Economic Feasibility Assessment of Cocoa in Agroforestry Systems

Amazon (Pará) and the Atlantic Forest (Bahia)

Organization: Instituto Arapyaú and CocoaAction Brasil (WCF)

UPDATE EDITION

2026

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Executive summary

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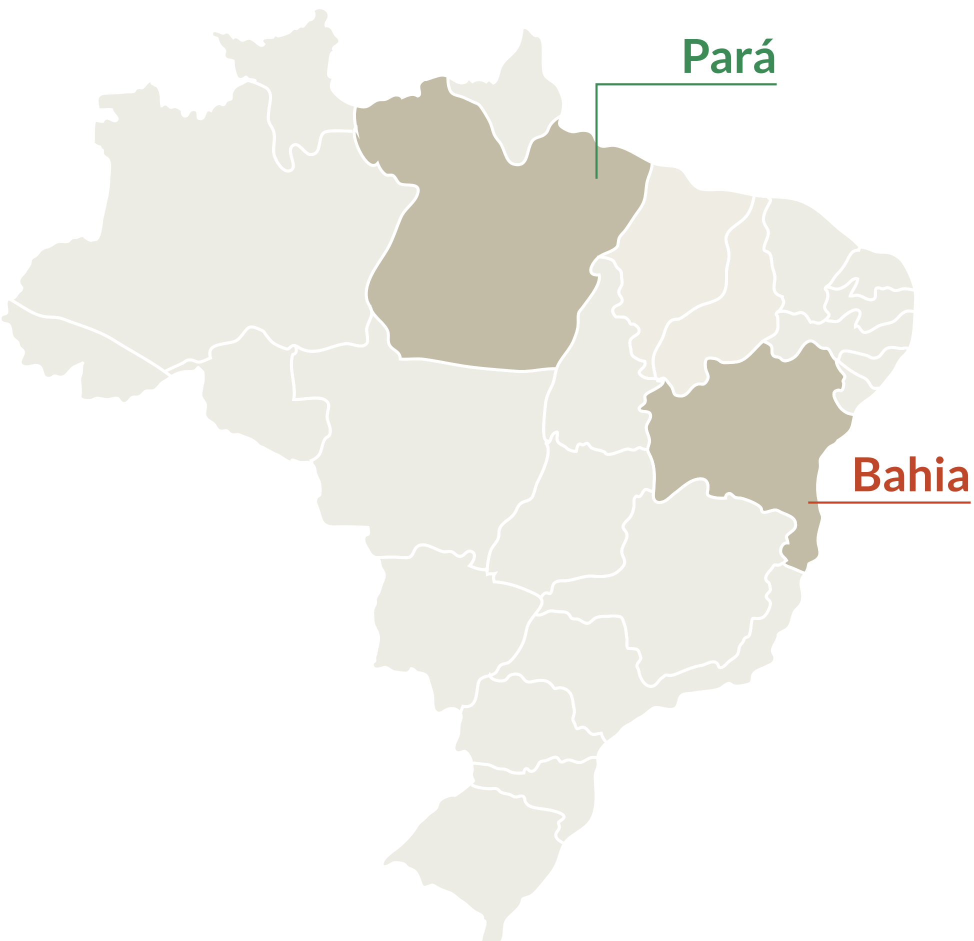
1. Executive summary

Cocoa in agroforestry systems combines profitability, forest conservation, and regional development

Objective

This publication presents **economic feasibility modeling for cocoa production in agroforestry systems across Brazil's two main producing biomes**. The study demonstrates that it is possible to integrate agricultural production with standing forests while generating continuous income and measurable environmental benefits.

Agroforestry systems across Brazil's two main producing biomes



What are cocoa agroforestry systems?

Agroforestry systems (AFSs) are production models that integrate agricultural crops, such as cocoa, with forest species in arrangements that replicate forest dynamics.

Advantages of cocoa production in AFSs:

* Diversification of species and income sources
* Different production cycles over time
* Reduction of economic risk
* Conservation of soil and biodiversity
* Contribution to the restoration of degraded landscapes and the connection of forest fragments
* Continuous income generation for family farmers and financial returns for investors

The study

The study economically projects **11 cocoa-based agroforestry systems** developed from technical parameters grounded in the productive realities of Bahia and Pará, including:

* 7 models in the Atlantic Forest (southern Bahia)
* 4 models in the Amazon (Pará), including an oil palm arrangement developed by Natura
* Systems reflecting the edaphoclimatic conditions of each biome
* Production arrangements based on family farming and smallholder producers
* Models based on technical assumptions validated with field specialists

Each model presents:

- Planting spacing and density
- Production curve over time
- Projected cash flow
- Establishment and maintenance costs
- Financial results from both production and investment perspectives
- Sensitivity analysis

Summary table – Species by model

	Bahia							Pará			
	Cocoa I	Cocoa II	Cocoa + Açaí I	Cocoa + Açaí II	Cocoa + Açaí III	Cocoa + Cupuaçu	Cocoa + Coconut	Cocoa	Cocoa + Açaí	Cocoa + diverse forest species	Cocoa + Oil Palm
Fruit species											
Cocoa	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Banana	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Cassava		/////	/////	/////	/////	/////			/////	/////	
Açaí			/////	/////	/////				/////		/////
Cupuaçu						/////					
Coconut							/////				/////
Oil Palm											/////
Forest species											
Rubber tree						/////					
Jequitibá	/////	/////		/////							
Mahogany	/////		/////		/////						
Laurel		/////									
Andiroba								/////	/////	/////	/////
Ipê								/////	/////		
Jatobá								/////	/////		
Bagassa (Tatajuba)										/////	
Cumaru										/////	
Freijo										/////	

Conclusions

* There are multiple possible and viable arrangements for cocoa production in AFSs
* There is no single or inherently superior solution
* Each model must be adapted to local realities with appropriate technical support
* Productive diversification reduces risks and stabilizes income
* Cocoa acts as an anchor crop for productive restoration
* Well-managed systems are economically competitive
* AFSs strengthen territorial economies and family farming

The results indicate that cocoa production in AFSs is possible across different biomes and through a variety of production arrangements. In all scenarios analyzed, there are economic returns for producers and investors, while also strengthening restoration and local development agendas

Introduction

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2. Introduction

The new edition of the study *"Economic Feasibility of Agroforestry Systems with Cocoa – Modeling in the Amazon (Pará) and the Atlantic Forest (Bahia)"* aims to provide updated information on cocoa production in agroforestry systems (AFSs) in Brazil. Prepared by CocoaAction Brasil and the Arapyaú Institute, the study consolidates technical data and presents economic models that expand knowledge about the costs, results, and specific characteristics of cocoa farming in AFSs by supporting producers, technicians, companies, financial institutions, and public policymakers in decision-making.

Since 2018, the production of content, the promotion of technical publications, and the dissemination of knowledge on cocoa farming have been priorities for CocoaAction Brasil and the Arapyaú Institute, with the goal of strengthening Brazil's cocoa value chain and its global competitiveness. In such context, in 2020, the first edition of the economic feasibility study analyzed different cultivation systems – from agroforestry systems, including cabruca, to full-sun systems – by consolidating information that had previously been dispersed and structuring a technical baseline for analyzing cocoa production in Brazil's main producing centers.

In light of recent transformations in the cocoa value chain – such as rising international market prices, increasing production costs, new market requirements, and growing interest in credit and financing – updating the economic feasibility analyses have become necessary. In addition, advances in technical and empirical knowledge of production systems made it possible to refine the models and, in this edition, focus exclusively on cocoa-based agroforestry systems, providing a detailed analysis of crop performance across different productive forest arrangements.

Cocoa production in AFSs represents a strategic opportunity to consolidate Brazil as a global reference in sustainable production models. This objective is aligned with the Inova Cacau 2030 Plan, a national strategy that seeks to position the country as a source of sustainable cocoa, with a focus on productive conservation as well as improving living and working conditions throughout the value chain. AFSs contribute to maintaining standing forests, restoring degraded areas, and meeting international climate and biodiversity agendas — which have gained even greater prominence in the context of COP30 in the Amazon and the advancement of regulatory requirements such as the European Union Deforestation-Free Products Regulation (EUDR).

Although historically perceived as less competitive, the results of this study demonstrate that agroforestry arrangements can combine environmental and climate gains with financial returns by providing concrete inputs for investment decisions and public policy-making.

For this potential to translate into concrete results in the field, practical challenges still remain, such as the limited availability of inputs and seedlings, the scarcity of credit under suitable conditions, and difficulties in accessing qualified technical assistance and rural extension services TARE. Strengthening TARE is especially important to support the adaptation of production models to the specific realities of each property. In this context, the **Kawá Fund** acts as a strategic instrument by integrating financing and technical assistance, which enables the conversion of the identified potential into effective on-the-ground productivity. More information: *arapyau.org.br/en/kawa.*

This study is the result of a collective effort by several institutions committed to strengthening the cocoa value chain and to the development of the communities involved. The publication combines data from public and official sources with field information generously shared by the supporting institutions: Belterra, CEPLAC, CIC, FAEB, Mondelez International, Natura, PCTSul, Renova Cacau, SENAR Bahia, Solidaridad Brasil, Symbiosis, UESC, and WRI Brasil. Its main value lies precisely in this integrative character. The diversity of actors involved has lent technical robustness and relevance to the study, making it a valuable contribution to the entire cocoa value chain.

In addition to this introduction, the publication is organized into four parts. The first presents an overview of cocoa farming in Brazil, fixating on its presence in the Amazon and Atlantic Forest biomes and contextualizing the territories of Bahia and Pará, which are the focus of the analyses. The second describes the methodological approach adopted to evaluate the production systems and guides the interpretation of the results. The third outlines the economic models of the eleven cocoa-based agroforestry systems analyzed in the two states. Finally, the fourth part brings together the study's main conclusions and their implications for producers, investors, public policymakers, and other actors in the cocoa value chain.

Have a good reading!

Characterization of the territories

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3. Characterization of the territories

In the international context, according to official data from the Food and Agriculture Organization of the United Nations, cocoa production is led by West African countries – particularly Côte d'Ivoire and Ghana – with significant participation from producers in Latin America and Southeast Asia, such as Indonesia and Ecuador. Brazil ranked among the world's largest producers throughout the 20th century but lost prominence amid the rapid expansion of African production. **In recent decades, however, Brazil's cocoa sector has undergone a process of productive reconfiguration, supported by technological innovation, genetic diversification, and territorial expansion.**

This resurgence repositions the country within the global landscape and highlights an **important comparative advantage: production within highly biodiverse biomes, a long-standing tradition in agroforestry systems, and the presence of a complete and integrated cocoa value chain** encompassing production, processing, industry, and domestic consumption. These elements differentiate Brazil in the contemporary debate on sustainability, traceability, and deforestation within global cocoa supply chains.

Brazilian cocoa farming is structured across two of the country's most significant tropical forest biomes – the Amazon and the Atlantic Forest – both recognized for their high biodiversity and strategic potential within the bioeconomy. Native to tropical forests, cocoa stands out as a crop capable of reconciling environmental conservation with income generation, while also producing significant social impacts by involving thousands of smallholder and family farmers for whom it represents an important source of livelihood and economic dynamism in their territories.

By focusing on production models guided by a conservation-oriented logic, this study presents economic models of seven AFSs in the southern Atlantic Forest region of Bahia and four AFSs in the state of Pará, one of them the Oil Palm AFS, which its singularity will be presented further. The choice of these territories reflects, on the one hand, Bahia's historical relevance in Brazilian cocoa farming and, on the other, the recent dynamism of Pará, which has been increasing its importance in national production.

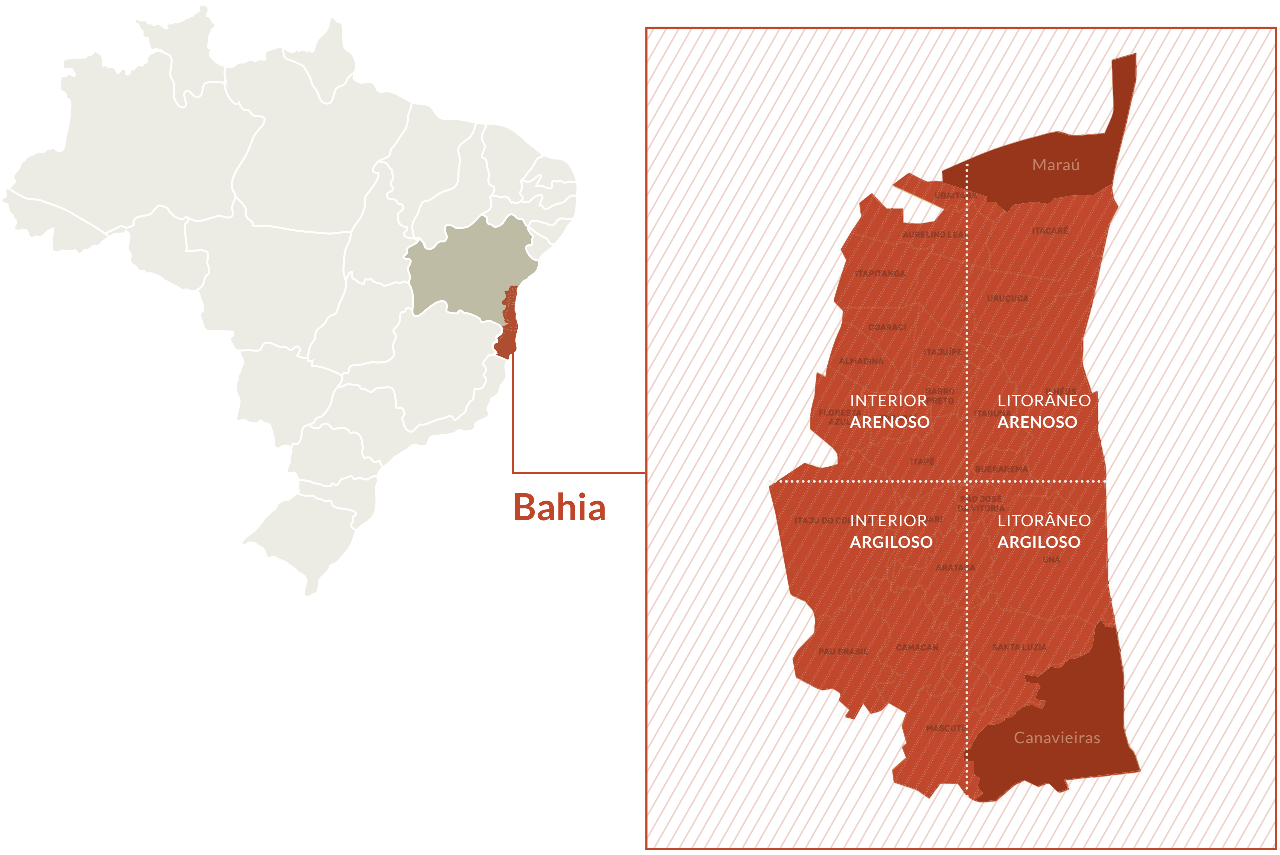
In both regions, representative production systems of small- and medium-sized farms and family agriculture were modeled, considering unirrigated arrangements and reflecting the productive diversity of each territory.

Bahia – Atlantic Forest

Bahia holds a central place in the history of Brazilian cocoa farming. Strongly concentrated in the southern region of the state, cocoa cultivation has historically consolidated itself as a structuring activity of the regional economy and territorial occupation. The region is marked by high socio-environmental diversity, with forest remnants, mangroves, and coastal restingas, in addition to a strong cultural identity associated with cocoa production.

The Southern Bahia territory encompasses 26 municipalities – including Ilhéus, Itabuna, Camacã, Canavieiras, Maraú, and Uruçuca – and it concentrates a population of over 700 thousand people. For analytical purposes, this study subdivides southern Bahia into four macro-regions, defined based on edaphoclimatic conditions: sandy coastal (Camamu and Maraú), argillaceous coastal (Ilhéus and Itabuna), sandy inland (Ipiaú), and argillaceous inland (Camacã and Floresta Azul).

Bahia - Atlantic Forest



Although it has a high degree of urbanization, the rural sector plays an important role in the territorial dynamics of southern Bahia, encompassing family farmers, agrarian reform settlements, quilombola communities, and Indigenous peoples. Producers operating small and medium-sized farms are highly relevant to cocoa production in Bahia, which is characterized by significant heterogeneity of production. Different production systems reflect variations in soil, climate, levels of technification, and production arrangements, ranging from more intensified models to agroforestry systems and cabrucas, a traditional regional management system historically associated with the maintenance of forest cover.

In recent years, cocoa farming in Bahia has resumed its growth trajectory, with the expansion of cultivated areas accompanied by productivity gains and technological advances in production. This movement has been driven by the introduction of new genetic materials, improvements in management practices, and increased professionalization of the activity. As a result, Bahia has consolidated itself as a reference in the production of fine and flavor cocoa, with beans internationally recognized and increasingly integrated into premium and bean-to-bar chocolate markets, in which quality, territorial identity, and sustainable practices are key value drivers.

