Climate Change Adaptation Plan for the Cocoa Sector in Costa Rica

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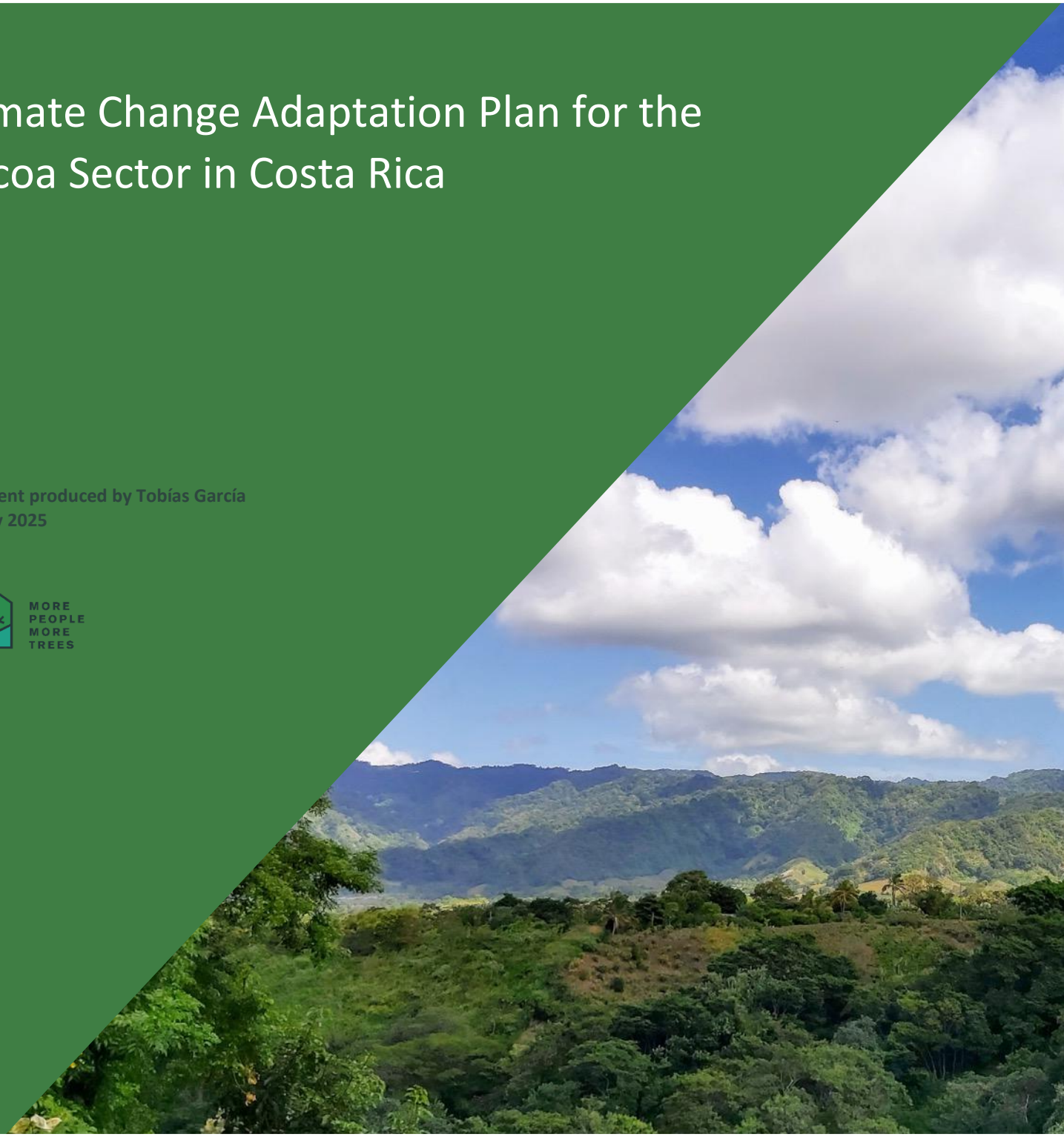

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TABLE OF CONTENTS

FOREWORD

Cocoa is an emblematic crop in Costa Rica, not only for its historical and cultural value but also for its potential to generate sustainable economic opportunities for rural communities. However, climate change represents a growing threat to its production, with impacts such as increased pests and diseases, soil degradation, and variability in rainfall and temperature patterns. Given these challenges, there is a need for a comprehensive strategy to strengthen the resilience of the sector and ensure its long-term viability.

The Adaptation Plan for the Cocoa Sector in Costa Rica is a working guide designed to promote resilient, sustainable, and inclusive production systems. Its objective is to strengthen climate resilience, sustainability, and social inclusion in the cocoa value chain by implementing regenerative practices, landscape restoration, and improved competitiveness of Costa Rican cocoa in differentiated markets.

This plan has been developed based on a participatory methodology that integrates the technical knowledge of academic institutions such as Cornell University, the experience in cocoa production and marketing of private companies like ECOM, and the contributions of producers and key actors in the value chain. Through four strategic axes-sustainable productive transformation, integrated landscape management, climate resilience, and value chain strengthening-concrete actions are established to reduce the sector's vulnerability and maximize its potential.

This document defines a path towards a more sustainable and competitive cocoa production and proposes a joint commitment between producers, organizations, private sector, and government entities to build a resilient future for Costa Rican cocoa. This plan aims to serve as a roadmap for adaptation to climate change and as a replicable model for other sectors in the search for solutions based on sustainability and inclusion.

SUMMARY

The *Adaptation Plan for the Cocoa Sector in Costa Rica* offers a comprehensive approach to address the challenges of climate change that threatens the productivity, quality, and sustainability of cocoa. This crop, recognized as strategic for rural development and environmental conservation, faces significant challenges arising from climate variability, such as changes in temperatures, alterations in rainfall patterns, increased pests and diseases, and soil degradation. The plan, therefore, establishes a strategic framework designed to strengthen the resilience of cocoa agroforestry systems, ensure their economic sustainability, and promote the well-being of cocoa-producing communities.

Vision and General Objective

The vision is to promote resilient, sustainable, and inclusive cocoa production systems that not only respond to climate challenges but also foster the regeneration of productive landscapes, conservation of natural resources, and equity in the value chain. This purpose is embodied in a general objective to strengthen climate resilience, sustainability, and social inclusion by promoting regenerative agricultural practices, technical capacity building, landscape restoration, and improving the competitiveness of Costa Rican cocoa in niche markets.

Work Methods

The methodological approach is based on the integration of diverse sources of information. This includes Cornell's work in biodiversity, and climate change, as well as ECOM's experience and leadership in cocoa cultivation. In addition, inputs obtained through group discussions and key interviews are incorporated, allowing for a more complete and informed view of the context.

Strategic Axes

The plan is articulated around four strategic axes, each with specific lines of action designed to address the sector's main challenges:

1. **Sustainable Productive Transformation:** This axis prioritizes the adoption of regenerative and climate-smart agricultural practices to improve the sustainability of cocoa plantations as their productivity increases. It includes:
    - **Agroforestry systems -** Capacity building in establishing diversified crops with timber and fruit species that increase resilience, diversity, and associated

ecosystem services (pest control, pollination, temperature regulation, and soil protection).

- Integrated pest and disease management - Implementation of bioinputs such as natural fungicides and biological pest control.
- Soil health - Promotion of periodic soil analysis, use of bio-inputs, implementation of community biofactories to produce organic inputs, and application of compost and other soil improvers.
- Resilient agricultural infrastructure - Construction of drip irrigation systems, fertigation, and design of roads with suitable drainage.-Use of terraces and cover crops in areas with slopes to prevent soil erosion.

2. Integrated Landscape Management: This axis integrates agricultural production and environmental conservation, thus promoting ecological connectivity and the restoration of productive landscapes. The main actions include:
    - Reforestation with multipurpose native species in non-productive areas of farms or lands.
    - Establishment of live fences and/or "pollinator islands" in farms to increase plant structure.
    - Protection of water sources through the protection, enhancement or creation of forest strips around rivers and springs.

3. Climate Resilience and Adaptation: This axis seeks to reduce the vulnerability of plantations to extreme climatic events such as droughts, floods, and temperature variations. Measures include:
    - Early warning and climate monitoring systems - Installation or use of weather stations and development of warning mechanisms
    - Weather insurance - Creation of specific financial products to protect producers against losses caused by weather events.
    - Adaptive infrastructure - Agroforestry and construction of drains and canals to mitigate the impact of floods and heavy rains.

4. **Strengthening the Sustainable Value Chain:** This axis seeks to improve the competitiveness of Costa Rican cocoa through certifications, market diversification, and empowerment of key stakeholders in the value chain. It includes:
    - Improved harvest and postharvest management to increase productivity.
    - Promotion and timely implementation of sustainability certifications, such as organic agriculture, Rainforest Alliance, fair trade, and others, once the harvest is improved.
    - Development of value-added strategies to position Costa Rican cocoa as a premium product in international markets.
    - Involvement and generational integration of young people and older adults through leadership and business management workshops.

Expected Impact

The plan has a multidimensional impact that encompasses:

- **Environmental:** Increased landscape connectivity, protection of water sources, and improved biodiversity in the productive landscape.
- **Economic:** Increased productivity per hectare, increased income for producers through access to differentiated markets, and better harvest and post-harvest practices.
- **Social:** Strengthening the community fabric with a gender focus and improving the quality of life in the producing regions.

Concrete Actions and Expected Results

The plan establishes clear indicators to evaluate the success of its interventions, providing references that guide the actions to be developed:

- **Productive transformation:** 60% of farms using biological pest control and better harvest and post-harvest practices, 10 operational biofactories, and 30 hectares under diversified agroforestry systems. Increase of at least 25% in production.
- **Landscape management:** 25,000 native trees planted, multipurpose live fences established on 50% of the participating farms, and 30 springs protected.
- **Climate resilience:** six weather stations installed and climate monitoring systems developed.

- Value chain: 40% of farms are under sustainability programs or certified under sustainability seals and a 30% increase in the income of certified/organized producers.

Proposed Implementation of the Plan

The success of the plan depends on strong governance, inter-institutional collaboration, and access to sustainable financing. A Climate Change Adaptation Team is established in the cocoa sector with the private sector (ECOM, roasters, and cocoa farmers) leading the axes of integrated landscape management (reforestation and agroforestry) and sustainable productive transformation. In addition, key stakeholders such as cocoa producers and government institutions - municipalities and public universities- are involved in the development of early warning axes, value added, and generational integration, thus facilitating synergies and maximizing resources.

Conclusion

The *Adaptation Plan for the Cocoa Sector* positions Costa Rica as in the integration of regenerative agricultural practices, environmental conservation, and social development in the context of climate change. This comprehensive approach not only ensures the resilience and sustainability of Costa Rican cocoa but also strengthens its international competitiveness and promotes the welfare of producing communities, thus making cocoa a symbol of sustainability and excellence in global markets.

