methods are micro-sprinkling and drip irrigation, which are localized irrigation systems where water is applied to the base of the plant, according to its water needs, calculated based on a set of indicator parameters and efficiency coefficients (BOUIX et al., 2013). Localized irrigation presents greater efficiency, less labor use, lower water consumption, and can adapt to practically any type of soil and topography (SERRA & SODRÉ, 2021).

Even in regions with favorable climatic conditions for cocoa cultivation, such as Southern Bahia, irrigation has been increasingly adopted to ensure sufficient water availability during periods of temporary water scarcity. This includes prolonged droughts during the dry season, particularly from June to August, and short dry spells *(veranicos)*, which are becoming more frequent as a result of climate change.

In the establishment phase, when seedlings or young plants are more susceptible to water stress, irrigation ensures greater survival and initial growth of the planting. Subsequently, irrigation brings benefits to the crop such as higher productivity and the extension of the harvest period, allowing the farmer to offer the product during times of raw material scarcity, thereby achieving a premium price.

With recent favorable prices, cocoa farming is expanding rapidly to regions that were not traditionally used for cultivation. For example, the state government's rural extension agency in São Paulo is encouraging the planting of cocoa in regions where temperatures are compatible, but with water deficits, recommending drip irrigation of 40 to 60 L/plant/day. However, the expansion of large, irrigated areas should be treated with caution where the water issue for human consumption is already problematic. According to the **United Nations Food and Agriculture Organization (FAO)**, agriculture is the sector that consumes the most water, reaching nearly 70% of all water used. In Brazil, this value reaches 72%[36]. Solutions such as the development and selection of productive genotypes adapted to water stress can help reduce water demand and allow for more sustainable expansion of the cultivar, reducing pressure on water resources (Araujo et al. 2024).

[35] the acronym for an agriculture frontier encompassing regions from four states: Tocantins, Maranhão, Piaui and Bahia.
[36] See at: https://www.ufsm.br/pet/agronomia/2022/08/23/o-uso-da-agua-na-agricultura#:~:text=Segundo%20o%20Fundo%20de%20Na%C3%A7%C3%B5es,40%25%20de%20toda%20a%20produ%C3%A7%C3%A3o

5.7. Integrated Pest and Disease Control

Cocoa is highly vulnerable to a range of pests and diseases. Marelli et al. (2019) estimate that diseases—primarily of fungal and viral origin—account for nearly 40% of global production losses. Insect pests also contribute significantly to economic losses by damaging multiple plant structures, including leaves, stems, and pods. According to a technical bulletin by SENAR (2018)[37], the fungal diseases that stand out most in Brazil are Witches' Broom *(Moniliophthora perniciosa)*, Black Pod Rot (*Phytophthora spp.*), and Mal-do-facão *(Ceratocystis cacaofunesta)*. The main insect pests that attack the cocoa tree are: monalonion *(Monalonion spp.)*, cigarrinha *(Hoplophorion pertusum)*, thrips *(Selenothrips rubrocinctus)*, vaquinhas *(Taimbezinhia theobromae, Percolaspis ornata, and Colaspis spp.), zebrinha (Membracis sp.)*, mites *(Tetranychus mexicanus and Eriophyes reyesi)*, mealybug *(Planococcus citri)*, whitefly *(Bemisia sp.)*, and beetles *(Lasiopus cilipes, Lordops aurosa,* and *Naupactus bondari)*.

Integrated pest and disease management in cocoa includes the use of resistant or tolerant genetic materials, chemical control with agrochemicals, biological control using natural enemies—mainly targeting insect pests—and cultural practices such as pruning or, in extreme cases, the removal of infected plants. It is also important to emphasize the genetic base of cocoa cultivars in pest management. CEPLAC/MAPA has promoted the use of a diverse set of varieties to combine resistance to pests and diseases with high productivity. This approach enabled CEPLAC to successfully control Witches' Broom disease and redefine cocoa cultivation in Brazil. Today, in collaboration with neighboring countries, CEPLAC continues to apply this strategy in the management of other emerging threats such as the Moniliasis (frosty pod rot), caused by the fungus *Moniliophthora roreri*.

Full-sun cultivation systems have shown a higher incidence of insect pests, while in AFS the occurrence of fungal diseases is more recurrent. In an informative pamphlet aimed at family farmers and small cocoa producers prepared by **AIPC**, titled "Integrated Management Guide for Cocoa Pests and Diseases," of the six diseases listed, which include Witches' Broom, Black Pod Rot, Ceratocystis Wilt (Mal-do-facão), in addition to floral *buba (Fusarium spp.)*, anthracnose *(Colletotrichum spp.),* and Lasiodiplodia canker *(Lasiodiplodia theobromae)*, only the latter is more common in full-sun cultivation areas, with the others associated with AFS and cabruca areas.

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[37] Serviço Nacional de Aprendizagem Rural. Cacau: produção, manejo e colheita (Coleção Senar, 215) / Serviço Nacional de Aprendizagem Rural – Brasília: Senar, 2018. 145 p. See at: https://www.cnabrasil.org.br/assets/arquivos/215-CACAU.pdf

Regarding the organisms recognized as insect pests, among the 11 mentioned in the AIPC (2025[38]) guide, all were reported exclusively in full-sun cocoa plantations, except for the incidence of ants and diseases such as moniliasis, which were not associated with specific production systems. This suggests that in more biodiverse systems, such as cocoa AFS, biodiversity itself may serve as a potential tool for maintaining low pest incidence, thereby contributing to the reduced or non-use of pesticides in these types of production systems.

In the case of fungal diseases, proper system management is essential to create microclimatic conditions that inhibit disease proliferation. This includes pruning cocoa trees and shade trees to improve light penetration and reduce humidity that favors disease development, as well as implementing agricultural practices that ensure cocoa plants remain physiologically healthy, with sufficient nutrient and water availability. In addition, phytosanitary practices such as cleaning infected materials, removing affected plant parts or individuals, and clearing pod husks from the plantation are recommended.

Today, the main concern of Brazilian cocoa farming production is the disease caused by the fungus *Moniliophthora roreri*, with impacts already detected in neighboring countries, such as

[38] Available in: https://aipc.com.br/educacau/

Ecuador and Peru, and in Colombia, Venezuela, and Bolivia. In Brazil, it was first identified in July 2021, in an urban residential area in the municipality of Cruzeiro do Sul, in Acre state. In November 2022, the disease was detected in the municipality of Tabatinga, in the state of Amazonas, in riverside rural communities. In June 2024, the disease was detected for the first time in a commercial cocoa plantation in the municipality of Urucurituba, in the state of Amazonas, creating an alert to phytosanitary authorities to isolate the focal region, in order to prevent its dissemination, through coordinated action by the Ministry of Agriculture **(MAPA)** to reinforce vigilance and phytosanitary control, with the declaration of a phytosanitary emergency for the states of Acre, Rondônia, Amazonas, and Pará until August 2026. In Bahia, following the traumatic experience caused by the introduction of Witches' Broom disease, there remains considerable concern over its potential reoccurrence in the state. To date, no cases of the disease have been detected in Bahia.

As part of its strategy to protect Brazilian cocoa farming from moniliasis, CEPLAC/MAPA sent cocoa clones for testing in Ecuador and Costa Rica[39]. A total of 128 clonal varieties were evaluated in areas with high disease pressure. In parallel, major companies in the sector are also investing in genetic improvement programs, developing clonal varieties with diverse characteristics, including varying levels of resistance to diseases.

5.8. Soil Fertilization

Fertilization encompasses the application of lime, phosphate, gypsum, and macro- and micronutrients (through soil and plant leaves). The quantity, frequency, and timing of these applications vary according to soil type, nutrient availability—determined through laboratory analyses of periodically collected soil samples—and the nutritional demands of the crop at different growth stages. Establishment-phase fertilization supplies the essential macro- and micronutrients needed for the proper growth and development of cocoa seedlings. During the productive phase, fertilization is crucial for replenishing the nutrients extracted from the soil throughout the production cycle, thereby supporting high yields and maintaining bean quality (Nestlé Brasil and RR Agroflorestal, 2022)[40]. Maintaining adequate soil fertility is a key factor in ensuring plant health, as it enhances resistance to physiological stress and reduces susceptibility to diseases.

In cocoa AFS, including cabrucas, part of this nutritional demand is supplied by the nutrient cycling resulting from the

[39] https://www.gov.br/agricultura/pt-br/assuntos/noticias/ceplac-testa-clones-de-cacau-em-paises-vizinhos-contra-a-moniliase

[40] Nestlé Brasil e RR Agroflorestal. Manual de Adubação e Produção do Cacaueiro, 2022. 50 p. See at: https://rragroflorestal.com.br/images/downloads/manual-adubacao-cacaueiro.pdf

deposition of organic matter in the system, accelerated by biomass management practices, such as selective weeding, mowing, and tree pruning. In full-sun monoculture systems, soil fertility is conditioned almost exclusively by the addition of external mineral or organic fertilizers to the cultivation area. Regardless of the system, frequent soil sampling and chemical analysis is necessary annually to assess the need for fertilization to maintain optimal levels of nutrient availability for good production. Bioanalysis, or biological analysis of the soil to evaluate and optimize soil health, allows a view of the soil microbial activity that can contribute to the more efficient use of chemical fertilization and the productivity and resilience of cocoa. Technical informative materials are presented with recommendations for the fertilization of cocoa cultivation, based on experiments contrasting dosages and productivity. One of these informative materials is presented by CEPLAC/MAPA[41] where it is found that the use of recommendations for soil amendment and fertilizer dosages, associated with the management of shading (thinning), presented promising results with productivities above 1,200 kg/ha, evidencing a close association between fertilization and productivity.

A cocoa fertilization recommendation manual developed through a partnership between Nestlé Brasil and RR Agroflorestal (2022) presents the results of an experiment conducted in the Ilhéus municipality, Southern Bahia. The study established reference values for the optimal nutrient levels required by cocoa trees at different growth stages and throughout their reproductive cycle, based on expected productivity. The manual also includes an economic viability analysis demonstrating favorable outcomes for the adoption of these fertilization recommendations. For yields ranging from 1,200 to 1,800 kg/ha, the estimated Internal Rate of Return (IRR) reached 19.6% and 20.5%, respectively, when compared to only 7.5% in areas without supplementary fertilization.

As part of the **Solidaridad Foundation's Amazon Program** in partnership with **Cargill**, a study was conducted in the municipality of Novo Repartimento, Pará state, to evaluate the impact of chemical fertilizer-based nutrition management on the

[41] https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/boletins-tecnicos-bahia/bt-203.pdf

agro-economic performance of cocoa farms. The research confirmed that strategic fertilization significantly boosts both productivity and revenue (Solidaridad, 2022)[42]. Over a three-year period, farms that applied the recommended dosage—an average of 326 kg/ha of NPK 13-11-21 enriched with micronutrients—achieved an average yield increase of 489 kg/ha/year. This represented a 42% gain in productivity and an additional revenue of R$3,670.00 (~US$682.11) compared to farms without fertilizer application. The results demonstrated the effectiveness of fertilization practices for cocoa cultivation within the supported community. However, the study also highlighted the importance of adapting fertilization strategies to include alternative sources—such as organic and locally available inputs—which offer better carbon sequestration potential and lower costs for smallholder families.

These proposals align with the strategies of the **National Bio-inputs Program**, being implemented by the federal government, which has several correlative norms (Decree No. 10.375, of May 26, 2020, and its Regulatory Framework, Law No. 15.070, of December 23, 2024, and other normative instructions). In the second half of 2025, the **Brazilian Development Bank (BNDES)** announced a R$60 million (~US$11,15 million) investment in non-reimbursable funds (grant) for family farming cooperatives for the production and multiplication of bio-inputs in the North and Northeast of the country, which should benefit cocoa farmers in these regions by providing access to this type of input[43].

[42] Soliedarid e Cargill. Estudo de adubação de cacaueiros e seu efeito na produtividade e rentabilidade da cultura na região de Novo Repartimento (PA). Boletim Técnico Cacau Fertil, 2022, 26p. See at: https://aipc.com.br/wp-content/uploads/2022/11/boletim_tecnico_cacau_fertil.pdf
[43] See at: https://agenciadenoticias.bndes.gov.br/socioambiental/BNDES-anuncia-R$-60-mi-para-cooperativas-de-agricultura-familiar-produzirem-bioinsumos/

An important fact from these reports is that the gain in productivity efficiency, which is not associated exclusively with nutritional management but with the set of complementary agroecosystem management techniques, including shading, becomes essential for cocoa farming to be a sustainable practice in all its dimensions.

5.9. Native Cocoa Extractive Practices

The production of native cocoa, also known as wild cocoa, *cacaul* (or *cacauí*), and in specific situations like "várzea" (floodplain) cocoa — differs from other traditional production systems because they are managed and harvested following the same logic as extractive products. Management is practically restricted to harvesting, with some possibilities of pruning and thinning neighboring plants. Carried out by traditional communities and Indigenous peoples, it generates income and enhances the bioeconomy while helping to preserve the forest. Unfortunately, there is not much information on the volume of wild cocoa production in Brazil. The available information comes from specific initiatives in some locations in the Legal Amazon, with emphasis in the Jari and Baixo Tocantins rivers, and in the municipality of Boca do Acre in the Mapiá and Médio Purus region in Acre state.

A characteristic of the *cacaul* value chain is the verticalization of the chain or direct supply to manufacturers in the fine chocolate market, among which the following have stood out in the processing of this raw material: De Mendes, Luisa Abraan, and Nakau. In the business for 20 years, César de Mendes is one of the oldest names in the artisanal chocolate sector in Pará and has exhibited, as a guest, at chocolate salons in Milan and was awarded in Paris. Today, he exports to European countries, the United States, and sells his products to several Brazilian states[44]. The cocoa beans are supplied by Indigenous communities, *quilombolas (afro-descendent communities), caboclos*, riverside dwellers, and family farmers[45]. In partnership with the Instituto Socioambiental (ISA), this chocolatier produces a chocolate with wild cocoa beans from the Yanomami Peoples.

Nakau chocolates are produced by the company called "Na Floresta Alimentos Amazônicos" (In the Forest Amazonian Foods), which was founded in 2013 with the objective of developing actions with positive socio-environmental impact by valuing products and the peoples of the Amazon. The processed beans come from caboclos, riverside dwellers, and Indigenous peoples, supported by the company. A highlight is the fact that it is the "only chocolate in the world made 100% with organic *várzea* Amazonian cocoa[46]," according to the company's communication. To produce its product lines, Nakau works with 28 communities in 3 Amazonian states, Pará, Rondônia, and Amazonas, providing technical assistance to more than 300 families, with 60 families being organically certified.

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[44] See at: https://www.demendes.com.br/
[45] See at: https://g1.globo.com/pa/para/noticia/2024/07/07/maior-produtor-do-brasil-para-cultiva-cacau-nativo-oriundo-de-arvores-seculares-e-se-torna-o-novo-terroir-de-chocolates-finos-do-pais.ghtml
[46] See at: https://www.nakau.com.br/

Researcher Mirela Carvalho, a collaborator at the **Museu Paraense Emilio Goeldi (MPEG)**, comments that “the Amazonian geo-environment is the great differentiator in the organoleptic qualities (color, brightness, transparency, texture, odor, and flavor) of cocoa due to climatic conditions, soil composition, and floodplain sediments, which seems to be an important for the aroma and terroir of the final product.”

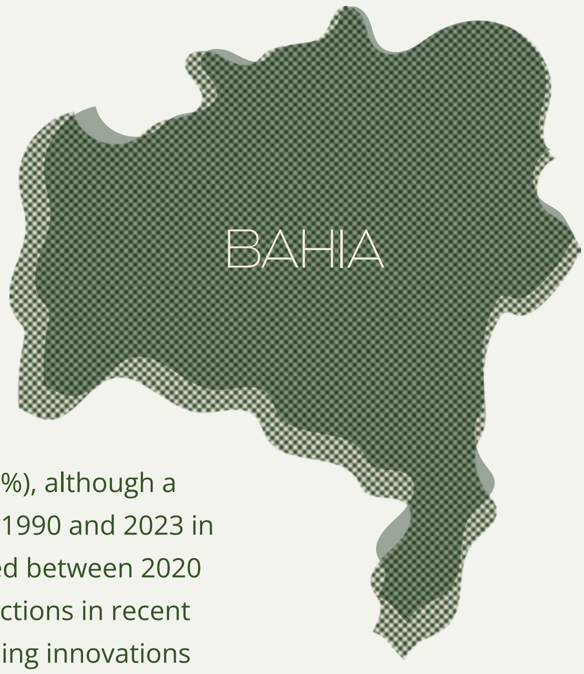
Another noteworthy initiative is the **“Native Cocoa”** project in Boca do Acre, Amazonas state, led by the **Brazilian Agricultural Research Corporation (Embrapa)** in collaboration with the **Agroextractive Cooperative of Mapiá and Médio Purus (Cooperar)**. This project aims to develop and validate technologies that enhance the production of native cocoa, while also identifying the unique quality attributes associated with the origin of cocoa cultivated by riverside communities along the Purus River. Currently, in the Boca do Acre region, the extractivism of native cocoa is carried out in floodplain areas (várzea), an aspect that makes it difficult to collect the fruits during times of major annual floods of the Purus River. With the project’s actions, in addition to intensifying the management of plants in *várzea* areas, there is support for producers in planting cocoa on dry lands *(terra firme)*, as a component of AFS, along with Brazil nut *(Bertholletia excelsa H.B.K)*, açaí, and other species of interest to the community. This is a strategy to provide greater stability in the production of cocoa to compensate the seasonal production in floodplains, as pointed out by Embrapa researcher, Elias Miranda, the project leader[47].

The opportunity for *várzea* cocoa management is also explored by communities on the islands of the municipality of Mocajuba, Baixo Tocantins region, in Pará state. Research led by the **Federal Rural University of the Amazon (UFRA)**[48] has contributed to improving the end-to-end quality of the production chain, aiming to aggregate value to the commercialized product. Through the research carried out, environmental aspects of the island that influence the flavor of the bean have been recognized, associating these characteristics with the nutrition of the plants through the sediment deposited in the *várzea* soil by the movement of the river level caused by the tides. One of the project’s goals is to boost the production of quality beans and create a process for recognizing the indication of origin of the native cocoa from Lower Tocantins — the region that concentrates the largest *várzea* cocoa production area in the state.

[47] Embrapa desenvolve ações para melhoria da produção de cacau nativo da Amazônia - Portal Embrapa
[48] See at: https://www.andifes.org.br/2024/04/01/ufra-projeto-tem-foco-no-cacau-de-varzea-que-cresce-de-acordo-com-a-influencia-dos-rios/

6. CHARACTERISTICS OF COCOA FARMING IN THE THREE MAIN PRODUCING STATES

6.1. Bahia



In the 1980s, at the peak of cocoa production Brazil was the second world´s largest cocoa producer with almost the entirety production from Bahia, specifically in the southern part of the state. This cycle suffered a major impact with the arrival of Witches' Broom in 1989, when production began to collapse. Years of crisis and diminished in production were followed by a period of recovery in the early 2000s, with the introduction of varieties resistant and/or tolerant to Witches' Broom, propagated by CEPLAC/MAPA. Even today, Bahia holds the largest share of the country's cocoa plantations (69.5%), although a 22.4% reduction in planting area was observed between 1990 and 2023 in Bahia. In terms of yield, increases of 29.3% were observed between 2020 and 2023. This advancement was driven by continuous actions in recent years to raise production and productivity indices, including innovations in the orchards, such as the introduction of new clones, densification, fertigation, and artificial pollination (BISPO, 2025)[49].