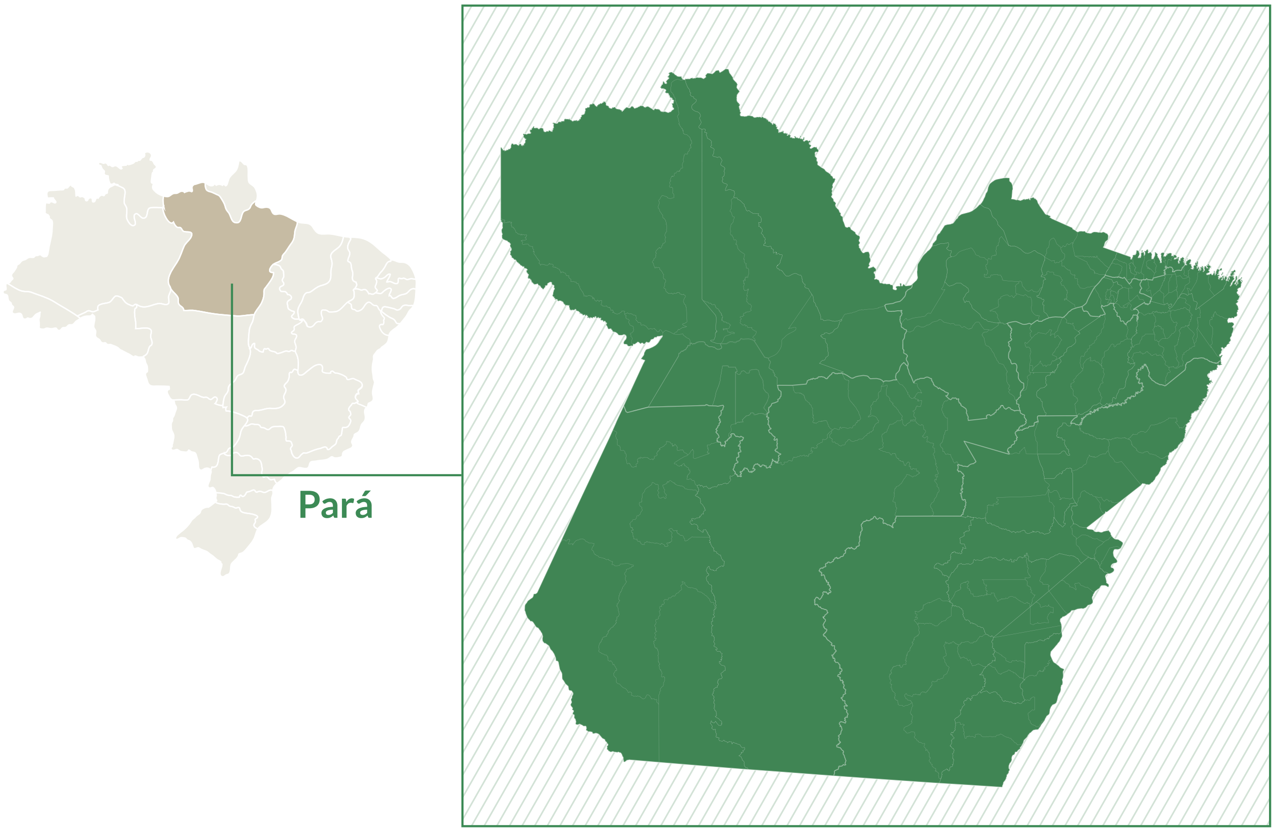
In cocoa-based AFSs in Bahia, a high diversity of tree species is observed, including fruit trees and timber species such as cupuaçu, açaí, coconut, rubber tree, jequitibá, mahogany, and laurel. The diversity of species and the range of possible forest arrangements reinforce the environmental relevance of the territory and its strategic potential for conservation, bioeconomy, and territorial development agendas.

Pará - Amazon

Over the past decades, Pará has consolidated itself as the main expansion frontier of Brazilian cocoa farming, occupying a prominent position in national production. Located within the Amazon biome, the state has combined production growth with the adoption of AFSs in degraded areas, particularly former pastures and capoeiras. This dynamic has transformed cocoa into a driver of forest restoration and environmental regularization, linking income generation with the recovery of productive landscapes in the Amazon.

Cocoa farming in Pará is characterized by a diversified production profile, encompassing family farmers, medium-scale producers, and corporate enterprises. However, the recent expansion of cocoa-based AFSs has been primarily driven by family farmers, especially concentrated in the Trans-Amazonian region, an important highway corridor in northern Brazil.
In these areas, favorable edaphoclimatic conditions – medium- to high-fertility soils combined with a hot and humid climate – along with state-level public policies and increased system technification, have fostered professionalization and productivity gains.

Pará - Amazon



In Pará, cocoa has evolved from being merely an agricultural crop to becoming a central axis of public policies aimed at productive restoration, the conversion of degraded pastures, and the consolidation of an Amazonian bioeconomy based on standing forests, with economic models characterized by high productivity. In this sense, the cocoa value chain operates simultaneously as an economic activity and as an instrument for land-use reorganization, integrating production, conservation, and regional development.

In Pará's AFSs, shading is composed of multi-purpose species that combine ecological and productive functions. Among the species associated with productive arrangements are andiroba, cumaru, and jatobá, in addition to palms such as açaí and oil palm, which contribute both to income generation and to system structuring. Native timber species such as ipê, tatajuba, and freijo are also integrated into the models, expanding productive diversification, ecological resilience, and the economic potential of agroforestry systems.

Oil Palm AFS

The Oil Palm AFS, developed by Natura, systematizes productive arrangements in the state of Pará for the implementation and management of AFSs that integrate oil palm cultivation with other agricultural and forest species, with particular emphasis on cocoa. Although the development process of this model followed its own methodology, distinct from that adopted for the other systems analyzed, there is strong conceptual and technical convergence with the AFSs presented here, especially regarding regenerative agriculture, productive diversification, ecological functionality, and income generation over time. The model also incorporates sustainable management practices, parameters for land tenure and environmental regularization, and requirements compatible with recognized socio-environmental certifications.

In this study, the Oil Palm AFS is presented as an additional reference arrangement for the Amazon region. Its inclusion is informative and complementary, expanding the technical repertoire analyzed and contributing to a better understanding of the economic dynamics of diversified AFSs. It therefore constitutes an exercise in technical approximation that enriches the diversity of possible AFS models. However, due to its specific characteristics, the model is presented separately from the other models from the state of Pará.

Foundations of the modeling

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4. Foundations of the modeling

This section presents the construction process, methods, and analytical concepts and choices that support the economic models developed in this study. Its objective is to ensure technical transparency of the analyses and to guide the reader in interpreting the models, indicators, and results presented. At the end of the publication, a glossary compiles the main terms used.

From field experience to economic modeling

The economic models presented in this publication are the result of a **long-term collaborative process** initiated in 2018 by the Arapyaú Institute, with the participation of various actors in the cocoa value chain, including producers, field technicians, researchers, companies from the chocolate and grinding sectors, and representatives of the public sector. The objective of this effort was to strengthen the technical basis for decision-making in the sector through economically consistent analyses grounded in the productive realities of the territories.

As part of this process, the AFS Rally was conducted in southern Bahia in 2019. This initiative enabled the identification of concrete production experiences, opportunities, and challenges associated with the implementation of cocoa-based AFSs. Field evidence gathered during this process supported the initial formulation of production models and the definition of technical, productive, and financial parameters used in the analyses.

Based on this learning, the process was **expanded to other territories**, particularly Pará, through coordination with organizations, technicians, and producers already operating within the cocoa value chain in the region. This expansion made it possible to incorporate different production contexts, levels of technological adoption, and agroforestry arrangements, reflecting the diversity and dynamism of Brazilian cocoa farming.

As a result of this collective effort, **eleven economic models** were developed, representing distinct cocoa-based productive arrangements in Bahia and Pará. These models are referential in nature and were conceived as **tools to support planning, risk analysis, and decision-making** for producers, investors, and other actors in the cocoa value chain.

Modeling of Cocoa-Based Agroforestry Systems

The economic feasibility assessment presented in this publication is based on the modeling of cocoa-based production systems, understood as the technical and economic representation of different agroforestry arrangements using agronomic, financial, and management parameters. **This approach allows for standardized and comparable estimation of system performance over time, considering establishment and maintenance costs, expected revenues, and economic return indicators.**

The models were built from a combination of empirical evidence, field information, and consolidated technical references, incorporating productive experiences observed in the analyzed territories. The standardization of assumptions enables both individual analysis of each arrangement and comparison among production alternatives, while respecting territorial specificities and different levels of technological adoption.

In AFSs, different plant species are combined to integrate agricultural production and environmental conservation, promoting ecological diversity, productive resilience, and staggered harvests over time. In the analyzed models, AFSs are represented through Production Curve Frameworks, which describe the evolution of species productivity throughout the production cycle. **The diversity of species types enables staggered productive and economic returns over time, as each group performs specific functions within the system:** *(i) perennial species* ensure continuous long-term production; *(ii) temporary species* contribute to faster returns and income diversification; *(iii) native species* reinforce biodiversity conservation and ecological functionality; and *(iv) exotic species* expand the productive portfolio and market opportunities. The articulation among these components enables the structuring of systems that are economically more stable, productively resilient, and efficient in the use of natural resources.

The models presented are referential and should be interpreted as planning and decision-support scenarios rather than arrangements to be automatically replicated. Differences in scale, management, access to inputs, labor organization, and local conditions may influence actual system performance, reinforcing the importance of adapting the models to the specific reality of each farm. Whenever possible, financial results are presented in both Brazilian reais and U.S. dollars to enhance readability and facilitate international comparability.

Technical Parameters of the Models

For analytical purposes, all models consider a **standard area of 1 hectare**, allowing direct comparison among different productive arrangements and adaptation of results to different production scales.

Productivity and price assumptions for the species composing the AFSs are based on field-observed averages and consolidated technical references. For cocoa, productivity of 1 kg or 1.5 kg per plant was considered, with a reference price aligned with the average commodity market price in 2025. For the other species, parameters compatible with their role in the productive system were adopted, whether as a source of short-term income or as a medium- and long-term asset. The adopted values are systematized in Table 1 below. The models do not consider revenues or expenses related to the valuation or commercialization of carbon or other ecosystem services.

Species, productivity and price

Species	Productivity (Kg/planta)	Price (R$/Kg)	(USD/ton) *
Fruit crops			
Cocoa	1 or 1.5	27.93. Oil Palm AFS: 20	4,996. Oil Palm AFS: 3,578
Banana	12 or 15	2.98	533. Oil Palm AFS: 179
Cassava	1	1.72	308
Açaí	10 or 15	2.5. Oil Palm AFS: 5.2	447. Oil Palm AFS: 930
Cupuaçú	17	1.13	202
Coconut**	80	0.7	125
Oil Palm	159	0.79	141
Forest Species			
Rubber tree	1.2	3.20	572
Jequitibá	0.8	500	89,445
Mahogany	1.2	600	107,335
Laurel	1	300	53,667
Freijo	1	80	14,311
Andiroba	0.5	1,000	178,891
Andiroba Seeds	13	2	358
Ipê	0.5	1,200	214,669
Jatobá	0.8	800	143,113
Bagassa (Tatajuba)	0.8	800	143,113
Cumaru	0.5	1,000	178,891

**Exchange rate: USD 1 = BRL 5.59*
***Unlike the others, the unit of measurement is per fruit: Productivity (fruits/plant) and Price (R$/fruit).*

Regarding **financial parameters**, an **income tax rate of 15%** and a **Discount Rate of 20%** were adopted for cash flow evaluation. The discount rate was defined as compatible with the level of risk associated with agricultural activity and the productive arrangements analyzed.

The **cost** structure of the models includes both **investment costs**, concentrated in the first four years of establishment, and recurring and fixed maintenance costs throughout the production cycle. Investment costs (years 0 to 3) include soil preparation equipment, tractor and vehicle, soil preparation inputs, planting seedlings, and labor. Recurring and fixed costs from the fourth year onward include maintenance inputs, labor, and administrative costs.

Among cost components, **labor** plays a central role, reflecting the labor-intensive nature of cocoa-based AFSs, particularly during establishment, management, and harvesting phases. During the initial investment period, labor costs were estimated assuming two workers in year zero, one and a half workers in year one, and, in subsequent years, the allocation of one worker per five hectares. These estimates reflect the effort required for management and maintenance activities throughout the production cycle and allow for consistent estimation of labor's impact on the economic performance of different productive arrangements.

The **reference monthly labor cost was set at BRL 2,500** under Brazil's Consolidation of Labor Laws (CLT), resulting in an average annual cost of BRL 51,000, as presented in the cost tables. In cases where the producer directly undertakes system establishment and no formal labor is hired, Free Income is assumed to be increased by the corresponding value to reflect the opportunity cost of labor.

Another factor considered in the cost structure relates to land use conditions, whether through leasing or ownership. In the scenarios presented, land leasing was considered at an average annual cost of R$ 800 per hectare for Bahia and R$ 1,200 per hectare for Pará, as specified in the tables. When production occurs on owned land, this cost should be excluded from the cost structure.

All models in this publication present Free Income under two scenarios: including land lease and hired labor costs, and alternatively excluding these costs.

Presentation of the models and interpretation of the results

The results of this publication are presented using a **standard model** applied consistently across the eleven AFSs analyzed. Each model is organized into information blocks that allow integrated understanding of the system's productive structure, costs, economic returns, and associated risks. Thus, each AFS is presented according to the structure below, which also guides interpretation of its main components.

1) General description of the productive arrangement

Each model begins with a brief descriptive paragraph presenting the name and main characteristics of the productive arrangement, highlighting the logic of species combination, system profile, and objectives. This description guides interpretation of results by clarifying productive choices that influence both cost structure and expected returns over time.

2) Spacing, density, and production curve

After general characterization, the agronomic basis of the model is presented. Each productive arrangement is described through a technical framework that includes the species composing the system, adopted spacing, planting density (number of plants per hectare), and the corresponding production curve, which illustrates the evolution of production over time and highlights the staggered return logic characteristic of AFSs.

3) Spatial distribution of the arrangement

The visual representation of the system's spatial configuration complements agronomic technical information and supports understanding of field organization, which directly influences land management practices.

4) Financial results

After presenting the agronomic dimension, financial results are introduced, synthesizing economic performance from two complementary perspectives:

» *FROM THE PRODUCTION PERSPECTIVE*

initial investment (R$/ha), corresponding to the sum of costs incurred in years 0 to 3, the first four years of system implementation;

average direct costs after year 3 (R$/ha/year), representing the average annual maintenance costs of the production model from year 4 onward;

average net revenue after year 3 (R$/ha/year), reflecting the average net revenues generated by the model from year 4 onward, when the system reaches regular cocoa production;

average free income after year 3 (R$/ha/year), representing the average annual economic return effectively available to the producer after deducting direct costs; and, finally,

average free income after year 3, without land lease and no hired labor (R$/ha/year), which expresses the average free income presented above for cases in which the land is owned by the producer and labor is predominantly family-based, allowing visualization of system returns under the logic of the producer who directly plants and manages the crop.

» *FROM THE INVESTMENT PERSPECTIVE*

These indicators allow the analysis of the attractiveness of different production arrangements and their alignment with investors' return expectations.

Discounted Payback, an indicator that estimates the period required to recover the initial investment from discounted cash flows over time. Unlike simple payback, the calculation incorporates the time value of money, making the analysis more consistent for long-term projects. The longer the investment recovery period, the higher the level of uncertainty of the project tends to be. In perennial crops, such as cocoa AFSs, a longer payback is expected due to the productive maturation period of the species

Internal Rate of Return (IRR), an indicator that expresses the annual profitability rate of a project over its analysis horizon. The IRR corresponds to the rate that equalizes the present value of positive and negative cash flows, allowing comparison of project performance with the adopted minimum attractiveness rate.

Interpretation:
* **IRR > discount rate:** the project is economically viable
* **IRR < discount rate:** the project is not economically viable

Net Present Value (NPV), an indicator that represents the current value of a project's future cash flows, discounted by a minimum attractiveness rate. NPV expresses the difference between projected economic benefits and the investment made, allowing evaluation of whether the project generates wealth over time.

Interpretação:
* **NPV > 0:** the project is economically viable
* **NPV = 0:** the project is neutral
* **NPV < 0:** the project is not economically viable

5) Annual free cash flow

After the financial results, the annual free cash flow chart presents the system's financial trajectory over time. It highlights periods of greater financial effort, the transition between investment and revenue generation, and the moment of stabilization of returns, serving as a key tool for jointly reading costs and returns throughout the productive cycle.

6) Sensitivity analyses

Finally, the economic results of the models are concluded with risk analyses. The sensitivity analysis tables evaluate how variations in cocoa bean productivity and price affect the main economic indicators of the model. The first sensitivity table analyzes the impacts of these variations under the production logic, using Average Free Income after year 3 as the variable, while the second focuses on the investment perspective, highlighting the effects on IRR.