KEY MESSAGES

Climate Change and Cocoa: *"Cocoa is highly sensitive to climate variations, including changes in temperature, precipitation patterns, and extreme weather events. Recent studies highlight that rising global temperatures could reduce the areas suitable for cocoa cultivation in traditional regions such as Central America. This calls for urgent adaptation strategies."*

Increasing biodiversity as a tool for adaptation: "Climate change reduces predictability and increases the uncertainty of the factors necessary for cocoa production. Increasing the diversity of the community of pest controllers and pollinators, but in general of the cocoa habitat and its surroundings - through agroforestry, protection of forest remnants, reduction of agrochemicals, and strengthening of biological corridors- increases the resilience of rural communities."

Impacts of Climate Change on the Value Chain: *"Climate change directly affects every link in the cocoa value chain. Heavy rains increase the incidence of diseases such as moniliasis, while droughts reduce fruit development. The lack of adequate infrastructure aggravates these problems, affecting bean quality and limiting access to international markets."*

Promotion of Agroforestry Systems: *"Cocoa agroforestry combines trees with cocoa cultivation to create diversified systems that improve the sustainability and resilience of production systems. This model contributes to soil and water conservation, provides shade, regulates microclimates, and promotes biodiversity, becoming a key tool to restore degraded landscapes."*

Financial Barriers: *"Limited access to finance is one of the main obstacles for small producers. This impedes the adoption of agroforestry systems and innovative technologies, which are essential to address climate change. Lack of infrastructure, such as irrigation and drying systems, also affects the sector's competitiveness."*

Integrated Landscape Management: *"Restoring landscapes through reforestation, protection of water sources, and biodiversity conservation is crucial. Implementing live fences, biological corridors, and forest strips around springs and rivers reinforces the environmental and productive sustainability of cocoa plantations."*

Technical Capacity Building: *"Training in sustainable management, pest control, regenerative techniques, and climate adaptation strategies are essential to strengthen the resilience of cocoa farmers. This is achieved through hands-on workshops, field schools, and climate monitoring systems."*

Social Inclusion and Empowerment: *"Low participation of women and youth in the cocoa sector underscores the need for inclusive programs that promote their active integration. Designing strategies that strengthen their involvement in production and decision making is key to sustainability and generational replacement."*

Strengthening the Value Chain: *"Promoting certifications, access to differentiated markets and fair trade guarantees the economic sustainability of the cocoa sector. Certifications such as organic and fair trade*

allow producers to access premium markets that value quality and sustainability."

Multisectoral Collaboration: *"Cooperation between producers, government institutions, NGOs and the private sector is critical to implement climate-smart solutions. Strengthening existing cross-sectoral platforms and supporting the creation of new platforms and a digital platform for monitoring ensures participatory and effective governance."*

Strategic Vision: *"The vision of this plan is to ensure climate resilience, sustainability and inclusive growth of cocoa agroforestry systems, promoting regenerative agricultural practices, equity in the value chain and conservation of the productive landscape. This seeks to ensure the productivity and well-being of cocoa farming communities in a constantly changing environment."*

1. INTRODUCTION

The project "Removing Barriers to Access Finance from the National Cacao Plan in Costa Rica: Cacao Agroforestry for Rural Development and Landscape Restoration and Adaptation" was born out of a collaboration between ECOM and the Cornell Lab of Ornithology, to assess financial and productive barriers in the national cacao agro-chain and the climate challenges it faces. This two-year project (2023-2024) was designed with Costa Rica's National Cocoa Plan in mind, aiming to chart a roadmap for cocoa climate adaptation and agroforestry upscaling for national export.

Partially funded by the Global EbA Fund, both ECOM and the Cornell Lab of Ornithology are working together to maximize the impact of their actions. The project focuses on the Northern Huetar, Brunca, and Huetar Atlantic regions of Costa Rica, key areas for cacao cultivation. Initiatives are being implemented to research and improve climate change resilience and to explore alternative livelihoods within cacao agroforestry systems.

In this context, services on climate change resilience and alternative livelihoods within cocoa agroforestry systems are developed as part of a larger project in the Northern Huetar, Brunca, and Huetar Atlantic regions of Costa Rica. This agroforestry approach incorporates the project results, intending to improve adaptability and resilience, offering benefits to both the production units and the landscape.

To prepare for the Adaptation Plan, a participatory methodology including characterization of the sector, development of a strategic framework, implementation of adaptation actions, and a monitoring and evaluation system has been developed. The characterization of the sector is based on a documentary review, an analysis of the climate change situation, and the identification of specific challenges. The active participation of cocoa farmers and other key stakeholders is ensured through workshops, field visits, and meetings with experts.

This collaborative and multidimensional approach allows not only to identify current barriers but also for the development of effective strategies to overcome them, promoting the sustainability and resilience of cocoa production in Costa Rica.

METHODOLOGICAL SUMMARY

The project on is based on a participatory methodology. This methodology is structured in several phases - characterization of the sector, development of a strategic framework, implementation of adaptation actions, and a monitoring and evaluation system. The Climate Change Adaptation Plan for the cocoa sector in Costa Rica is a strategic guide designed to strengthen resilience, sustainability, and inclusion in cocoa production. This document charts a path towards a more sustainable and competitive cocoa production and represents a joint commitment between producers, organizations, the private sector, and government entities toward building a resilient future for Costa Rican cocoa.

Sector Characterization

The first phase focuses on conducting a desk review to understand the current context of cocoa cultivation in the Northern Huetar and Brunca Zones of Costa Rica. This process includes the compilation and analysis of existing reports, studies, and data on cocoa production, the impact of climate change, and current trends affecting the sector. Key documents to be considered include the National Cacao Plan 2018-2028, the Regional Action Plan for Adaptation to Climate Change 2022-2026, and the Regional Cacao Strategy 2022-2032, in addition to documents generated by the project "Removing Barriers to Access Finance from the National Cacao Plan in Costa Rica: Cacao Agroforestry for Rural Development and Landscape Restoration and Adaptation".

Furthermore, a review of the climate change situation will be conducted, to identify how this situation is affecting and could affect cocoa cultivation in the future. An essential component of this phase will be to incorporate a review of case studies related to climate resilience and alternative livelihoods in cocoa agroforestry. These studies will provide valuable lessons learned and good practices that could be applied or adapted to the specific conditions of the region, thus enriching the climate change adaptation strategy.

By holding participatory workshops with producers in the Huetar Norte and Brunca regions, we will identify both challenges and solutions. Challenges related to production units, landscape, climate, and the value chain will be prioritized. In addition, field visits will be made to obtain a practical and direct vision of the challenges and opportunities present in the production units. To complete this phase, meetings will be held with key stakeholders, including representatives of government institutions, local organizations, and experts to integrate their perspectives and knowledge.

The Adaptation Plan for the Cocoa Sector in Costa Rica is a roadmap designed to promote resilient, sustainable, and inclusive production systems. This document not only defines a path toward a more sustainable and competitive cocoa production, but also impulse constitutes a joint commitment between producers, organizations, the private sector, and government entities to build a resilient future for Costa Rican cocoa. This plan will serve as a roadmap for climate change adaptation and as a replicable model for other sectors in the search for solutions based on sustainability and inclusion.

Table I. Interviews conducted.

Interview: Mr. Ignacio Murillo	Cocoa Coordinator	Ecom, Costa Rica	1
Interview: Mr. Eliás Cruz	Producer	Guatuso, Northern Huetar Region	2
Interview: Mr. Arcelio Garro, Rosaura Miranda	Producer	Guatuso, Northern Huetar Region	1
Interview: Mr. Victor Ruiz	Producer	Guatuso, Northern Huetar Region	1
Interview: Mrs. Vicenta Gonzales	Producer	Guatuso, Northern Huetar Region	1
Rafael Chaves	Producer	Brunca Region	1
Alfredo Quintero	Osacoop	Puerto Escondido, Brunca Region	1
Lorena Muñoz	Producer	Rayito, Brunca Region	1
Interview: Eng. Alexander Solorzano	Osacoop Manager	La Palma, Brunca Region	1
Interview: Mr. Ing Mainor Leitón	Agency Manager Guatuso	Ministry of Agriculture and Livestock MAG, Guatuso	1
Interview: Mr. Kennett Bolivar	Cahuita Agency Manager.	Ministry of Agriculture and Livestock MAG, Cahuita	1
Ms. Rocío Fallas	National CACAO Coordinator, MAG	Ministry of Agriculture and Livestock MAG	1
Interview, Dr. David Ramos	Specialist	Institute for Innovation in Agriculture and Livestock of Panama (IDIAP)	1
Mr Oscar Brenes	Cocoa Specialist	Consultant.	1
Mr. Falguni Guharay	Cocoa Specialist	World Cocoa Foundation	1
Mr. Miguel Vallejo	Sustainability Consultant	Costa Rica	1

Table II. Activities carried out in the Huetar Norte and Brunca Regions.

Activity	Contact information	Location	Participants
Workshop: Climate-related challenges in the cocoa value chain	Producers working with ECOM	Mexico de Upala, Northern Huetar Region	13 participants
Workshop: Climate-related challenges in the cocoa value chain	Producers associated with Osacoop.	Osacoop, Brunca Region	12 participants

Development of the Strategic Framework

During the second phase, the Strategic Framework for adaptation will be developed. This stage includes the definition of the plan's vision, the strategic axes, and their linked objectives. Likewise, we propose a series of measures for adaptation to climate change that respond to the social, cultural, and climatic reality of the regions identified in the previous diagnosis developed.

The definition of the plan's vision will include a clear focus on the sustainability and resilience of cocoa producers in the face of climate challenges. The strategic axes will be defined based on the identified risks and specific objectives will be established for each axis, aimed at improving the adaptive capacity of producers and strengthening the cocoa value chain.

In addition, the implementation structure of the plan will be analyzed, identifying the necessary resources and the coordination and follow-up mechanisms. It will also address the main barriers that must be overcome to effectively implement the adaptation plan, such as financial limitations, resistance to change, and lack of access to technology and information.

Implementation of Adaptation Actions

The implementation of adaptation actions will be based on the solutions and recommendations identified during the participatory workshops, field visits, and stakeholder meetings, among others. This will include implementing sustainable practices and nature-based solutions adapted to the specific needs and conditions of cocoa farmers in the region.

Solutions can include reforestation, using live fences, water conservation, and sustainable soil management. However, specific actions will be determined based on the information gathered and analyzed through the participatory processes and document review.

Monitoring and Evaluation System

The final phase of the guide will propose a monitoring and evaluation system to track progress and assess the impact of actions. Performance indicators and monitoring tools will be developed, and periodic evaluations will be conducted to adjust and improve strategies.