According to the **State Government's Secretariat of Agriculture (SEAGRI)**, cocoa production in Bahia is concentrated in 20 municipalities along the so-called **Cocoa Coast**, with Ilhéus, Wenceslau Guimarães, and Ibirapitanga being the municipalities with the highest production. In this territory, 78% of the establishments produce cocoa under the cabruca

[49] See at: http://www.seagri.ba.gov.br/noticias/2024/09/24/bahia-lidera-produ%C3%A7%C3%A3o-nacional-de-cacau-e-impulsiona-economia-regional

system (CHIAPETTI et al., 2020), with the remainder represented by other cultivation methods, including simplified consortia to intensive systems, such as full-sun cocoa planting, which occupied 8.7% of the planted area in the state until 2020. Cabruca productivity is very low, ranging from annual 11.8 to 15 @/ha (177 to 225 kg/ha/year). Importantly, a large part of the production (approximately 80%) comes from small and medium producers[50], generally beneficiaries of agrarian reform in the region[51].

The cabruca is considered a low-environmental-impact and biodiversity-friendly system. Through the management of the understory and the introduction of cocoa, the system maintains the permeability of the forest landscape, and its structure contributes to the maintenance of natural cycles without major alterations to the biome's forest ecosystems. The multiple-use management regime, practiced over the years on cocoa farms in this region, even if empirically, has promoted the effective conservation of existing natural resources, as well as the forest heritage within the agricultural production arrangements practiced (Lobão, 2023).

The operational management practices in cabruca are common to agroforestry management, including: (a) cocoa pruning, aimed at productivity vigor, and also pruning of other species, especially for the control of luminosity in the system; (b) mowing and selective weeding, for the control of undesirable invasive species; (c) liming and fertilization, with the aim of improving the physical and chemical conditions of the soil to meet the crop's demands; and (d) phytosanitary control of pests and diseases.

This cocoa shading has the primary function of promoting the thermal and environmental comfort of the crop; therefore, the silvicultural management of the cocoa shading trees (raising and/or reducing the canopy, thinning trees, and planting) is among the practices that should not be neglected. According to LOBÃO (2023), in adjusting the shading, three basic situations should be addressed: (i) heavily shaded areas, where pruning and/or thinning should be carried out to adjust them to an optimal light condition for the crop; (ii) unprotected areas, where the upper protection system must be re-established or recovered; and (iii) areas where individual trees need to be eradicated and/or replaced because they are formed by inappropriate species, dead, or diseased trees.

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[50] The definition of small rural producer varies according to the context, whether fiscal or environmental. For the purpose of accessing credit, such as Pronaf, the classification is based on annual revenue, being up to R$500 thousand for a small family farmer. For environmental purposes, the Forest Code defines the small rural producer as the individual who owns an area of up to 4 fiscal modules, works it with family labor, and derives their main income from the rural activity.
[51] https://arapyau.org.br/wp-content/uploads/2022/12/caso-cacau-port-02dez22.pdf

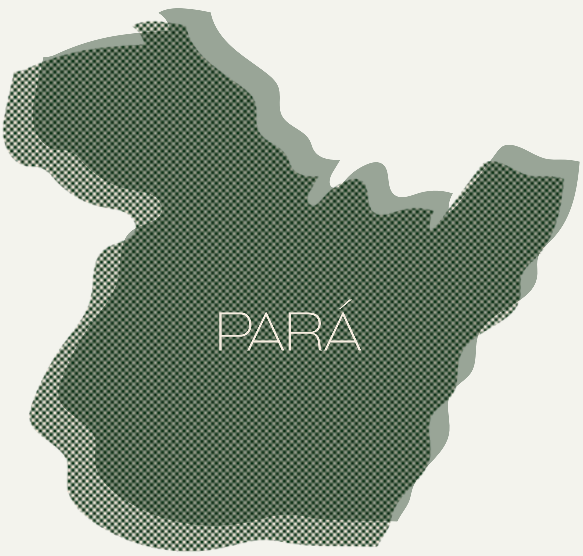
However, due to the maintenance of a high diversity of native tree species in the cabrucas, this system has legal protection, with its management regulated by State Decree No. 10.225/2015[52]. In its Article 15, the decree defines cabruca as "the agrosilvicultural system with a tree density equal to or greater than 20 (twenty) native species individuals per hectare, which is based on cultivation in association with native or exotic tree species in a discontinuous and random manner in the Atlantic Forest biome," bringing strict criteria for the thinning and removal of native tree individuals for the purpose of increasing productivity.

Nevertheless, this decree is seen by a large part of the producers as a barrier to crop renewal, as it implies high costs to effectively remove native individuals and limits the management options adopted by the producer. Since the decree does not include criteria for the removal or pruning of exotic arboreal species, regularized intensification on the farms has occurred through the removal of these individuals which, as studies show, are abundant in the region. This reduction in the abundance of trees, even exotic ones, simplifies the system and negatively impacts the biodiversity and environmental services provided by it.

Although cocoa AFS largely predominates in Bahia, full-sun cocoa is gaining traction, with the promise of high productivity and ease of management and linked to the heavy use of inputs and agrochemicals. As mentioned earlier, production gains do not always reflect economic gains and can compromise the social and environmental gains aggregated to the cocoa production system.

6.2. Pará

In recent decades, cocoa cultivation in Pará has increased significantly, making it one of the most important states for the crop, alongside Bahia. By implementing AFS with cocoa on degraded pasture areas or through the enrichment of *capoeiras* (secondary forests), cocoa has become a strong ally in the conversion of degraded areas into productive ecosystems and environmental compliance. This approach has not only allowed environmental gains but additional income



[52] http://www.inema.ba.gov.br/wp-content/files/Portaria_Conjunta_SEMA_INEMA_03_-_Procedimentos_para_a_concesso_da_Autorizao_de_Manejo_da_Cabruca.pdf

generation to family farmers and small farmers in recent decades. A study led by Embrapa and partners, titled "The sustainable expansion of cocoa *(Theobroma cacao)*" demonstrated that the sustainable expansion of cocoa has been extremely beneficial for the Amazon, integrating job and income generation with forest conservation. In Pará, 70% of the cultivation is done through AFS on degraded areas, mostly by family farmers and small farmers. The result is the recovery of thousands of hectares of degraded lands and the reduction of fire and deforestation and degradation in the region[53]. According to BARBOSA (2025), in the last 17 years, the cocoa AFS has allowed the recovery of 229 thousand hectares.

Pará has one of the highest average productivities in the world, according to data from the **Annual Cocoa Harvest Report in the State of Pará**, a document prepared in partnership by the CEPLAC/MAPA and the Secretariat of Agricultural Development and Fisheries (Sedap)[54]. Currently, Pará's productivity exceeds 900 kg/ha, surpassing by far the national average, currently around 480 kg/ha, and the African continent, the largest global producer with an average of 500 kg/ha. In the municipality of Medicilândia, in the southwest portion of the State, this number is even more impressive: 1,190 kg/ha, making the municipality the largest producer of cocoa beans in the country (SEDAP, 2025)[55]. The report also shows that production increased 3.8% between the years 2023 and 2024 (from 138,449 tons to 143,675 tons) and an increase of 8,172 hectares (5.1% year-over-year) of cocoa cultivation and production.

Data from the Government of Pará regarding the cocoa harvest in the state in 2024[56] observed that 86.6% of cocoa production in the state of Pará is concentrated along the Transamazônica - a 4,260 km-national highway that cuts the Amazon Forest (700 km of which are within the state of Pará). The medium to high-fertility soils combined with the hot and humid climate favor production of cocoa in 11 municipalities, responsible for 85% of all production in Pará[57]. According to a survey by the State Secretariat of Agricultural Development and Fisheries of Pará (Sedap), the municipality of Medicilândia in the Xingu Integration Region is also the main cocoa producer in the State, with more than 44 thousand tons produced annually and 34.69% of Pará's production. In second place is Uruará municipality, with more than 17 thousand tons and 13% of the state production. Other major producing

[54] See at: https://www.sedap.pa.gov.br/node/535
[55] https://agenciapara.com.br/noticia/67827/para-tem-a-maior-produtividade-de-cacau-no-mundo-e-celebra-forca-da-cadeia-sustentavel#:~:text=English%20Version-,Par%C3%A1%20tem%20a%20maior%20produtividade%20de%20cacau%20no,celebra%20for%C3%A7a%20da%20cadeia%20sustent%C3%A1vel&text=O%20Par%C3%A1%20segue%20na%20lideran%C3%A7a,em%20sistema%20agroflorestal%20(SAF).
[56] Available in: https://sedap.pa.gov.br/node/348
[57] https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/folders/cartilha-cacau-do-brasil-versao-portugues.pdf

municipalities in Para state are Anapu, Brasil Novo, Placas, Altamira, Vitória do Xingu, Senador José Porfírio, Tucumã, in southeastern Pará, and Pacajá.

It is worth emphasizing that the state government has implemented a public policy to strengthen the cocoa production chain: **Program for the Development of the Cocoa Production Chain in Pará (Procacau)**. Supported by the state fund **FUNCACAU**, this initiative seeks to position cocoa cultivation as a strategic ally in advancing sustainable agriculture. In its official communications, the state government highlights the regenerative impact of this production system, particularly its role in restoring degraded pasturelands.

6.3. Espírito Santo

In Espírito Santo, the third largest producing state, cocoa is grown in more than 50 municipalities with the participation of 1.4 thousand families. Cocoa occupies a cultivated area of 16,013 hectares in Espírito Santo, with a production of 12,443 tons of beans (SIDRA/IBGE). As in the other producing states, the profile of cocoa-producing properties is small size (family farming). According to a survey conducted by the **Capixaba Institute for Research, Technical Assistance, and Rural Extension (INCAPER)** in 2022, 54.1% of cocoa farmers in the state of own properties up to 30 hectares in size, while 58.2% of cocoa farms have an area smaller than three hectares[58].

Most of the cocoa cultivation in the state (66.7%) is done in consortium with other crops, 23.8% is monoculture of cocoa and 4.8% under cabrucas[59]. Linhares is the municipality with the highest cocoa production, sometimes representing more than 80% of the state's output. The main species cultivated in consortium with cocoa in the state are banana (41.2%), rubber (seringueira) (35.3%), and coconut (11.8%)[60]. The method of cocoa propagation by

[58] https://biblioteca.incaper.es.gov.br/digital/bitstream/item/4248/1/Livro-cadeiaprodutivadocacau-Incaper.pdf
[59] https://biblioteca.incaper.es.gov.br/digital/bitstream/item/4248/1/Livro-cadeiaprodutivadocacau-Incaper.pdf
[60] https://biblioteca.incaper.es.gov.br/digital/bitstream/item/4248/1/Livro-cadeiaprodutivadocacau-Incaper.pdf

grafting is the predominant one in Espírito Santo, using graft and seminal rootstock, with clonal seedlings by cutting also found in large quantities. Seminal propagation occurs in smaller numbers.

The State Government, seeking to minimize the problems faced by rural producers, launched in 2012 the **Program for the Revitalization of Cocoa Producing Areas**. This program is based on the renewal and/or revitalization of areas under the *cabruca* system affected by Witches' Broom, aiming to provide cocoa farmers with alternatives for re-establishing the economic, social, and environmental performance of the activity[61].

Since its launch, the program set out to rehabilitate 2,000 hectares of diseased cocoa plantations annually and achieve a production target of 14,000 tons of beans per year by 2015[62]. Although there was a sharp 26% decline in production between 2013 and 2018, the last six years have shown a steady upward trend. Notably, this recovery occurred despite a reduction in cultivated area, indicating a significant increase in productivity across the state. This improvement is linked to enhanced management practices, including the adoption of precision irrigation and the use of high-yielding clonal and grafted genetic materials. These strategies—especially the implementation of efficient irrigation systems and the propagation of superior seedlings—have proven essential to boosting cocoa production in the region[63].

In addition to the Revitalization Program, the state has established a Payments for Ecosystem Services (PES) initiative designed to channel financial incentives toward the restoration and preservation of water bodies. This program also provides funding to support the implementation of cocoa-based AFS, with a particular focus on small rural producers who dedicate, part of their land to environmental conservation or sustainable agricultural practices.

Family farming in Espírito Santo is further distinguished by the vertical integration of cocoa production, particularly through post-harvest processes that yield high-quality fine cocoa recognized at both national and international levels. This advancement has been driven by the adoption of best post-harvest management practices and by the growing momentum of the "bean-to-bar" movement within the state. The number of artisanal chocolate brands has increased dramatically, from just three brands four years ago to more than 40 today, underscoring the sector's rapid growth and significant value-added potential[64].

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[61] https://incaper.es.gov.br/fruticultura-cacau
[62] https://incaper.es.gov.br/fruticultura-cacau
[63] https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/folders/cartilha-cacau-do-brasil-versao-portugues.pdf
[64] https://aipc.com.br/espirito-santo-ja-conta-com-40-marcas-de-chocolate-de-fabricacao-artesanal/

6.4. Comparisons of Bahia and Pará production

The Table 6a presents a summarized comparison of the main features of the two major cocoa-producing states in Brazil, Bahia and Pará. Note that different numbers provided for Production by the two consulted sources, the IBGE and the AIPC, related to the different methodologies applied by each institution.

Table 6a. Main characteristics of the largest cocoa producing states in Brazil.

Characteristics	Bahia	Pará
Predominant Cultivation System	Cabruca	Cocoa AFS on degraded lands with high technical inputs
Productivity and Expansion	Productivity is still limited by low-technical inputs. Production is concentrated in the south of the state, mainly in Ilhéus and Itabuna municipalities	Because it is one of the largest national cocoa producers in recent years, holding the highest productivity level nationwide. The region has a high potential to expand production and productivity and increase its quality because of the good adaptation to the Amazonian climate conditions
Environmental Sustainability	Cabruca is considered an ecologically sound practice, as it reduces environmental impact and maintains the forest. It is recognized as an example of sustainable commodity and is receiving payments for environmental services (PES) in some projects	The advancement of cocoa AFS on degraded lands in the Amazon is considered a sustainable practice, but it requires close attention to illegal deforestation in future expansion of cocoa production
Producer Profile and Land Structure	Most of the production is done by family, small and medium producers. There is a strong cultural identity linked to production. Family farming accounts for 80%	Production is more diversified, including everything from small to large landowners and agroindustry. The interest of new investors has boosted cocoa expansion recently
Quality and Specialty Markets	The region has a tradition in the production of fine cocoa, with several internationally awarded beans and chocolate. Bahian cocoa is recognized in the premium and bean-to-bar chocolate market	Although the focus is still on volume, the state has expanded its presence in the fine cocoa and chocolate market, with emphasis on certification, traceability, and organic production projects under AFS
Production in 2024	137,028 tons, 46.1% of national production, according to IBGE, (2025)[65] 106,481 tons, 59% of national production, according to AIPC[66]	137,455 tons, 46.2% of national production according to IBGE, (2025)[67] 65,654 tons, 37% of national production, according to AIPC[68]

[65] See at: https://www.ibge.gov.br/explica/producao-agropecuaria/cacau/br
[66] See at: https://aipc.com.br/estatisticas/recebimento/
[67] See at: https://www.ibge.gov.br/explica/producao-agropecuaria/cacau/br
[68] See at: https://aipc.com.br/estatisticas/recebimento/

7. SOCIO-ENVIRONMENTAL IMPACTS OF THE COCOA SUPPLY CHAIN IN BRAZIL

7.1. Opportunity for Environmental Compliance through the Recovery of degraded lands with Cocoa-Agroforestry Systems (AFS)

The main law governing the protection of native vegetation in Brazil is the Federal Law of Native Vegetation Protection (Law nº 12.651/2012) and is popularly known as the "New Forest Code". Through this law, two essential legal instruments were created to be executed by the state governments: the Rural Environmental Registry (CAR), with the objective of identifying the surplus and deficit of vegetation required by the law in all on rural properties, and the Environmental Regularization Program (PRA), to enable the regularization of environmental liabilities in Permanent Preservation Areas (APP) and Legal Reserve (RL) areas (Instituto Escolhas, 2023)[69]. The legal requirements are very depending on the biome in which the rural property is located and in some cases on the status of the Economic and Ecologic Zoning. Two Federal Decrees, No. 7.830/2012 and No. 8.235/2014, were established to provide operational guidelines for the

[69] Instituto Escolhas. Estratégias de recuperação da vegetação nativa em ampla escala para o Brasil. Relatório Técnico. São Paulo, 2023. See at: https://escolhas.org/wp-content/uploads/2023/09/Relatorio_RecuperacaoVegetal_Final.pdf. Accessed on: September 15, 2025.

CAR and to set forth general rules for PRA implementation. These decrees delegated to the state governments the responsibility of tailoring PRA regulations to local conditions through specific legislation. By the end of 2024, 19 states and the Federal District had already enacted their respective PRA regulations (Lopes et al., 2024).

The effective restoration of native vegetation in altered or degraded rural areas, as mandated by the Forest Code, plays a crucial role in meeting **Brazil's Nationally Determined Contribution (NDC)** under the Paris Agreement. It also aligns with the goals of the **National Plan for the Recovery of Native Vegetation (PLANAVEG)**, which targets the restoration and reforestation of 12 million hectares of forests and degraded lands by 2030 (BRASIL, 2015)[70]. The PLANAVEG is the main implementation

[70] Brasil. "Intended Nationally Determined Contribution (iNDC): Towards achieving the objective of the United Nations Framework Convention on Climate Change". Brasília: República Federativa do Brasil, 2015. See at: https://antigo.mma.gov.br/images/arquivo/80108/BRASIL%20iNDC%20portugues%20FINAL.pdf. Accessed on: September 15, 2025.

instrument of the **National Policy for the Recovery of Native Vegetation *(Proveg)***, instituted by Decree No. 8.972, of January 23, 2017, which has as one of its guidelines, the improvement of the regulatory environment and the increase of legal security for the recovery of native vegetation for ecological purposes and economic exploitation. As specified in its latest version (2025-2028), the PLANAVEG "aims to foster AFS that combine native species necessary for the ecosystem balance of the biomes and territories, attracting resources for concrete and integrated actions for the environmental compliance and regularization of rural properties in a connected way with low-carbon agricultural practices, based on the logic of a functional rural property."