The highlighted values correspond to the assumptions used as the basis for the calculations, allowing evaluation of the economic robustness of the systems in the face of alternative scenarios and uncertainties inherent to productive activity. The detailed definitions of concepts used in this publication that are not explained here can be found in the attached Glossary.

7) Exceptions in the parameters of the Oil Palm AFS

Finally, some exceptions to this structure apply to the Oil Palm AFS. The model is based on assumptions typical of family farming, in which the land is generally owned by the producing family and labor is predominantly family-based. For this reason, land lease costs and external labor remuneration were not considered. In addition, the model does not include economic sensitivity analysis, and the cocoa price considered is slightly lower than that adopted in the other models.

Results of the productive models

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AFSs in Bahia

Results per model

AFSs in Bahia
Results per model

Cocoa I

This production arrangement is characterized as a low-complexity model. The banana tree provides temporary shade for cocoa and generates revenue in the initial years. Mahogany and jequitibá, high value-added tree species, serve as permanent shade and offer the possibility of long-term revenue through timber products.

Cocoa I. Spacing, density, and production curve

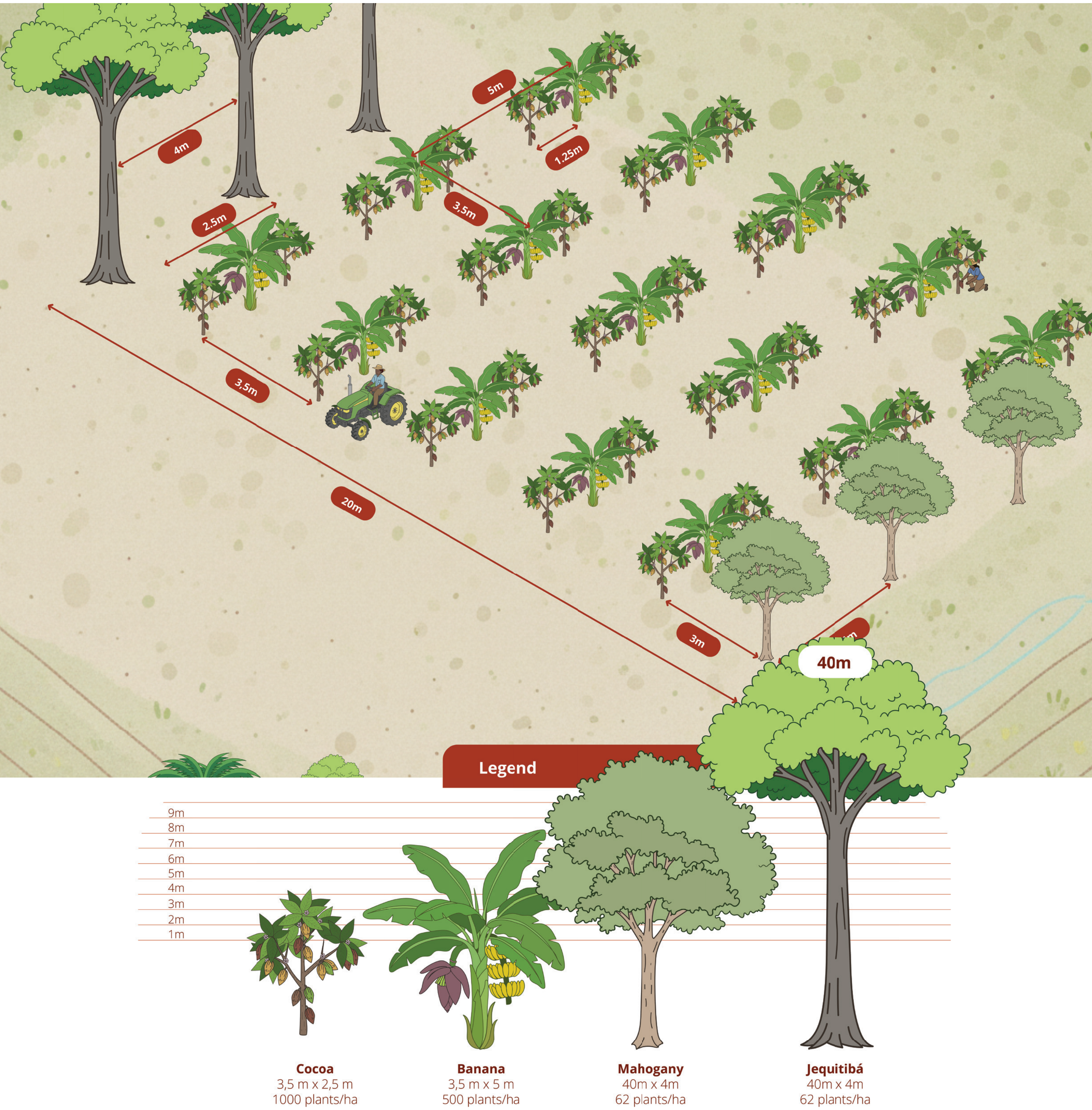
Species	Spacing (m)	Plants/ha	Production curve Year 0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	3.5x2.5	1000				/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Banana	3.5x5	500		/////	/////	/////	/////																										
Jequitibá	40x4	62																															/////
Mahogany	40x4	62																															/////

Cocoa I. Financial results

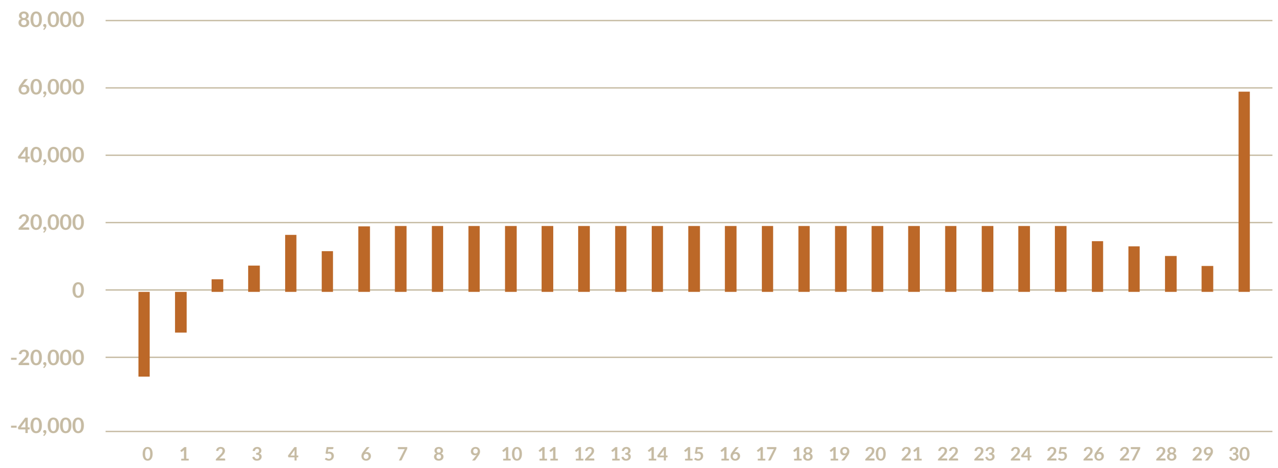
Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$11,828.16
Average Direct Costs After year 3 ($/ha/year)	-$2,518.85
Average Net Revenue After year 3 ($/ha/year)	$7,483.16
Average Free Income After year 3 ($/ha/year)	$3,195.29
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$5,163.09

Investment Logic	
Discounted Payback	0.33
IRR (%) 30 years	29%
NPV ($/ha)	$3,888.61

Cocoa I. Spatial distribution of the arrangement



Cocoa I. Annual free cash flow
USD/ha × years



Cocoa I. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	n/a	$491	$740	$1,012	$1,311
3,769	**21.07**	n/a	n/a	$211	$951	$1,924	$2,313	$2,741	$3,212
4,653	**26.01**	n/a	$44	$734	$1,636	$2,837	$3,317	$3,846	$4,427
4,997	**27.93**	n/a	$199	$934	$1,903	$3,192	$3,708	$4,276	$4,900
5,700	**31.86**	n/a	$512	$1,343	$2,447	$3,918	$4,506	$5,153	$5,865
6,284	**35.13**	$72	$769	$1,683	$2,899	$4,521	$5,170	$5,883	$6,668
6,928	**38.73**	$288	$1,051	$2,057	$3,398	$5,186	$5,901	$6,688	$7,553

Cocoa I. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	n/a	7%	10%	13%	16%
3,769	**21.07**	n/a	n/a	3%	12%	21%	23%	26%	29%
4,653	**26.01**	n/a	1%	10%	19%	27%	29%	32%	35%
4,997	**27.93**	n/a	3%	12%	21%	29%	31%	34%	37%
5,700	**31.86**	n/a	7%	16%	24%	32%	35%	38%	41%
6,284	**35.13**	1%	11%	19%	27%	35%	38%	41%	44%
6,928	**38.73**	4%	13%	22%	30%	38%	41%	44%	47%

Cocoa II

This arrangement is characterized as a low-to-medium complexity model. The banana tree and cassava provide temporary shade for cocoa and generate revenue in the initial years. Freijo and jequitibá, high value-added tree species, serve as permanent shade and offer the possibility of long-term revenue through timber products.

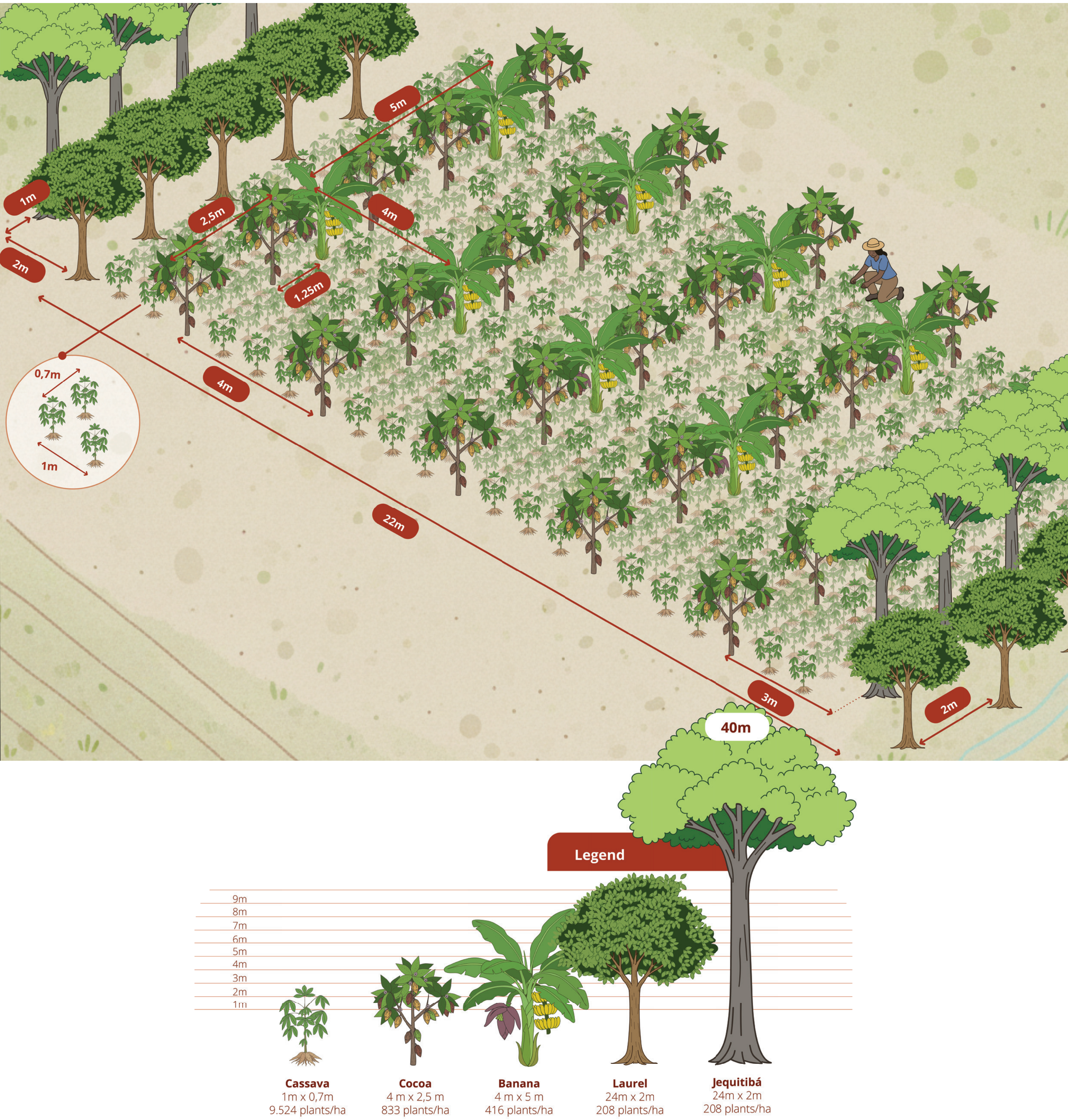
Cocoa II. Spacing, density, and production curve

			Production curve Year																														
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	4x2.5	833			/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Banana	4x5	416		/////	/////	/////	/////																										
Cassava	1x0.7	9524		/////																													
Jequitibá	24x2	208																															/////
Laurel	24x2	208																															/////

Cocoa II. Financial results

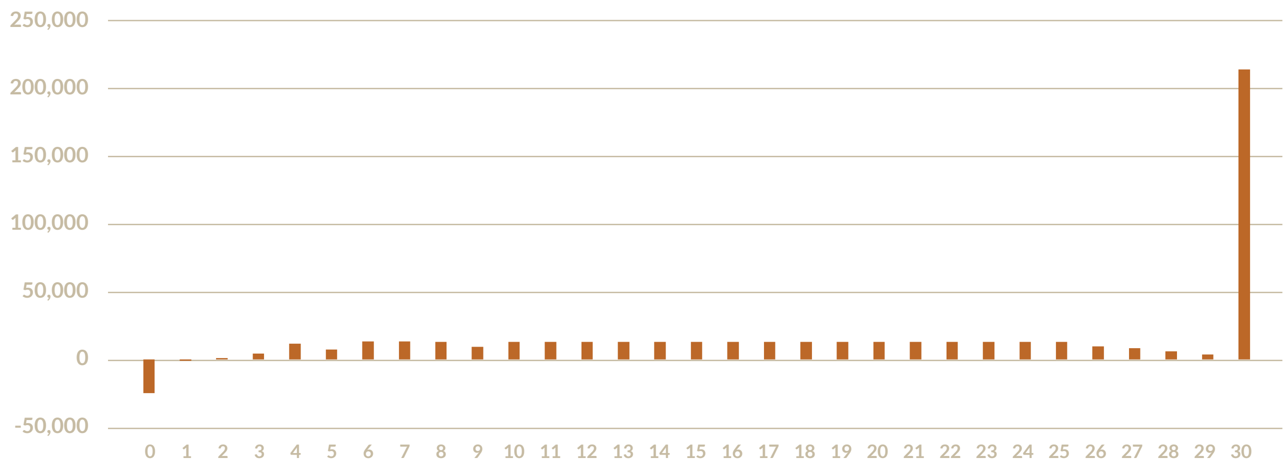
Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$11,708.56
Average Direct Costs After year 3 ($/ha/year)	-$2,713.96
Average Net Revenue After year 3 ($/ha/year)	$7,688.30
Average Free Income After year 3 ($/ha/year)	$3,237.05
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$5,204.85
Investment Logic	
Discounted Payback	0.8
IRR (%) 30 years	26%
NPV ($/ha)	$2,108.92

Cocoa II. Spatial distribution of the arrangement



Cocoa II. Annual free cash flow

USD/ha × years



Cocoa II. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	$176	$508	$952	$1,123	$1,296	$1,485
3,769	**21.07**	$179	$512	$957	$1,494	$2,178	$2,449	$2,747	$3,075
4,653	**26.01**	$459	$886	$1,412	$2,071	$2,939	$3,286	$3,667	$4,087
4,997	**27.93**	$568	$1,032	$1,582	$2,293	$3,234	$3,611	$4,025	$4,481
5,700	**31.86**	$791	$1,300	$1,926	$2,746	$3,839	$4,276	$4,757	$5,285
6,284	**35.13**	$977	$1,518	$2,209	$3,123	$4,341	$4,829	$5,365	$5,954
6,928	**38.73**	$1,169	$1,756	$2,521	$3,539	$4,895	$5,438	$6,035	$6,691

Cocoa II. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	0%	1%	3%	6%	7%	9%	11%
3,769	**21.07**	1%	3%	6%	11%	17%	20%	22%	25%
4,653	**26.01**	3%	5%	10%	16%	24%	26%	29%	32%
4,997	**27.93**	3%	7%	11%	18%	26%	29%	31%	34%
5,700	**31.86**	5%	9%	15%	22%	30%	33%	36%	38%
6,284	**35.13**	6%	11%	17%	25%	33%	36%	39%	42%
6,928	**38.73**	8%	13%	20%	28%	36%	39%	42%	45%

Cocoa + Açaí I

Among the production arrangements presented in this study, this model is characterized as the most complex. The banana tree and cassava provide temporary shade for cocoa and generate income in the initial years. Açaí, in turn, serve as permanent shade for cocoa and also provide additional income to producers in the medium term through the sale of fruits/pulp. Finally, mahogany also fulfills the function of permanent shade and, due to its high added value, represents a potential source of long-term income through timber products.