Ongoing participation of producers and other key stakeholders will be ensured through open communication, facilitating their active participation in decision-making and project monitoring.

3. CHARACTERIZATION OF THE SECTOR

The cocoa sector in Costa Rica has a solid regulatory framework and a series of strategic initiatives that seek to promote its sustainable development, increase its competitiveness, and strengthen its resilience to climate change. This sector has been identified as a crucial economic driver for rural communities and, at the same time, as a key instrument for landscape restoration and biodiversity conservation (FAO, 2023).[1]

Policy and institutional support include national policies and regional strategies that promote sustainable agroforestry practices and climate-smart approaches. Through initiatives such as the *National Cocoa Sector Development Plan* MAG, 2024)[2] and international cooperation programs, Costa Rica is making progress toward consolidating a competitive, resilient, and sustainable cocoa model. These actions not only seek to address the challenges associated with climate change but also to preserve natural resources and ensure economic benefits for producing communities, promoting social equity and the responsible use of soil and water (IICA, 2024).[3]

[1] FAO (2023). *Agroforestry systems for sustainable development*. Food and Agriculture Organization of the United Nations.
[2] MAG (2024). *National Cocoa Sector Development Plan*. Ministry of Agriculture and Livestock of Costa Rica.
[3] IICA (2024). *Regional strategies for climate and economic sustainability in the agricultural sector*. Inter-American Institute for Cooperation on Agriculture.

Regulatory and Institutional Framework for the Development of the Cocoa Sector in Costa Rica

The cocoa sector is governed by several laws, decrees, and strategic plans that promote its growth and sustainability:

- **Law No. 7064: Law for the Promotion of Agricultural Production (1987):** This law establishes the general guidelines to encourage agricultural production, including cocoa. The objective is to boost the development of productive farms and improve the conditions of farmers through incentives and support programs (MAG, 2018).[4]
- **Executive Decree No. 39230-C-MAG (2015):** This decree declares of national interest the production, processing, marketing, and export of cocoa. Through this instrument, the Government recognizes cocoa as a strategic crop that can generate economic and social opportunities for rural communities (MAG, 2015).[5]
- **National Cocoa Plan 2018-2028:** The *National Cocoa Plan* is an initiative of the Ministry of Agriculture and Livestock (MAG) and other institutions that aims to reactivate and consolidate the cocoa agro-chain. Its focus ranges from increasing the productivity and quality of beans to promoting agroforestry systems and sustainable practices. The plan sets the goal of increasing the area of cocoa production under agroforestry systems by more than 6,000 hectares (MAG, 2018).
- **International Cocoa Agreement 2010 (Law No. 9154):** Costa Rica is a signatory to this international agreement, which promotes global cooperation in the cocoa sector. The agreement seeks to ensure the sustainable development of cocoa production and guarantee economic benefits for producers, promoting stability in international prices (MAG, 2010).[6]
- **State Policy for the Agrifood Sector and Rural Development (2010-2021):** This policy establishes a general framework to strengthen the agrifood sector, promoting sustainability, innovation, and the integration of small producers into value chains. Cocoa is one of the production chains that is prioritized to boost rural development (MAG, 2010).

[4] Ministry of Agriculture and Livestock (MAG). (2018). *National Cocoa Plan 2018-2028: Reactivation of the Cocoa Production Chain in Costa Rica*. Ministry of Agriculture and Livestock, Costa Rica.

[5] Government of Costa Rica (2015). *Executive Decree No. 39230-C-MAG: Declaration of national interest for the production, processing, marketing, and export of cocoa*. Published in La Gaceta No. 164 of August 24, 2015.

[6] International Cocoa Organization (ICCO). (2010). *International Cocoa Agreement 2010*. Adopted at the International Cocoa Conference in Geneva, Switzerland, under the auspices of the United Nations.

Regional Instruments and Complementary Projects

- **Regional Action Plan for Adaptation to Climate Change 2022-2026**: This plan, developed by the Climate Change Directorate (DCC) of the Ministry of Environment and Energy (MINAE), seeks to strengthen the adaptive capacity of vulnerable productive sectors, such as cocoa. The plan focuses on reducing climate vulnerability by implementing agroforestry systems, restoring degraded landscapes, and promoting sustainable practices.[7]

Relevance to climate change:

- Promotion of diversified agroforestry systems to mitigate climate impacts.
- Training of producers in climate change resilient practices.
- Financial support to implement sustainable agricultural technologies.

Cocoa is considered a strategic crop because of its ability to conserve soils, foster biodiversity, and promote ecosystem-based adaptation.

- **Regional Cocoa Strategy 2022-2032**: Developed by the member countries of the Central American Integration System (SICA), this strategy aims to improve the competitiveness of the cocoa sector in the region. Costa Rica plays a key role in its implementation, focusing on sustainable and resilient practices.[8]

Relevance to climate change:

- Adoption of sustainable technologies and agroforestry systems.
- Integrated management of pests and diseases related to climate change.
- Landscape restoration through sustainable production chains.
- Promote fine and aromatic cocoa in international markets.

Costa Rican cocoa, recognized for its quality, is positioned as a key product for regional sustainability.

- **Project "Removing Barriers to Access Finance from the National Cacao Plan in Costa Rica".**
  This project seeks to remove economic barriers that hinder access to finance for

[7] Climate Change Directorate (DCC), MINAE (2022). *Regional Action Plan for Adaptation to Climate Change*.
[8] Central American Integration System (SICA). (2021). *Regional Cocoa Strategy 2022-2032*.

small and medium-sized cocoa producers by promoting sustainable agroforestry systems.[9]

Relevance to climate change:

- Promoting resilience practices through tailored financing.
- Restoration of degraded lands with cocoa agroforestry systems.
- Technical and financial capacity building for farmers.

This project contributes to rural development and positions cocoa as a key tool in landscape restoration.

- Climate Change Adaptation Program for the Agricultural Sector (MAG - IADB) This program, developed in collaboration with the Inter-American Development Bank (IDB), seeks to strengthen the resilience of agricultural sectors vulnerable to climate change, including cocoa.[10]

Relevance to climate change:

- Implementation of pilot projects in regenerative and climate-smart agriculture.
- Technical assistance to reduce the carbon footprint and improve the efficiency of production systems.
- Access to green financing to promote sustainable practices.
- REDD+ Program (Reducing Emissions from Deforestation and Forest Degradation) Although the main focus of REDD+ is on reducing deforestation, the program incorporates cocoa in agroforestry systems as a tool to restore degraded lands.[11]

Relevance to climate change:

- Financing cacao agroforestry projects to capture carbon.
- Conservation of biological corridors through sustainable systems.
- Incentives for producers who integrate crops that protect biodiversity and natural resources.

[9] Central American Integration System (SICA). (2021). *Removing Barriers to Access Finance*.
[10] Ministry of Agriculture and Livestock (MAG). (2023). *Climate Change Adaptation Programs*.
[11] REDD+ Costa Rica (2021). *REDD+ Program*.

Characteristics of the cocoa sector in the Northern Huetar, Huetar Atlantic, and Brunca Regions

Cocoa cultivation in Costa Rica has historically been a very important agricultural activity, linked to the rural and indigenous communities that inhabit the main producing areas of the country. The Huetar Norte, Huetar Caribe, and Brunca regions concentrate most of the national production and represent the core of the Costa Rican cocoa industry. These areas stand out for their production capacity and their key role in biodiversity conservation, landscape restoration, and income generation for local communities (MAG, 2018).[12]

Costa Rican cocoa is internationally recognized for its quality, being classified as "fine and aromatic cocoa". This recognition has allowed it to enter specialized market niches, generating opportunities for producers. However, despite its potential, the sector faces significant challenges related to climate change, moniliasis (a cocoa disease), and the need to access financing and appropriate technologies (SICA, 2021).[13]

In response to these challenges, Costa Rica has implemented strategies such as the *National Cocoa Plan 2018-2028*, the *Regional Cocoa Strategy 2022-2032,* and the *Regional Action Plan for Adaptation to Climate Change 2022-2026*. These initiatives seek to strengthen production, promote agroforestry systems, and ensure the sustainability of the sector. The three regions mentioned are priority areas within these plans, not only because of their production volume but also because of their importance in landscape restoration and rural development (MAG, 2018; SICA, 2021).

Northern Huetar Region: The Northern Huetar Region, made up of cantons such as San Carlos, Guatuso, and Upala, has a landscape dominated by plains and high-fertility areas. The tropical climate of this region varies from dry in the west to humid in the east, favoring agricultural and livestock development.

In terms of cocoa production, the Huetar Norte Region is the second most important region in the country, concentrating approximately 23% of the national cocoa area, equivalent to 594 hectares. More than 85% of the territory is suitable for cocoa cultivation under agroforestry systems, which contribute to soil conservation and the maintenance of local ecosystems (MAG, 2018).

[12] Ministry of Agriculture and Livestock (MAG). (2018). *National Cocoa Plan 2018-2028*
[13] Central American Integration System (SICA). (2021). *Regional Cocoa Strategy of the SICA countries 2022-2032*.

However, this region faces challenges in terms of human development. It is one of the areas with the lowest schooling levels in the country, with an average of 7 years of formal education (repositorio.utn.ac.cr). This situation limits access to technologies and better agricultural practices, hindering the growth of the sector.

Huetar Atlantic Region: The Huetar Atlantic Region is the main cocoa-producing area in Costa Rica, representing 40% of the national cultivated area, equivalent to 1,216 hectares. Limón and Talamanca are the main production centers, where many indigenous communities, such as the Bribri and Cabécar, are dedicated to cocoa cultivation as a key economic activity.

The region's humid tropical climate and high rainfall create ideal conditions for the growth of cocoa. This region is known for producing fine and aromatic cocoa, which is recognized in international markets. The crop is fundamental to the local economy and plays an important role in forest conservation, as it is grown in agroforestry systems that promote biodiversity (SICA, 2021).

Despite its advantages, the region faces socioeconomic inequalities and high vulnerability, which represents a challenge to the sustainable development of the sector (repositorio.conare.ac.cr). Initiatives such as the *National Cocoa Plan 2018-2028* and the *Regional Action Plan for Adaptation to Climate Change 2022-2026* seek to strengthen production, improve the living conditions of producers, and promote agroecological practices.[14]

Brunca Region: The Brunca Region, located in the south of Costa Rica, stands out for its geographical diversity, which includes coastal and mountainous areas. Cantons such as Pérez Zeledón, Osa, and Golfito lead cocoa production in this region, with a 19% share of the national area, representing 573 hectares of crops. It is one of the main cocoa-producing areas of the country. According to the VI National Agricultural Census of 2014, conducted by the National Institute of Statistics and Census (INEC)[15], the region has approximately 476.9 hectares planted with cocoa, of which 390.7 hectares are of production age.