Other relevant national policy is the **National Plan for the Conversion of Degraded Pastures (PNCPD)**[71] with the objective of recovering 40 million hectares of low-productivity pasture in agricultural areas and having AFS as one of the investment modalities, and the **Brazilian Agricultural Policy for Climate Adaptation and Low Carbon Emission (ABC+ Plan)**[72], with the objectives of promoting adaptation to climate change and mitigating greenhouse gas (GHG) emissions in Brazilian agriculture, with increased efficiency and resilience of production systems through integrated landscape management[73]. Thus, PLANAVEG, PNCPD, and ABC+ are presented as "national strategies for the recovery of degraded areas," and for this, "they presuppose a systemic reading of territorial intelligence, which allows strategic decisions about the best possible combination between the conversion of pastures into sustainable productive systems and the recovery of native vegetation for the purposes of biodiversity conservation and climate and water rebalancing, generating food security, work, and income, especially for the poorest populations, while strengthening Brazilian agribusiness." This is the concept of **"Regenerative Agriculture (AR)"**, a term which, according to Mangabeira et al. (2025), the term refers to "a production system based on a set of agricultural practices that aims to reverse the depletion of natural resources caused by agriculture models based on external chemical inputs, aggressive to soil life and not adapted to local environments." Therefore, through sustainable agricultural practices, AR aims to reconcile environmentally healthy agricultural production, seeking to harmonize the health of the soil and cultivars with the conservation, rehabilitation, and restoration of ecosystems, making agriculture more resilient to climate change.

[71] See at: https://www.gov.br/agricultura/pt-br/assuntos/noticias/governo-federal-institui-programa-nacional-de-conversao-de-pastagens-degradadas

[72] https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/planoabc-abcmais/publicacoes/abc-sumario-executivo-2022-ingles.pdf

[73] Assad, E. D. et al. Role of the ABC Plan and Planaveg in the adaptation of crop and cattle farming to climate change. Working Paper. São Paulo, Brazil: WRI Brasil. Available online at: https://wribrasil.org.br/pt/publicacoes

Together, PLANAVEG, the PNCPD, and the adoption of AR models constitute essential strategies for enabling the recovery of the country's environmental liabilities, which are estimated at 23.78 million hectares. This deficit includes altered and/or degraded areas in rural settlements (APP and RL liabilities), rural properties (APP and RL liabilities), Indigenous Lands, and federal Conservation Units. In other words, the estimated deficit is nearly double the national restoration target of 12 million hectares. While recognizing the challenges to achieve this ambitious goal of vegetation and pasture recovery, the imminent opportunity of these actions as drivers of the **National Bioeconomy Development Plan**[74] is also notable, through the adoption of sustainable agricultural practices, reconciling environmental conservation and socioeconomic development. The adoption of these regenerative practices will allow the country to expand its cultivated area without encroaching on natural ecosystems, offering unique market opportunities. This situation is especially favorable for Brazilian cocoa, as this commodity is one of the main causes of deforestation and degradation in some African countries.

In this sense, the promotion of the development of sustainable productive activities is one of the pillars of the **Law of Native Vegetation Protection (Instituto Escolhas, 2023)**[75] and other public policies relevant to the sustainable development of Brazil. An example is the use of economic or productive restoration models for the regularization of environmental liabilities, with the possibility of implementing AFS and the sustainable management of products generated by these systems in Legal Reserve and APP areas, in this case, on small rural properties or holdings, including areas in *quilombola*[76] territories, Indigenous lands, and conservation units.

One of these legal provisions is briefly presented below to better recognize this opportunity to use AFS as a method for the recovery of vegetation and degraded lands in areas of environmental liability, with a focus, when possible, on cocoa AFS.

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[74] See at: https://www.gov.br/mma/pt-br/composicao/sbc/dpeb/plano-nacional-de-desenvolvimento-da-bioeconomia
[75] Instituto Escolhas. Estratégias de recuperação da vegetação nativa em ampla escala para o Brasil. Relatório Técnico. São Paulo, 2023. See at: https://escolhas.org/wp-content/uploads/2023/09/Relatorio_RecuperacaoVegetal_Final.pdf. Accessed on: September 15, 2025.
[76] Quilombola territory are areas in Brazil traditionally occupied by communities of descendants of African people who escaped slavery and established independent settlements known as quilombos.

7.1.1. Agroforestry Systems as a Method for Recovery of Vegetation and Degraded lands in Legal Reserves and APP

Restoration is an important science with specific definitions for technical terms. To avoid any misuse of key concepts related to restoration, this document follows the specific definitions established by the Society for Ecological Restoration (SER), which considers ecological restoration, here referred to simply as restoration, as "the process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed (SER 2004)." Thus, it is important to highlight that, for the sake of this document, we consider that the local establishment of cocoa AFS is primarily intended to produce this commodity, not to specifically recover a natural ecosystem. Although we have adopted this more restricted and well-defined concept of restoration throughout the document, we make exceptions when specific and important laws establish the contrary; that is, when laws specifically adopt a broader definition of restoration to include AFS. In addition, the establishment of any agroforestry can also be viewed as a tool for revegetation, which is the "establishment, by any means, of plants in locations (including terrestrial, freshwater, and marine areas) that may or may not involve local or native species." Indeed, by revegetating areas previously devoid of tree cover, AFS can contribute significantly to ecological restoration at the landscape scale. They can act as ecological corridors or stepping stones, connecting previously isolated fragments and allowing the flow of species and ecological processes. Depending on their composition and structural complexity, agroforests can serve as habitat for some biological elements, therefore being a source for optimizing passive restoration of entire landscapes.

A clear definition of the use of AFS for vegetation recovery is provided by the **Environmental Regularization Program** (PRA), a legal administrative instrument (State Decree 48.127/2021)[77] established by the State of Minas Gerais allowing rural landowners to **regularize environmental liabilities**: "Successional Agroforestry Systems – SAFS: a system of use and occupation of the soil in which perennial woody plants are managed in association with herbaceous plants, shrubs, agricultural crops, and fodder in the same management unit, with interactions between these

[77] See at: https://www.almg.gov.br/legislacao-mineira/texto/DEC/48127/2021/. Available in: 15/09/2025.

components and some degree of native species diversity, which is conducted in a way that reproduces the ecological processes, structure, and environmental functions of the native vegetation originally present in that ecosystem."
To enable the economic use of protected areas, the Forest Code allows, under

certain limitations, the use of exotic[78] species to promote vegetation recovery. A summary of these possibilities is presented in the study by **Instituto Escolhas (2023)[79]**, pointing out the following:

• In the APPs of small rural holdings or properties, the intercropping of exotic non-timber woody species, perennial or long-cycle, and native species is allowed, aiming at sustainable agroforestry management. In the Legal Reserve areas, this possibility of intercropping of natives with exotic species is permitted for any property size.

• In plantings, regardless of the location and classification and size of the rural property, the temporary cultivation of non-invasive herbaceous or shrub exotic species (annual agricultural crops or green manure species) is allowed. The use of these species at the beginning of the recovery is seen as a strategy to help improve soil conditions, control grasses with invasive potential, and favor the establishment of native vegetation, while also potentially reducing maintenance costs and even generating income from the commercialization of cultivated agricultural products.

• In the use of exotic species, the following parameters must be observed: the planting must be combined with native species of regional occurrence, in a consortium manner; the area recovered with exotic species is limited to 50% of the total area; the economic exploitation of these species is permitted through sustainable forest or agroforestry management.

• In the planting of exotic arboreal species in a Legal Reserve area, the following principles and guidelines must be observed: the system must be conducted in a way that promotes the succession of native vegetation; the use of agrochemical inputs must be restricted only to those authorized for application in these locations; the use of problematic species, such as invasive exotic, should be avoided.

Although the Forest Code presents the opportunity for the use of productive restoration models for the recovery of native vegetation for compliance purpose, there are provisions to regulate the exploration of AFS and sustainable forest management. These practices, including the harvest of non-timber forest products, when undertaken on small rural properties or family holdings, or developed in territories of traditional peoples and communities, are considered activities

[78] Exotic species are cited because cocoa is considered native in a large part of the phytophysiognomies of the Amazon biome, but an exotic naturalized species in the Atlantic Forest, such as in the forests of Bahia, where it can be found growing spontaneously in the forests of this biome.
[79] Instituto Escolhas. Estratégias de recuperação da vegetação nativa em ampla escala para o Brasil. Relatório Técnico. São Paulo, 2023. See at: https://escolhas.org/wp-content/uploads/2023/09/Relatorio_RecuperacaoVegetal_Final.pdf. Accessed on: September 15, 2025.

of social interest and low environmental impact, and can be carried out in APPs and in Legal Reserve areas, provided they do not impact the existing native vegetation cover or impair the environmental function of the area. In medium and large properties (properties larger than 4 Fiscal Modules), the economic exploitation of native vegetation is restricted to the Legal Reserve areas.

Given the prerogatives presented, it can be considered that cocoa-AFS, particularly the traditional cabrucas are a great opportunity for the environmental regularization of rural properties under the new Forest Code. In Bahia, the cabruca system stands out as a powerful strategy for conserving the Atlantic Forest biome, while also serving as a landscape, cultural, economic, and socio-environmental heritage of the cocoa-producing regions. Its significance is such that State Decree No. 15.180/2014[80], which outlines the state's Environmental Regularization Program, includes a dedicated section titled *"Section IV – Of the Cabruca Agroforestry System."* Under this decree, cabrucas are defined as an "agrosilvicultural system characterized by at least 20 native tree individuals per hectare, where cocoa is cultivated in association with native or exotic tree species in a discontinuous and random pattern within the Atlantic Forest biome". Regarding the management of cabrucas, the thinning of tree species is conditioned to the maintenance of a minimum of 40 (forty) native species individuals per hectare, and the suppression of rare or endangered species is not permitted. Furthermore, the management of cabruca is authorized for the maintenance of cocoa tree productivity and the conservation and sustainable use of the agroecosystem. This can be accomplished through ecological enrichment of the area, conserving young individuals of native species, maintaining or rehabilitating ecological functionalities, and the via sustainable management and use of products and by-products originating from the native and exotic species existing in the area under the cabruca system.

Building on Bahia's initiative to promote cocoa AFS as a restoration strategy to comply with the Forest Code, the State of Pará introduced its own regulatory framework through a joint Normative Instruction (IN) SEMAS/IDEFLOR-BIO No. 07/2019. This regulation establishes specific criteria and procedures for the recovery of Legal Reserve (RL) areas using cocoa cultivation. Beyond outlining the technical and legal parameters for cocoa planting within Legal Reserves, the instruction emphasizes the collaborative role of environmental agencies, partner institutions, and

[80] Under Brazilian law, small properties are those with an equivalent area of up to 4 fiscal modules, which are units varying between 5 and 110 hectares, depending on the municipality. Therefore, a small property in the country can have a total area between 20 and 440 hectares. https://www.legisweb.com.br/legislacao/?id=270968. Accessed on: September 15, 2025.

rural producers. It encourages the development of research, training programs, knowledge exchange, technical assistance, and rural extension services focused on advancing cocoa agroforestry. The regulation also mandates the monitoring and evaluation of environmental, social, and economic outcomes resulting from its implementation. The release of this Normative Instruction is regarded as a regulatory milestone, providing legal certainty for producers in Pará who seek to recover RL areas through the adoption of cocoa AFS[81].

Regarding the use of economic restoration methods for the recovery of vegetation deficit in Permanent Preservation Areas (APPs) or Legal Reserves (RLs), it is important to highlight that such approaches are permitted only when deforestation occurred prior to the legal cutoff date of July 22, 2008, as established by the new Forest Code (Law No. 12.651/2012). According to this legislation, any native vegetation cleared after this date is classified as illegal deforestation and must be recovered exclusively for ecological purposes, without the possibility of integrating productive or commercial activities.

In summary, AFS with multiple species and agroecological principles have demonstrated positive economic, social, and environmental performance, and should be encouraged as a method of promoting sustainable agriculture, in contrast to the predominant development model where land use change occurs through deforestation and environmental degradation for conventional agricultural practices (Instituto Escolhas, 2023)[82].

[81] See at: https://agenciapara.com.br/noticia/15133/estado-cria-marco-regulatorio-para-plantio-de-cacau. Available in September 15, 2025.
[82] Instituto Escolhas. Estratégias de recuperação da vegetação nativa em ampla escala para o Brasil. Relatório Técnico. São Paulo, 2023. See at: https://escolhas.org/wp-content/uploads/2023/09/Relatorio_RecuperacaoVegetal_Final.pdf. Accessed on: September 15, 2025.

7.2. Ecosystem Services

7.2.1. Carbon

Among the environmental services provided by cocoa AFS is the capacity of these systems to remove and store carbon and therefore, to mitigate climate change. Seeking a better understanding of the positive impacts of cocoa AFS for global warming mitigation, studies on carbon stocks in the different reservoirs of this element have been conducted worldwide, making it possible to quantify the potential of cocoa AFS as atmospheric carbon sinks.

In cocoa AFS, carbon stock estimates vary considerably, mainly depending on the composition and density of the predominant tree species, which hold most of the stored carbon in the above-ground biomass reservoir, also accelerating and increasing stocks in other reservoirs such as the litter and the soil, in the process of organic matter cycling. In this regard, despite the lower number of trees in the system compared to cocoa plants, the larger, shading tree species contribute proportionally the greatest amount of carbon stock to the system.

In Southern Bahia, Santos et al. (2021) estimated carbon stock on 17 cocoa-producing properties under the cabruca system, including other information such as floristic diversity, shading levels, and management intensity. The results indicate that the sampled cabrucas showed an average of 61 MgC/ha), with variations between 31 MgC/ha and 110 MgC/ha. In the same region, Schroth et al. (2016) estimated average above-ground carbon stocks of 87 MgC/ha in traditional cocoa AFS and 46 MgC/ha in intensified systems. The authors warn that the low carbon stock values of intensified cocoa AFS, almost half the average stock of traditional cabrucas, indicate a threat to the landscape C stocks due to current trends of intensification, which generally involves increasing the density of cocoa and other arboreal crops and reducing the density of large shading trees.

In the Amazon, these values also varied considerably. Brancher (2010) studied the carbon stock of above-ground tree biomass and soil in four AFS in Tomé-Açu-PA, in the Eastern Amazon, of which two of them were composed of cocoa, açaí, banana, and other trees species such as rubber, *macaúba, paricá,* and *taperebá*. At 14 years of age, the estimated average carbon varied between 40 and 44 MgC/ha. Santos et al. (2004) studied the above-ground biomass and carbon of seven 12-year-old cocoa and *várzea* açaí AFS in Cametá-PA, formed by managing already exploited natural forest, a characteristic practice of *cabruca* formation. The authors estimated the average biomass stock at 298.4 Mg/ha. This average biomass stock is equivalent to 140.2 MgC/ha. In the referenced study, cocoa, which represented 26% of the sampled individuals in the survey, contributed only 1.45 t/ha of biomass, or 0.68 MgC/ha, representing only 0.5% of the total carbon stored in the system, considering a 47% carbon fraction in biomass. Açaí, with 54% of the sampled individuals, contributed 4.47 MgC/ha or 1.5% of the total carbon in the system. This demonstrates that cabruca agroforests, formed in areas previously composed of ancient forests, the understory plants represented by cocoa and açaí have little relevance in the total carbon stock of the system when compared to the remnant trees maintained in the cabruca.

Pereira Neto (2012) analyzed the carbon stock of AFS in a municipality in the BR-230 region (Transamazônica Highway) in the state of Pará, with different planting ages and composition of shading plants. The estimates of biomass stock in cocoa AFS reported by the author vary from 111.8 Mg/ha for 10-year-old plantings, 297.3 Mg/ha for 28-year-old plantings, and 419.3 Mg/ha for 32-year-old plantings, which are equivalent to 52.6, 139.7, and 197.1 MgC/ha, respectively. Of this total, the carbon stock of the cocoa plants represented 36%, 30%, and 25%.

For the sake of comparison, we present here the results of an extensive sampling by Somarriba et al. (2013) to estimate carbon stock in cocoa AFS across five different countries in Central America. The average age of the sampled plantings was 23.5 ± 12.0 years, and the average tree density was 866 ± 296 plants/ha, with the density of cocoa plants/ha in the system being 545 ± 192. The results point to an average total carbon stock in the systems of 117 ± 47 MgC/ha, with large differences between the sample plots (46–333 MgC/ha). The average carbon in the above-ground biomass for the total samples was 49 ± 35 MgC/ha. Of the total above-ground carbon, 18.3% is represented by the stock of cocoa plants (9.0 ± 5.1 MgC/ha). The average carbon in the below-ground biomass (roots) was 11.5 ± 7.9 MgC/ha. Thus, the average carbon stock in tree biomass is estimated at 60.5 MgC/ha, which includes both the carbon of the cocoa plants and the shade species that compose the canopy layer of AFS.

These results underscore a significant contribution of cocoa AFS to regional carbon stocks. For example, Schroth et al. (2016) estimated that cabruca systems in Southern Bahia store 51% of the region's above-ground carbon within forest biomes. Beyond their role in carbon storage, these systems also function as active carbon sinks. In Southern Bahia, Faria et al. (2025) analyzed data over a seven-year period on the structure and dynamics of cabruca systems established more than 20 years ago. They reported an average annual mean increment

(IMA-C) of 3.14 MgC/ha/year, slightly exceeding the average found in Central American studies (2.6 ± 2.4 MgC/ha/year, Somarriba et al. 2013). Further supporting this potential, Pereira-Neto (2012) modeled carbon stocks in cocoa AFS, estimating a total of 163.5 MgC/ha over 30 years, including both above- and below-ground biomass. This corresponds to an IMA-C of 5.7 MgC/ha/year. Applying the IPCC root-to-shoot ratio of 0.221[83], the above-ground biomass increment is estimated at 4.4 MgC/ha/year, surpassing previously reported averages. These values are comparable to carbon sequestration rates in advanced successional forests in southeastern Brazil, which average 2.4 MgC/ha/year and range from 0.2 to 7 MgC/ha/year (Maia et al. 2025).

The climate mitigation potential of cocoa agroforestry is also evident in studies from Africa. Asigbaase et al. (2021) conducted a comparative analysis of 42 organic cocoa agroforests and 42 conventional full-sun plantations in Ghana, evaluating biomass and carbon stocks across three age categories: young (≤15 years), mature (16–30 years), and old (≥31 years). Their findings revealed that:

• Above-ground biomass carbon in cocoa AFS averaged 41.3 ± 3.62 MgC/ha, nearly double that of conventional systems (22.9 ± 2.60 MgC/ha).

• Below-ground biomass carbon was 7.8 ± 0.67 MgC/ha in cocoa AFS versus 4.2 ± 0.66 MgC/ha in conventional ones.

• Soil carbon stocks were also higher in agroforestry systems (59.7 ± 3.36 MgC/ha) compared to conventional ones (49.7 ± 3.33 MgC/ha).

A key insight from the study is that dominant shade tree species—averaging 15 per system—accounted for over 70% of vegetation carbon stocks in both organic and conventional systems. This underscores the importance of maintaining or introducing shade trees to enhance the climate resilience of cocoa production, regardless of the cultivation model.