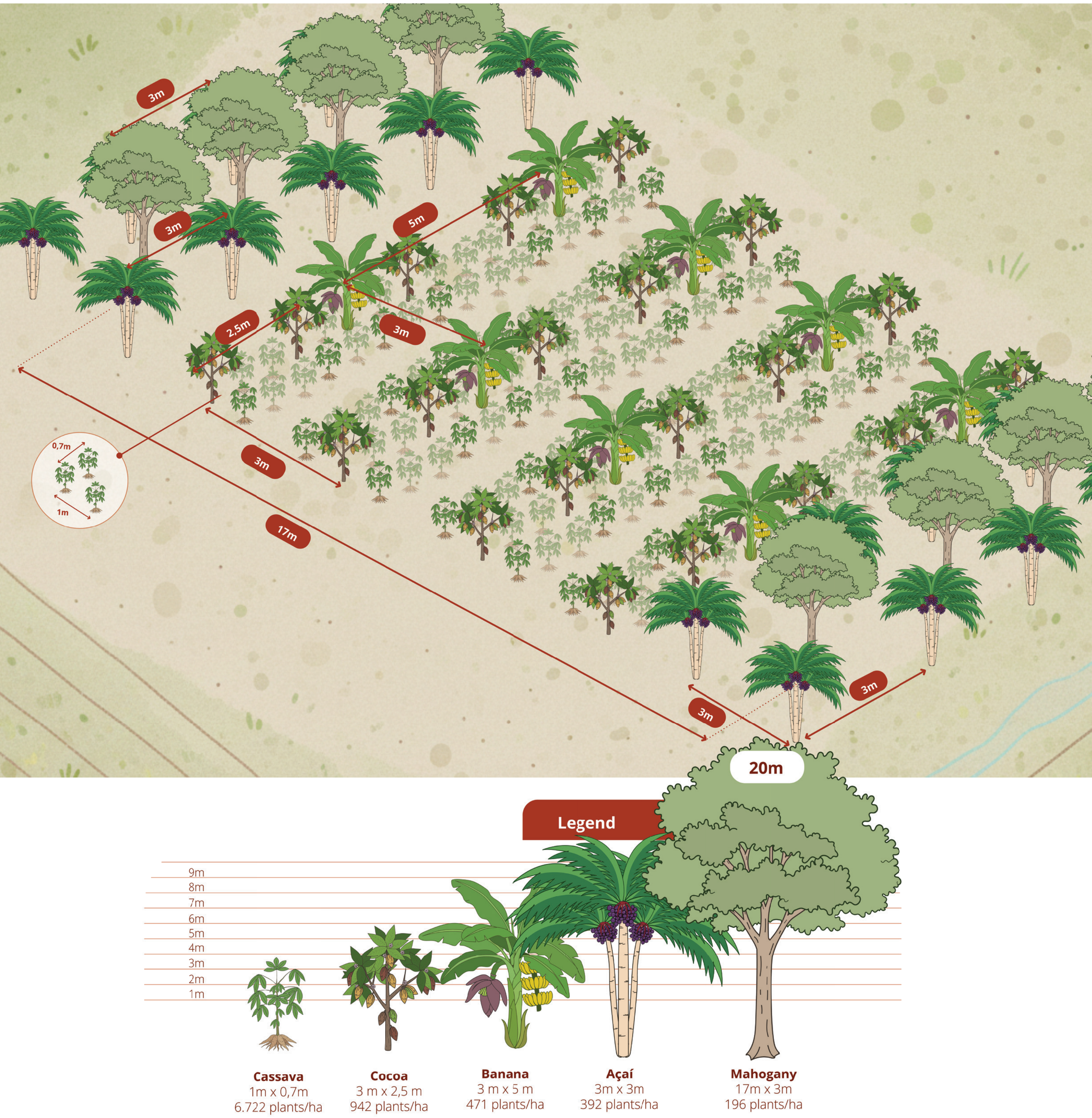
Cocoa + Açaí I. Spacing, density, and production curve

			Production curve Year																														
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	3x2.5	942			////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Banana	3x5	471		////	////	////	////																										
Cassava	1x0.7	6722		////																													
Mahogany	17x3	196																															////
Açaí	3x3	392					////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////

Cocoa + Açaí I. Financial results

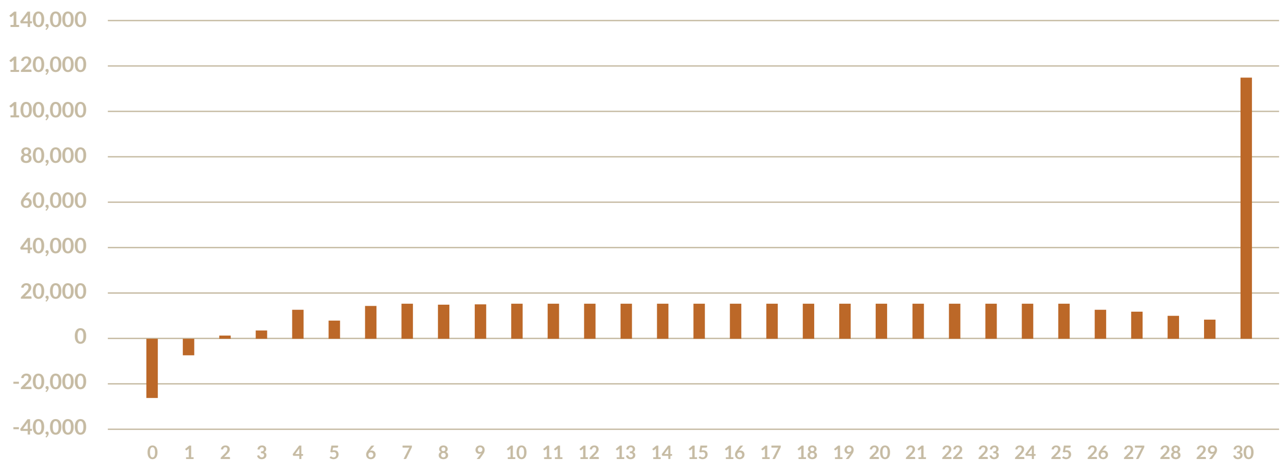
Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$12,120.20
Average Direct Costs After year 3 ($/ha/year)	-$2,408.06
Average Net Revenue After year 3 ($/ha/year)	$7,067.21
Average Free Income After year 3 ($/ha/year)	$2,953.42
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$4,921.22
Investment Logic	
Discounted Payback	0.15
IRR (%) 30 years	24%
NPV ($/ha)	$1,832.63

Cocoa + Açaí I. Spatial distribution of the arrangement



Cocoa + Açaí I. Annual free cash flow

USD/ha × years



Cocoa + Açaí I. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	$592	$754	$970	$1,258	$1,831	$2,003	$2,192	$2,400
3,769	**21.07**	$973	$1,261	$1,645	$2,155	$3,177	$3,483	$3,820	$4,191
4,653	**26.01**	$1,216	$1,584	$2,074	$2,728	$4,036	$4,429	$4,861	$5,335
4,997	**27.93**	$1,310	$1,709	$2,242	$2,951	$4,371	$4,797	$5,265	$5,781
5,700	**31.86**	$1,502	$1,966	$2,583	$3,407	$5,055	$5,549	$6,092	$6,690
6,284	**35.13**	$1,662	$2,179	$2,868	$3,786	$5,623	$6,174	$6,780	$7,447
6,928	**38.73**	$1,838	$2,414	$3,181	$4,204	$6,249	$6,863	$7,538	$8,280

Cocoa + Açaí I. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	5%	7%	9%	11%	16%	18%	19%	21%
3,769	**21.07**	9%	11%	15%	19%	26%	28%	29%	31%
4,653	**26.01**	11%	14%	18%	23%	30%	32%	35%	37%
4,997	**27.93**	12%	15%	20%	24%	32%	34%	36%	39%
5,700	**31.86**	14%	17%	22%	27%	35%	38%	40%	42%
6,284	**35.13**	15%	19%	24%	29%	38%	40%	42%	45%
6,928	**38.73**	16%	21%	26%	31%	40%	43%	45%	48%

Cocoa + Açaí II

This arrangement is characterized as a medium-complexity model. The banana tree and cassava provide temporary shade for cocoa and generate income in the initial years. Açaí, in turn, serves as permanent shade for cocoa and also provides additional income to producers in the medium term through the sale of fruits/pulp. Finally, jequitibá also fulfills the function of permanent shade and, due to its high added value, represents a potential source of long-term income through timber products.

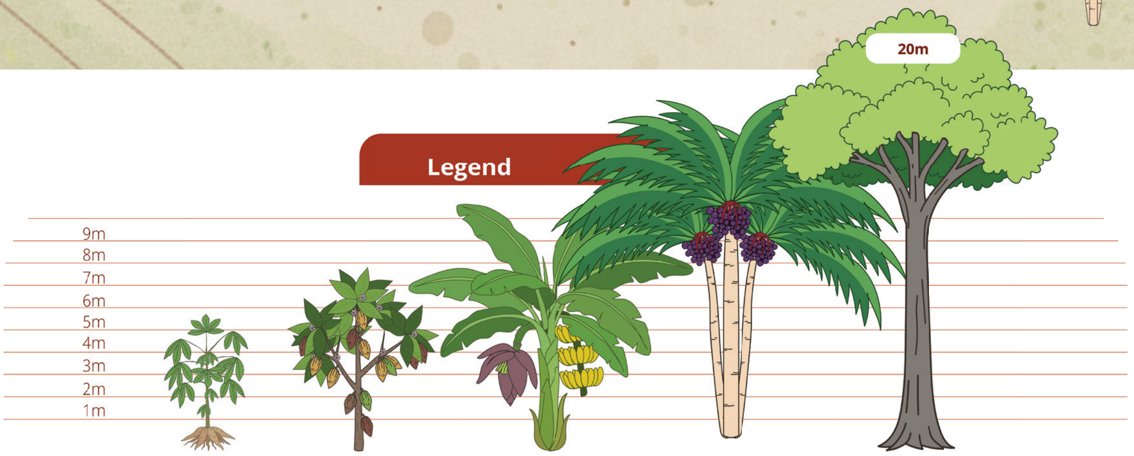
Cocoa + Açaí II. Spacing, density, and production curve

			Production curve Year																														
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	4x2.5	769			////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Banana	4x5	384		////	////	////	////																										
Cassava	1x0.7	8791		////																													
Jequitibá	26x2	192																															////
Açaí	4x4	192			////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////

Cocoa + Açaí II. Financial results

Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$11,877.83
Average Direct Costs After year 3 ($/ha/year)	-$3,099.04
Average Net Revenue After year 3 ($/ha/year)	$7,235.09
Average Free Income After year 3 ($/ha/year)	$2,620.33
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$4,588.13
Investment Logic	
Discounted Payback	0.25
IRR (%) 30 years	28%
NPV ($/ha)	$2,997.05

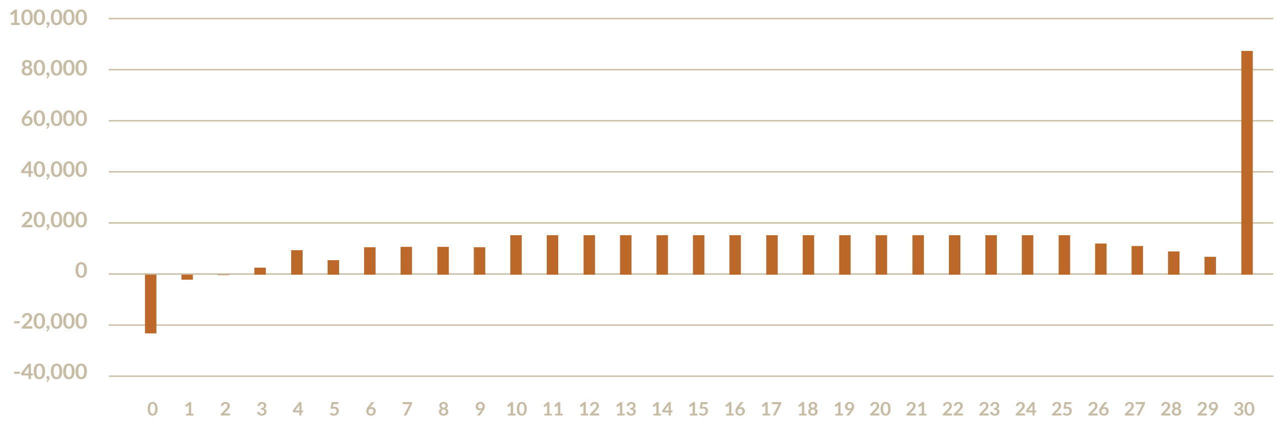
Cocoa + Açaí II. Spatial distribution of the arrangement



Cassava	**Cocoa**	**Banana**	**Açaí**	**Jequitibá**
1m x 0,7m	4 m x 2,5 m	4 m x 5 m	4m x 4m	26m x 2m
8.791 plants/ha	769 plants/ha	384 plants/ha	192 plants/ha	192 plants/ha

Cocoa + Açaí II. Annual free cash flow

USD/ha × years



Cocoa + Açaí II. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	$189	$556	$702	$861	$1,033
3,769	**21.07**	n/a	$192	$560	$1,041	$1,669	$1,919	$2,194	$2,497
4,653	**26.01**	$148	$502	$967	$1,570	$2,371	$2,691	$3,043	$3,431
4,997	**27.93**	$239	$622	$1,121	$1,775	$2,644	$2,991	$3,374	$3,795
5,700	**31.86**	$424	$866	$1,437	$2,193	$3,202	$3,605	$4,049	$4,537
6,284	**35.13**	$577	$1,063	$1,697	$2,541	$3,666	$4,115	$4,610	$5,155
6,928	**38.73**	$745	$1,280	$1,985	$2,924	$4,177	$4,678	$5,229	$5,835

Cocoa + Açaí II. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	2%	5%	7%	9%	10%
3,769	**21.07**	n/a	2%	5%	11%	17%	19%	21%	23%
4,653	**26.01**	1%	5%	10%	16%	22%	25%	27%	30%
4,997	**27.93**	2%	6%	11%	18%	25%	27%	30%	32%
5,700	**31.86**	4%	9%	14%	21%	28%	31%	34%	36%
6,284	**35.13**	6%	11%	17%	24%	31%	34%	37%	39%
6,928	**38.73**	7%	13%	19%	27%	34%	37%	40%	43%

Cocoa + Açaí III

This arrangement is characterized as a medium-complexity model. The banana tree and cassava provide temporary shade for cocoa and generate income in the initial years. Açaí, in turn, serves as permanent shade for cocoa and also provides additional income to producers in the medium term through the sale of fruits/pulp. Finally, mahogany also fulfills the function of permanent shade and, due to its high added value, represents a potential source of long-term income through timber products.