Cocoa in the Brunca Region is grown under agroforestry systems, which combine fruit and timber trees, thus contributing to the protection of water sources and soil conservation. This region also hosts cocoa restoration and reactivation projects, with the introduction of new

[14] CONARE Repository. (2020). *Socioeconomic situation of the Huetar Caribe Region*.

[15] National Institute of Statistics and Census (INEC). (2014). *VI National Agricultural Census 2014: General Results*. INEC, Costa Rica. Available at: https://www.inec.go.cr

varieties resistant to pests and diseases, which has generated greater interest in the sector (UCR, 2019).[16]

Cocoa in the Brunca region is seen as a pillar for local development and the conservation of areas bordering protected areas such as Corcovado National Park and the Golfo Dulce Forest Reserve, where agroforestry is promoted as a tool for conservation and economic development.

4. CLIMATE CHANGE TRENDS AND COCOA

Cocoa cultivation in Latin America represents a deeply rooted sociocultural tradition. This crop is key to food security and plays a key role in the region's agricultural dynamics. However, climate change requires rethinking the agricultural practices used in its production. Given this reality, case studies of experiences in Peru, Panama, and Honduras demonstrate how agroforestry practices can be an effective solution to improve resilience of cocoa crops in the face of climate change. The integration of cocoa with other crops, such as banana and timber trees seen in ACOPAGRO (Peru), establishes a model that not only improves farm productivity by diversifying income sources but also promotes soil conservation and favors biodiversity. Also, it incorporates cocoa varieties that are more resistant to climate change. In Panama, the COCABO example highlights the importance of adapting infrastructure and farming techniques to local conditions. Improved water infrastructure and the use of soil conservation practices are crucial to mitigate the effects of climate variations and ensure consistent and sustainable production. These efforts show that investments in technology and local capacity building strengthen productivity by increasing resilience to climate challenges. In Honduras, the model proposed by APROSACAO combines crop diversification and training in sustainable agricultural management practices, offering producers more opportunities to adjust to markets and changing weather patterns.

From these case studies, it is concluded that to ensure the sustainability of cocoa cultivation, one strategy is the integration of agroforestry systems, the selection of more climate change resistant cocoa varieties, and the strengthening of community capacities through an approach that promotes sustainable resource management and continuous training of farmers in new technologies that complement their efforts, ensuring greater crop resilience and food security. Together, these practices improve the ecological conditions of productive areas and favor local economies, promoting a more inclusive and sustainable agriculture over time.

In Latin America, about 90% of production depends on small farmers who, through family farming, have passed on traditions and sustainable practices that have been adapted over

[16] University of Costa Rica (UCR) (2019). *New cocoa varieties in the Brunca Region*.

time to local conditions. Agroforestry Systems (AFSs) are part of these traditions and are essential to addressing environmental challenges and improving productivity. By integrating cocoa with other crops, such as bananas and timber species, these practices optimize land use, promote biodiversity, and enhance the provision of ecosystem services, while contributing to forest conservation and reducing the impacts of climate change.

In summary, the combination of socio-cultural practices surrounding cocoa, the fundamental role of family farming, and the implementation of agroforestry systems and other sustainable practices configure a paradigm of opportunity for production that not only protects the stability of yields and promotes the conservation of ecosystems, but also boosts community development, offering a promising path for the future of cocoa in the Region.

Impact of Climate Change on Cocoa Cultivation

Cocoa is highly sensitive to climatic variations, including changes in temperature, precipitation patterns, and extreme weather events. Recent studies highlight that rising global temperatures could reduce the areas suitable for cocoa cultivation in traditional regions such as Central and South America (Bunn et al., 2019).[17] Cocoa agroforestry is a viable solution to address the challenges of climate change, providing environmental, social, and economic benefits for rural communities (Global AbE Fund, 2021).[18] Furthermore, research by Läderach et al. (2017)[19] predicts that many major cocoa-growing regions will face less favorable climatic conditions in the coming decades, requiring urgent adaptation strategies.

In Mesoamerica, de Sousa et al. (2019)[20] have explored the future of cacao and coffee agroforestry systems, highlighting that these systems offer critical solutions to mitigate climate change impacts while promoting resilience in rural communities.

Cocoa Agroforestry as an Adaptation Strategy

Cocoa agroforestry combines trees with cocoa cultivation to create diversified systems that improve the sustainability and resilience of production systems. This model helps mitigate

[17] Bunn, C., Lundy, M., Wiegel, J., & Castro-Llanos, F. A. (2019). Impact of climate change on cocoa production for Central America and the Caribbean: atlas. International Center for Tropical Agriculture (CIAT). Retrieved from https://bvearmb.do/handle/123456789/3763

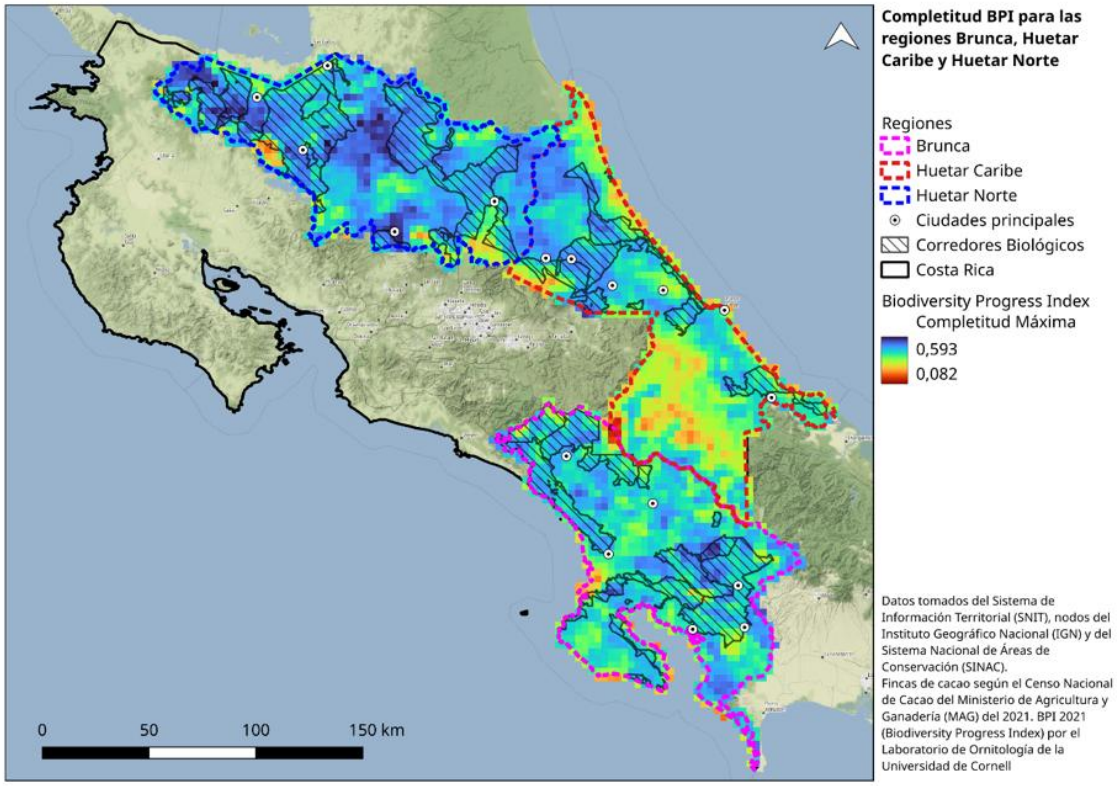
[18] Global Ecosystem-based Adaptation Fund (EbA) (2021). "Cocoa agroforestry is a viable solution to address climate change challenges, providing environmental, social and economic benefits for rural communities." Available at: [https://example.com/eba-cacao]

[19] Läderach, P., Martínez-Valle, A., Schroth, G., & Castro, N. (2017). Predicting the future climatic suitability for cocoa farming of the world's leading producing countries. *Climatic Change, 119*(3), 841-854. https://doi.org/10.1007/s10584-013-0774-8

[20] de Sousa, K., van Zonneveld, M., Holmgren, M., Kindt, R., & Ordoñez, J. C. (2019). The future of coffee and cocoa agroforestry in a warmer Mesoamerica. *Scientific Reports, 9*, 8828. https://doi.org/10.1038/s41598-019-45491-7.

the effects of climate change by providing shade and regulation of the microclimate, as well as contributing to soil and water conservation. Cocoa cultivation under agroforestry systems enhances biodiversity, contributes to soil conservation, and promotes essential ecosystem services (IKI, 2020). Vaast and Somarriba (2014)[21] highlight that agroforestry systems also provide a balance between crop intensification and ecosystem service provision.

In addition, cocoa agroforestry can act as a tool to restore degraded landscapes and improve ecological connectivity, promoting biodiversity conservation. By using the bird community as an indicator of biodiversity, the Cornell Lab of Ornithology was able to identify areas where the completeness (the ratio of the expected number of species, according to geographic and environmental parameters versus observed) of species was higher or lower at a resolution of 3kmx 3km. This helps prioritize using the national biological corridors, which are the sites where reforestation efforts are most needed and where there is sufficient cover, but the lack of diversity is due to other management practices



[21] Vaast, P., & Somarriba, E. (2014). Trade-offs between crop intensification and ecosystem services: The role of agroforestry in cocoa agroecosystems. *Agroforestry Systems, 87*, 1007-1021. https://doi.org/10.1007/s10457-013-9615-9.

Figure 1. Map showing the avian community completeness in the three cocoa-growing regions of the country.

In Costa Rica, initiatives led by ECOM have demonstrated that this agroforestry model, in addition to increasing the completeness of bird communities and potentially other fauna species, also generates economic benefits for local communities, consolidating itself as a key strategy for rural development. According to ECOM, Costa Rica (2022).[22] "Agroforestry cocoa is a key tool to restore degraded landscapes, improve ecological connectivity, and generate sustainable income for producers."

Identification of Barriers and Solutions

One of the main challenges of adopting agroforestry systems in cocoa cultivation is the limited access to financing for small producers. This obstacle is being addressed through projects such as the Removal of Barriers to the National Cocoa Plan in Costa Rica, which seeks to eliminate financial barriers and promote access to technologies and training. According to IUCN, (2021)[23], "Lack of access to finance is one of the main obstacles to the adoption of cocoa agroforestry systems, especially among smallholders".

Capacity building also plays an essential role. Training activities and the implementation of strategic plans can transform production systems into sustainable and regenerative models. Agroforestry should be accompanied by training activities aimed at transforming production systems into sustainable and regenerative models.