Higher carbon stocks and levels of shade are generally associated with yields below the regional average. In the municipality of São Félix do Xingu,

[83] 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories;Vol. 4, Chapter 4 – Forest Land, Table 4.4, pag 4.18. https://www.ipcc-nggip.iges.or.jp/public/2019rf/vol4.html

state of Pará, BONAMICO (2017) studied the relationship between above-ground carbon stock and cocoa productivity in AFS. The results demonstrate that AFS with an average of 14.4 ± 4.9 years of planting and an average Canopy Cover Index (CCI) of 28 ± 23%, produced an average of 354.32 kg of dry cocoa beans/ha/year, with an average stock of 13.5 MgC/ha in cocoa trees and 16.1 MgC/ha in shade trees, totaling 29.6 MgC/ha. The study also showed that there is a negative non-linear correlation between the canopy cover index or total above-ground carbon stock and productivity. The plot with the best carbon/productivity ratio, which had a canopy cover index greater than the average (CCI of 49%), had a productivity of 501 kg/ha/year. Moreover, the total above-ground carbon estimate was 29.4 MgC/ha, with 17.9 represented by shade trees and 11.5 MgC/ha by cocoa trees. However, such trade-off between production and shade seem to be more complex. In Bahia, Schroth et al. (2016) investigated such a relationship, and showed that yield levels of up to 585 kg/ha — practically double the regional productivity at the time (285 kg/ha) — and carbon storage of up to 65 MgC/ha of above-ground biomass allocated in shade trees with DBH >30 cm, are compatible with shading of up to 55%.

Another essential climate-related factor in agricultural production is the balance between greenhouse gas (GHG) emissions and removals. Given their ecological characteristics, cocoa AFS — particularly when compared to conventional agricultural models — offer clear advantages in terms of climate impact. Until recently, the cocoa sector lacked a dedicated tool for assessing GHG emissions, relying instead on general protocols such as those provided by the Cool Farm Tool. Using this methodology, Schroth et al. (2016) conducted a study on 26 cabrucas in Southern Bahia, revealing that the primary source of GHG emissions was the application of fertilizers. Despite this, overall emission levels were intermediate (< 0.5 kg CO_2e/kg of cocoa) to low (< 0.25 kg CO_2e/kg of cocoa), values equivalent of 0.13 and 0.06 kgC/kg of cocoa. The same study also highlighted that while increased fertilizer use can enhance productivity, other limiting factors — such as shade levels — play a significant role. This underscores the need for careful viability assessments that weigh productivity gains against economic costs and environmental impacts, to ensure that cocoa AFS remains both sustainable and climate-resilient.

Compiled information on the carbon storage potential in different cocoa production systems can be found in Table 7a.

Table 7a. Information on carbon storage in different cocoa production systems.

Region	System	Age (years)	Source	Total Carbon (MgC/ha)	Carbon equivalent (MgCO2e/ha)[1]	Reference
BR-230 - Pará	Cabruca/AFS	10	AGB	53	194	Pereira Neto (2012)
BR-230 - Pará	Cabruca/AFS	28	AGB	140	513	Pereira Neto (2012)
BR-230 - Pará	Cabruca/AFS	32	AGB	197	722	Pereira Neto (2012)
Sul da Bahia	Traditional cabruca	S/I	AGB	87	319	Schroth et al. (2016)
Sul da Bahia	Traditional cabruca	S/I	Total	61 (31-110)	242 (115-402)	Santos et al. (2021)
Sul da Bahia	Intensified cabruca	S/I	AGB	46	169	Schroth et al. (2016)
Cametá-Pará	Cacao/açai AFS	12	AGB	140 (60-189)	514 (222-694)	Santos et al. (2004)
Tomé-Açú -Pará	Diversified cocoa AFS	12	AGB	42 (40-44)	154 (147-161)	Brancher (2010)
São Felix do Xingu - Pará	Diversified cocoa AFS	14	AGB	30	109	Bonâmico (2017)
América Central	Diversified cocoa AFS	23	Total	117 (46-333)	429	Somarriba et al. (2013)
América Central	Diversified cocoa AFS	23	AGB	49	180	Somarriba et al. (2013)
Gana - África	Cocoa AFS	Variável	AGB	41,3	151	Agibbaase et al. (2021)
Gana - África	Full-sun cocoa	Variável	AGB	22,9	84	Agibbaase et al. (2021)

[1.] The conversion factor of MgCO2e to MgC is 3.66.

Using the same general GHG assessment tool, a Nestlé study reported distinct emission values across different cocoa production systems. Cabruca systems showed emissions ranging from 1.02 to 1.92 $MgCO_2e$/ha (~0.52MgC/ha), while full-sun plantations ranged between 1.44 (0.39 MgC/ha) and 1.75 $MgCO_2e$/ha (0.47MgC/ha). In contrast, agroforestry systems (AFS) in consortium arrangements demonstrated lower emissions, between 0.95 and 0.98 $MgCO_2e$/ha (0.25-098MgC/ha). However, the use of varied methodologies and tools for estimating GHG emissions poses a significant challenge to the sector because it undermines comparability, precision, and transparency, which are essential for aligning climate strategies given the economic, social, and environmental relevance of cocoa as a global commodity.

To address this gap, in February 2025, the World Cocoa Foundation (WCF), in partnership with Quantis, launched a GHG inventory tool for the cocoa sector. This initiative marks a critical step toward the standardization of emissions accounting, enabling more consistent and credible climate action across the value chain.

7.2.2. Biodiversity

In tropical regions, extensive forest conversion and agricultural expansion are widely recognized as the main drivers of land-use change and biodiversity loss (Sala et al., 2000; Wright, 2005). In this context, AFS are usually recognized as biodiversity-friendly agricultural practices, capable of harboring a wide variety of species and providing multiple ecosystem services. However, the capacity of AFS to support biodiversity depends on local factors, such as species composition and structural complexity, as well as on the surrounding landscape context. One of the most well-studied AFS in Brazil that harbors the most biodiversity are the cabrucas of Southern Bahia (for a detailed synthesis, see Faria and Cassano 2024). Many studies show that cabrucas with diverse floristic composition and a well-developed canopy layer harbor up to two-thirds of the species diversity found in natural environments. Although there is a predominance of generalist species that live in altered environments, a huge portion of species associated with mature forests also utilize these cabrucas. This includes several plant species currently threatened with extinction, such as *Platymenia reticulata*, *Cedrela fissilis*, and *Petorocarpus rohnii*, which are now quite rare in remnant forests due to extensive exploitation.

Several endangered fauna species, such as *Leontopithecus chrysomelas, Bradypus torquatus, Callistomys pictus*, and *Acrobatornis fonseca*i, use cabrucas as refuges for survival (Cassano et al, 2009). However, most forest species present in cabrucas originate from adjacent forests. In other words, the greater the native forest cover in the landscape where a given cabruca is inserted, the more forest species can be found. Therefore, structurally complex cabrucas inserted in landscapes with large remnant forest cover contain the most native forest species. However, it is also important to highlight that even impoverished cabrucas located in deforested landscapes are important for maintaining part of the regional biodiversity because they represent the only refuges with forest characteristics. By integrating cocoa with other native trees, fruits, and plants, these AFS generate income for farmers and aid in the recovery of degraded areas, making production more resilient and balanced in terms of agriculture production and forest conservation, as found in the

Amazon and the Atlantic Forest (Senar, 2017[84]; Imaflora, 2022[85]).

It is important to emphasize that biodiversity in full-sun cocoa cultivation is very low when compared to systems like cabruca or AFS because monoculture reduces species diversity (Maney et al. 2022) and increases susceptibility to pests and diseases (Veloso et al., 2025). For example, the low diversity of soil microbiota due to lesser production of litter compared with cocoa-agroforestry severely limits decomposition and release of organic components that are essential for plant´s development and make these systems more dependent of chemical inputs and more vulnerable to degradation (Maney et al. 2022).
Beyond their capacity to retain biodiversity at the local level, cocoa AFS offer a range of environmental benefits, particularly in highly deforested and fragmented landscapes. These systems provide the following benefits:

- Provide habitats for species that can tolerate moderate levels of disturbance.
- Help reduce the conversion of natural habitats by lowering pressure to clear additional land for agriculture.
- Support the integrity of remaining forest fragments by functioning as ecological corridors or stepping stones, thereby enhancing landscape connectivity and permeability.
- Deliver vital ecosystem services, including carbon sequestration, and improvements in air, water, and soil quality, while actively contributing to biodiversity conservation (Martins, 2013).

Furthermore, AFS can alleviate resource use pressure in protected areas, improving habitats for some wild species and increasing the connectivity of landscape components, thus making conservation more effective (McNeely; Schroth, 2006). Bhagwat et al. (2008) compiled evidence from studies in the tropics, where the richness and species composition of AFS are compared with those of neighboring forest reserves, and concluded that several examples in the tropics showed that a substantial proportion of the biodiversity of forest reserves is represented in agroforests. Thus, the maintenance and creation of habitats in human-dominated landscapes can help conserve a large proportion of biodiversity. Also, Bhagwat et al. (2008) suggests that agroforests with a high canopy cover exhibit high species richness and are more similar to neighboring forest reserves than agroforests with intensive management and open canopy.

It is important to highlight that biodiversity loss can affect the resilience of agricultural landscapes (see Redhead

[84] See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/informe-ao-cacauicultor/manejo/cartilhas-senar/199-sistemas-agroflorestais.pdf
[85] See at: https://acervo.socioambiental.org/sites/default/files/documents/m6d00059.pdf

et al. 2020). Among the components of biodiversity whose loss produces the most notable impacts on agriculture are the natural enemies of pests and the pollinators. There is substantial evidence that the preservation of biodiversity within and around agroecosystems plays a fundamental role in maintaining the population dynamics of natural enemies of pests (Altieri, 1999). Furthermore, pollinators play an important functional role in most terrestrial ecosystems and represent a vital ecosystem service for the maintenance of wild plant populations and for agricultural productivity. In a tropical environment, 94% of flowering plant species depend on pollinators in one form or another (Ollerton et al., 2011). The main pollinators of cocoa are composed of at least two species of aphids, *Aphis gossypii* and *Aphis (toxoptera) aurantii*, being essential for fruit formation and cocoa productivity (Nakayama, 2023).

Finally, Alarcon et al. (2022) stated that despite the body of evidence demonstrating the positive effects of AFS on soil quality, habitat, and gene pool, their establishment and management must be carefully conducted to harness the full potential and synergies of multiple ecosystem services. The authors stated that, despite AFS not performing as well as pristine native vegetation in relation to habitat and soil quality, ecological AFS performed quite similarly compared to more simplified production systems, such as average traditional agriculture (slash-and-burn), pastures, or monocultures.

7.2.3. Water and Microclimate

In Brazil, AFS are particularly relevant in Pará, Acre, Minas Gerais, Mato Grosso, and other states on the South and Northeast regions, possibly due to the system's effectiveness in maintaining water, microclimate, and regenerating soil fertility (Schembergue et al., 2017). AFS are used by farmers for adaptation to climate change, mainly considering temperature and rainfall (Schembergue et al., 2017; Tschartntke et al., 2011).

In Brazil, the adoption of AFS in municipalities with lower average rainfall demonstrates that farmers consider them as a climate change adaptation strategy (Schembergue et al., 2017). The shade of the trees that compose the AFS provides a favorable microclimate for crop development, reducing the incidence of solar energy, air temperature, wind, and evapotranspiration. AFS also add social and economic value, as they reduce family vulnerability to climatic stress, pest outbreaks, price drops, and food insecurity (Tschartntke et al., 2011).

Cocoa AFS is considered a sustainable alternative to annual cultivation systems and shifting cultivation, as they are profitable and can provide multiple environmental services, including soil and water resource conservation (Watson et al., 2000). Although several studies have investigated tropical pastures, little is known about the interaction between tropical perennial cultivation systems and the atmosphere, and their effects on local climate, local and regional water flows, or greenhouse gas balances. Falk et al. (2005), studying AFS with cocoa in Indonesia, verified that the potential impact of cocoa AFS on the regional climate may be less than that of other types of land use that cultivate annual crops in shifting cultivation, due to the permanent soil cover and the transpiration of perennial cocoa trees.

Alarcon et al. (2022), drawing on multiple studies published in Brazil, highlighted the positive impacts of ecological forest management systems on various ecosystem services. Their findings underscore the significant potential of AFS for climate regulation. The authors also emphasize that land-use decisions and public policies—particularly those related to soil quality, habitat provision, genetic resources, and climate regulation—should prioritize the expansion of sustainable production systems.

Finally, it is important to emphasize that the adoption and maintenance of AFS in Brazil for sustainable cocoa production has a relevant repercussion on various public climate policies. These systems are considered by the **National Policy on Climate**

Change (Law nº 12.187 of 2009)[86] as a strategy for mitigating greenhouse gas emissions and adapting to climate change. Federal Decree No. 7.390 of 2010[87], and revoked by Decree No. 9.578 of 2018, which regulates the implementation of Brazil's voluntary agreement, has under its umbrella the "Sectoral Plan for Adaptation to Climate Change and Low Carbon Emission in Agriculture", aiming at Sustainable Development - ABC+, which began in 2010 and is currently in its second phase 2020-2030. The ABC+ Plan lists Agroforestry Systems (AFS), along with Crop-Livestock-Forest Integration Systems (ILPF), as mitigation actions, comprising the Integration Systems technology and an implementation goal of 10 million hectares[88]. Furthermore, this regulation is associated with the National Plan for the Restoration of Native Vegetation initially launched in 2017[89] and revised in 2024, PLANAVEG 2.0[90], and specific credit lines focused on agroecology and silviculture for small and medium farmers within the scope of the National Program for Strengthening Family Farming (more details on the financing lines in section 8 of this report).

7.3. Job Creation potential in the Supply Chain

As one of the largest producers and among the largest consumer markets for cocoa in the world, Brazil has the opportunity to generate wealth, create jobs and enhance income for its population in the different links of the supply chain in the production, manufacturing, and commercialization sectors of cocoa derivatives.

[86] See at: https://www.planalto.gov.br/ccivil_03/_ato2007-2010/2009/lei/l12187.htm
[87] See at: https://www.planalto.gov.br/ccivil_03/_Ato2015-2018/2018/Decreto/D9578.htm#art25
[88] See at: https://www.gov.br/agricultura/pt-br/assuntos/sustentabilidade/planoabc-abcmais/abc
[89] See at: https://www.gov.br/mma/pt-br/assuntos/biodiversidade-e-biomas/biomas-e-ecossistemas/conservacao-1/politica-nacional-de-recuperacao-da-vegetacao-nativa/planaveg_plano_nacional_recuperacao_vegetacao_nativa.pdf
[90] See at: https://www.gov.br/mma/pt-br/composicao/sbio/dflo/plano-nacional-de-recuperacao-da-vegetacao-nativa-planaveg/planaveg_2025-2028_2dez2024.pdf

According to the **Agricultural Census** (IBGE, 2017) , Brazil has over 93,000 cocoa-producing establishments, with the majority located in Bahia (69,000 establishments, representing 74% of the national total), followed by Pará (18,000 establishments, or 19%). The estimated referenced labor force per establishment is 2.89 people, which translates to approximately 269,000 direct jobs in the sector. In terms of labor intensity, Baiardi and Teixeira (2010) highlight that cocoa production requires a substantial workforce, with labor costs accounting for 67% of total fixed production expenses, compared to 18% for inputs and 15% for other costs. On average, cocoa farms generate one direct job for every 2.4 hectares cultivated. Based on the current planted and harvested area in Brazil—640.5 thousand hectares—and applying this employment ratio, it is estimated that cocoa farming currently supports around 267,000 direct agricultural jobs.

The AIPC, formed by companies that together represent approximately 93-95% of cocoa purchasing and processing in Brazil, estimates that they are responsible for about 4,000 direct and indirect jobs just in this processing link of the supply chain, with an estimate of more than 120 thousand jobs, including rural producers and chocolate industries[92].

A 2020 report produced by the **Federation of Industries of the State of São Paulo (FIESP)**, the **Brazilian Association of the Chocolate, Cocoa, Peanut, Candy and Derivatives Industry (ABICAB)** and **AIPC** indicates a total of 635 chocolate-producing establishments in the country, based on information from the **Annual Social Information Report (RAIS)**, linked to the **Ministry of Economy**. It also reports the country's opportunity to have all the major multinational companies based in Brazilian territory, generating about 39 thousand jobs, between direct and temporary employment during the Easter period (ABICAB, 2019)[93]. It also adds that of this universe, 85% of the establishments are small (up to 19 employees), while 46% of the jobs are generated in companies with more than 500 employees. This information aligns with the news disseminated by the Ministry of Agriculture and Livestock (MAPA, 2020)[94] that the cocoa supply chain in Brazil generates almost 300 thousand direct jobs, from cultivation to chocolate production.

Thus, the possibility of expanding cocoa production in the country is an opportunity for generating work and income, especially in the North and Northeast regions, where job availability is lower than in other regions, and therefore can be understood as a vector for social well-being and socioeconomic development in these regions, which commonly present low Human Development Indices (HDI).

[93] Available in: https://static.poder360.com.br/2020/10/Sumario-Executivo_RAIS-2019.pdf
[94] See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/folders/cartilha-cacau-do-brasil-versao-portugues.pdf

8. FINANCING MECHANISMS FOR THE COCOA SUPPLY CHAIN IN BRAZIL

Cocoa farming is highly dependent on financing and credit, which in a country with one of the highest interest rates, often receives significant subsidies. The sector is entirely dependent on labor, and as a commodity, cocoa presents high price volatility, in addition to being quite sensitive to productivity fluctuations (e.g. due to climate and management), characteristics that only emphasize the need for financial mechanisms that reduce its sensitivity, as well as initiatives that encourage the implementation of sustainable cocoa by family farmers and small rural producers.

The main financing mechanisms for the cocoa chain for family farming include the **National Program for Strengthening Family Farming** (PRONAF), which offers public credit for family farmers with low interest rates; funds like Fiagro Kawá, which combine public, philanthropic, and private resources to finance small producers; the issuance of Sustainable CRAs *(Certificados de Recebíveis do Agronegócio* – Agribusiness Receivables Certificates)

to raise funds from investors; the Climate Fund, coordinated by BNDES, with the purpose of guaranteeing resources to support projects and finance ventures for climate change mitigation; and specific initiatives such as the support from Banco do Nordeste (BNB) to strengthen cocoa farming. Furthermore, there is the potential to generate revenue through carbon credits and investment funds focused on social and environmental impact. We will describe in more detail some of these main financing mechanisms below.

8.1. National Program for Strengthening Family Farming (PRONAF)

PRONAF is a federal government initiative that has been in effect for 30 years, offering low-interest credit lines to small family farmers registered with the **National Family Farming Registry (CAF)**. The main objective is to assist with the costing of inputs, equipment, and labor, and with investment for the implementation or replanting of cocoa crops, acquisition of machinery, equipment, and implements.

The rules for accessing PRONAF funds vary annually according to the current Harvest Plan *(Plano Safra)*, such as the conditions of the financing (interest rates, terms, grace periods, and limits) and the family income limit to access PRONAF. Below are summarized the main requirements and benefits of the public credit lines available under PRONAF according to the 2025/2026 Harvest Plan. The main financial institutions that operate credit lines aimed at family cocoa farming are: Banco do Brasil (BB), Banco do Nordeste (BNB), Banco da Amazônia (BASA), Banpará, Caixa Econômica Federal, Sicoob, Bancoob, and Cresol. Bradesco is one of the main private Financial Institutions (IFs) that operates some PRONAF lines.