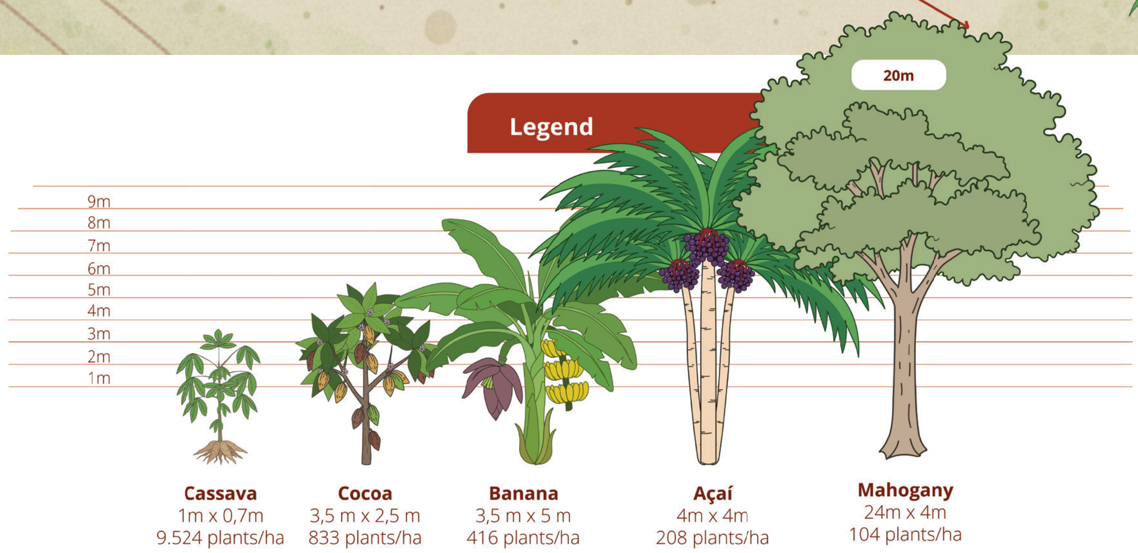
Cocoa + Açaí III. Spacing, density, and production curve

			Production curve Year																														
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	3.5x2.5	833			//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//
Banana	3.5x5	416		//	//	//	//																										
Cassava	1x.07	9524		//																													
Mahogany	24x4	104																															//
Açaí	4x4	208			//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//	//

Cocoa + Açaí III. Financial results

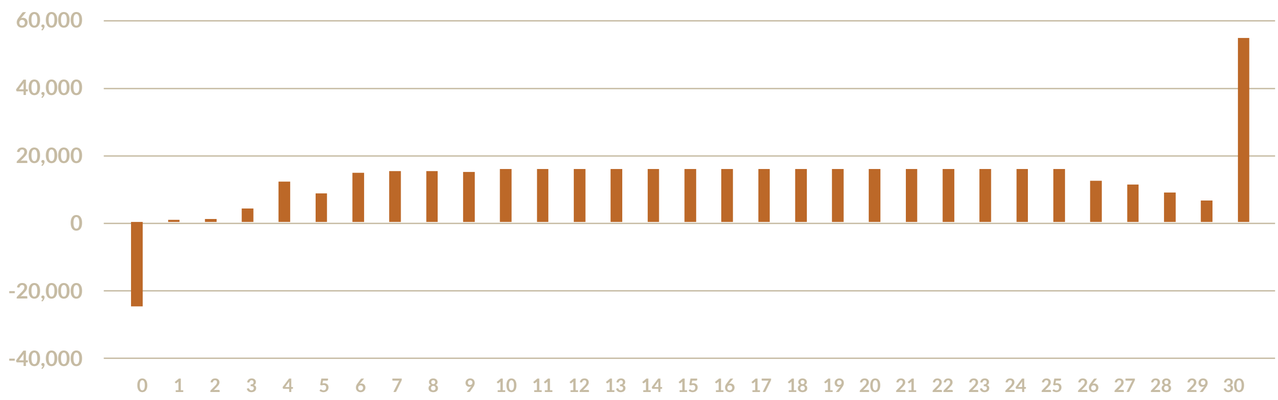
Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$11,407.73
Average Direct Costs After year 3 ($/ha/year)	-$2,706.35
Average Net Revenue After year 3 ($/ha/year)	$6,899.55
Average Free Income After year 3 ($/ha/year)	$2,646.13
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$4,613.93
Investment Logic	
Discounted Payback	0.15
IRR (%) 30 years	25%
NPV ($/ha)	$1,654.63

Cocoa + Açaí III. Spatial distribution of the arrangement



Cocoa + Açaí III. Annual free cash flow

USD/ha × years



Cocoa + Açaí III. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	n/a	$366	$521	$690	$875
3,769	**21.07**	n/a	n/a	n/a	$884	$1,562	$1,833	$2,131	$2,459
4,653	**26.01**	n/a	$309	$803	$1,454	$2,322	$2,669	$3,051	$3,470
4,997	**27.93**	$23	$436	$970	$1,676	$2,618	$2,994	$3,409	$3,864
5,700	**31.86**	$226	$694	$1,310	$2,130	$3,222	$3,659	$4,140	$4,669
6,284	**35.13**	$388	$907	$1,593	$2,506	$3,725	$4,212	$4,748	$5,337
6,928	**38.73**	$566	$1,141	$1,904	$2,922	$4,278	$4,821	$5,418	$6,075

Cocoa + Açaí III. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	n/a	6%	8%	10%	13%
3,769	**21.07**	n/a	n/a	6%	13%	20%	22%	25%	27%
4,653	**26.01**	n/a	5%	12%	19%	26%	29%	31%	34%
4,997	**27.93**	0%	7%	14%	21%	28%	31%	33%	36%
5,700	**31.86**	4%	11%	18%	25%	32%	35%	37%	40%
6,284	**35.13**	6%	13%	20%	28%	35%	38%	40%	43%
6,928	**38.73**	9%	16%	23%	30%	38%	41%	43%	46%

Cocoa + Cupuaçu

This arrangement is characterized as a medium-complexity model. The banana tree and cassava provide temporary shade for cocoa and generate revenue in the initial years. Cupuaçu and rubber tree, however, serve as permanent shade for cocoa while also providing additional medium-term income to producers through the sale of fruits/pulp and latex/dry rubber.

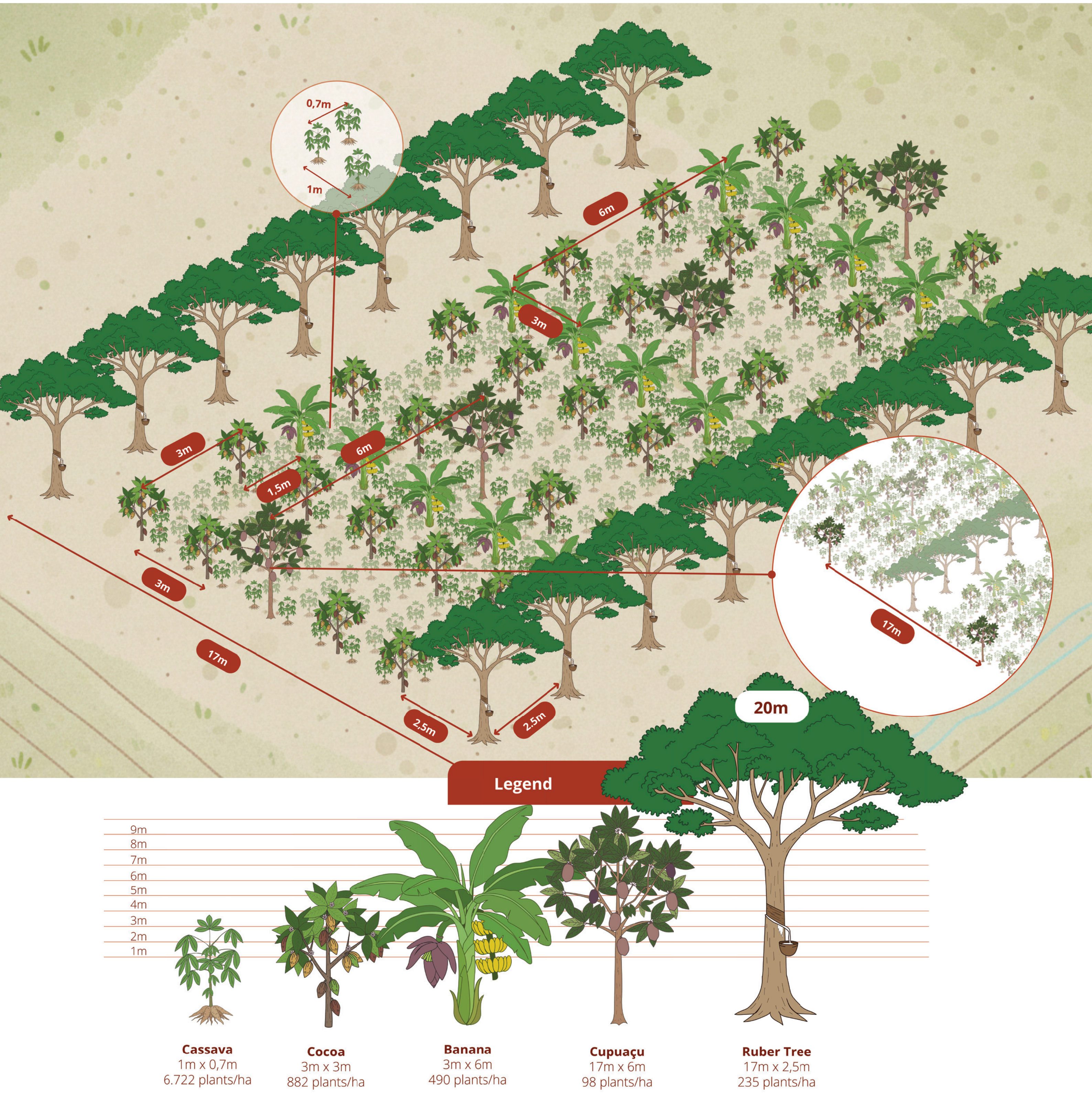
Cocoa + Cupuaçu. Spacing, density, and production curve

			Production curve Year																													
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	3x3	882			/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/
Banana	3x6	490		/	/	/	/																										
Cassava	1x0.7	6722		/																													
Cupuaçu	17x6	98					/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	
Rubber tree	17x2.5	235							/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	

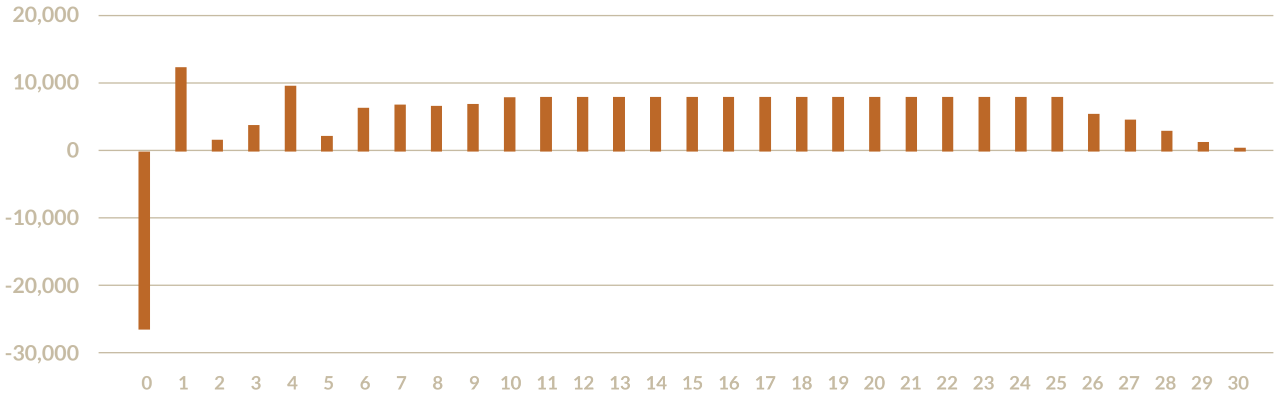
Cocoa + Cupuaçu. Financial results

Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$12,154.36
Average Direct Costs After year 3 ($/ha/year)	-$2,615.58
Average Net Revenue After year 3 ($/ha/year)	$4,623.75
Average Free Income After year 3 ($/ha/year)	$1,120.27
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$3,088.07
Investment Logic	
Discounted Payback	0.11
IRR (%) 30 years	26.04%
NPV ($/ha)	$1,282.63

Cocoa + Cupuaçu. Spatial distribution of the arrangement



Cocoa + Cupuaçu. Annual free cash flow
USD/ha × years



Cocoa + Cupuaçu. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	n/a	$58	$223	$403	$600
3,769	**21.07**	n/a	n/a	$63	$610	$1,329	$1,616	$1,932	$2,279
4,653	**26.01**	n/a	n/a	$524	$1,216	$2,134	$2,502	$2,906	$3,351
4,997	**27.93**	n/a	$133	$702	$1,451	$2,448	$2,846	$3,285	$3,768
5,700	**31.86**	n/a	$408	$1,063	$1,931	$3,088	$3,550	$4,059	$4,619
6,284	**35.13**	$82	$635	$1,362	$2,330	$3,620	$4,135	$4,703	$5,327
6,928	**38.73**	$271	$884	$1,692	$2,770	$4,206	$4,781	$5,413	$6,108

Cocoa + Cupuaçu. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	n/a	5%	11%	15%	19%
3,769	**21.07**	n/a	n/a	6%	19%	28%	31%	34%	37%
4,653	**26.01**	n/a	n/a	18%	27%	36%	38%	41%	44%
4,997	**27.93**	n/a	9%	21%	30%	38%	41%	44%	46%
5,700	**31.86**	n/a	16%	25%	34%	42%	45%	48%	51%
6,284	**35.13**	6%	20%	29%	37%	46%	49%	51%	54%
6,928	**38.73**	13%	23%	32%	40%	49%	52%	55%	58%

Cocoa + Coconut

Among the production models, this is the simplest, yet no less compelling. The banana tree provides temporary shade for cocoa and generates income in the initial years. Coconut begins to generate income in the short to medium term and, over time, contributes by serving as permanent shade for cocoa. In this model, we observe a simplified intercropping system with a high potential for mechanization.

Cocoa + Coconut. Spacing, density, and production curve

			Production curve Year																														
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	4x2.5	1230			////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Banana	one row 2.5	615		////	////	////	////																										
Coconut	6.5x7.5	205			////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////

Cocoa + Coconut. Financial results

Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$12,575.64
Average Direct Costs After year 3 ($/ha/year)	-$4,743.63
Average Net Revenue After year 3 ($/ha/year)	$10,600.78
Average Free Income After year 3 ($/ha/year)	$3,898.10
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$5,865.90
Investment Logic	
Discounted Payback	0.57
IRR (%) 30 years	35%
NPV ($/ha)	$7,159.42

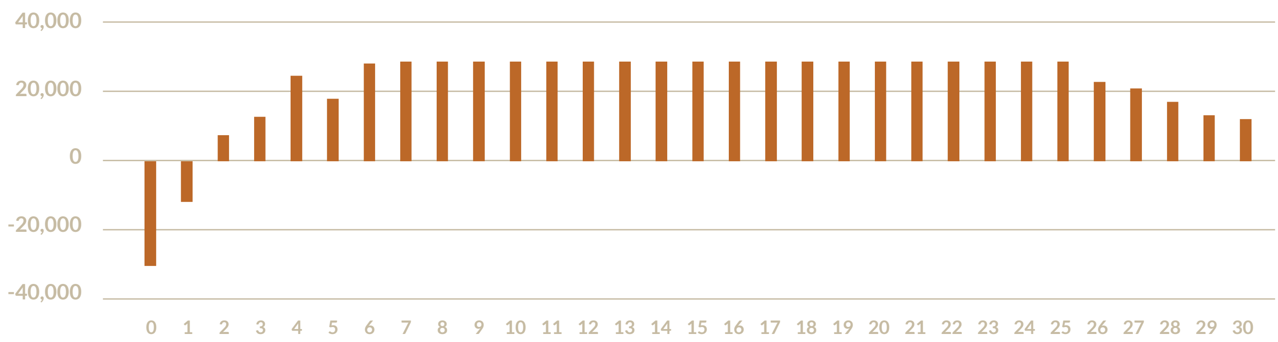
Cocoa + Coconut. Spatial distribution of the arrangement

Cocoa
4 m x 2,5 m
1.230 plants/ha
(double row)

Banana da Terra
2,5m x 2,5m
615 plants/ha

Coconut
6,5m x 7,5m
205 plants/ha

Cocoa + Coconut. Annual free cash flow
USD/ha × years



Cocoa + Coconut. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	$6	$577	$802	$1,049	$1,321
3,769	**21.07**	n/a	$11	$583	$1,335	$2,335	$2,735	$3,175	$3,659
4,653	**26.01**	n/a	$493	$1,216	$2,176	$3,457	$3,970	$4,533	$5,153
4,997	**27.93**	$84	$679	$1,461	$2,504	$3,894	$4,450	$5,062	$5,735
5,700	**31.86**	$372	$1,056	$1,963	$3,173	$4,787	$5,432	$6,142	$6,923
6,284	**35.13**	$609	$1,369	$2,381	$3,730	$5,529	$6,248	$7,040	$7,910
6,928	**38.73**	$869	$1,714	$2,841	$4,343	$6,347	$7,148	$8,029	$8,999

Cocoa + Coconut. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)							
USD/ton	R$/Kg	0.5	0.6	0.8	1.1	1.5	1.7	1.8	2.0
2,385	**13.33**	n/a	n/a	n/a	0%	12%	15%	17%	20%
3,769	**21.07**	n/a	1%	12%	20%	27%	29%	32%	34%
4,653	**26.01**	n/a	11%	19%	26%	33%	35%	38%	40%
4,997	**27.93**	4%	14%	21%	28%	35%	38%	40%	43%
5,700	**31.86**	9%	17%	24%	32%	39%	42%	44%	47%
6,284	**35.13**	13%	20%	27%	34%	42%	45%	47%	50%
6,928	**38.73**	16%	23%	30%	37%	45%	48%	50%	53%

AFSs in Pará

Results by model

AFSs in Pará
Results by model

Cocoa

This arrangement is characterized as a low-complexity model. The banana tree provides temporary shade for cocoa and generates income in the initial years. The tree species, in turn, serve as permanent shade and also offer high value-added long-term returns, allowing producers/investors the possibility of management for timber and non-timber uses. Andiroba, for example, produces seeds that can be commercialized, while ipê and jatobá represent potential sources of income through timber products.