Policies and Institutional Framework

The success of cocoa agroforestry also depends on the policy environment and financial incentives that promote its implementation. Initiatives such as Ecosystem-based Adaptation (EbA) and collaboration between international and local institutions are essential to ensure that global climate goals are met. The "Cocoa & Forests Initiative" (2018)[24] also provides a global framework for action that drives sustainable cocoa production while addressing deforestation issues.

[22] ECOM Costa Rica (2022). *Agroforestry cocoa as a key tool to restore degraded landscapes and generate sustainable income.*

[23] IUCN (2021). *Barriers to the adoption of cocoa agroforestry systems: financing and sustainability.* International Union for Conservation of Nature.

[24] Cocoa & Forests Initiative (2018). Global Framework for Action. Available at: [https://www.idhsustainabletrade.com/initiative/cocoa-and-forests-initiative/]

5. CLIMATE CHANGE AND REGIONAL PROJECTIONS (NORTHERN HUETAR, HUETAR ATLANTIC, AND BRUNCA REGIONS).

Costa Rica is a unique country due to the diversity of its agroclimatic zones, which range from hot-dry areas to temperate and cold zones. The hot-dry areas, with more than 600,000 hectares, are mainly concentrated in the northwest, while areas suitable for crops such as cocoa are located in the south, on the border with Panama (MINAE, 2022)[25]. However, by 2050, a significant reduction in areas suitable for cocoa cultivation is projected due to rising temperatures and changes in precipitation patterns. Cold and temperate zones will disappear as suitable areas, thus requiring more intensive adaptation efforts in regions such as the west of the country, including the transformation of cropping systems in some areas (MINAE and GIZ, 2021).[26]

Impacts and Vulnerability of the Cocoa Value Chain

Cocoa is especially vulnerable to climate change due to its dependence on stable climatic conditions. Projections indicate that increased temperatures and irregular rainfall will increase the risks of pests and diseases such as moniliasis and witches' broom (Läderach et al., 2017).[27] In addition, the loss of areas suitable for cultivation could generate significant economic impacts, especially for small producers.

Lack of access to finance and the need for infrastructure to implement sustainable practices are major barriers to adaptation in rural communities. However, strengthening value chains, economic diversification, and technical training can mitigate these impacts. Agroforestry systems emerge as a key solution, providing shade, enhancing biodiversity, and regulating microclimates (Vaast and Somarriba, 2014).[28]

[25] MINAE (2022). *Climate Change Adaptation Action Plan for the Northern Huetar Region*. Available at: https://cambioclimatico.go.cr

[26] MINAE and GIZ. (2021). Climate Vulnerability Assessment for the Socioeconomic Regions of Costa Rica. Available at: https://www.giz.de

[27] Läderach, P., Martínez-Valle, A., Schroth, G., & Castro, N. (2017). Predicting the future climatic suitability for cocoa farming of the world's leading producing countries. *Climatic Change, 119*(3), 841-854. https://doi.org/10.1007/s10584-013-0774-8

[28] Vaast, P., & Somarriba, E. (2014). Trade-offs between crop intensification and ecosystem services: The role of agroforestry in cocoa agroecosystems. *Agroforestry Systems, 87*, 1007-1021. https://doi.org/10.1007/s10457-013-9615-9.

Regional Trends

Northern Huetar Region

The Northern Huetar Region is one of the most vulnerable areas to climate change in Costa Rica due to its dependence on agriculture and its exposure to extreme weather events. Climate projections indicate an average temperature increase of between 1.5 and 2 °C by mid-century, as well as greater variability in precipitation, with longer periods of drought and intense rainfall events (MINAE, 2022).[29]

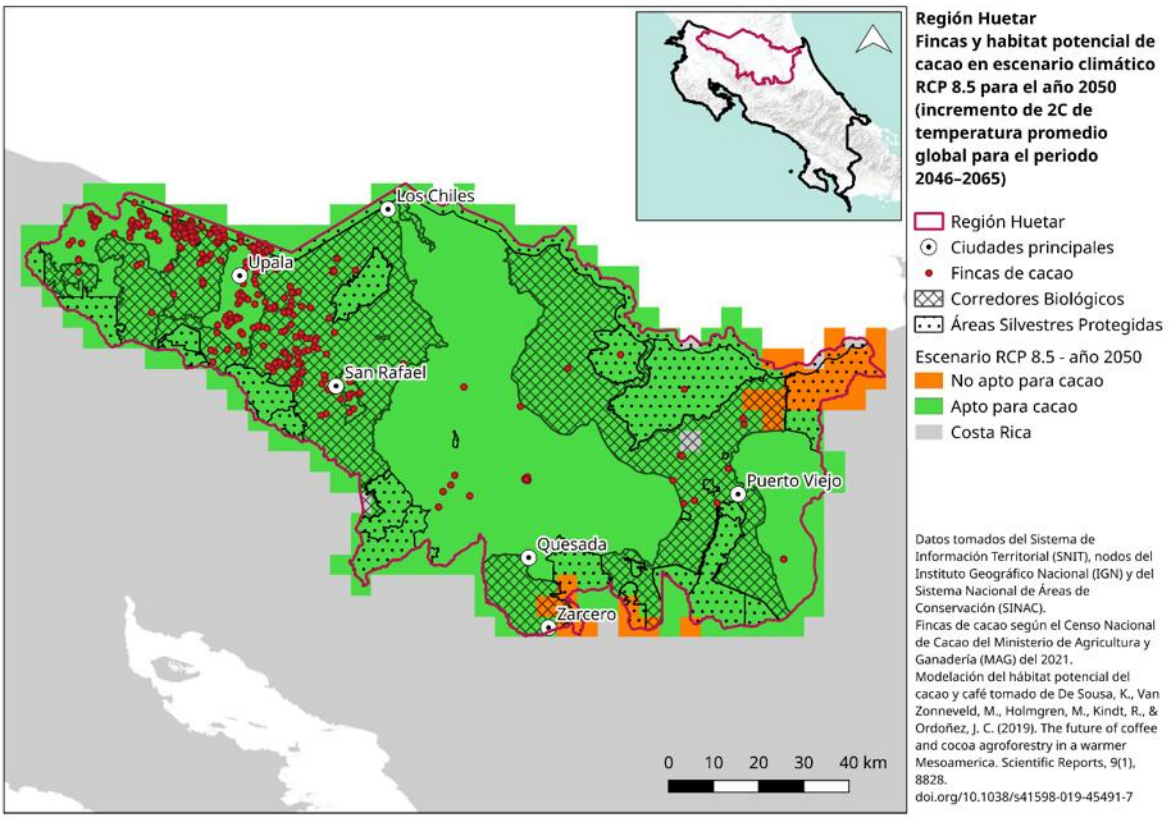


Figure 2. Map showing suitable and unsuitable regions for cocoa on RCP 8.5 scenario for 2050, in the Northern Huetar Region.

These climate changes could significantly reduce agricultural productivity, thus affecting crops such as rice, pineapple, and cassava, in addition to other productive activities such as livestock. Based on the maps developed, cocoa would be a viable crop if managed

[29] MINAE (2022). Climate Change Adaptation Action Plan for the Northern Huetar Region. Available at: https://cambioclimatico.go.cr

sustainably. Even so, rural communities will face challenges such as soil erosion, biodiversity loss, and limited access to water resources. To mitigate these impacts, it is recommended:

- Implementing agroforestry systems with native and climate-resilient species.
- Promoting the restoration of degraded ecosystems through agroforestry and reforestation, especially in the Ruta los Maleku, Medio Queso, and Las Camelias biological corridors.
- Strengthening training and technical climate risk management programs for small producers (Götz et al., 2020).[30]

Huetar Atlantic Region

The Huetar Atlantic Region, known for its high biodiversity and agricultural activities such as banana and cacao cultivation, is exposed to increased temperatures and decreased annual rainfall. These conditions generate greater vulnerability to diseases such as moniliasis and reduced soil quality (MINAE, 2022).[31]

[30] Götz, S., Schader, C., & Stolze, M. (2020). *Agroforestry and climate resilience in Central America*. *Climate Change and Sustainable Agriculture.*

[31] MINAE (2022). *Climate Change Adaptation Action Plan for the Huetar Caribe Region*. Available at: https://cambioclimatico.go.cr

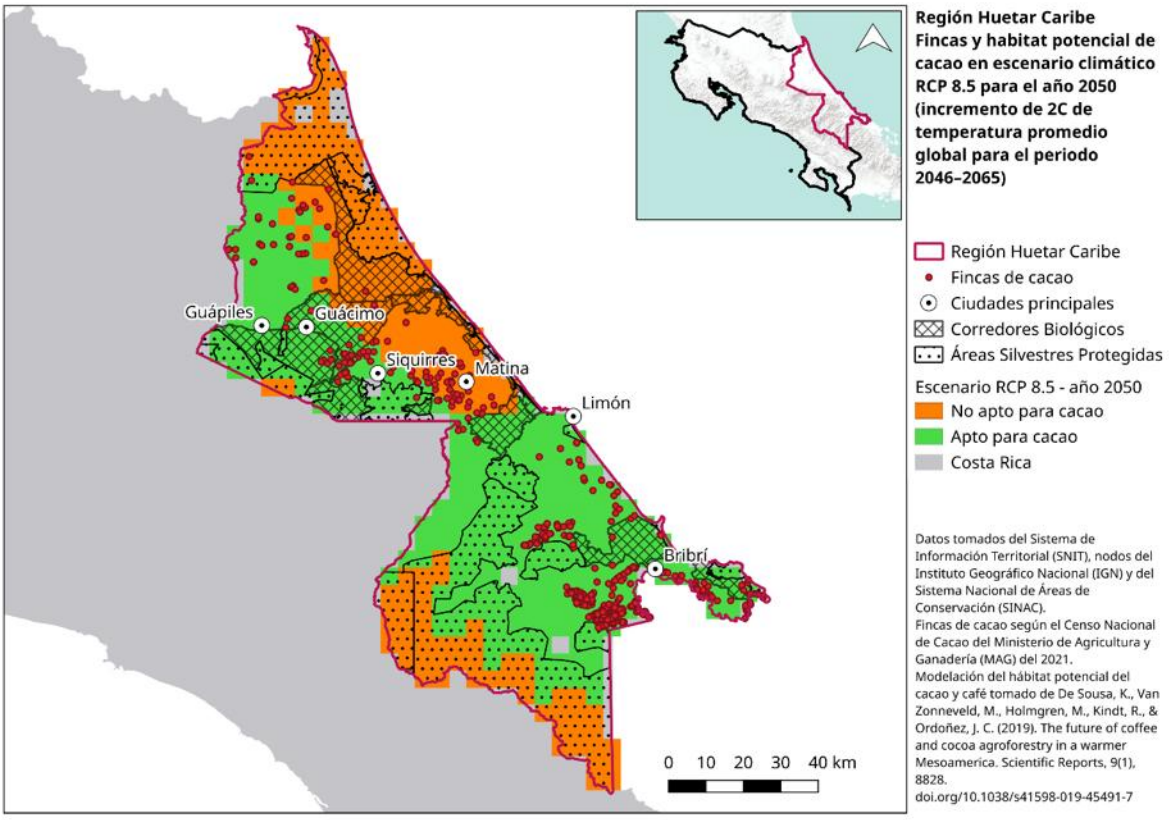


Figure 3. Map showing suitable and unsuitable regions for cocoa in an RCP 8.5 scenario for 2050, in the Huetar Atlantic Region.