According to the Inova Cacau 2030 Plan[95], access to credit for costing and investment for cocoa, under the **Harvest Plan** in 2021, was only 7,000 contracts. The main barriers to low access are problems related to land regularization, low availability of bank guarantees, low performance of ATER (Technical Assistance and Rural Extension), uncertainties regarding bank indebtedness, among other factors. Thus, the Plan aims to strengthen and propose mechanisms to producers that help increase the number of credit contracts (15,000 contracts/year by 2030), reaching values close to R$250 million taken via the Harvest Plan.

PRONAF Costing

Agricultural costing financing is a rural credit line that allows farmers to finance routine and essential expenses of their activities, such as the purchase of seeds, fertilizers, pesticides, and other inputs for cocoa production, thus ensuring the maintenance and development of the productive cycle until harvest. This type of credit is annual, and must be requested from banks and financial cooperatives. It is fundamental for the execution of planting and the sustainability of rural properties. In the case of cocoa production, it is possible to apply for costing, with a financing limit of up to R$250,000 per agricultural year and per beneficiary, for operations intended for the cultivation of socio-biodiversity products or products, inserted into agroecological production systems, or in transition to agroecological systems, with an effective pre-fixed interest rate of up to 2% p.a. (two percent per year). For cultivated cocoa, the effective pre-fixed interest rate is up to 3% p.a. The repayment deadlines for agricultural costing for the conditions applicable to cocoa production vary as follows:

• Up to 24 (twenty-four) months for biennial crops and sustainable forest management.

• Up to 20 (twenty) months for coffee farming and fruit farming.

• Up to 14 (fourteen) months for permanent crops.

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[95] See at: https://www.gov.br/agricultura/pt-br/assuntos/ceplac/publicacoes/inova-cacau-2030/inova-cacau-2030.pdf

PRONAF Investment

PRONAF also presents a rural credit line that allocates resources for rural producers to invest in long-term improvements on the property, such as the acquisition of machinery, equipment, the construction or reform of buildings, and the implementation of perennial crops or livestock. In the 2025/2026 Harvest Year, PRONAF Investment has some financing lines for cocoa planting, such as: PRONAF Forest; PRONAF More Food *(Mais Alimentos)*; Investment Credit Line for Income Aggregation – PRONAF Agroindustry; Investment Credit Line for Women - PRONAF Woman; Investment Credit Line for Agroecology – PRONAF Agroecology; Investment Credit Line for Extractive Exploration Systems, Socio-biodiversity Products, Renewable Energy, and Environmental Sustainability – PRONAF Bioeconomy; and Investment Credit Line for Young People - PRONAF Youth.

A key highlight for financing cocoa production within **Agroforestry Systems (AFS)** is the incentive for agroecological transition through **PRONAF Agroecologia**, as well as support for socio-biodiversity products via **PRONAF Bioeconomia**. Both lines offer an effective fixed interest rate of up to 3% p.a. Equally significant is PRONAF Floresta, which also carries a 3% p.a. interest rate. This line provides credit for AFS, sustainable forest management, and the implementation and maintenance of **Permanent Preservation Areas (APP)** and **Legal Reserves (RL)**. Additionally, it covers the recovery of degraded land and the enrichment of existing forest cover through the planting of native species.

According to **World Cocoa Foundation (WCF)**, credit disbursements to family farmers and smallholders through **PRONAF** have grown significantly. Funding surged by 400% between 2018 and 2023, with a notable 48% increase occurring between 2022 and 2023 alone (Figure 8a). Despite this upward trend, total investment remains far below the sector's actual needs. This gap is evidenced by cocoa's ranking in 2023, where it placed only 40th in terms of PRONAF resource allocation (Table 8a).

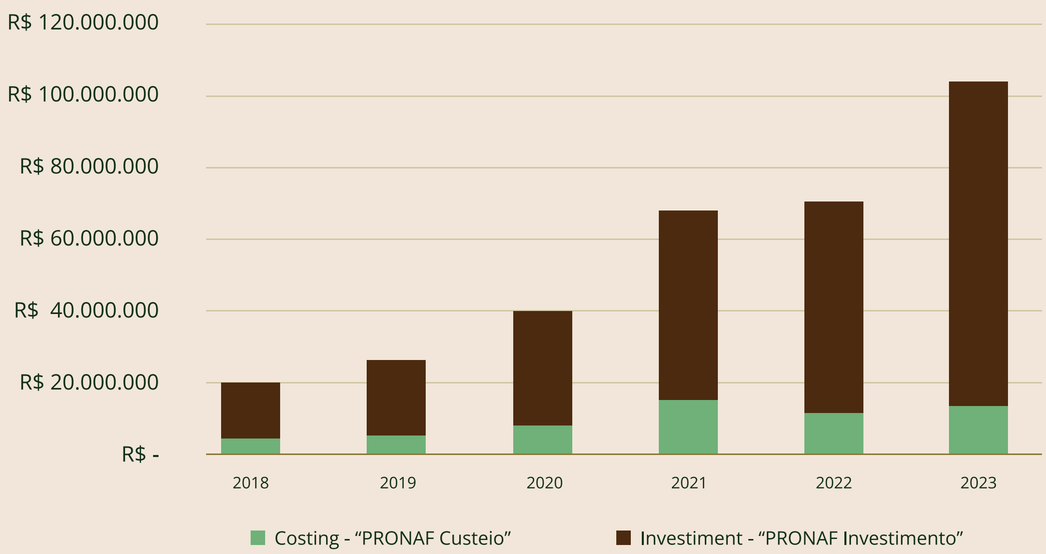

Figure 8a. Value accessed from PRONAF for cocoa between 2018 and 2023 (Source: WCF, 2025 – personal presentation).

Table 8a. Credit accessed by PRONAF by crop type in 2023 (Adapted from - Source: WCF, 2025 – personal presentation)

Ranking	Product	Area (ha)	Contracts number	Value (R$)	%
1	Soy	1,510,887	96,756	6,420,288,765	36
2	Corn	769,251	82,740	3,829,980,938	21
3	Wheat	628,496	43,043	2,443,246,151	14
4	Coffee	120,680	39,688	2,193,003,403	12
5	Onion	16,166	5,538	559,410,371	3
11	Casava	16,211	1,950	111,185,152	0.62
12	Banana	6,849	1,620	101,023,574	0.56
31	Broccoli	1,814	634	25,940,808	0.14
39	Ornamental plants	174	213	14,796,372	0.08
40	Cocoa	1,999	426	13,466,055	0.07

8.2. Climate Fund (Fundo Clima)

The **BNDES Climate Fund Program** is intended to apply the reimbursable portion of the **National Fund on Climate Change (FNMC)**, or **Climate Fund**, created by Law nº 12.114, of 12/9/2009, with its regulation defined by Decree nº 9.578, of 11/22/2018, and amended by Decree nº 11.549, of 06/05/2023. The Climate Fund is one of the instruments of the National Policy on Climate Change and constitutes an accounting fund, linked to the Ministry of the Environment, with the purpose of guaranteeing resources to support projects or studies and finance ventures aimed at climate change mitigation. Among the 7 modalities supported by the Climate Fund, the following stand out:

• Native Forests and Water Resources: To support the conservation, recovery, and sustainable management of forests and promote climate mitigation, environmental sustainability, water availability, the protection and sustainable use of biodiversity, and resilience to climate change.

• Green Services and Innovation: To support sustainable solutions, contributing to the transition to a more sustainable and climate-resilient economy by reducing negative environmental impacts and/or encouraging the reduction of greenhouse gas emissions.

Is important to highlight that the value approved by the Climate Fund in 2024 reached a record, totaling R$7.3 billion in financing between April and October, which represents more than double the total approved in a decade (2013-2023). There was a significant increase in disbursements and project approval, especially in the Northeast and Central-West regions, with the Union's contribution in 2024 being R$10.2 billion (Figure 8b).

For the two synergistic modalities with the recovery of degraded areas through the implementation of AFS, an amount of approximately R$800 million was disbursed in the period until 09/30/2025. In this scenario, the financing of R$100 million for the company Belterra to expand its cocoa AFS deserves to be highlighted. The amount of R$100 million is part of a larger investment of R$135 million to restore 2,750 hectares by 2027, focusing on degraded areas in states such as Mato Grosso, Bahia, Pará, and Rondônia, combining environmental recovery with the production of cocoa, income generation for small producers, and carbon sequestration.

Value approved by Climate Fund (millions of reais) R$

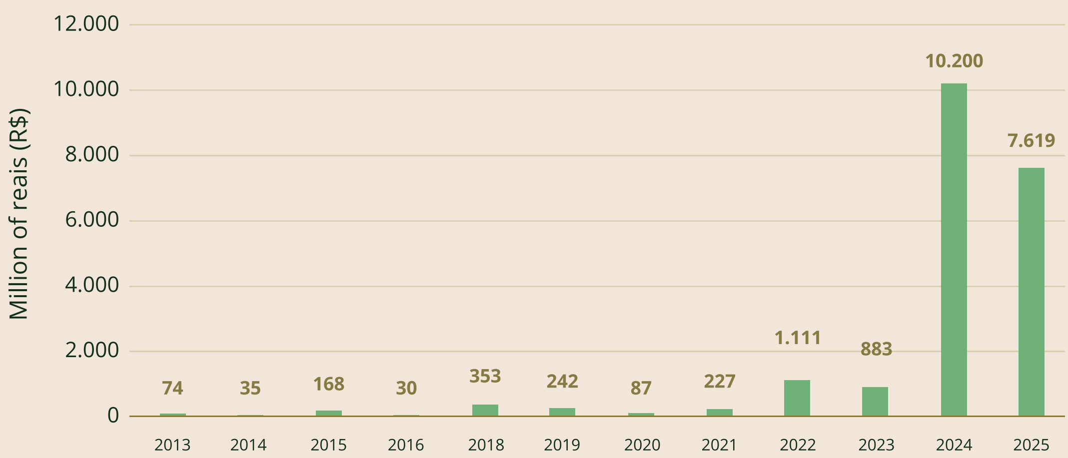

Figure 8b. Monitoring of BNDES approvals and disbursements for projects supported with Climate Fund resources (Adapted from - Source: Climate Fund Panel, 2025[96]).

[96] See at: https://www.bndes.gov.br/wps/portal/site/home/transparencia/estatisticas-desempenho/painel-fundo-clima/!ut/p/z0/fY_BT8IwFIf_Fg47Nu1g4Dw2U7e4EZwGMnshb6VAtXstayH--VbiwQPx-JIv3-97VNCOCoSLPkDQFsHE-10sts19_VhlK9aUryxlfF4_8c1DPcvXC_pMRQTu2rKoeJY2ZZNOWbvOX9q3vJqtiuzHMB2XxfJAhYNwJBr3lnb7M-4skUYP8Kv4ZyMq9MfpJDgV0mJQX4F2Pe6U32r0QYezvMYm7GgHlbAwAnoHo0KpIWHKh_hN5CR4Yp0a4YprT6JBDb013vqEOdCoDPkbdjv9Bug-RT83l4bzyeQb5xdDtg!!/

8.3. Sustainable Agribusiness Receivables Certificates (CRAs)

The **Agribusiness Receivables Certificates (CRAs)** for cocoa are fixed-income securities backed by financing and receivables from the production and commercialization of cocoa, allowing investors to finance rural producers through a securitized structure, offering tax exemption for individuals. **Sustainable CRAs** are a financial innovation and have been used to promote the increase in productivity and income of small producers, with projects that have already benefited several farmer families in Brazil, especially in the producing regions of Bahia and Pará.

The Sustainable CRA allows the financing of production, processing, or industrialization of cocoa in social impact projects, aimed at increasing the productivity and income of small cocoa producers, often with little or no technical assistance and access to the financial system. This instrument was structured under the concept known as "blended finance," a model that combines different sources of investment, including philanthropic and market capital, expanding access to credit for family farmers settled in agrarian reform. This strategy began in 2020, when a pioneer Sustainable CRA project for cocoa was launched by Arapyaú Institute in 11 municipalities in Southern Bahia that raised R$1 million, benefiting more than 200 farmers on small properties in the territory, increasing the average family income by 38%, with almost zero delinquency (Instituto Arapyaú, 2023)[97]. This type of financing is an alternative to reach small producers who are marginalized from traditional rural credit and public policies for production due to the barriers already described previously.

Currently, the strategy of financing cocoa production through the Sustainable CRA is in its second phase, expanding its support to more than 700 family cocoa farmers in AFS in 25 municipalities in Bahia and Pará (Instituto Arapyaú, 2024)[98], with individual amounts ranging between R$5,000 (~US$930.00) and R$40,000 (~US$7,435.00) to strengthen sustainable cocoa cultivation on 2,000 hectares and conserve 3,000 hectares of native vegetation. With a planned duration of five years, the new operation raised R$23.6 million (~US$4.9 million), with R$10.3 million (~US$1.91 million) through CRAs and R$13.3 million (~US$24.7 million) through

[97] See at: https://arapyau.org.br/wp-content/uploads/2024/05/relatorio-anual-2023-alt-final.pdf
[98] See at: https://arapyau.org.br/wp-content/uploads/2025/05/relatorio_anual_arapyau_2024.pdf

other sources, both coming from market investors, philanthropic institutions, and impact organizations, such as Instituto Arapyaú, ihumanize and Itaúsa, Solidaridad Foundation, Rabo Foundation, and BNDES — the latter with a contribution of R$4 million (~US$740,000.00).

8.4. Pará State Cocoa Farming Support Fund (FUNCACAU)

On January 16, 2008, Law 7.093[99] instituted the Program for the Acceleration of Growth and Consolidation of **Cocoa Farming in the State of Pará (PAC CACAU-PA**) and created the Pará State **Cocoa Farming Support Fund (FUNCACAU)**. FUNCACAU financially supports programs and actions for the generation and diffusion of technologies, technical assistance, development, and commercialization, aimed at the expansion, strengthening, and consolidation of local productive arrangements of cocoa farming in the state of Pará. FUNCACAU's administration is exercised by a Managing Council and coordinated by the Secretariat of Agricultural Development and Fisheries (Sedap), which together form a committee that manages the resources of this public investment fund intended for the cocoa supply chain in the state of Pará. This committee is composed of EMATER-PA, the State Secretariat of Agricultural Development and Fisheries (SEDAP), the Executive Commission for the Cocoa Farming Plan (CEPLAC), the Secretariat of Finance, the Brazilian Agricultural Research Company (EMBRAPA), the Federation of Agriculture and Livestock of Pará, among other bodies.

FUNCACAU's resources mainly come from the **Pará Cocoa Farming Modernization Fee (TMC)** originating from Law nº 7.079 of December 28, 2007, and extended for another ten years by Law nº 8.585 of December 28, 2017. This is a state law that established a tax intended to finance the modernization and development of the state's cocoa sector. The fee is collected based on a specific amount on production (Collection of 30 Fiscal Standard Units of the State of Pará - UPF-PA), as established in the **State Collection Document (DAE)**.

Revenues from FUNCACAU's also come from other sources such as:
I - annual allocations in the Pará State Government Budget; II - resources from agreements and transfers of any nature resulting from agreements with the Federal Government; III -

donations, legacies, and transfers from governmental or private entities intended for actions promoted by the State Secretariat of Agriculture; and IV - resources raised abroad from loans, agreements, donations, and contributions from private or official institutions. The institutions that can access fund resources are: Science, Technology, and Development Institutions; Agricultural Defense Institutions; Teaching, Research, and Extension Institutions; Municipalities in the Cocoa Region; Cocoa Producer Cooperatives; Federations of Producers and Workers in agriculture; and Cocoa Producer Associations.

Among the priority projects and activities financed by FUNCACAU are: I. production and distribution of propagules; II. training and qualification of rural labor; III. development and diffusion of cocoa AFS; IV. preservation of germplasm and genetic improvement of cocoa and related perennial crops; V. development and diffusion of phytosanitary control methods; VI. technification of crops aiming at increased productivity; VII. improvement of the quality of regional products; VIII. support for cooperativism and other forms of association; and IX. support for the commercialization and industrialization of cocoa and related products. It also supports the following priority actions of relevant interest for the sustainable development of the state's cocoa regions: I - development and diffusion of agroecological or environmental preservation techniques; and II - ecosystems compatible with the presence of cocoa cultivation (zoning) and, preferably, are intended for the recovery of altered areas[100].

8.5. Investment Funds in Agro-industrial Supply Chains

The Brazilian fund for cocoa costing, known as the **Kawá Fund**, is an Investment Fund in Agroindustrial Supply Chains (FIAGRO) that aims to strengthen family farmers and regenerative agriculture in the sector, with a focus on small producers in Bahia and Pará. It offers accessible credit and specialized technical assistance to finance costs such as fertilization, irrigation, equipment, and seedlings, boosting the sustainable development and conservation of ecosystems on small cocoa AFS properties.

The Kawá Fund was created by **Instituto Arapyaú**, along with the **Violet platform, Mov Investimentos**, and **Tabôa Fortalecimento Comunitário**. It is the largest Brazilian fund for cocoa costing in family farming, with an initial volume of R$30 million, potentially reaching R$1 billion in credits by 2030.

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[100] More information in: https://www.sedap.pa.gov.br/node/91

It has direct access to producers and intends to benefit, in this first phase, about 1,200 farmers in Bahia and Pará. In five years, this number could rise to 5,000 producers.

According to IBGE data, only 20% of agricultural establishments in Brazil receive technical assistance and rural extension services (ATER), with only 8% in the Northeast and only 10% in the North. Also, currently, about 80% of cocoa production in the country is in the hands of farmers on small properties, a stakeholder that is completely marginalized from the financial system and rarely accesses public policies for production and technical assistance. The result of this combination is low income and low productivity. At the same time, there are 82 million hectares of degraded pasture in Brazil, with the National Plan to the Conversion of Degraded Pasture (PNCPD) having a goal to recover 40 million.

Similar to the Sustainable CRA, the Kawá Fund is a blended finance model, using resources from private investors and philanthropic organizations, relying on the partnership of Violet, the fund manager, VERT, and the NGO Tabôa, the organization responsible for operationalizing the credit. Technical assistance to producing families will be offered by Tabôa, Fundação Solidaridad, Ciapra (Intermunicipal Consortium of the Low South Bahia APAs Mosaic), and Polímatas Soluções Agrícolas e Ambientais. The costing of this assistance was leveraged by Instituto Arapyaú with partners such as Suzano, the Cocoa industries, through the CocoaAction Movement, and national and international philanthropies. Reseed will oversee the carbon credits for the operation. The National Association of Cocoa Processing Industries (AIPC) is also a partner, ensuring the connection of its associates with the purchase of cocoa produced by the farmers.

8.6. Eco Invest

The Eco Invest Program[101], also considered a blended finance model, coordinated by the Ministries of Finance and Environment and Climate Change, with the support of the Ministry of Agriculture and Livestock and the IDB, has the auction as the main instrument to foster the recovery of degraded areas. It aims to mobilize resources to recover 1.4 million hectares of degraded pastures within the scope of the Caminho Verde Brasil Program. Currently, the Program held two auctions with the objective of attracting private capital through local financial institutions and foreign investment, to finance projects that promote the conversion of degraded lands into sustainable productive systems[102].