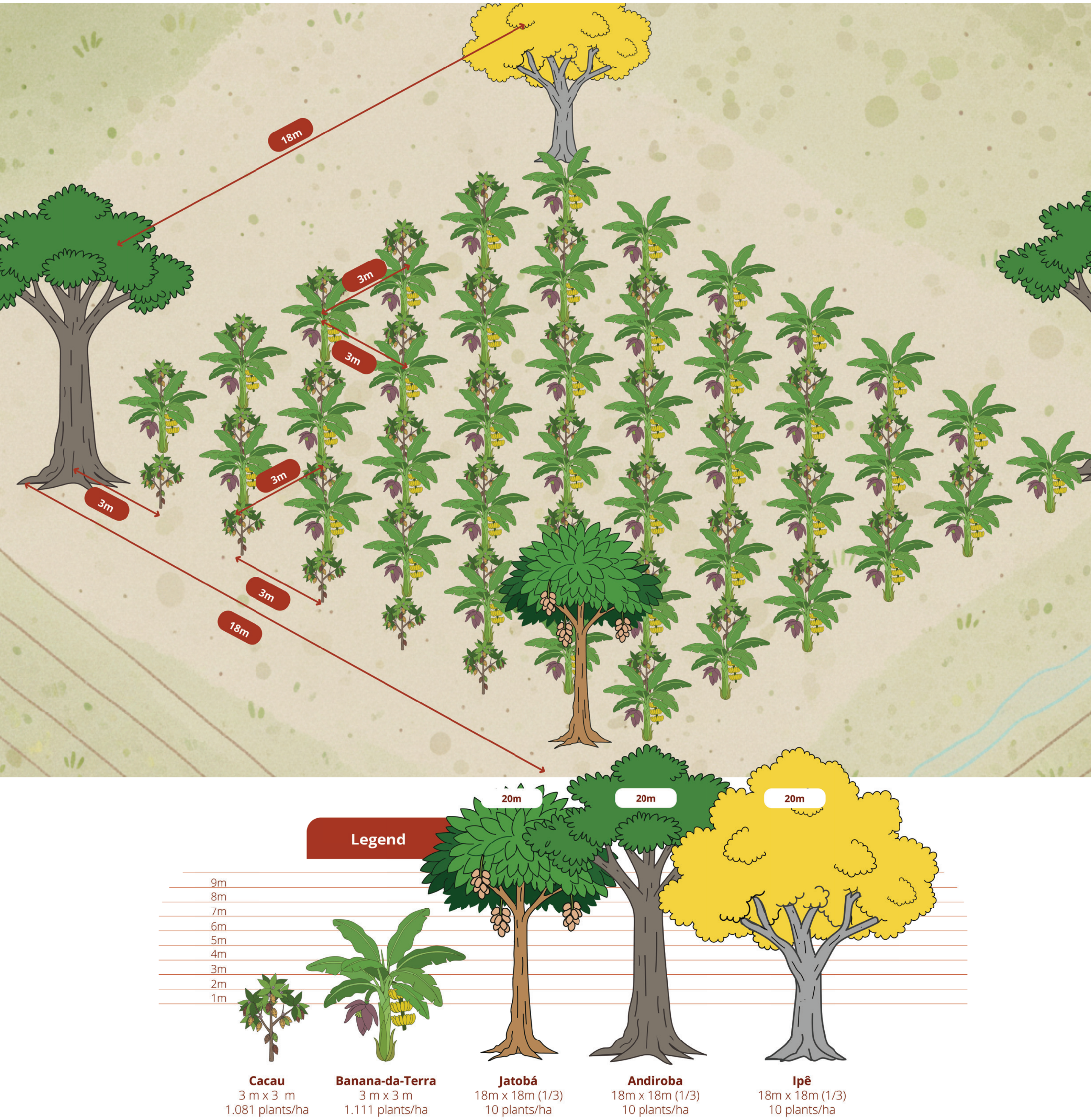
Cocoa. Spacing, density, and production curve

Species	Spacing (m)	Plants/ha	Production curve Year 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Cocoa	3x3	1081	//
Banana	3x3	1111	//////////////
Andiroba	18x18	10	/////
Ipê	18x18	10	/////
Jatobá	18x18	10	/////

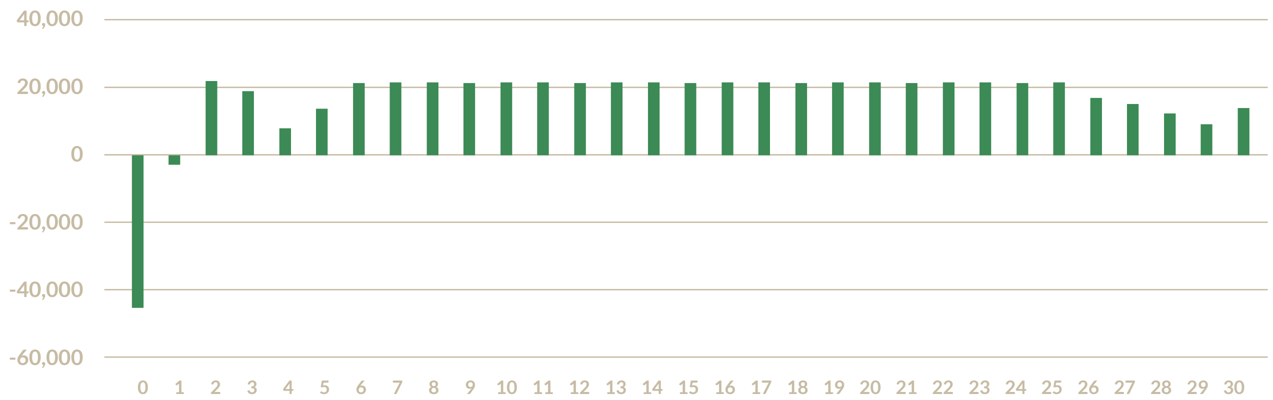
Cocoa. Financial results

Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$12,803.27
Average Direct Costs After year 3 ($/ha/year)	-$2,636.89
Average Net Revenue After year 3 ($/ha/year)	$7,459.57
Average Free Income After year 3 ($/ha/year)	$3,871.69
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$5,911.04
Investment Logic	
Discounted Payback	0.4
IRR (%) 30 years	30%
NPV ($/ha)	$5,136.08

Cocoa. Spatial distribution of the arrangement



Cocoa. Annual free cash flow
USD/ha × years



Cocoa. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)								
USD/ton	R$/Kg	0.5	0.9	1.2	1.5	1.7	2.0	2,3	2.6	3.0
2,385	**13.33**	n/a	n/a	$109	$608	$927	$1,399	$1,912	$2,403	$2,894
3,769	**21.07**	n/a	$710	$1,534	$2,357	$2,891	$3,692	$4,546	$5,400	$6,255
4,653	**26.01**	n/a	$1,385	$2,426	$3,445	$4,124	$5,142	$6,229	$7,315	$8,401
4,997	**27.93**	$108	$1,642	$2,768	$3,872	$4,608	$5,712	$6,889	$8,067	$9,244
5,700	**31.86**	$412	$2,181	$3,457	$4,733	$5,584	$6,860	$8,221	$9,582	$10,944
6,284	**35.13**	$673	$2,612	$4,032	$5,452	$6,399	$7,819	$9,333	$10,848	$12,362
6,928	**38.73**	$949	$3,088	$4,666	$6,245	$7,297	$8,875	$10,559	$12,243	$13,927

Cocoa. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)								
USD/ton	R$/Kg	0.5	0.9	1.2	1.5	1.7	2.0	2,3	2.6	3.0
2,385	**13.33**	n/a	n/a	n/a	9%	12%	16%	20%	23%	26%
3,769	**21.07**	n/a	10%	17%	23%	26%	29%	33%	36%	38%
4,653	**26.01**	n/a	16%	23%	28%	31%	35%	38%	41%	44%
4,997	**27.93**	n/a	18%	25%	30%	33%	37%	40%	43%	46%
5,700	**31.86**	6%	22%	28%	33%	36%	40%	44%	47%	50%
6,284	**35.13**	10%	24%	31%	36%	39%	43%	46%	50%	53%
6,928	**38.73**	12%	27%	33%	38%	41%	45%	49%	53%	56%

Cocoa + Açaí

This arrangement is characterized as a high-complexity model. The banana tree and cassava provide temporary shade for cocoa and generate income in the initial years. The double rows of açaí, in turn, serve as permanent shade for cocoa and also provide additional income to producers in the medium term through the sale of fruits/pulp. The tree species also fulfill the function of permanent shade and are configured as a source of high value-added long-term returns through both timber and non-timber uses. Andiroba, for example, produces seeds that can be commercialized, while ipê and jatobá represent potential sources of income through timber products.

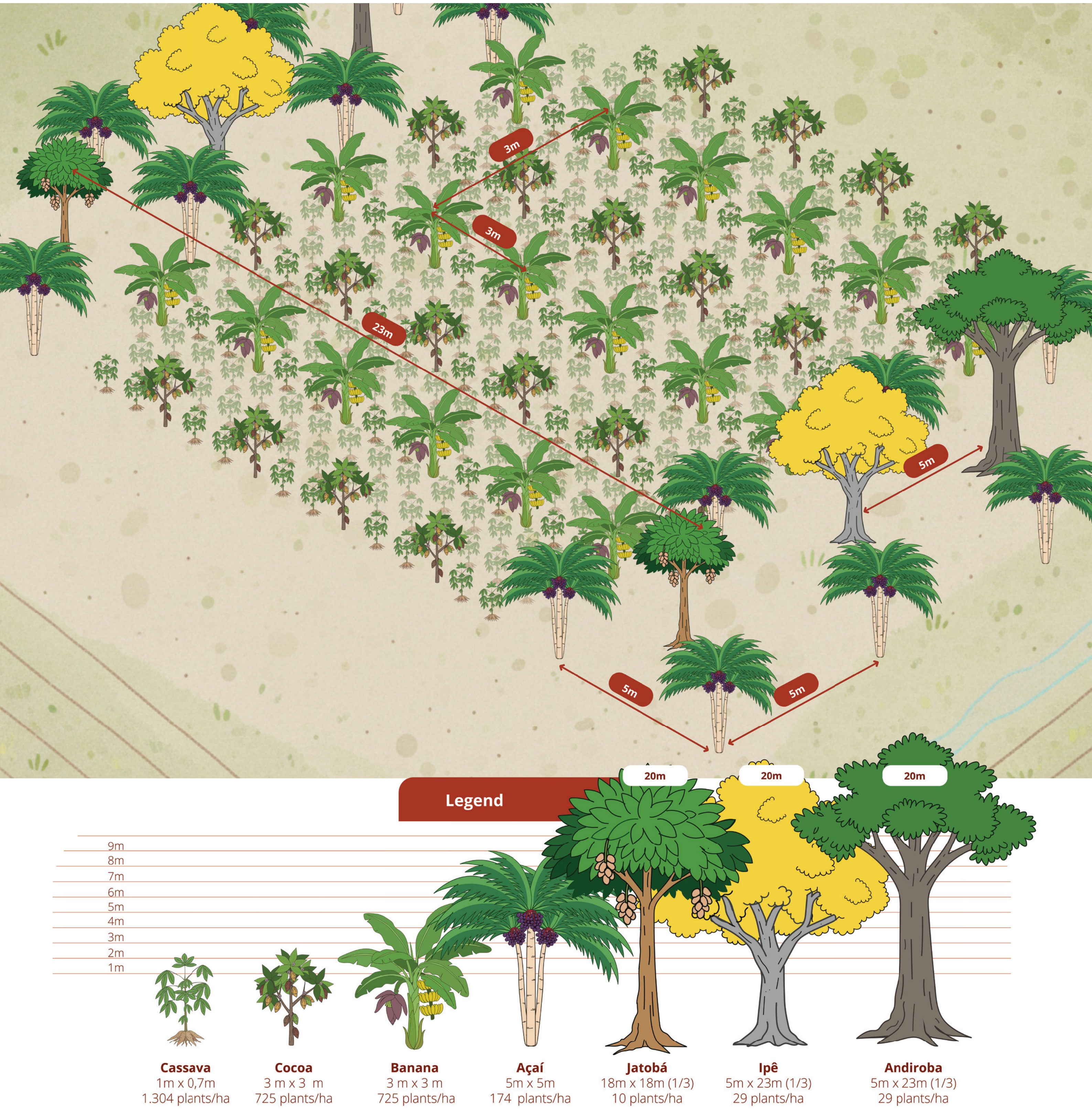
Cocoa + Açaí. Spacing, density, and production curve

			Production curve Year																													
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	3x3	725			/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Banana	3x3	725		/////	/////	/////																											
Cassava	1x0.7	7457		/////																													/////
Açaí	5x5	174					/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Andiroba	5x23	29																															/////
Ipê	5x23	29																															/////
Jatobá	5x23	29																															/////

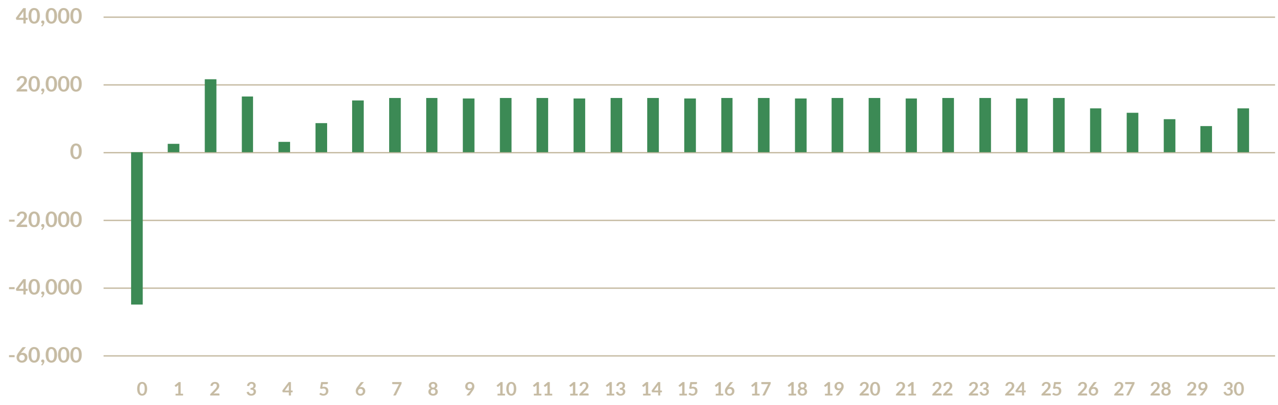
Cocoa + Açaí. Financial results

Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$12,177.77
Average Direct Costs After year 3 ($/ha/year)	-$2,642.06
Average Net Revenue After year 3 ($/ha/year)	$6,142.56
Average Free Income After year 3 ($/ha/year)	$2,679.11
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$4,718.47
Investment Logic	
Discounted Payback	0.23
IRR (%) 30 years	27%
NPV ($/ha)	$2,791.76

Cocoa + Açaí. Spatial distribution of the arrangement



Cocoa + Açaí. Annual free cash flow
USD/ha × years



Cocoa + Açaí. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)								
USD/ton	R$/Kg	0.5	0.9	1.2	1.5	1.7	2.0	2,3	2.6	3.0
2,385	**13.33**	n/a	n/a	$140	$433	$617	$900	$1,194	$1,487	$1,781
3,769	**21.07**	n/a	$590	$1,108	$1,618	$1,959	$2,484	$3,026	$3,569	$4,111
4,653	**26.01**	$141	$1,048	$1,709	$2,385	$2,824	$3,482	$4,185	$4,887	$5,590
4,997	**27.93**	$247	$1,224	$1,943	$2,677	$3,154	$3,871	$4,636	$5,400	$6,165
5,700	**31.86**	$456	$1,583	$2,436	$3,272	$3,829	$4,665	$5,557	$6,449	$7,340
6,284	**35.13**	$622	$1,881	$2,832	$3,767	$4,390	$5,325	$6,323	$7,320	$8,317
6,928	**38.73**	$812	$2,225	$3,269	$4,313	$5,009	$6,053	$7,167	$8,280	$9,394

Cocoa + Açaí. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)								
USD/ton	R$/Kg	0.5	0.9	1.2	1.5	1.7	2.0	2,3	2.6	3.0
2,385	**13.33**	n/a	n/a	2%	8%	11%	14%	17%	19%	21%
3,769	**21.07**	n/a	10%	16%	20%	22%	26%	29%	31%	33%
4,653	**26.01**	2%	15%	21%	25%	28%	31%	34%	36%	39%
4,997	**27.93**	5%	17%	22%	27%	29%	32%	35%	38%	41%
5,700	**31.86**	8%	20%	26%	30%	32%	36%	39%	42%	44%
6,284	**35.13**	11%	22%	28%	32%	35%	38%	41%	44%	47%
6,928	**38.73**	13%	24%	30%	34%	37%	40%	44%	47%	50%

Cocoa + diverse forest species

This arrangement is characterized as a low-to-medium complexity model. The banana tree and cassava provide temporary shade for cocoa and generate income in the initial years. The tree species, in turn, serve as permanent shade and also offer high value-added long-term returns, allowing producers/investors the possibility of management for both timber and non-timber uses. Andiroba and cumaru, for example, produce seeds that can be commercialized, while bagassa *(tatajuba)* and freijo represent potential sources of income through timber products.