In addition, this region faces a high risk of flooding due to heavy rains and rising river levels. Rural communities, many of which depend on cocoa as their main source of income, need specific strategies to adapt to these conditions. Some recommendations include:

- Promoting crop diversification to reduce economic risks.
- Incorporating sustainable water management practices to mitigate the impact of extreme rainfall.
- Developing green infrastructure to improve climate resilience in vulnerable agricultural areas (Cocoa & Forests Initiative, 2018).[32] Promote the restoration of degraded ecosystems through agroforestry and reforestation, especially in the Aquifers and Central Volcanic Talamanca biological corridors.

[32] Cocoa & Forests Initiative (2018). *Global Framework for Action*. Available at: [https://www.idhsustainabletrade.com/initiative/cocoa-and-forests-initiative/]

Brunca Region

The Brunca Region, in the southern area of the country, presents a mixed picture in the face of climate change. Although this region could become an agro-climatic haven for crops such as cocoa due to its favorable conditions, it also faces significant challenges related to rising temperatures and irregular rainfall patterns (UNDP, 2019).[33]

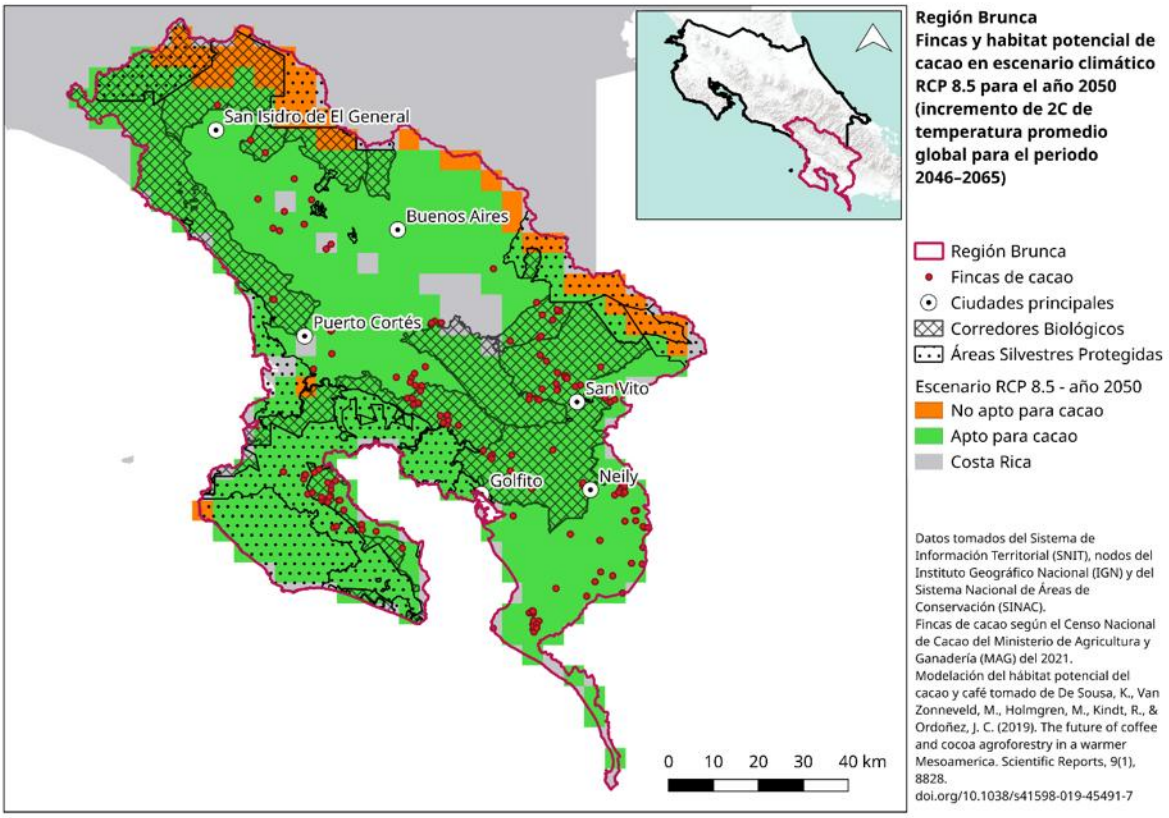


Figure 4.

Map showing suitable and unsuitable regions for cocoa in an RCP 8.5 scenario for 2050, in the in the Brunca Region.

Climate change could increase the frequency of landslides and floods, affecting both infrastructure and agricultural production systems. In addition, the region's indigenous communities, which rely on traditional agriculture practices, are particularly vulnerable to these changes.

[33] UNDP (2019). Costa Rica: National Climate Change Strategy. Available at: https://cambioclimatico.minae.go.cr

Proposed adaptation strategies include:

- Identifying and protecting areas most resilient to climate change to support sustainable production.
- Designing specific programs to strengthen the adaptive capacity of indigenous communities, while respecting their traditional knowledge.
- Promoting diversified agroforestry systems that integrate cocoa, coffee and other climate-adapted crops (Vaast and Somarriba, 2014).[34]
- Promoting the restoration of degraded ecosystems through agroforestry and reforestation, especially in the Talamanca-Caribbean biological corridors and the Golfo Dulce Forest Reserve.

6. IDENTIFICATION OF CHALLENGES AND SOLUTIONS IN THE NORTHERN HUETAR AND BRUNCA REGIONS

Analysis of Challenges, Needs and Key Aspects in the Huetar Norte and Brunca Regions

The results of the participatory workshops held in the Huetar Norte and Brunca regions identified the main challenges and possible solutions. These workshops focused on four key subjects - sustainable productive transformation, integrated landscape management, climate resilience and adaptation, and strengthening the sustainable value chain. The identification of these challenges has also made it possible to identify needs and opportunities to improve the adaptability and resilience of cocoa agroforestry systems in the region.

The Huetar Norte and Brunca regions are fundamental to cocoa production in Costa Rica, but face critical challenges that threaten their sustainability, productivity and resilience to climate change. This analysis provides a comprehensive overview of the commonalities, priority needs, and specific aspects that require strategic attention to strengthen the cocoa sector in these regions.

[34] Vaast, P., & Somarriba, E. (2014). Trade-offs between crop intensification and ecosystem services: The role of agroforestry in cocoa agroecosystems. *Agroforestry Systems, 87*, 1007-1021. https://doi.org/10.1007/s10457-013-9615-9.

Points in Common

Both regions face significant challenges resulting from climate change, such as variations in rainfall, increased temperatures, pests, and diseases. These phenomena directly affect the productivity, quality, and sustainability of cocoa plantations. In addition, deforestation and biodiversity loss are recurrent problems, exacerbated by intensive agricultural practices and unplanned crop expansion.

In economic terms, producers in both regions struggle to access markets that value sustainably produced cocoa, thus limiting their ability to obtain fair prices. In addition, limited access to adequate financing, advanced technology, and technical training restricts their ability to adopt regenerative and sustainable agricultural practices.

Identified Needs

The shared challenges highlight several priority needs:

1. Training and technical assistance: Producers require specific training in sustainable soil management, pest and disease control, and climate adaptation strategies. Environmental education and participatory workshops are essential to strengthen their capacities.
2. Infrastructure and financing: There is an urgent need to improve infrastructure, such as roads and water management systems, to reduce logistical costs and mitigate climate impacts. Providing access to financing to invest in technologies, quality inputs, and certifications is also crucial.
3. Empowerment and generational replacement: The low participation of women and young people in the sector underscores the need for inclusive programs that foster their integration, promoting empowerment and ensuring the long-term sustainability of the sector.
4. Strengthening the value chain: There is a need to create stronger linkages with sustainable markets, develop capacities to add value to cocoa, and ensure that producers receive fair prices.

Specific Key Issues

Each region has unique characteristics that require differentiated approaches:

- In the Northern Huetar Region, producers stress the importance of better understanding soil diseases, adapting their management practices and addressing territorial conflicts that affect natural resource management. In addition, the lack of

access to advanced agricultural techniques and the absence of competitive local markets limits their development.

- In the Brunca Region, challenges include the need to implement good sustainable agricultural practices, harmonize production with biodiversity conservation, and promote environmental education. They also face social problems such as lack of security and efficient transportation, which negatively affect cocoa production and marketing.

Strategic Recommendations

To address these challenges, a comprehensive and coordinated approach is proposed that considers the following actions:

1. **Technical capacity building:** Implement training programs in good agricultural practices, pest management, agroforestry and climate adaptation techniques.
2. **Infrastructure improvements and access to finance:** Prioritize investments in roads, water management systems and inclusive financial mechanisms to enable producers to modernize their plantations and adopt sustainable practices.
3. **Strengthening sustainable markets:** Promote cocoa certification, develop value-added strategies and create links with international markets that value sustainability.
4. **Integration of community strategies:** Encourage collaboration between producers and neighboring communities to adopt sustainable practices collectively, ensuring landscape-level impact.
5. **Social inclusion and empowerment:** Design programs that integrate women and youth, ensuring their active participation in production and decision-making.

Challenges identified by producers in the Huetar Norte and Brunca Regions.