[101] See at: https://www.gov.br/tesouronacional/pt-br/fomento-ao-investimento/eco-invest-brasil
[102] The second edition was held in February 2025 with the goal of mobilizing resources to recover 1 million hectares of degraded land.

These projects must follow rigorous environmental criteria, including soil recovery and environmental preservation.

Eco Invest Brasil Auction No. 2/2025 registered a demand of R$17.3 billion in catalytic resources, unlocking the potential for R$31.4 billion in total public and private investments dedicated to the restoration of degraded areas across Brazil[103]. With an additional R$13.7 billion in private capital, a total of R$30.2 billion will be directed toward the recovery of 1.4 million hectares[104]. This initiative also addresses a persistent barrier to attracting foreign investment in long-term projects: exchange rate volatility. To mitigate this risk, the program offers credit lines specifically designed to hedge against currency fluctuations, thereby enhancing predictability and reducing financial uncertainty for long-maturity investments in Brazil. In addition, the program provides publicly backed credit lines under favorable conditions, strategically designed to leverage both domestic and international private capital, accelerating the transition toward a more sustainable and resilient economy.

8.7. Carbon Credits

Cocoa's ability to sequester carbon offers a clear pathway for the sector to capitalize on carbon markets. By implementing regenerative models, agroforestry-based cocoa production can advance into degraded areas, transforming environmental liabilities into productive carbon sinks. Beyond land restoration, these initiatives also emphasize the maintenance of high-biodiversity productive systems like the traditional cabruca.

Within the framework of regenerative agriculture, the project led by the company **Belterra Agrofloresta**, currently listed and undergoing validation by the certifier Verra[105],stands out as a promising initiative. Its goal is to restore agricultural lands and degraded pastures across the Amazon and Atlantic Forest biomes, using AFS over an area of 6,954 hectares in highly impacted states such as Pará, Rondônia, Mato Grosso, and Bahia. The project employs a diversified strategy that includes the intercropping of cocoa with native and exotic forest species, alongside short-cycle crops like banana and cassava. This agroforestry model not only delivers economic benefits, such as job creation for local communities, but also

[103] See at: https://lefosse.com/noticias/2o-leilao-do-eco-invest-brasil-atrai-demanda-de-r-173-bilhoes-e-pode-gerar-r-314-bilhoes-em-investimentos-para-recuperacao-de-areas-degradadas/
[104] See at: https://capitalreset.uol.com.br/financas/tesouro-concede-r-165-bi-em-leilao-para-recuperar-pastagem/
[105] See at: https://registry.verra.org/app/projectDetail/VCS/5006

contributes significantly to climate change mitigation. Over a 25-year period, the initiative is expected to remove approximately 1,409,852 tCO_2e, an average of 203 tCO_2e/ha. In addition to its environmental impact, the project is set to benefit around 300 local families, fostering socioeconomic development and enhancing community resilience through sustainable land use and ecosystem restoration.

Another noteworthy initiative currently undergoing validation by Verra and the Climate, Community & Biodiversity (CCB) registry is The Green Branch's grouped restoration project, which spans 10,000 hectares in Southern Bahia[106]. The project focuses on land restoration through afforestation, utilizing a mix of native and non-native species to rehabilitate degraded areas. In addition to reforestation, the project includes the implementation of AFS featuring cocoa, coffee, and açaí, along with sustainable harvesting practices. This diversified approach is designed to maximize environmental, economic, and social benefits, supporting both ecosystem recovery and the well-being of local communities involved in the initiative.

The project by Symbiosis Investimentos[107] is good example of an initiative already registered and validated in the international Verra carbon project standard. The goal is to recover 5 thousand hectares of degraded pastures in Southern Bahia through the implementation of cocoa AFS, and to this end, Symbiosis will partner with rural producers, investing in the forest component, in the form of inputs and technical assistance. Following the arrangement proposed by Instituto Arapyaú, the AFS will be composed of 416 trees/ha of two native species and 833 cocoa plants/ha. The cycle rotation will be 40 years for the carbon project, with an estimated stock of 199.5 MgCO2e/ha or 5.0 MgCO2e/ha/year. The main investor in the Symbiosis project is Apple, through its Restore Fund, created in 2021 with the objective of expanding natural solutions to combat climate change, and in partnership with Goldman Sachs and Conservation International[108]. Apple's strategy follows an important trend diagnosed in the annual report by Ecosystem Marketplace[109], which points to the high demand for carbon credits by technology companies to offset their emissions. Furthermore, according to this report, carbon removal projects such as Afforestation, Reforestation, and Revegetation (ARR) and Agroforestry had an average price increase of 20% in 2024 compared to the previous year (Table 8b). In addition, buyers demonstrated a strong preference for removal credits, increasing the average price of these credits in 2024 and raising the premium for removals compared to reductions to up to 381%.

[106] See at: https://registry.verra.org/app/projectDetail/VCS/4476
[107] See at: https://registry.verra.org/app/projectDetail/VCS/4592
[108] See at: https://www.apple.com/br/newsroom/2024/03/apples-restore-fund-cultivates-new-roots-in-the-atlantic-forest/
[109] See at: https://3298623.fs1.hubspotusercontent-na1.net/hubfs/3298623/SOVCM%202025/Ecosystem%20Marketplace%20State%20of%20the%20Voluntary%20Carbon%20Market%202025.pdf

Table 8b. Volumes, values, and prices of Voluntary Carbon Market (VCM) transactions by types of forest and land use projects, 2023-2024 (Forest Trends, 2025)[110].

	2023			2024			Percent Change		
Project Cluster	Volume ($MtCO_2e$)	Value (USD)	Price (USD)	Volume ($MtCO_2e$)	Value (USD)	Price (USD)	Volume	Value	Price
REDD+	28.2	$222.3M	$7.87	13.6	$82.1M	$6.03	-52%	-63%	-23%
Improved Forest Management (IFM)	2.6	$41.9M	$16.2	8.8	$132.3M	$14.97	242%	216%	-8%
Afforestation-Reforestation and Revegetation (ARR)	4.8	$82.4M	$17.15	3.8	$77.7M	$20.44	-21%	-6%	19%
Agroforestry	0.7	$8.1M	$11.58	0.6	$8.3M	$14.11	-17%	1%	22%

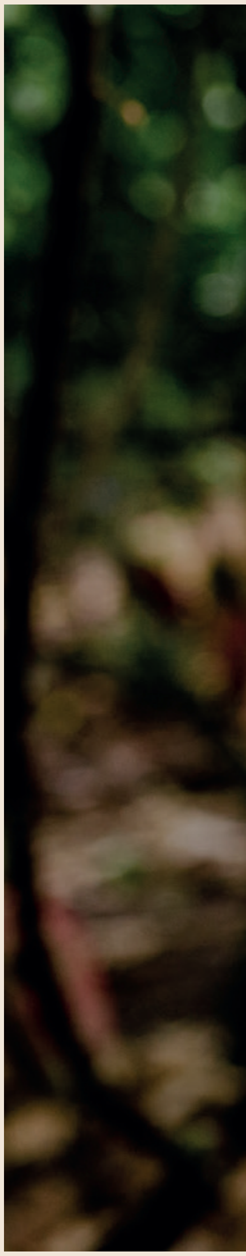
Note: this table includes data on ACR, ART, BioCarbon, CAR, CDM, Cercarbono, Global Carbon Council, Gold Standard, Plan Vivo, and VCS registries).

It is important to note that the most expensive type of credit was projected removal credits, such as the Production of so-called Biochar, a carbon-rich material similar to charcoal, created from biomass, such as wood chips, agricultural residues, or animal manure that is highly stable when incorporated into the soil. Although biochar can attain an average price of more than US$165/tCO2e, it still represented less than one percent of transactions in 2024 (Forest Trend, 2025)[111].

In addition to the sequestration potential, cocoa production can benefit from the sale of stored carbon. In Southern Bahia, the chocolate brand Dengo initiated the Dengo Credits for Life project aimed to reduce deforestation and degradation in the region by channeling carbon credit revenue to small producers under the cabruca system and employing the Social Carbon Protocol for Family Farming (PCSAF). The credits are generated through outcome-bond financing provided by the World Bank, covering a four-year period dedicated to producer mobilization, diagnosis, and data collection (2023—2027), validation, monitoring, reporting, verification, and auditing (2024—

[110] See at: https://www.forest-trends.org/publications/forest-trends-impact-report-2025/
[111] See at: https://www.forest-trends.org/publications/forest-trends-impact-report-2025/

2025) to trigger certification and first payments. An important aspect of this model is that the resources from this negotiation are allocated as follows: 80% channeled directly to farmers through compensatory payments and technical assistance, while the remaining is used to reimburse the initial outcome-bond financing to ensure the financial sustainability and scalability of the operational model. Therefore, there is no need for the small producers (carbon generators) to use their own resources for the implementation of the project. By 2025, 99 families and 104 properties have already been involved, benefiting 1,566.88 ha of cabruca and 939.60 ha of native forests. This amounts to over 1 million tons of CO_2 conserved, and R$2.2 million distributed in 2025 to producers through payments and technical assistance. Combining verified methodologies with participatory processes and transparency via blockchain, the model was designed to be scalable, potentially benefiting 3,000 producers and 75,000 hectares in Bahia.



8.8. Biodiversity Credits

In addition to climate resilience, cocoa AFS are recognized as biodiversity-friendly systems. As discussed earlier, this characteristic is due to the presence of trees, which in some systems like cabruca contains a diversity of native species and is structurally like a natural forest. Several species of the native biota find resources and favorable conditions in these agroforests, using them as secondary or even primary habitat. For example, a study in Southern Bahia showed that two-thirds of the forest species from various fauna groups are found in cabrucas (Pardini et al. 2009). Even more simplified systems, such as AFS intercropped with few native species, have the potential to enhance biodiversity when replacing open and degraded areas. Through the maintenance or increase of local biodiversity levels, there is the possibility that these cocoa agroforests may be eligible to receive funds from emerging biodiversity credit markets.

Although the term originated in the 1990s in initiatives in Australia and the United States, the use of **Biodiversity Credits** as a financial mechanism to mitigate and reverse the current loss of biodiversity gained momentum after the **15th Conference of the Parties (COP15)** of the **Convention on Biological Diversity (CBD)** in December 2022. During the conference, the **Kunming-Montreal Global Biodiversity Framework** was presented with objectives and targets to halt and reverse biodiversity loss by 2030, including global strategies to finance the actions.

As with carbon, the idea of the biodiversity credit market is to turn natural capital into a financial asset. Thus, a biodiversity credit would represent a unit of measure of biodiversity increment that can be traded (Wauchope et al. 2024). It is therefore necessary that the implementation or maintenance of agroforests demonstrates additionality, meaning that the existence of these systems effectively increases local biodiversity levels. However, unlike carbon, which is a chemical element measured and represented by standardized units (e.g., MgC/ha), biodiversity is much more complex to measure and monetize. It refers to the diversity of organisms on the planet, including different levels of hierarchical organization, such as genes, species, and communities, which can be measured with different metrics (e.g., richness, abundance, composite indices) and dimensions (taxonomic, phylogenetic, functional) and vary in spatial and temporal scale. Given this variation in terms of criteria, measures, and units for calculating biodiversity credits, several protocols with distinct methodologies for calculation and commercialization of the credits are available, with many still being developed. However, there are official documents such as the "Biodiversity Credits: A Guide to Identify High Integrity Projects" that guide minimum criteria to ensure the high integrity of these assets.

The portfolio of credit measurement and certification protocols is quite varied, as it considers the specific needs of each region and type of asset. For example, in the Savimbo methodology[112], a biodiversity credit is based on indicator species per 1 hectare for 30 days, remunerating the community involved. The methodology applied by Terrassos[113] focuses on threatened ecosystems, considering that the conservation or restoration of $10m^2$ of area for at least 20 years generates 1 credit.

Currently, Brazil stands out among the ten leading countries in projects with biodiversity credits, along with Colombia, with the United Kingdom and the United States leading this market. In Brazil, the following initiatives deserve to be highlighted:

• Instituto Homem Pantaneiro (IHP), in partnership with ERA and Regen in Mato Grosso do Sul, is responsible for the certified issuance of biodiversity credits in the Pantanal of Mato Grosso do Sul. The IHP project aims at the protection of the jaguar (Panthera onca) on 40.6 thousand hectares of the region known as Serra do Amolar. The jaguar is considered an umbrella species because its protection encompasses the preservation of other fauna and flora species.

[112] More information at: https://pt-br.savimbo.com/biodiversity
[113] More information at: https://www.terrasos.co/en/terrasos-targets-voluntary-biodiversity-credits/

• The state of Paraná, which became the first sub-national government in the world to institute a biodiversity credit policy with the objective of fostering companies, funds, and institutions to finance projects for the protection of threatened species or the recovery of habitats. The credits function as certificates that prove the actions. It is legally backed by the State Policy on Biodiversity Credit of Paraná[114], a normative instrument that aims to encourage the conservation, restoration, and recovery of the state's biodiversity through economic mechanisms that generate income for the actors who promote these actions. Officially launched in October 2024, the policy creates a biodiversity credit market. The Hospital Pequeno Príncipe became the first health institution to acquire biodiversity credits in partnership with Society for Wildlife Research and Environmental Education (SPVS)[115].

• Initiative with extractivism in Pará, the result of a partnership between Terrasoss, Natura, and the Federal University of Pará, seeks to diversify the sources of income of the communities that supply raw materials to Natura. Thus, as in pension funds, the resources go to the project agents, such as communities or owners of a certain area. However, a part is reserved in a fund and is only received by the community as the project achieves predetermined objectives.

• Initiative in Rondônia that assesses the use of molecular technology to investigate the local biological richness of a forest area in Cujubim, Rondônia, which belongs to a forest management company called Manoa Sustentável that already operates in the carbon credit market. They employ environmental DNA (eDNA) to identify all DNAs contained in the soil, air, or water. eDNA indicates the probability of a species of plant, animal, fungus, or microorganism being in that place. It allows for the identification of species present in areas with thousands of hectares in weeks or a few months.

[115] See at: https://pequenoprincipe.org.br/noticia/creditos-de-biodiversidade-pequeno-principe/

• In the cocoa region of Southern Bahia within the scope of the Dengo Credits for Life carbon project, biodiversity indicators are being developed with the objective of adding 20% of the carbon credit value in most participating farms.

• Developed by the Scientific and Technological Park of Southern Bahia (PCTSul), Arapyaú Institute, and Taboa, the Biodiverse Cocoa project aims to improve biodiversity conservation by improving and promoting the sustainable management of AFS with cocoa, combined with the conservation of native forests. Using Verra's Nature Framework methodology, the project strengthens the integration between agroforestry production and conservation. The project seeks to reduce, and even reverse, the trends of biodiversity loss and ecosystem degradation in the project areas located in the Atlantic Forest. In this context, improving support for producers through technical, financial, and social mechanisms is essential to ensure sustainable cocoa production and scale up environmental outcomes. These are precisely the main challenges: reconciling conservation and production, offering adequate support to farmers, and ensuring practices that maintain biodiversity. To address these challenges and conserve biodiversity, the Biodiverse Cocoa Project aims to strengthen cabruca cocoa producers through activities focused on: (1) sustainable production and income generation; (2) payment for environmental services; and (3) maintenance of the cabruca, forest protection and environmental monitoring. By implementing agroecological practices and increasing the income of small producers, the project recognizes and values those who produce and conserve, reinforcing that AFS are a powerful tool to conserve local biodiversity.

Through several initiatives already underway in Brazil and globally[116], it can be stated that biodiversity credits are a promising financial instrument to foster sustainable practices like cocoa AFS and ensure the

[116] More information on biodiversity credit markets, expert insights, and trend analysis on the Platform Bloom Labs: https://bloomlabs.earth/

financial health of the system. Furthermore, they can support companies in meeting the Global Biodiversity Framework and other ESG (Environmental, Social, and Governance) targets.

8.9. Examples of Other Initiatives to Leverage Sustainable Cocoa Production in Brazil

8.9.1. Socio-environmental Credit Activators Network (CrediAmbiental)

The **Socio-environmental Credit Activators Network (CrediAmbiental)** is an initiative led by the Sustainable Connections Institute **(Conexsus)**[117] that combines local capacity building with increasing financing, aiming to boost the income of family production units (extractive workers, traditional communities, fishermen, and family farmers). Since 2020, Conexsus has been the rural credit agent for **Banco da Amazônia (BASA)**, expanding and ensuring assistance to socio-biodiversity associations and cooperatives in the Amazon region in accessing public credit from the financial institution.

In 2025, CrediAmbiental, **Cocoa Cooperative of the Atlantic Forest of Bahia (Coopermata)**[118] and Bank of Brasil (BB) signed credit agreements of approximately US$186 thousand to support family farmers in southern Bahia.

[117] The Instituto Conexões Sustentáveis (Conexsus) is a non-governmental, non-profit organization, created in 2018 with the mission of activating the socio-environmental impact business ecosystem, especially those based on community initiatives, to expand its contribution to income generation in rural areas, the conservation of threatened biomes, and the maintenance of standing forests. More details at: https://www.conexsus.org/

[118] Coopermata, Cocoa cooperative formed by family farmers in the South of Bahia.

This partnership inspired the establishment of the **Northeast Socio-bioeconomy Hub**, to remove the main barriers for small producers to access PRONAF rural credit in the region, especially barriers related to bureaucratic requirements. This initiative represented a significant step towards the economic strengthening of small cocoa producers, encouraging sustainable agricultural practices and promoting income generation in traditional communities in the region.

8.9.2. Sustainable Chocolate Brands – Quality Market

Founded in 2017, the Brazilian chocolate brand **Dengo** is committed to promoting sustainability across the cocoa supply chain, from the farmer to the final consumer. With retail locations in Brazil and France, Dengo has earned recognition for its premium quality chocolates and its positive socio-environmental impact on the Brazilian cocoa sector. All cocoa sourced by Dengo comes from a network of over 150 producers, the majority of whom are small and medium-scale farmers. Cultivation is carried out using the traditional cabruca system, in which cocoa is grown under the canopy of native forest species. According to a state decree in Bahia, a cabruca system must contain at least 20 native trees per hectare. Farms supplying cocoa to Dengo exceed this threshold, with an average density of 54 native trees per hectare, reinforcing the brand's commitment to biodiversity and forest conservation. In addition to its supply from Southern Bahia, Dengo has expanded its portfolio with an exclusive product line made from Amazonian cocoa, developed through strategic partnerships with producers in Pará. This initiative not only diversifies flavor profiles but also strengthens sustainable practices in multiple biomes across Brazil.

8.9.3. Cantagalo Group: Fine Cocoa Production

The **Cantagalo Group**[119], chaired by Claudia Sá, was founded in the 1960s in the municipality of Ituberá (Southern Bahia) and went through several historical moments of cocoa farming, including the devastating production drop due to Witches' Broom. The group owns 14 cocoa farms in Southern Bahia, totaling 1,800 hectares. Of this total, 900 ha are cultivated under traditional AFS system and cabruca system. Currently, the average productivity of the farms is around 45@ (675kg)/ha. However, in some cabruca areas, productivity reaches 100@ (1,500kg)/ha, with the goal of doubling productivity in 3 years through investments in management and technology.