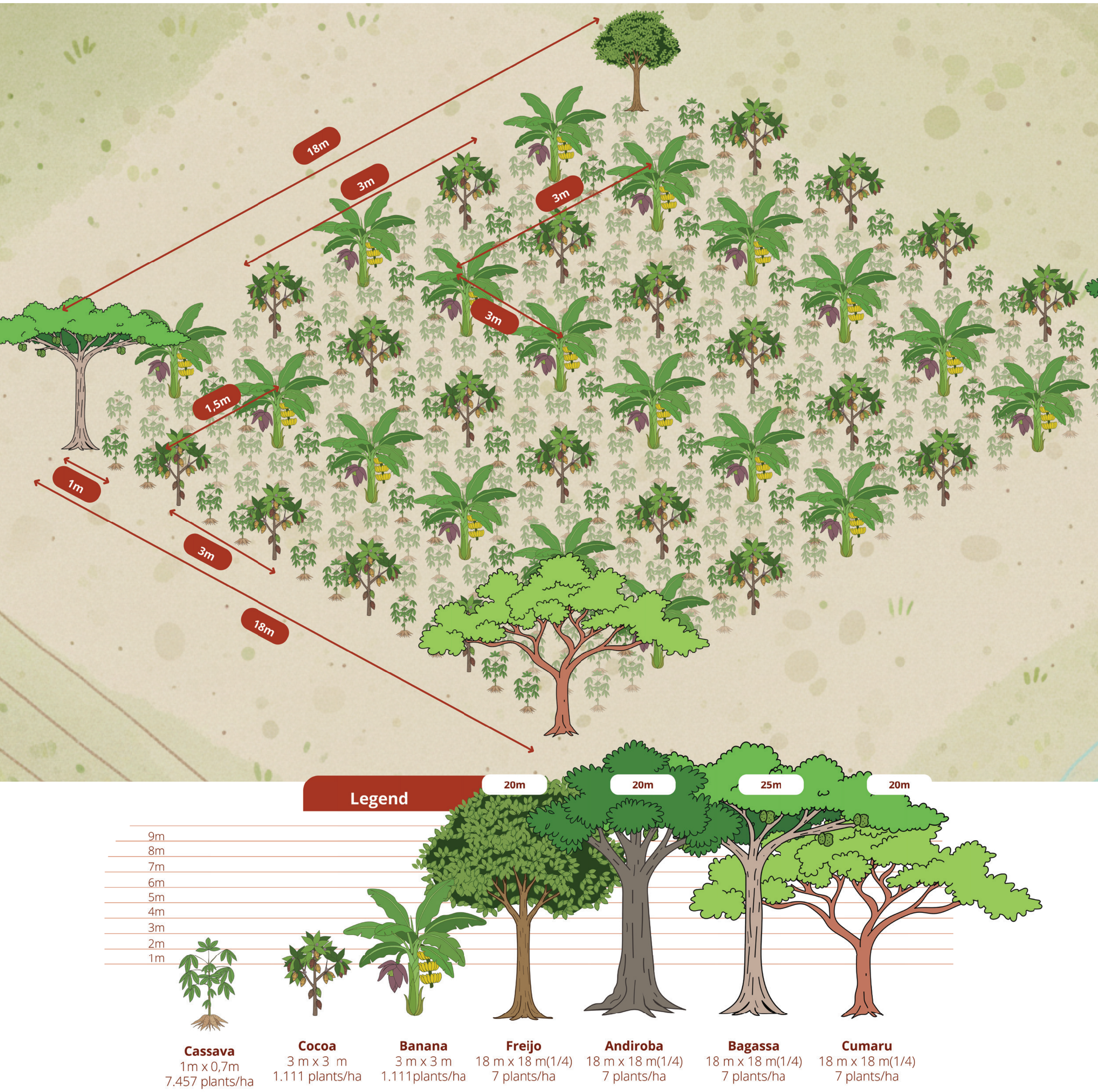
Cocoa + diverse forest species. Spacing, density, and production curve

			Production curve Year																													
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Cocoa	3x3	1081			/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////
Banana	3x3	1111		/////	/////	/////																											
Cassava	1x0.7	7457		/////																													
Andiroba	18x18	7																															/////
Bagassa (Tatajuba)	18x18	7																															/////
Cumaru	18x18	7													/////																		/////
Freijo	18x18	7		/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////	/////

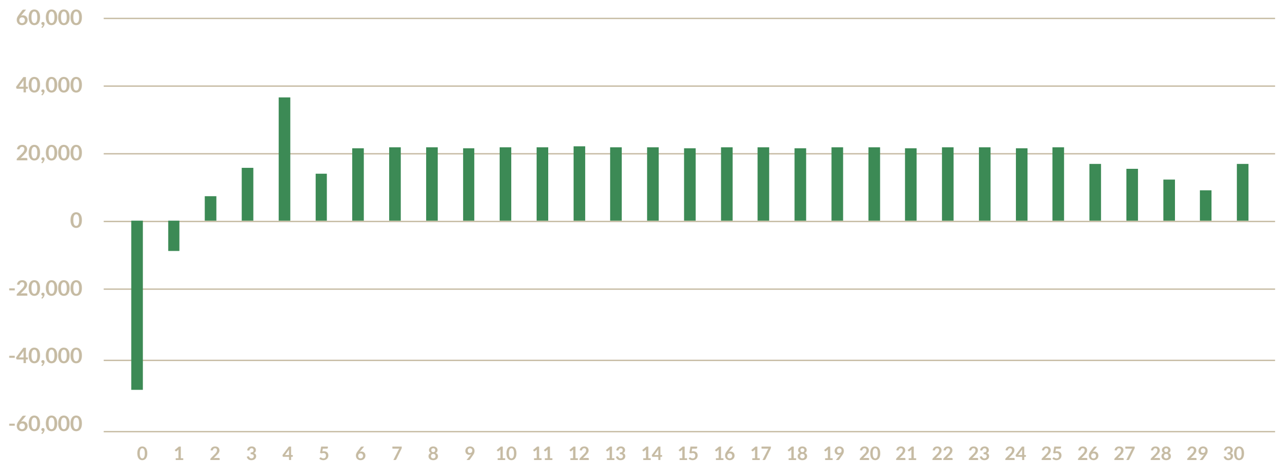
Cocoa + diverse forest species. Financial results

Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$13,552.49
Average Direct Costs After year 3 ($/ha/year)	-$2,797.76
Average Net Revenue After year 3 ($/ha/year)	$7,885.28
Average Free Income After year 3 ($/ha/year)	$4,049.16
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$6,088.52
Investment Logic	
Discounted Payback	0.28
IRR (%) 30 years	26%
NPV ($/ha)	$3,756.59

Cocoa + diverse forest species. Spatial distribution of the arrangement



Cocoa + diverse forest species. Annual free cash flow
USD/ha × years



Cocoa + diverse forest species. Sensitivity analysis – Free Income as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)								
USD/ton	R$/Kg	0.5	0.9	1.2	1.5	1.7	2.0	2,3	2.6	3.0
2,385	**13.33**	n/a	n/a	$225	$728	$1,053	$1,533	$2,037	$2,542	$3,046
3,769	**21.07**	n/a	$833	$1,671	$2,494	$3,042	$3,864	$4,741	$5,618	$6,496
4,653	**26.01**	$29	$1,519	$2,565	$3,611	$4,308	$5,353	$6,469	$7,584	$8,700
4,997	**27.93**	$222	$1,780	$2,913	$4,045	$4,800	$5,933	$7,141	$8,349	$9,557
5,700	**31.86**	$532	$2,313	$3,623	$4,933	$5,807	$7,117	$8,515	$9,912	$11,310
6,284	**35.13**	$795	$2,756	$4,214	$5,672	$6,643	$8,101	$9,656	$11,211	$12,766
6,928	**38.73**	$1,075	$3,244	$4,865	$6,485	$7,566	$9,186	$10,915	$12,644	$14,372

Cocoa + diverse forest species. Sensitivity analysis – IRR as a function of cocoa bean productivity and price

Price		Productivity (Kg/plants)								
USD/ton	R$/Kg	0.5	0.9	1.2	1.5	1.7	2.0	2,3	2.6	3.0
2,385	**13.33**	n/a	n/a	n/a	8%	11%	14%	17%	20%	22%
3,769	**21.07**	n/a	9%	15%	20%	22%	25%	28%	31%	34%
4,653	**26.01**	n/a	14%	20%	25%	27%	30%	34%	36%	39%
4,997	**27.93**	n/a	16%	22%	26%	29%	32%	35%	38%	41%
5,700	**31.86**	5%	19%	25%	29%	32%	35%	39%	42%	44%
6,284	**35.13**	8%	21%	27%	31%	34%	38%	41%	44%	47%
6,928	**38.73**	11%	23%	29%	34%	36%	40%	44%	47%	50%

Oil Palm AFS (Natura)

Results by model

The Oil Palm AFS is a production model that integrates the cultivation of oil palm *(Elaeis guineensis)* with a variety of other agricultural, fruit, and/or forest species within the same area. This system is aligned with the principles of regenerative agriculture, as it seeks to reconcile agricultural production with environmental conservation and the generation of socioeconomic benefits. The objective of the Oil Palm AFS is to offer an alternative to monoculture, serving as an environmentally sustainable, socially fair, and economically viable model, used, for example, in the Tomé-Açu region of Pará, as to strengthen sustainable family farming.

The main characteristics of the Oil Palm AFS include crop diversification, sustainable management, natural shading, and improved farmer income. Diversification is achieved by cultivating oil palm together with species such as cocoa, banana tree, açaí, passion fruit, and andiroba, optimizing land use and promoting soil fertility. The system increases biodiversity, reduces the need for agrochemicals, and improves soil and water quality. In addition, the diversity of crops and production cycles enables family farmers to generate income throughout the year.

For the implementation of the Oil Palm AFS, two main production arrangements are recommended: Double Rows and Quadruple Rows. The Double Row arrangement consists of oil palm rows arranged in pairs (9 m × 9 m), with cocoa planted in the adjacent inter-rows and a 15.60 m-wide biodiverse strip integrating açaí, forest species, and other crops. The Quadruple Row arrangement uses four oil palm rows in a block (9 m × 9 m in a triangular layout), with cocoa in the inter-rows and two 15.60 m biodiverse gaps, which accommodate açaí in isolated clumps and forest species with wider spacing along the rows.

Oil Palm AFS (Natura)
Results by model

Cocoa + Oil Palm
Double Row Arrangements

This model organizes planting in oil palm rows arranged in pairs, with 9 m × 9 m spacing between plants, cocoa in the adjacent inter-rows, and a 15.60 m-wide biodiverse strip integrating açaí, forest species, and other crops. This arrangement creates wide intercalary strips that facilitate mechanized management and allow greater light penetration for the intercropped crops. The project's technical specifications indicate an alternation of spacings measuring 7.80 m, 4.00 m, and 3.80 m, defining distances between plants and between rows. To ensure the agroforestry component, this arrangement establishes as a non-negotiable rule the presence of at least 20 forest trees per hectare, although the choice of complementary species is flexible and left to the producer's discretion.

Cocoa + Oil Palm - Double Row Arrangements. Spacing, density, and production curve

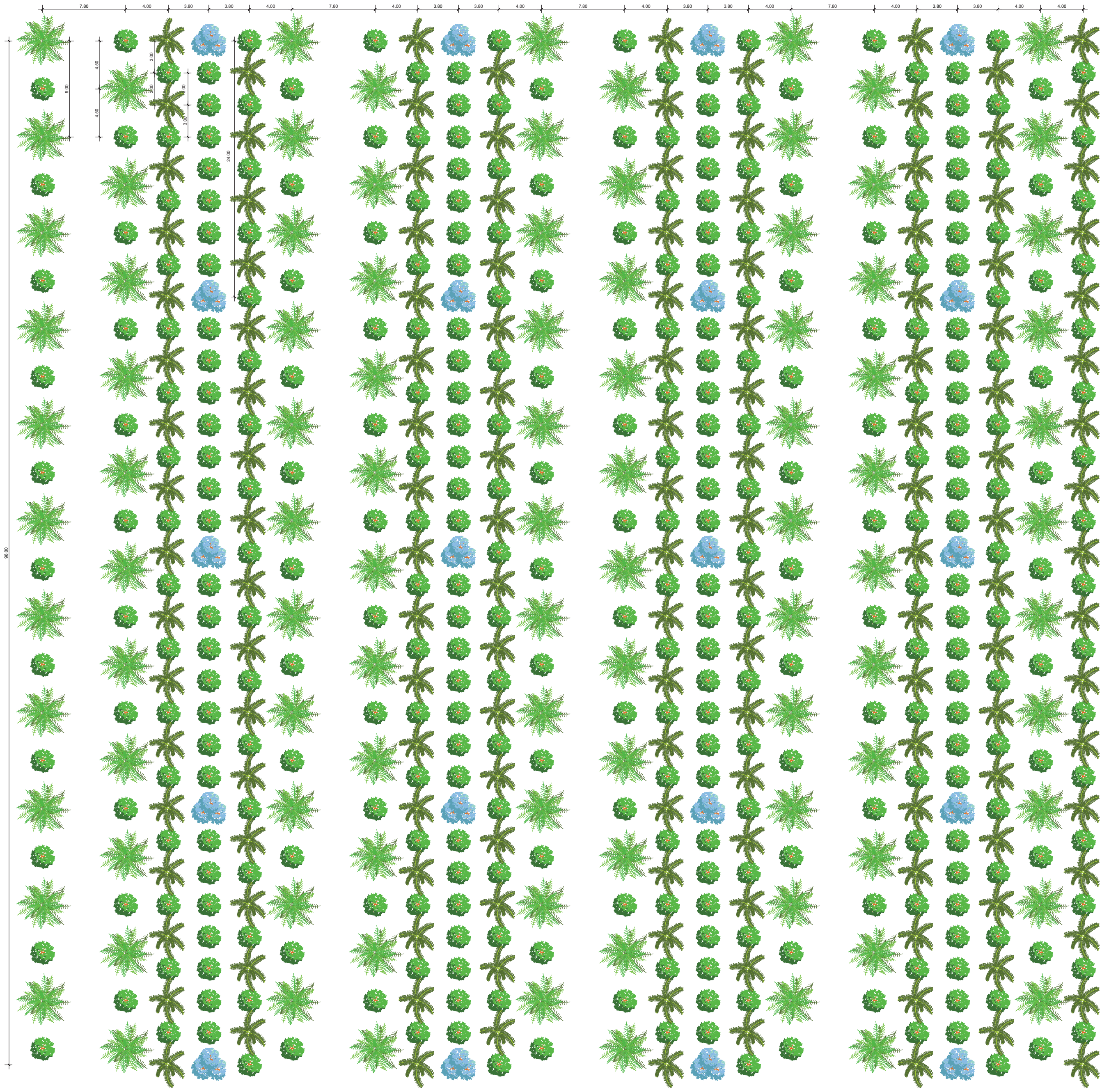
			Production curve Year																													
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Oil Palm	9 x 9.75	99				////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Cocoa	9x7.8 and 3x3.8	359				////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Açaí	3x3 and 3x20.4	149				////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Andiroba	18 x 23.4	20								////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Banana	4.5x7.8 and 3x3.8	584		////	////	////	////																										

Cocoa + Oil Palm - Double Row Arrangements. Financial results

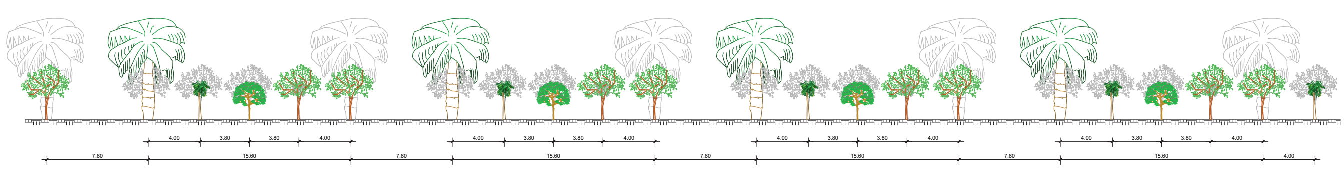
Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$9,782.82
Average Direct Costs After year 3 ($/ha/year)	-$2,127.30
Average Net Revenue After year 3 ($/ha/year)	$5,016.06
Average Free Income After year 3 ($/ha/year)	n/a
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$2,659.08
Investment Logic	
Discounted Payback	9
IRR (%) 30 years	9.31%
NPV ($/ha)	$16,905.14

Cocoa + Oil Palm - Double Row Arrangements. Spatial distribution of the arrangement

FIFTH CYCLE - SCALE: 1/200



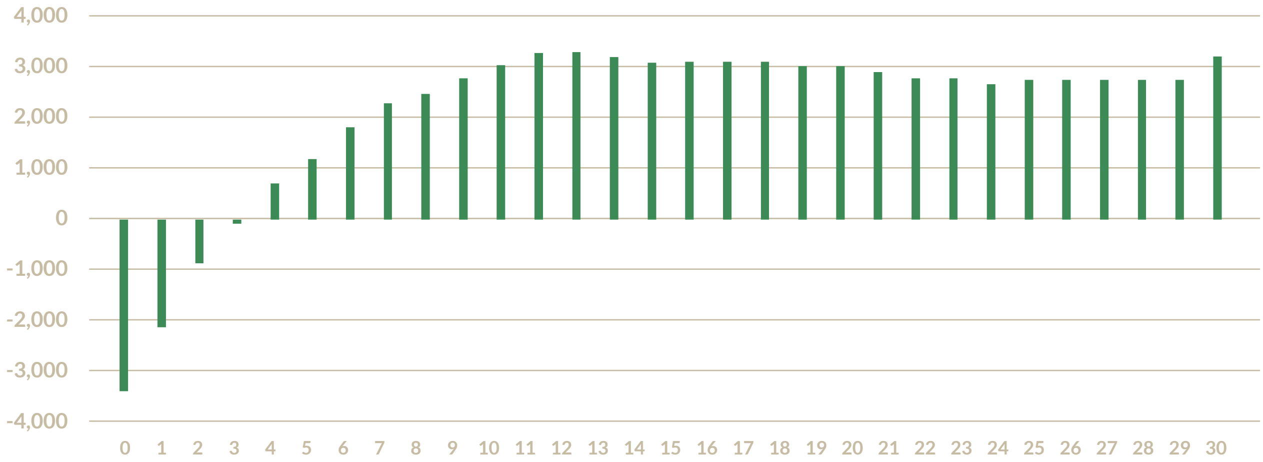
ELEVATION FIFTH CYCLE - SCALE: 1/150



	Oil Palm	Cocoa	Açaí	Andiroba	Total
Quantity	99	359	149	20	627

NOTE: The diversity and selection of complementary forest species are flexible and at the producer's discretion. However, planting must ensure a **minimum of 20 individuals per hectare.**

Cocoa + Oil Palm - Double Row Arrangements. Annual free cash flow
USD/ha × years



Cocoa + Oil Palm - Double Row Arrangements. Sensitivity analysis

There is not.