Work axis: Sustainable productive transformation			
Challenges identified			
Northern Region		Brunca Region	
Knowledge and Control of Pests and Diseases	During the participatory activity, cocoa producers highlighted the difficulty of properly identifying and managing the pests and diseases that affect their crops. The lack of	Implementation of Good Agricultural Practices	In the participatory activity, cocoa farmers identified the adoption and maintenance of sustainable agricultural practices as a significant challenge.

	knowledge and resources to implement effective control strategies jeopardizes the health and productivity of the plantations.		The lack of access to resources, knowledge, and appropriate technologies hinders the implementation of these practices, which are essential to optimize the use of natural resources, reduce environmental impact, and improve crop productivity.
Sustainable Management Practices	Producers identified the need to adopt sustainable agricultural practices as a key challenge. Lack of access to information and resources needed to implement sustainable management techniques, such as agroforestry and soil conservation, limits the ability to maintain productivity and soil health.	Knowledge of the Variety to Plant	Growers stressed the importance of knowing which cocoa varieties are best suited to their specific soil and climatic conditions. The lack of information on disease resistance, yield and bean quality complicates informed decision-making, which is crucial for adapting to climatic changes and maintaining the viability of plantations.
Lack of knowledge of soil nutrition	It was noted that many producers lack knowledge of soil nutrition, which negatively affects the fertility and health of their crops. Lack of soil analysis and proper application of fertilizers and amendments impede the optimization of productivity and sustainability of plantations.	Increased Production	Increasing crop productivity without compromising sustainability was identified as an ongoing challenge. Limitations in access to inputs, technology, and training, together with the adverse effects of climate change, such as droughts and extreme temperatures, make

			this goal difficult to achieve.
Changes in Production	Changes in production due to climatic variations, pests, diseases and inadequate management practices represent a significant challenge. Growers need to adapt to these fluctuations to maintain consistent, high-quality production.	Generational Change	Producers expressed concern about the lack of interest of new generations in agriculture. Ensuring the continuity of plantations by incorporating young people is crucial for the sustainability of the sector, but many young people are discouraged due to perceived low incomes and harsh working conditions.
Financial Access	Difficulty in accessing financing was identified as a major obstacle. Financial barriers limit the ability of producers to invest in technological improvements, quality inputs, and sustainable practices, preventing the modernization and expansion of plantations.	Infrastructure (New Roads)	The lack of adequate infrastructure, such as roads, was identified as a significant barrier. Poor road conditions affect logistics, increase costs and make it difficult to sell the product, limiting access to markets and resources.
Lack of New Techniques	Lack of access to new agricultural techniques and technologies was another challenge identified. Producers need training and resources to adopt advanced methods to improve the productivity and sustainability of their crops.	Diseases in Cocoa	Diseases, such as moniliasis and witches' broom, represent a critical challenge for growers. These diseases can devastate plantations and drastically reduce production. Lack of access to effective treatments and knowledge about prevention and control

			exacerbates the problem.
Knowledge of Soil Diseases	Growers pointed to the lack of knowledge about soil diseases and how to manage them as a critical problem. This lack affects the health of the plantations and reduces cocoa productivity and quality.	Animal Pests	Animal pests, such as rodents and birds, cause considerable damage to cocoa plantations. Pest control is essential to protect production, but traditional methods are often ineffective or harmful to the environment, which is a constant challenge.
Humidity	Proper moisture management in the soil and environment is crucial for cocoa growing. Growers face challenges related to too much or too little moisture, which affects plant health and quality.		
Axis of work: Integral landscape management			
Challenges identified			
Northern Huetar Region		Brunca Region	
Bias in Neighborhood Practices	Producers noted that neighbors' resistance to adopting sustainable practices can negatively affect their efforts. Lack of cooperation and the influence of conventional farming practices can hinder the transition to more sustainable methods.	Harmonization with Nature	Producers stressed the importance of achieving a balance between agricultural practices and conservation of the natural environment. Harmonization with nature implies respecting and protecting local ecosystems, avoiding soil degradation and promoting coexistence between agricultural production and

			biodiversity, although economic pressures and lack of support make this balance difficult.
Deforestation	Deforestation was identified as a significant threat to biodiversity and climate stability in cocoa-producing areas. Producers face the challenge of avoiding indiscriminate forest clearance and promoting reforestation, despite economic pressures to expand cultivation areas.	Biodiversity Conservation	Protecting and promoting plant and animal species diversity on farms is crucial. Producers noted that biodiversity is threatened by intensive agricultural practices and climate change, and the lack of knowledge and resources to implement biodiversity-friendly practices exacerbates this challenge.
Biodiversity loss	Biodiversity loss due to intensive agricultural practices and deforestation negatively affects ecosystem health and the resilience of cocoa plantations. Farmers need to implement strategies that promote species conservation and biodiversity.	Water Collection Management	Efficient water management is a key challenge for cocoa farmers. Developing rainwater harvesting and storage systems, as well as efficient irrigation practices, is essential to ensure adequate supply and improve resilience to extreme weather events.
Knowledge and Treatment of Water Sources	Proper management of water sources is essential for the sustainability of cocoa plantations. Producers stressed the need to know and protect water sources, develop	Biodiversity awareness	Producers mentioned the need to have a thorough knowledge of the biodiversity that inhabits their land to implement management strategies

	catchment and storage systems, and implement efficient irrigation practices.		that favor biodiversity and the sustainability of agricultural production.
Territorial problems such as logging, drainage, and land tenure	Land conflicts and inadequate natural resource management represent significant challenges. Producers need comprehensive solutions to manage these problems and ensure sustainable land use.	Product and Livestock Theft	Security is a growing problem, with theft of produce and livestock affecting incomes and discouraging investment in better practices and technologies. Lack of security in rural areas compounds this challenge, negatively impacting production and the well-being of communities.
		Lack of security	The overall insecurity in rural areas, which includes the lack of basic protection services and public order, creates an environment of fear and uncertainty, negatively affecting productivity and the quality of life of producers.
		Lack of Transportation	The absence of efficient and affordable transportation services limits the ability of producers to get their products to market, affecting profitability and access to inputs and resources needed to improve production.

		Drug addiction and insecurity	Social problems such as drug addiction and insecurity have a direct impact on agricultural communities, reducing the available labor force and creating an environment that is not conducive to economic and social development.
Main line of work: Climate resilience and adaptation			
Challenges identified			
Northern Huetar Region		**Brunca Region**	
Pests and diseases:	Increased incidence of pests and diseases due to climate change was identified as a continuing challenge. Adapting to these new conditions requires advanced knowledge and integrated management strategies.	**Deforestation**	Deforestation was identified as a significant threat to climate stability and ecosystem health. Producers pointed to the need to avoid indiscriminate logging and encourage reforestation, although they face pressures to expand cultivation areas.
Climate Change:	Climate variations, such as changes in temperature and rainfall patterns, affect cocoa production. Growers must adapt to these changing conditions to maintain the viability of their plantations.	**Promotion of Environmental Education**	Lack of access to environmental education programs, workshops and training was highlighted as an obstacle to understanding and commitment to sustainability. Environmental education is crucial to address climate change, resource conservation and the

			implementation of sustainable agricultural practices.
Loss of Balance:	The ecological balance in cocoa plantations is threatened by climate change and unsustainable agricultural practices. Producers need strategies to restore and maintain this balance, to be able to ensure the health of the ecosystem.	Obtaining Organic Certification	Achieving organic certification was seen as a major challenge. The requirements and costs associated with certification, as well as the lack of technical and financial support, limit producers' ability to access more lucrative markets.
Lack of Knowledge in Adaptation Techniques:	The lack of training and resources to implement climate change adaptation techniques limits the ability of farmers to meet these challenges. Education and technical support are essential to build resilience in cocoa plantations.	Temperature changes	Extreme variations in temperatures, exacerbated by climate change, represent a considerable challenge. These conditions can affect cocoa growth and production, reducing crop quality and yields.
Flooding:	Flooding, which is becoming more frequent and severe due to climate change, represents a significant risk to cocoa plantations. Growers must develop infrastructure and water management practices to mitigate the effects of flooding.	Root Death due to Heavy Rains	Heavy rains can cause cocoa root death, severely affecting plant health and productivity. Managing excess water and preventing root damage are critical challenges.
Knowledge of Local Climate:	Understanding local climatic conditions is crucial for adapting cropping practices and improving resilience. Growers need access to accurate weather	Flooding:	Floods represent a significant risk, destroying crops, eroding soil and causing economic losses. The lack of adequate flood

	information and early warning systems to make informed decisions.		management infrastructure leaves farmers vulnerable to these extreme weather events.
Rainfall (Scarce or Heavy):	Variations in the amount of rainfall, either too little or too much, affect cocoa production. Growers must develop strategies to manage these fluctuations and maintain the health and productivity of their plantations.		
Work axis: Strengthening the sustainable value chain			
Challenges identified			
Northern Huetar Region		Brunca Region	
Lack of Buyers for Fair Price	The lack of buyers offering fair prices limits the profitability of cocoa producers. Accessing markets that value and pay an adequate price for sustainably produced cocoa is a significant challenge.	Lack of Market	Limited access to adequate markets to sell cocoa affects the profitability of producers. The lack of connections to buyers and markets that value quality, sustainably produced cocoa is a significant challenge.
Product Quality:	Maintaining and improving cocoa quality is crucial to access premium markets and obtain better prices. Producers need technical support and resources to implement practices to ensure bean quality.	Labor Shortage	The availability of labor to work on cocoa plantations is a growing challenge. Many young people are seeking opportunities in urban areas, leaving producers with an insufficient labor force.
Seed Capital for Strengthening:	Lack of access to seed capital prevents producers from investing in technological improvements, quality	Technical Support	Lack of access to technical assistance and training limits farmers' ability to improve their farming

	inputs and sustainable practices. Adequate financing is essential to strengthen plantations and increase productivity.		practices and adapt to the challenges of climate change. Producers need continuous support in terms of training, advice and technical resources.
Value added	Improving the added value cocoa through processing and certification is a major challenge. Producers need to develop capacities to add value to their products and access markets that value these improvements.	Product Ages	Fluctuations in cocoa quality due to tree age present a challenge. Older trees may produce less cocoa and of lower quality, while young trees require time to reach full production.
Empowerment:	Promoting the empowerment of producers, especially women and youth, is essential for the sustainability of the sector. Lack of training, access to resources and participation in decision-making limits the potential for empowerment.	Implementation of Fair Trade	Ensuring that producers receive fair compensation for their labor and products is a major challenge. Fair trade promotes decent working conditions and community development, but producers face difficulties in accessing markets that value and pay a fair price for sustainably produced cocoa.
High Economic Value Labor:	The availability of skilled and well-paid labor is an ongoing challenge. Producers must attract and retain skilled workers by offering fair working conditions and career development opportunities.	Obtaining Environmental Recognition (Blue Flag)	Obtaining environmental recognition such as the Blue Flag award can improve the visibility and reputation of cocoa producers. Meeting specific standards and

			demonstrating commitment to sustainability is a challenge that requires resources, support and knowledge.
		Biodiversity Conservation in the Osa Zone	Integrating biodiversity conservation into agricultural practices in the Osa region -known for its high biodiversity- is a major challenge. Protecting natural habitats, implementing agroforestry practices and collaborating with local conservation initiatives requires coordination, resources and sustained commitment, especially in the context of economic pressures and climate change.

General Analysis of the Proposed Solutions in the Huetar Norte and Brunca Regions.

The analysis of the solutions proposed in the Huetar Norte and Brunca regions shows an integrated approach that seeks to respond to the challenges identified around four key axes - sustainable productive transformation, integrated landscape management, climate resilience and adaptation, and strengthening of the sustainable value chain. These proposals highlight both shared and differentiated strategies, adapted to the particularities of each region.