Since 1997, more than 800 cocoa varieties were tested in terms of their productivity, tolerance to Witches' Broom, bean size, and quality. In addition to these traits, varieties with higher off-season production *(temporão)* were considered to provide escape strategies regarding Witches' Broom. Ten percent of the total cocoa produced by the Cantagalo Group is for the fine cocoa market, sold to small and large bean-to-bar chocolate brands, where the price paid is up to three times higher than the so-called *bulk* cocoa, commercialized in large volumes to grinders.

Another important aspect in the Group's history was the entry of the new generation into business management as of 2018. It is important to note that this generational movement is revolutionizing cocoa production in Southern Bahia region, with greater investments in the segment of quality and sustainable cocoa production. In the Cantagalo Group, approximately 60% of the revenue was invested in technology and innovation in the 2024 harvest season, including technical assistance, renovation, densification, and mechanization.

[119] See at: http://cacaucantagalo.com/cacau-variedades.php

9. ECONOMIC AND FINANCIAL VIABILITY OF COCOA AFS

Economic viability and financial modeling studies are important to attract investments and support the structuring of businesses focused on cocoa-AFS. An important reference on the economic viability of different cocoa production models across Brazil's key producing regions is a study led by Instituto Arapyaú in 2021[120] and reviewed in 2025. In Bahia, the study compared several cabruca models with different shading intensities to rainfed and irrigated full-sun cocoa plantations. In Pará, the focus was on production models distinguished by their levels of species diversity, offering insights into the ecological and economic performance of each approach. The renovation of cabrucas with sufficient shading in Bahia is economically viable and proves to be a good investment, with an Internal Rate of Return (IRR) of 12% and annual income for the producer of R$5,400 (~US$1,000.00) per hectare. However, investment in the renovation of cabrucas with high shading proved to be not

[120] See at: https://arapyau.org.br/wp-content/uploads/2021/11/viabilidade-economica-de-sistemas-produtivos-com-cacau.pdf

economically viable. Full-sun cocoa models, both rainfed and irrigated, also show good financial returns, with an IRR of 16% for rainfed and 15% for irrigated, and annual income for the producer of R$10,500 (~US$ 1,950.00) and R$14,300 (~US$ 2,657.00) per hectare, respectively.

It is important to highlight that the lack of economic viability in the high-shading cabruca system was because of low productivity due to the lack of adequate management (thinning of the cabruca). However, in the low-shading model (30% canopy cover resulting from cabruca thinning in year zero) the operational costs are lower compared to full-sun cocoa systems. This model achieves economic viability at moderate productivity levels, typically around 1,125-1,200 kg per hectare. In contrast, full-sun cocoa requires productivity levels above 1,500 kg per hectare to be economically viable due to its higher costs and therefore a more financially risky model.

In the state of Pará, all three AFS analyzed demonstrated economic viability. The IRR across the models ranges from 15.8% to 17.3%, with annual income per hectare for producers varying between R$5,133 (~US$954) and R$8,623 (~US$1,602). The system with lower crop diversification requires less investment and labor but also has lower income. In contrast, the more diversified cocoa–açaí model demands greater investment in both implementation and maintenance yet delivers higher returns due to the additional revenue from açaí. Tables 9a. and 9b. summarize the results of these analyses.

Table 9a. Comparison between models analyzed in Southern Bahia.

Financial results and indicators	Cabruca – high shade	Cabruca - up to 30% shade	Full-sun, dry	Full-sun, irrigated
Training Costs (0 to 3 years R$/ha)	-17,600	-26,300	-39,800	-49,800
Average Net Revenue (after 3 years R$/ha/yr)	7,050	13,250	24,100	30,160
Average Direct Costs (after 3 years R$/ha/yr)	-5,300	-6,400	-11,300	-12,800
Average Indirect Costs (after 3 years R$/ha/yr)	-750	-750	-750	-750
Average Net Income (after 3 years R$/ha/yr)	895	5,414	10,524	14,301
Discounted Payback (years)	21	13	10	10
Internal Rate of Return (IRR) (%)	-4	12	16	15
Net Present Value (NPV) (R$)	-9,824	5,700	19,400	26,000

Table 9b. Comparison between models analyzed in Pará.

Financial results and indicators	SAF cocoa	SAF cocoa + açaí	SAF cocoa + nut
Training Costs (0 to 3 years R$/ha)	-19,908	-38,818	-23,856
Average Net Revenue (after 3 years R$/ha/yr)	10,284	17,305	11,840
Average Direct Costs (after 3 years R$/ha/yr)	-3,493	-6,662	-3,778
Average Indirect Costs (after 3 years R$/ha/yr)	-1,673	-2,274	-1,887
Average Net Income (after 3 years R$/ha/yr)	5,133	8,623	6,465
Discounted Payback (years)	9	9	8
Internal Rate of Return (IRR) (%)	15,8	16,6	17,3
Net Present Value (NPV) (R$)	16,938	35,105	25,803

A recent study assessing the economic viability and socio-environmental safeguards of AFS with native species in the Cerrado and the Cerrado–Amazon transition zone was published by NGO The Nature Conservancy (TNC, 2025)[121]. The analyzed system covers 300 ha and includes cocoa, açaí, turmeric, baru, mahogany, banana, taperebá, and mombaça. Implementation of the 300 ha cocoa AFS and associated crops was carried out over the first five years, with a total investment

[121] See at: https://reports.weforum.org/docs/WEF_SAF_Cerrado_2025.pdf

cost of R$71,000/ha (approximately US$13,200/ha). The financial modeling adopted a base scenario with constant prices throughout the analysis period, excluding inflation (i.e., a real-term model). Revenues were derived from cocoa, turmeric, dwarf banana, açaí, and baru (nuts), under the presumed profit tax regime. The dominant role of cocoa in ensuring the financial performance of the analyzed AFS is particularly noteworthy. Based on the model parameters, the study indicates a 90% probability that the internal rate of return (IRR) ranges between 23.82% and 33.36%, and a 90% probability that the net present value (NPV) lies between R$28,279,724 (~ US$5,256,455) and R$70,987,438 (~ US$13,194,670). These results strongly suggest that cocoa AFS, when integrated with other crops, represent a robust diversification strategy from operational, economic, and environmental perspectives. Moreover, such systems offer a promising model for productive restoration, capable of conserving unique ecosystems, supporting biodiversity, regenerating degraded areas, and simultaneously producing food.

10. BUSINESS ARRANGEMENTS IN BRAZILIAN COCOA SUPPLY CHAIN

10.1. Cocoa+ Program

In Bahia, specifically in the region known as Baixo Sul, 25,6 thousand families in 14 municipalities produce cocoa in an area of 99.6 thousand hectares which is responsible for 34.2% of the cocoa production in Bahia. In this territory, the **Cacau+ Program**, an initiative implemented by the **Intermunicipal Consortium of the Low South APAs Mosaic (Ciapra)**[122], a consortium formed by 15 municipalities in the region, in partnership with the state government and private partners, aims to raise cocoa productivity on small properties, with the goal of increasing family income to R$60,000.00 (~US$11,152,00)

[122] See at: https://www.ciapra.ba.gov.br/o-ciapra

annually. The project works with 2,400 families, 41.5% of whom are young people and 25% are women, impacting a total of 6,224 people. Working with rural producers, technicians make a precise diagnose each property, where 1 hectare is left as a demonstration plot for interventions and training by extension workers; those practices extend throughout the property. In three years, the project invested R$14.7 million (~US$2,73 million), an average of R$2,400.00 (~US$446.00) per family, increasing average production by 85.7%, going from 336 kg/ha in 2021 to 624 kg/ha in 2024, representing an increase of R$84.5 million (~US$15.7 million) worth in total production.

10.2. Belterra and Fundo Vale

Belterra is a startup that operates in the implementation of AFS in partnership with small and medium producers, especially in the Amazon and Southern Bahia, to sustainably produce cocoa, promoting environmental regeneration and generating local income. The company uses cocoa, cupuaçu, açaí, banana, peach palm *(pupunha)*, and cassava to restore degraded areas, offering an economic and sustainable alternative to traditional agriculture. The business model involves partnering with rural producers, offering technical support, access to resources, and a sustainable value chain for cocoa, including distribution and commercialization. The model also includes raising investments from funds, private companies, and philanthropy to finance the expansion of cocoa production through sustainable systems. The co-benefits of this business model are substantial, including job creation, the promotion of decent working conditions, and ensuring that rural producers are structured to continue producing independently in the long term.

The first action of the business plan is an evaluation of the extension and location of the property. Next, a detailed analysis of the property documentation, (e.g., land title, CAR. CCRI, ITR), and spatial analyses (e.g., topography, is altimetry, slope, and susceptibility to flooding or landslides) is performed. Subsequently, the partnership model is defined with different levels of producer engagement and participation: i) Lease for farmers who have available degraded areas, or people who have areas but do not live on site; ii) Rural partnership for farmers who want to enter a new market or expand their production; and iii) Integration for farmers who already have AFS and want to expand. Finally, combinations of the most profitable crops are selected and implemented according to the region, species peculiarity, and commercial interest.

The Belterra initiative relies on investment from **Fundo Vale**, a Brazilian impact investment and philanthropic fund created by the mining company Vale. Cocoa was defined as one of the priority supply chains of Fundo Vale to enable the productive systems implemented by the impact businesses supported and invested in the **Vale 2030 Forest Goal**, which foresees the voluntary recovery of 100 thousand hectares of areas and protection of 400 thousand hectares. Fundo Vale also aims to foster initiatives that, in addition to not impacting the environment, generate positive socio-environmental impacts, essential requirements to serving the European market. The initiative engages over 250 workers directly in cultivation and management activities, benefiting more than 300 families. The net profitability of one hectare of cocoa AFS can exceed R$20,000 (~US$3,717)—a stark contrast to extensive livestock farming, which yields approximately R$150 (~US$38) per hectare. A key feature of the initiative is the generation of carbon credits from degraded pasturelands converted into cocoa AFS. Belterra serves as a bridge between producers and major companies, such as Amazon, which prepays for preferential access to these credits over a 10-year period. This mechanism supports the reduction of greenhouse gas (GHG) emissions associated with corporate logistics, while promoting climate-smart agriculture and ecosystem restoration.

10.3. Floresta de Valor (Value Forest)

Since 2010, under the coordination of **Instituto de Manejo e Certificação Florestal e Agrícola (IMAFLORA[123])**, **Floresta de Valor** has worked with Indigenous peoples in traditional communities and family farmers in the Brazilian Amazon, encouraging productive activities through new business models. In São Félix do Xingu, southeastern Pará state, the initiative aims to support the improvement of family farmers' income through the maintenance and expansion of activities that contribute to the conservation and protection of natural resources, reducing deforestation, area degradation, and GHG emissions.

One of the Program's lines of action is cocoa production in AFS. In São Felix do Xingu, activities are carried out that promote good agricultural, agroecological production practices, and the strengthening of the cocoa production supply chain in partnership with local actors, including the **Mixed Alternative Cooperative of Small Producers of Alto Xingu (CAMPPAX)**, the **Association for the Development of Family Farming of Alto Xingu (ADAFAX)**, and the **Association of Women Producers of Fruit Pulps (AMPPF)**, in addition to the partnership with the **Rural Family House (CFR)**.

10.4. Amazon Program – Solidaridad Foundation

Another outstanding example in the Amazon is the **Amazon Program**, implemented by the **Solidaridad Foundation** since 2015[124], which offers a range of innovative tools to stimulate cocoa production. Its primary goal is to deliver high-quality technical assistance to rural producers. Notable results have been observed in the Tuerê settlement, located in Novo Repartimento municipality, in Pará state, particularly in terms of productive restoration of the biome through AFS and the increase in productivity and family income. These outcomes are documented in two benchmark publications within the agri-environmental sector, reinforcing the

[123] Brazilian non-profit organization dedicated to promoting sustainable land use, responsible supply chains, and socio-environmental certification.
[124] See at: https://solidaridadlatam.org/brasil/news/modelo-de-restauracao-da-solidaridad-na-amazonia-e-destaque-em-publicacoes-do-setor-agroambiental/

program's impact and relevance. The first is the report "Reforestation with native trees: case study, economic viability and environmental benefits," launched by the **Brazilian Climate, Forests, and Agriculture Coalition**, which provides details on the AFS implemented by Solidaridad with arrangements that combine banana trees, native trees for shading cocoa trees, and combination plantings with cassava. The publication highlights the improvement in the carbon balance of the farms and the increase in the income of producing families through the sale of cocoa beans, superior to that obtained with other productive models.

Secondly, is the publication organized by **CocoaAction Brazil (World Cocoa Foundation), Instituto Arapyaú, and WRI Brasil**, titled "Economic viability of productive systems with cocoa," which compiled data from various organizations, including the Solidaridad Foundation, to compare the cabruca, full-sun, and cocoa AFS models in the states of Bahia and Pará. The study concluded that all three systems can be economically viable provided there is good productivity. In the case of the AFS, by allowing intensification and diversification in the same area, it can bring better financial results through the generation of anticipated revenues for the producer from the other crops associated with cocoa.

10.5. Renova Cacau: Partnership between the Cocoa Innovation Center (CIC) and Mondelez Brasil

The ongoing transformation in the cocoa sector is driven not only by financial mechanisms, but also by **innovative research and development initiatives**. A prime example is the **Mondelez Model**, implemented through the C**ocoa Innovation Center (CIC)** and the **Renova Cacau Project**.

Renova Cacau[125] is a collaborative initiative led by **Mondelez**, in partnership with **German Cooperation (GIZ)**, aimed at enhancing chocolate production and improving natural processes in the Southern Bahia. The project focuses on research and technical development, seeking to define best practices for cocoa cultivation and ensure the financial, economic, and environmental sustainability of both legacy and newly planted cocoa trees.

[125] See at: https://www.ba.gov.br/meioambiente/noticia/2024-03/16314/projeto-renova-cacau-e-tema-de-reuniao-entre-sema-e-o-centro-integrado-do e https://globorural.globo.com/agricultura/cacau/noticia/2025/08/produtores-de-cacau-testam-novas-variedades-no-semiarido-brasileiro.ghtml

As part of this effort, the **CIC** and **Mondelez Brazil** launched a genetic improvement program to test new cocoa clones under real-world cultivation conditions on selected farms in Brazil's semi-arid region. The program evaluates three key traits in the new genetic varieties, including: tolerance to water stress, resistance to major diseases and high productivity under technological systems. To identify optimal clones, the first progenies resulting from crossbreeding different cocoa varieties were rigorously assessed over a five-year period, providing robust data for future scaling.

11. BARRIERS, CHALLENGES, AND OPPORTUNITIES FOR COCOA PRODUCTION IN BRAZIL

11.1. Barriers for the adoption of Cocoa AFS Production in Brazil

The cocoa sector faces a critical challenge: maintaining a trajectory of continuous and sustainable growth in production and productivity, while aligning food security with socio-environmental sustainability. This challenge unfolds amid growing debates and social pressures for a new development model—one capable of reconciling economic growth with environmental conservation, enhancing the resilience of production systems, and reducing deforestation, land degradation, and greenhouse gases (GHG) emissions. In this context, it is critical to organize key information to support the planning and implementation of actions that promote the adoption of sustainable and resilient production technologies across Brazil's cocoa value chain.

The main difficulties in transitioning to more sustainable cocoa production systems include:

• Limited access to technical and financial viability data: There is a lack of recognition of cocoa agroforestry systems (AFS) as a profitable practice, largely due to the scarcity of regionally adapted studies on their economic and technical viability. This gap hinders widespread adoption. However, Technical Assistance and Rural Extension (ATER) services and financial institutions could play a pivotal role in building and disseminating this knowledge. According to IBGE's 2017 Agricultural Census, only 20% of agricultural establishments in Brazil receive ATER support—just 8% in the Northeast and 10% in the North, despite 76.8% of farms being family-owned, totaling nearly 3.9 million establishments. This scenario remains largely unchanged (Conceição, 2024). Importantly, ATER does not "teach" producers to grow cocoa in biodiverse systems, but rather helps them to enhance efficiency, financial management, and productivity, while also supporting ongoing management and maintenance—a profile currently underrepresented in ATER services.

• Insufficient investment in research and development: There is a lack of funding for regionally tailored technologies and scalable innovations that meet the specific needs of cocoa-producing areas.

• Limited access to agricultural inputs: In remote or underserved regions, infrastructure deficits and poor logistics hinder access to essential inputs for cocoa AFS, affecting productivity and quality.

• Weak integration with public policies: Cocoa production strategies often lack connectivity with broader public policy instruments, reducing their effectiveness and scalability.

• Land and environmental regularization issues: Many producers face legal and regulatory barriers that prevent access to credit and investment, limiting their ability to modernize and expand operations.

• Outstanding debt burdens: In Bahia, unresolved debts have long restricted producers' access to new financing. This barrier began to be addressed in September 2025, when the **Regional Development Commission (CDR)** approved the **Renova Cacau Program**, a restructuring initiative that forgives debts incurred during efforts to combat the Witches' Broom plague. The program cancels all outstanding balances, interest, and fines from loans issued under the **Program for the Recovery of Cocoa Farming in Bahia (PRLCB)**, which ran from 1995 until recent years.

Among the challenges listed, two stand out as important bottlenecks:

• The shortage of trained professionals.

• The lack of accessible, regionally adapted information on management and maintenance.

The risks and proposals listed in Table 12a for integrating programmatic strategies to leverage cocoa production through AFS in Brazil are aligned with the prioritized recommendations in other similar analyses. This includes the diagnostic carried out by Instituto Arapyaú in workshops with a range of relevant multidisciplinary actors in the cocoa supply chain. This diagnostic was used to discuss economic modeling studies, pilot projects, and forms of promoting cocoa production via AFS in degraded areas in the Southern Bahia, and lists risks and opportunities for different types of cocoa producers in the region, especially for the family farmers (properties of about 5 hectares) and medium farmers (properties of about 100 hectares)[126].

[126] See at: https://arapyau.org.br/wp-content/uploads/2020/04/3%C2%BA_workshop_Instituto_Arapyau_Modelagens_Econo%CC%82micas_SAFs_Cacau_Sul_da_Bahia.pdf

Table 12a. Risks and Opportunities of Cocoa Production in AFS for Family, Small, and Medium Farmers

	Family Farmers	Small and Medium Farmers
Risks	• Difficulties in accessing markets for non-cocoa AFS products (e.g., cupuaçu, açaí, etc.); logistics for commercialization; access to seedlings; social organization. • Complexity of the system versus access to ATER (Technical Assistance and Rural Extension). • Rural/generational exodus. • High cost of implementation/maintenance. • Need for access to credit for investment.	• Lack of qualified technical assistance and genetic improvement research. • Low qualification of labor and management. • Difficulties in accessing quality forest seedlings and the market for other crops. • Climate risks. • Lack of access to credit for investment.
Opportunities	• Diversification brings improved income/greater resilience. • Expand access and knowledge about the National Program for Strengthening Family Farming (PRONAF) and its various lines (e.g., forest, SAF, cocoa, etc.). • PES (Payment for Environmental Services). • Fine production cocoa. • Cooperativism/Associativism. • Support for social organizations. • Access to technology (improvement in technical assistance and commercialization.	• Promotion of associations/cooperatives. • Expand access to the National Program for Support to Medium Rural Producers (Pronamp). • Expansion of new markets. • High liquidity of cocoa. • PES (Payment for Environmental Services). • Timber as a savings/financial reserve. • Industry for wood processing.