Cocoa + Oil Palm

Quadruple Row Arrangements

The quadruple row configuration densifies the main crop by grouping oil palm in blocks of four consecutive rows, with 9 m × 9 m triangular spacing between plants, cocoa in the inter-rows, and two 15.60 m biodiverse gaps. This design alters spatial dynamics, requiring detailed planning of internal block spacing and separation strips. The technical design uses a combination of measurements — including 3.00 m, 3.30 m, 3.90 m, and 7.80 m — to structure corridors and planting rows, while maintaining commitment to ecological diversity and mandating the introduction of at least 20 forest tree individuals per hectare.

Cocoa + Oil Palm - Quadruple Row Arrangements. Spacing, density, and production curve

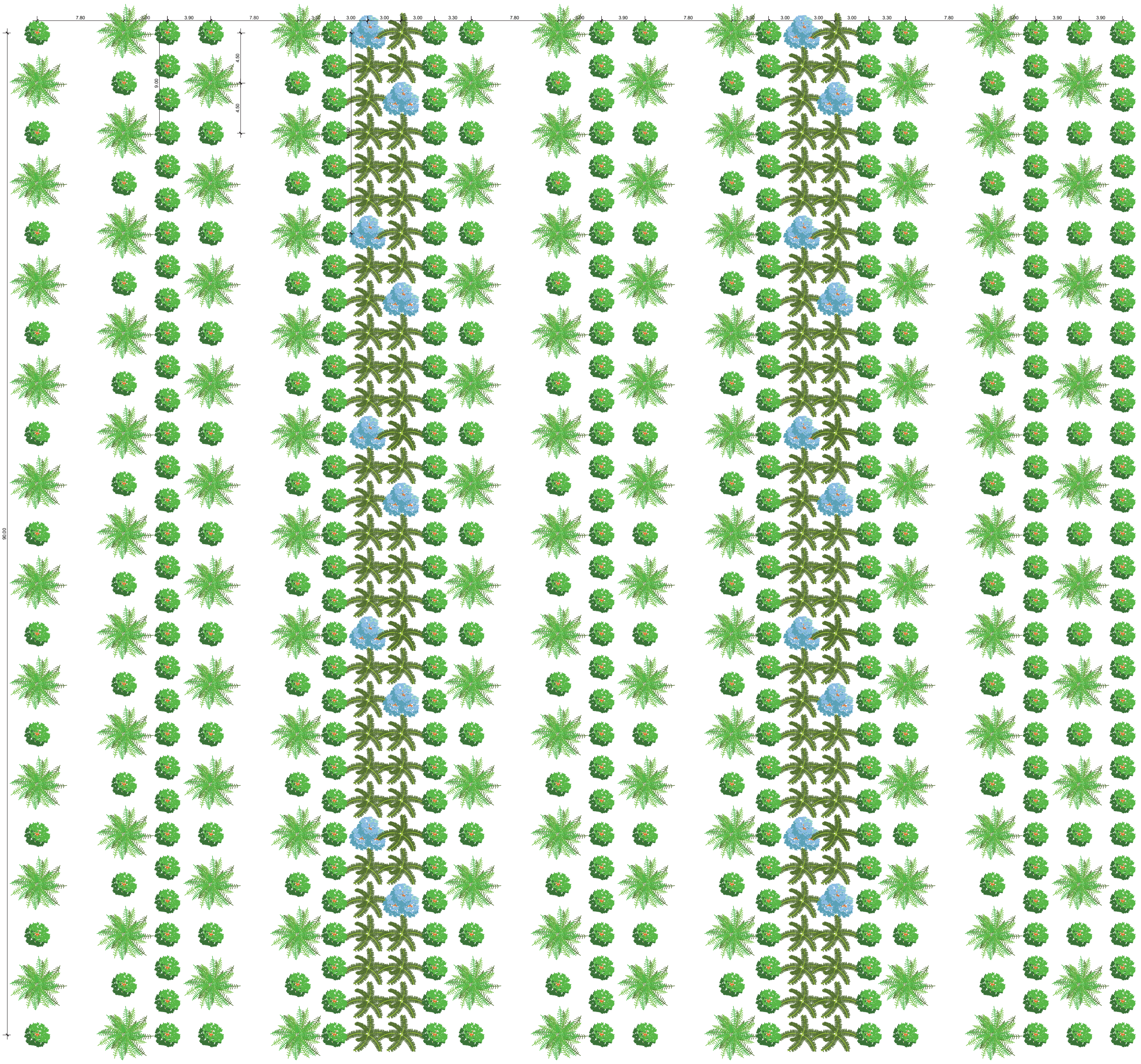
			Production curve Year																													
Species	Spacing (m)	Plants/ha	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Oil Palm	9 x 9.75	115				////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Cocoa	9x7.8 and 3x3.8	364				////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Açaí	3x3 and 3x20.4	104				////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Andiroba	18 x 23.4	20								////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////	////
Banana	4.5x7.8 and 3x3.8	460		////	////	////	////																										

Cocoa + Oil Palm - Quadruple Row Arrangements. Financial results

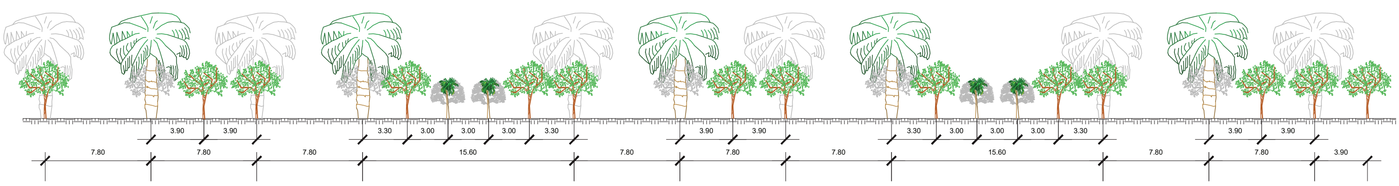
Production Logic	
Initial Investment Sum of years 0 to 3 ($/ha)	-$9,785.05
Average Direct Costs After year 3 ($/ha/year)	-$2,127.59
Average Net Revenue After year 3 ($/ha/year)	$5,042.50
Average Free Income After year 3 ($/ha/year)	n/a
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$2,685.51
Investment Logic	
Discounted Payback	9
IRR (%) 30 years	8.99%
NPV ($/ha)	$16,747.41

Cocoa + Oil Palm - Quadruple Row Arrangements. Spatial distribution of the arrangement

FIFTH CYCLE - SCALE: 1/200



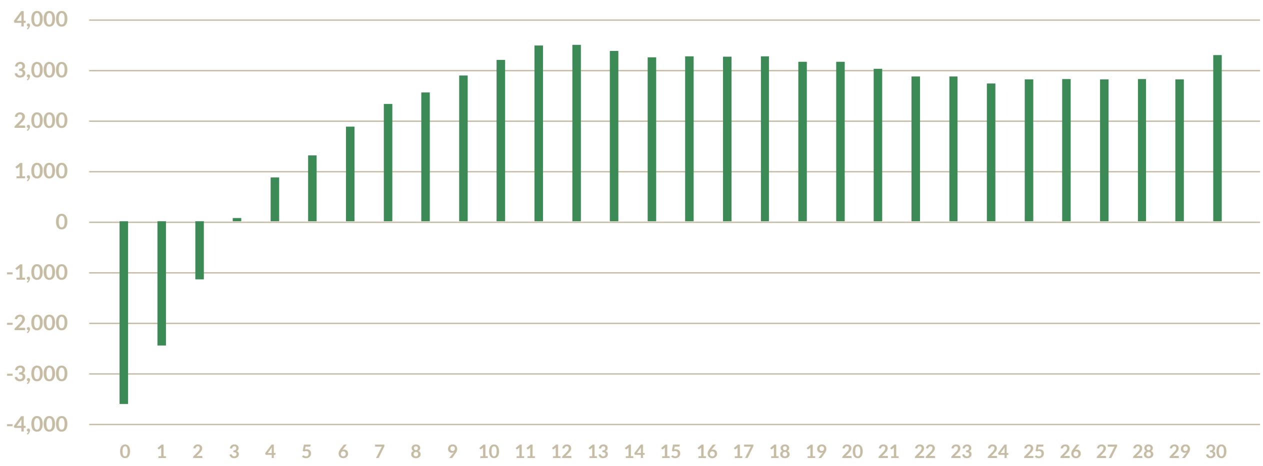
ELEVATION FIFTH CYCLE - SCALE: 1/150



	Oil Palm	Cocoa	Açaí	Andiroba	Total
Quantity	115	364	104	20	603

NOTE: The diversity and selection of complementary forest species are flexible and at the producer's discretion. However, planting must ensure a **minimum of 20 individuals per hectare.**

Cocoa + Oil Palm - Quadruple Row Arrangements. Annual free cash flow
USD/ha × years



Cocoa + Oil Palm - Quadruple Row Arrangements. Sensitivity analysis
There is not

Conclusions

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6. Conclusions

Resume table - Financial results and indicators

	Cocoa I	Cocoa II	Cocoa + Açaí I	Cocoa + Açaí II	Cocoa + Açaí III	Cocoa + Cupuaçu	Cocoa + Coconut	Cocoa	Cocoa + Açaí	Cocoa + diverse forest species	Cocoa + Oil Palm (double row)	Cocoa + Oil Palm (four row)
Production Logic												
Initial Investment Sum of years 0 to 3 ($/ha)	$-11.828,16	$-11.708,56	$-12.120,20	$-11.877,83	$-11.407,73	$-12.154,36	$-12.575,64	$-12.803,27	$-12.177,77	$-13.552,49	$-9.782,82	$-9.785,05
Average Direct Costs After year 3 ($/ha/year)	$-2.518,85	$-2.713,96	$-2.408,06	$-3.099,04	$-2.706,35	$-2.615,58	$-4.743,63	$-2.636,89	$-2.642,06	$-2.797,76	$-2.127,30	$-2.127,59
Average Net Revenue After year 3 ($/ha/year)	$7.483,16	$7.688,30	$7.067,21	$7.235,09	$6.899,55	$4.623,75	$10.600,78	$7.459,57	$6.142,56	$7.885,28	$5.016,06	$5.042,50
Average Free Income After year 3 ($/ha/year)	$3.195,29	$3.237,05	$2.953,42	$2.620,33	$2.646,13	$1.120,27	$3.898,10	$3.871,69	$2.679,11	$4.049,16	n.a.	n.a.
Average Free Income After year 3 without land lease and no hired labor ($/ha/year)	$5.163,09	$5.204,85	$4.921,22	$4.588,13	$4.613,93	$3.088,07	$5.865,90	$5.911,04	$4.718,47	$6.088,52	$2.659,08	$2.685,51
Investment Logic												
Discounted Payback	0,33	0,18	0,15	0,25	0,15	0,11	0,57	0,40	0,23	0,28	9,00	9,00
IRR (%) 30 years	28,73%	26,01%	24,36%	28,36%	24,56%	26,04%	35,07%	30,03%	26,88%	26,15%	9,31%	8,99%
NPV ($/ha)	$3.888,61	$2.108,92	$1.832,63	$2.997,05	$1.654,63	$1.282,63	$7.159,42	$5.136,08	$2.791,76	$3.756,59	$16.905,14	$16.747,41

This publication demonstrates that cocoa production in AFSs constitutes a productive model capable of generating economic profitability in both the Amazon and the Atlantic Forest. All analyzed models present positive financial results — with IRR above the discount rate and positive NPV and average net income — thus establishing cocoa-based AFSs as a concrete strategy for producers and investors.

Beyond financial performance, the models indicate that species diversification and the organization of production cycles over time reduce risks, stabilize income flows, and increase the economic resilience of farms. In this context, cocoa is consolidated as the structuring crop of the systems, acting as an axis for productive restoration and the reorganization of land use. By integrating trees, food crops, and commercially valuable species, AFSs broaden income horizons while simultaneously contributing to bioeconomy agendas, biodiversity conservation, and climate change mitigation.

The arrangements analyzed confirm that there is no single reference model. The viability of AFSs depends on adaptation to edaphoclimatic conditions, productive capacities, and the economic strategies of each territory. This flexibility is one of the system's main strengths, as it allows agricultural production and standing forest to be combined without excessive standardization, therefore preserving productive diversity and local autonomy.

Although the results confirm the profitability of the models, **strengthening cocoa production in AFSs requires public policies, technical assistance, and access to credit that are compatible with the complexity of these systems**, recognizing them as long-term productive infrastructure. In addition, the valuation of carbon and other ecosystem services could improve the profitability of the models and reduce risks through revenue diversification. Financing integrated with technical assistance is a central element for enabling their implementation and consolidation. In this sense, innovative financial instruments such as the **Kawá Fund** — structured as a blended finance model — **expand access to capital by integrating market and philanthropic resources, offering a complementary alternative to traditional credit and contributing to the strengthening of Brazil's regenerative cocoa agriculture.**

Complementarily, multisectoral initiatives such as the Brazilian Cocoa – People, Forest, and Culture initiative reinforce the competitiveness of national cocoa by valuing people, territories, and forests, promoting good socio-environmental practices, productive quality, and market access. The convergence of productive innovation, financing, and value chain governance enhances the conditions for the sustainable development of Brazilian cocoa farming.

In summary, cocoa-based AFSs demonstrate that it is possible to reconcile production, conservation, and income generation at scale. More than a technical alternative, AFSs are affirmed as a structuring strategy for the future of cocoa farming, thus connecting economic development, territorial stability, and the maintenance of standing forests.

Glossary

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7. Glossary

Amazon
The largest tropical forest biome in the world, with high biodiversity and a strategic role in climate regulation and the Brazilian bioeconomy.

Bioeconomy
An economic model based on the sustainable use of renewable biological resources to generate products, services, and income.

Atlantic Forest
A Brazilian biome characterized by high biodiversity and a high degree of endemism, originally distributed along the coastline and inland areas of the country, now greatly reduced due to human occupation, yet of major ecological, climatic, and socioeconomic importance.

Economic modeling
An analytical representation that simulates the financial performance of production systems based on technical and economic assumptions.

Production models
Technical and organizational arrangements that define cultivation, management, and land-use practices.

Discounted payback
An indicator similar to simple payback, but which considers the time value of money through the discounting of cash flows.

Modeling technical parameters
The set of assumptions adopted in the construction of the analyses, such as prices, productivity, and costs.

Revenue
The total value obtained from the sale of products generated by the production systems, calculated based on production volumes and sale prices.

Gross revenue
The total value obtained from the commercialization of production, before deducting costs.

Oil palm AFS
An agroforestry system that combines cocoa cultivation with oil palm and, in some cases, other species.

Agroforestry System (AFS)
A land-use system that integrates tree and agricultural species, therefore promoting productive, environmental, and social benefits.

Economic feasibility
The ability of a production system or project to generate positive financial results, considering returns, costs, and risks.

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