11.2. Challenges for a Sustained Cocoa Production Expansion in Brazil

In addition to the barriers family farmers encounter when adopting cocoa production in agroforestry, they also face significant challenges in sustaining and scaling these technologies. Challenges include:

• Low access to information: Difficulty in accessing technology transfer (TT) and information continuously after the implementation/adoption of the action, especially on economic viability; Difficulty in accessing information about weather unpredictability and climatic variations (e.g., droughts).

• Difficulty in accessing long-term economic and financial incentives for the maintenance of best practices.

• Difficulty in accessing inputs in the ideal quantity and frequency for planting and maintenance.

• Difficulty in accessing rural insurance, given that priority regions for the adoption of best practices are generally regions with a higher incidence of extreme weather events that can negatively impact production and productivity. Granting rural insurance to the farmers would increase the resilience of the systems against climate change.

• Environmental regularization of rural properties, identifying difficulties and proposing strategies for overcoming them, through state plans and models that generate income for the farmer.

• Lack of ATER with managerial and financial focus: a gap in management and maintenance.

Although sustainable cocoa production plays a vital role in protecting biodiversity, regulating ecosystem services, sequestering carbon, reducing greenhouse gas emissions, and generating local income and employment, some producers are opting for full-sun cocoa cultivation. This shift is driven by the desire to reduce labor dependency, scale up short-term production and productivity, and access credit for the use of chemical inputs and mechanized farming practices (Folhes & Serra, 2023). This is occuring due to the scarcity of credit for the use of sustainable technologies and innovations, technical assistance, and market information for cocoa AFS. This is happening even with the knowledge that monoculture makes the system more susceptible to diseases and pest outbreaks and extreme climatic events, causing losses in productivity, product quality, and income (Padovan et al., 2022; Santana et al., 2025).

12. Strategic Recommendations for Advancing Cocoa-Agroforestry Systems (AFS) in Brazil

In light of the barriers that hinder the adoption, continuity, and expansion of cocoa AFS, this study proposes a set of strategic actions to support the development and scaling of sustainable cocoa production across the country:

1. Characterize and Prioritize Strategic Areas:

Implement integrated assessments by using soil quality indicators, water availability and climatic risk, transport infrastructure, market access for diversified products, and economic viability of agroforestry crops. This analysis will likely reveal that regions with greater environmental vulnerability also face economic and logistical constraints, which may explain the slower adoption of cocoa AFS. To address this, targeted actions should include rural insurance mechanisms and expansion of PRONAF credit lines, especially those focused on socio-biodiversity food production

2. Strengthen the role of research institutions, including universities and agricultural research entities. These institutions are essential for:

- Generating regionally adapted knowledge and innovations
- Identifying best practices for cocoa AFS
- Establishing national and regional emission factors
- Conducting financial viability studies to guide producers and investors

3. Engage and Mobilize the Private Sector and foster collaboration with key actors of the cocoa supply chain:	Processing industries, suppliers of agricultural inputs, bio-inputs, machinery, and equipment, and financial institutions. This engagement is critical to ensure the availability of resources and technologies that support the adoption and long-term success of cocoa AFS.
4. Direct Financial Resources Toward Cocoa AFS:	Ensure that existing and new credit lines - such as PRONAF and constitutional funds—are specifically allocated to cocoa AFS initiatives and accessible to small-scale producers, who are key to scaling sustainable practices
5. Disseminate Technical and Financial Results:	Promote widespread dissemination of the economic and agronomic benefits of cocoa AFS by: • Strengthening the capacity of ATER (Technical Assistance and Rural Extension) network; • Supporting long-term management and monitoring of AFS; • Establishing Technological Reference Units (URTs) to serve as demonstration sites and hubs for innovation.

6. Integrate and Align Public Policies:

Ensure that cocoa AFS are embedded in broader policy frameworks, such as the updated Climate Plan (2035 horizon) and the National Policy on Climate Change (PNMC). This alignment will reinforce the role of family farming in climate resilience and sustainable development.

7. Connect Cocoa AFS to other Economic Sectors:

Strengthen the links between cocoa AFS and other sectors that rely on family farming products, especially in the early years following implementation. Examples include the school meal procurement programs and other institutional markets that guarantee income and help keep producers engaged and active in the field.

The risks and proposals listed above to integrate programmatic strategies to leverage cocoa AFS production in Brazil adhere to the recommendations prioritized in other similar analyses, such as the assessment carried out by Instituto Arapyaú through a series of workshops with several relevant multidisciplinary actors in the cocoa supply chain. Some of the main topics were economic modeling studies, implementation of pilot projects and ways to promote cocoa production via AFS in degraded areas in the Southern Bahia, and the mapping of risks and opportunities according to the profile of cocoa producers in the region, especially for the family farmers properties of 5 hectares) and medium farmers (properties of about 100 hectares).

13. TRADE-OFFS BETWEEN ENVIRONMENTAL AND ECONOMIC OUTCOMES IN COCOA PRODUCTION: FULL-SUN COCOA X COCOA-AGROFORESTRY SYSTEMS

Despite the relevance of the topic, there is a limited understanding of the relationship between environmental and economic benefits associated with different cocoa production systems. This gap is even more pronounced when focusing specifically on Brazil and small-scale farmers. To address this, we examined evidence from cocoa-producing regions, particularly West Africa, which accounts for the largest share of global cocoa production, and Central America. These regions offer valuable insights into the complex dynamics that influence the sustainability of various cocoa farming models. Key factors include the systems' ability to balance biodiversity conservation, climate resilience, soil health, and productivity outcomes.

In the following section, we explore how these variables interact within cocoa AFS compared to full-sun cultivation models, highlighting the trade-offs and synergies that shape their long-term viability.

• Productivity vs. Biodiversity Maintenance

In general, there is a trade-off (gain-loss) between a cocoa production system's capacity to maintain biodiversity and its productivity. In the short term, the productivity achieved in full-sun monoculture systems is generally higher than in AFS. However, the greater productivity leads to negative impacts such as soil degradation, increased use of chemical inputs, and loss of biodiversity (Armengot et al., 2023, Agbotui et al., 2023). On the other hand, cocoa AFS can support significant levels of biodiversity and a wide range of ecosystem services, although they exhibit reduced productivity compared to full-sun monocultures (Jadán et al., 2015, Blaser et al., 2018).

Some factors can alter this relationship, including differences in the complexity of AFS, the adoption of adequate management practices, and the biodiversity and ecosystem services (Faria and Cassano, 2024). Biodiversity in a cocoa AFS is linked to the maintenance of trees in the system, which can vary in species composition, diversity and individual density. Cocoa in very dense and diverse agroforestry tends to be more shaded, and therefore less productive. However, this relationship between shade and productivity is complex, with many studies indicating that intermediate shading values (30–50%) do not significantly reduce productivity, optimizing this trade-off between productivity and biodiversity (Schroth et al. 2016, Blaser et al., 2017, Blaser et al., 2018).

In the short term, the full-sun cocoa production systems may have higher productivity resulting from the use of chemical inputs, mechanization, and access to credit. In the long term, the AFS present secure profitability, social inclusion, biodiversity preservation, and reduced greenhouse gas emissions (Veloso, et al., 2025). The adoption of simple management practices in agroforests, which in monocultures are generally more standardized and intensive, can reduce the "yield gap" between the two systems (Aaron et al., 2024; Schneider et al., 2017). For example, within the 14 farms of the Cantagalo Group the productivity of some areas with cocoa grown in cabrucas systems can reach 100@/ha (1,500 kg/ha), with goals including the doubling of productivity in 3 years with constant investments in management and technology. Finally, the presence of a greater variety of cultivars in agroforests makes the total productivity higher and generally more stable than that reported in monocultures, contributing to a more diversified production and food security (Andres et al., 2016; Allen et al., 2024; Rüegg et al., 2024[127]).

Studies conducted to assess the impact of production systems on the sensory quality of cocoa are rare (Mattalia et al., 2022). Cocoa quality is determined by a complex composition of cocoa bean flavors and depends on the cocoa genotype and environmental factors, such as soil, light quality, altitude, and post-harvest processes (Kongor et al., 2016; Oliva-Cruz et al., 2021). It seems clear that genotypes strongly contribute to determining the chemical composition of the bean. For example,

[127] See at: https://orgprints.org/id/eprint/55007/1/Rueegg-etal-2024-TropicalForest-Issue62-p59-65.pdf

Motamayor et al. (2008) identified 10 genetic groups of cocoa, each with a unique sensory profile. However, while the sensory profile can be further modified by pre- and post-harvest processes to influence flavors, we found no evidence of a direct effect of production systems (e.g., shaded systems) on the aromatic quality of cocoa.

Some articles address the issue of the aromatic quality of cocoa in Ecuador. Herrmann et al. (2015) found that the Ecuadorian cocoa variety CCN-51, widely cultivated in Ecuador and Peru, is generally grown in monoculture systems and considered a non-aromatic variety with weak flavor. However, Huamanchumo de la Cuba (2013) reported that CCN-51 beans from Peru were of fine quality or weak flavor in important European cocoa forums. Scott (2016) argued that a possible reason for this controversy because the CCN-51 variety being grown in AFS in the Amazonian region, which is highly diversified ecologically, unlike other zones where this variety is mainly cultivated as a monoculture. Another cocoa variety is “el Nacional,” which is characterized by a floral aroma conferred by a combination of factors, including cultivation systems and agricultural practices (Gockowski et al., 2011). In fact, Franzen and Borgerhoff Mulder (2007) reported that Ecuadorian farmers consider traditional “el nacional” cocoa, grown in the shade, superior to cocoa grown in monoculture in terms of flavor complexity.

Finally, the relationship between cocoa flavor complexity and the cocoa production system is still unclear and has not been widely explored (Kongor et al., 2016).

• Cocoa Production Systems vs. Farmer Economics

AFS were found to have higher return on labor, lower environmental impact, and improved energy efficiency of the system compared to monoculture systems (Armengot et al., 2016). AFS can increase overall ecological resilience (Mbow et al., 2014) and the economic resilience of family farmers (Kiewisch 2015), by incorporating a diversity of associated species that provide a combination of ecosystem services. Such ecosystem services include light and water regulation, pest and disease control, pollinator community regulation, improved soil quality, and creation of a favorable microclimate (Mortimer et al., 2018). They generate significant additional revenue from the sale of a diversity of products, reducing financial risk (Notaro et al., 2020; Jagoret et al., 2019).

A carefully designed AFS, with different seasonal fruiting patterns, can ensure year-round production (Cerda et al. 2014). Furthermore, the production of food for domestic consumption, which provides additional income, is an important motivation for the adoption of AFS by cocoa producers (Gyau et al. 2014). The association with other plants or trees provides a greater diversity of marketable products, which is especially important in the case of failure or lower cocoa prices in the market (Notaro et al., 2020).

The economic viability of cocoa-based cultivation systems depends on their capacity to generate stable income, despite seasonal price and productivity volatility. The high diversification and sustained benefits from stable incomes and ecosystem services are only possible when market access is developed enough to ensure the commercialization of small quantities of certain products (Ruf, 2011). Thus, the creation of local markets or exports must be encouraged by national policies, services, and infrastructure (Jagoret et al. 2014). This poses problems for farmers in remote areas, with often underdeveloped road infrastructures, far from the urban market or potential exports. Furthermore, Delgado Vargas (2013) mentioned that farmers feel the need to increase their knowledge of cocoa crop management to improve their systems and productivity, but access to education, agronomic training, and market information is not always possible.

Previous studies suggested that certification processes can add value to cocoa, but also to associated products in diversified AFS. However, the diversity of crops in cocoa polycultures needs to be supported by the implementation of economic incentives, such as organic or fair trade certifications (Asare et al., 2014). In fact, the growing adoption of certification schemes (such as the Rain Forest Alliance) may be another factor leading to the decision to implement AFS (Gyau et al., 2014). These certification schemes aim to promote the adoption of AFS to improve overall sustainability performance, creating recognizable labels for consumers to differentiate this cocoa in global markets (Folefack and Darr, 2021). However, much of the certified cocoa is currently sold in bulk due to the lack of a local market (Amiel and Laurans, 2019).

Nevertheless, the higher short-term income from monocultures is a very attractive aspect for farmers who wish to migrate to this cultivation system (Ruf, 2011). In fact, cocoa-based AFS require a few years (depending on the species included) before providing marketable timber and fruits.

AFS requires farmers to deal with complex systems that bring together diverse cultivated plant species, thus inducing innovative crop management. As cocoa production is largely a family business, the creation of multi-generational ties among family members, to ensure the transfer of this knowledge and a good understanding of the system, is beneficial to its functioning (Delgado Vargas, 2013). This process can be fostered by making cocoa cultivation attractive to younger generations of farmers. This can be achieved by improving the image of cocoa farming and increasing the income generated by highly biodiverse and agroecological cultivation systems. Oteng Yeboah et al. (2012) and Vebrova et al. (2014) demonstrated that local knowledge about trees and crops and their interactions is frequently passed down from one generation to another. Knowledge of ecological interactions is crucial for managing complexity, to ensure the economic viability of AFS. Smith Dumont et al. (2014) reported that, in Côte d'Ivoire, some technical recommendations created barriers to farmer innovation, while Sanial and Ruf (2018) found that, in the same country, top-down technical recommendations without knowledge co-creation were unsuccessful. The transfer of traditional farmer knowledge and the promotion of broad knowledge exchange and transfer are seen as ways to develop the full potential of complex systems (Delgado Vargas, 2013).

14. FINAL CONSIDERATIONS

The cocoa value chain in Brazil is undergoing a significant phase of transformation and restructuring, shaped by a legacy of historical challenges and the emergence of new opportunities. Following a severe crisis in previous decades—primarily caused by the Witches' Broom outbreak in Bahia—the sector has been actively pursuing recovery and expansion strategies centered on sustainability, product quality, and the empowerment of farmers.

A key highlight of this transformation is the rapid growth of cocoa production in Pará, which has now become the leading cocoa-producing state in the Amazon and country. Additionally, the rise of new production frontiers in states such as Rondônia, Amazonas, and Mato Grosso signals a broader geographic diversification of the sector.

In recent years, notable progress has been made across multiple dimensions. The revitalization of cocoa farming in Bahia, the expansion of production in Pará, and the development of new agricultural regions underscore the sector's resilience and growth potential. Furthermore, a growing emphasis on high-quality cocoa—targeting the fine and origin chocolate market—has opened new avenues for smallholder inclusion and regional economic development.

Despite recent progress, significant challenges continue to hinder the full development of Brazil's cocoa industry. Some of the key issues:

• Low productivity in several regions.
• Limited access to technical assistance and rural extension, particularly for small-scale farmers.
• Insufficient availability of technology and financial resources.
• Informality in parts of the value supply chain.
• Socio-environmental concerns, such as deforestation and degradation.
• Precarious working and labor conditions.

Addressing these obstacles requires a coordinated effort, including the implementation of effective public policies, strengthening of technical assistance and rural extension, and targeted incentives to promote sustainable production models.

Moreover, Brazil has yet to achieve self-sufficiency in cocoa production to avoid importing of cocoa beans to meet industrial demand. To reverse this trend, it is crucial to promote greater integration among the links of the supply chain, strengthen cooperatives and farmer's associations, ensure fair prices for the farmer, and invest in research and innovation. These actions are essential to build a resilient, inclusive, and competitive cocoa sector that meets both domestic and global demands while advancing sustainability goals.

In this context, cocoa Agroforestry Systems (AFS) have emerged as a key strategy for the sustainable development of the sector. The cultivation of cocoa intercropped with native or fruit-bearing trees—particularly in regions such as the Amazon and Southern Bahia—offers an effective approach to harmonize agricultural production, environmental conservation, and income generation. This integrated model supports:

• Forest cover protection;
• Biodiversity conservation;
• Soil quality and health enhancement;
• Reduction of greenhouse gas emissions and carbon removal; and
• Economic and financial benefits to farmers.

Beyond ecological advantages, cocoa AFS play a vital role in social inclusion, as they are accessible to smallholder farmers and traditional communities, including riverside dwellers and Indigenous peoples. These systems contribute to the strengthening of family farming and the resilience of rural livelihoods. Looking ahead, the future of Brazil's cocoa sector increasingly depends on the adoption of sustainable practices like AFS. Driven by a growing appreciation for traditional varieties and a demand for low-carbon products, the sector is shifting toward a model of excellence. In this new paradigm, high-quality production, environmental stewardship, and social inclusion are no longer separate goals but are deeply interconnected drivers of growth.

Enabling Conditions for Brazil's Cocoa Transformation

The continuity and strengthening of efforts by key organizations have been instrumental in creating the enabling conditions that define the current momentum in Brazil's cocoa sector. In the case of Bahia, strategic investments made by Instituto Arapyaú, along with partners such as Good Energies, Instituto Humanize, and Instituto Floresta Viva, were pivotal in establishing transformative initiatives like the Cocoa Innovation Center (CIC), the Scientific and Technological Park of Southern Bahia (PCTSB), and the Southern Bahia Regional Development Agency (ADR Sul da Bahia). These institutions have laid the groundwork for the sector's ongoing evolution.

Equally vital has been the knowledge generated by leading research institutions, including:

- Executive Commission for the Cocoa Farming Plan (CEPLAC)
- Brazilian Agricultural Research Company (Embrapa)
- Federal University of Bahia (UFBA)
- State University of Santa Cruz (UESC)
- Federal University of Pará (UFPA)
- National Institute of Amazonian Research (INPA)
- Federal University of Southern Bahia (UFSB)

Together with cooperatives and farmer's associations, these entities have contributed to the development of innovative technologies, genetic improvement, pest control strategies, and sustainable AFS. Their collaboration has been essential in addressing core challenges such as disease management, productivity enhancement, and the adoption of sustainable agricultural practices.

Brazil's Strategic Advantages

Brazil possesses a unique set of attributes that position it to become a global leader in sustainable cocoa production:

• Robust environmental and social legislation.
• Availability of land, credit, and advanced technologies.
• A mature business and institutional environment.
• A stable democratic framework.
• A free market economy, with no government interference in pricing.
• A large domestic consumer base, ranking 5th globally, with 4 kg per capita consumption.

To fully realize this potential, Brazil must continue its transition toward a more sustainable and integrated cocoa production model, which requires the following:

• Effective public policies.
• Strategic investments in research and innovation.
• Technical training and capacity building.
• Robust partnerships among government entities, the private sector, and local communities.

By placing AFS at the core of its production strategies, Brazil is well-positioned to become a global leader not only in terms of production volume, but also in terms of cocoa quality and sustainability.

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