Sustainable Productive Transformation

In this area, both regions seek to improve the productivity and sustainability of cocoa plantations, but with different approaches:

- Northern Huetar Region: Solutions focus on technical training in pest management and advanced production techniques. In addition, it is proposed to conduct regular soil analyses to identify and meet their needs, as well as to seek financing to purchase inputs and improve agricultural infrastructure.
- Brunca Region: Priority is given to the implementation of bio inputs and the use of certified seeds to improve crop quality and yields. Partnerships between organizations are also encouraged to share resources and knowledge, along with practical workshops for wildlife management, decoy trees, and sustainable agricultural practices.

Points in common: Both regions identify the need to strengthen the technical capacities of producers, either through training, the use of appropriate technology, or the implementation of regenerative practices that guarantee long-term sustainability.

Comprehensive Landscape Management

Conservation of the natural environment and biodiversity is a priority objective in both regions, albeit with different approaches:

- Northern Huetar Region: The creation of diverse living fences, reforestation programs and the conservation of existing trees are proposed. In addition, the importance of protecting water resources through strategic alliances and the promotion of environmental education on soil health and sustainability is highlighted.
- Brunca Region: Solutions include the introduction of high-quality genetic material, the implementation of agrotourism to diversify income, and the creation of field schools for the continuous training of producers. Support from state organizations to strengthen local capacities is also prioritized.

Points in common: Both regions agree on the importance of restoring and protecting the landscape through actions such as reforestation, using live fences and conservation of natural resources, complemented by environmental education to ensure a lasting impact.

Climate Resilience and Adaptation

Climate change represents a cross-cutting challenge in both regions, so solutions are focused on strengthening the adaptive capacity of producers:

- Northern Huetar Region: The proposed strategies include the implementation of early warning systems, climate monitoring, and efficient irrigation systems. They also seek to improve access to technical information and establish insurance for climate emergencies.
- Brunca Region: The solutions focus on promoting the planting of trees to create microclimates, training in shade management and the conditioning of productive areas to cope with climate change. In addition, it promotes the exchange of ideas among producers and the active participation of young people.

Points in common: Both regions highlight the need to improve access to climate information, implement monitoring and irrigation systems, and strengthen technical capacities to mitigate the effects of climate change and ensure the resilience of plantations.

Strengthening the Sustainable Value Chain

Strengthening the value chain is essential to ensure the economic sustainability of the sector.

- Northern Huetar Region: Solutions include exploring new markets, obtaining sustainability certifications, and seeking technical and governmental support. It is also proposed to organize workshops and training to improve producers' skills and market positioning.
- Brunca Region: Priority is given to strategic alliances, agricultural training, and the implementation of technology packages to improve production. In addition, securing regular buyers and promoting effective pest management are sought.

Common ground: Both regions recognize the importance of certifying sustainable production, improving cocoa marketing, and establishing strategic alliances to strengthen their competitiveness in local and international markets.

Proposed solutions suggested by producers in the Huetar Norte and Brunca Regions

Work axis: Sustainable Productive Transformation			
Proposed Solutions			
Northern Huetar Region		Brunca Region	
Training in pest knowledge and management	Training to identify and control pests effectively.	Use of bioinputs	Implementation of bioinputs to improve soil health and crop quality.

Training in cocoa management techniques	Training in advanced techniques to optimize cocoa production.	Seeds	Use of certified seeds to ensure better crop quality and yield.
Soil analysis	Regular soil analysis to determine soil needs and improve soil quality.	Partnerships with other organizations	Developing partnerships with other organizations to share knowledge and resources.
Treatment of diseases	Implementation of strategies and treatments to prevent and control plant diseases.	Training	Training on pests, pruning, and inputs to improve agricultural practices.
Seek financing	Exploring financing options to purchase inputs and improve agricultural infrastructure.	Decoy trees	Use of decoy trees for vertebrate pest management and crop protection.
		Wildlife Management workshops	Conducting workshops on wildlife management to protect biodiversity and crops.
Axis of work: Integral Landscape Management			
Proposed Solutions			
Northern Huetar Region		Brunca Region	
Environmental education and soil health	Promoting education on the importance of soil health and sustainable environmental practices.	Attracting future producers	Promoting the inclusion of new producers in the region to strengthen the agricultural community.
Reforestation program	Implementing reforestation programs to recover and protect local ecosystems.	Genetic material	Introducing high-quality genetic material to improve crop production and resistance.
Various living fences	Creating living fences with a variety of plants to enhance biodiversity and protect crops.	Live fences	Implementing live fences for crop protection and landscape conservation.
Protection of water resources	Developing strategies to conserve and protect water sources.	Field School	Creating field schools for continuous training of producers.

Strategic alliances	Establishing alliances with other organizations and entities to strengthen local capacities.	More support from state organizations	Seeking greater support and collaboration from state organizations for rural development.
Planting of shade trees	Planting trees that provide shade and improve micro-climatic conditions.	Introducing agritourism	Incorporating agro-tourism on farms to diversify sources of income and promote knowledge about agriculture.
Conservation of existing trees	Avoid cutting down trees to conserve biodiversity and environmental benefits.		
Main line of work: Climate resilience and adaptation			
Proposed solutions			
Northern Huetar Region		Brunca Region	
More local weather information	Collecting and distributing region-specific climate information to improve decision-making.	Knowing the environment	Conducting studies and training to better understand the environment and adapt to climate change.
Early warning system	Implementing early warning systems to anticipate and mitigate the impacts of adverse weather events.	Soil improvement	Implementing soil improvement and conservation practices.
Access to information on management techniques	Improving access to up-to-date information on climate-adapted agricultural management techniques.	Planting	Encourage the planting of trees to create microclimates and protect crops.
Technical assistance	Seeking specialized technical assistance to address climate challenges.	Strengthening young people	Involvement and training of young people in sustainable agricultural practices.

Weather emergency insurance	Insurance policy to cover losses caused by extreme weather events.	Exchange of	Facilitating the exchange of ideas and experiences among producers.
Irrigation systems	Developing and implementing efficient irrigation systems to cope with climate variability.	Shade management training	Specific training on shade management to optimize growing conditions.
Communication channels on weather conditions	Establishing effective communication channels to report weather conditions in real-time.	Conditioning of productive areas	Improving productive areas to make them more resilient to climate change.
Temperature monitoring systems	Installing temperature monitoring systems to adjust agricultural practices according to environmental conditions.		
Work axis: Strengthening the Sustainable Value Chain			
Proposed Solutions			
Northern Huetar Region		Brunca Region	
Exploring new markets	Research and access to new markets to diversify sales opportunities.	Training	Continuous training to improve production efficiency and sustainability.
Accompaniment of governmental institutions	Seeking support and accompaniment from government institutions to strengthen the value chain.	Pest management	Developing specific programs for effective pest management.
Sustainability certification	Obtaining sustainability certifications to improve the added value and	Promote agricultural education	Promoting agricultural education to improve producers' skills.

	competitiveness of the product.		
Technical advice	Providing ongoing technical advice to improve production practices and efficiency.	Agreements with the productive market	Establishing agreements with the productive market to ensure the sale and distribution of products.
Workshops and training	Conducting regular workshops and training to update the knowledge and skills of producers.	Use of technology packages	Fostering the use of appropriate technology packages to improve production.
		Regular buyers	Seeking regular buyers to ensure stable marketing of products.
		Strategic alliances	Establishing strategic alliances with different stakeholders in the value chain to strengthen the position of producers in the market.

Results of stakeholder meetings: Perspective from the Cocoa Value Chain, Marketing and Improvement of Harvest and Post-Harvest Practices

Meetings and interviews were held with key stakeholders from various sectors, including government institutions, local organizations, and technical experts. The goal was to gather their perspectives and knowledge to strengthen the analysis, identify challenges and opportunities, and ensure that the proposals were relevant and feasible. The results obtained reflect a comprehensive and diverse vision, which will contribute to the formulation of more inclusive and sustainable strategies.

Climate Change Impacts on Production and Value Chain

Climate change has had a significant impact on the quantity, quality, and sustainability of cocoa in the Huetar Norte and Brunca regions, thus affecting every link in the value chain:

- Primary production: Heavy rains increase the incidence of diseases such as moniliasis and black ear, while droughts reduce fruit development and affect yields.
- Bean quality: Climate changes directly affect the fermentation and drying stages, which are essential for developing the flavor and aroma profile of cocoa. The lack of

adequate infrastructure aggravates these problems, generating inconsistencies in the final quality.

- Impacts on marketing: International buyers demand strict quality standards that are often not met due to a lack of uniformity in harvesting and post-harvest practices.

Harvest and Postharvest Barriers

Critical barriers to the implementation of good harvesting and -post-harvesting practices were identified during the interviews:

- Lack of technical training: Many producers do not know proper harvesting and fermentation techniques, resulting in quality losses.
- Poor infrastructure: The scarcity of on-farm fermentation and drying facilities limits the ability to ensure a uniform process.
- Insufficient investment: The high costs of equipment such as solar dryers, as well as the lack of accessible financing, hinder the improvement of these stages.

Current Strategies and Harvest and Postharvest Needs

- From the producers' point of view:
    - They request specific technical training in timely cocoa harvesting, bean classification and fermentation control.
    - They demand access to basic infrastructure, such as fermenting bins and drying patios.
- From the point of view of the marketing companies (ECOM):
    - They have implemented training programs on fermentation, drying, and storage; although they recognize that they need to be expanded and standardized.

Improvement of Good Harvest and Postharvest Practices

Interviews with experts and key stakeholders highlighted the need to prioritize actions to significantly improve the harvest and post-harvest stages:

1. Harvesting:
    - Promoting harvesting at the optimum moment of fruit maturity, avoiding premature or late harvests that affect grain quality.

- Training producers to avoid mechanical damage to the grain during harvesting.

2. Fermentation:
   - Establishing community fermentation stations to ensure a controlled and uniform process.
   - Promoting the use of standard design fermenter boxes, ensuring adequate times and optimal temperatures for flavor development.
3. Drying:
   - Implementing solar dryers on farms to reduce dependence on climate and improve drying uniformity.
   - Training producers in the proper rotation and handling of beans during drying to avoid secondary fermentation or contamination.
4. Storage:
   - Developing hermetic storage systems that protect beans from moisture, pests, and contamination.
   - Ensuring cleanliness and proper conditions of storage spaces.

Opportunities to Generate Value

The Costa Rican cocoa sector needs to improve its competitiveness and sustainability in a global market that values environmentally responsible products and biodiversity. To ensure stable earnings and strengthen the long-term viability of farms, strategies that add value to the product must be applied. Implementing regenerative agricultural practices, accessing financing for the transition to organic production, and differentiating cocoa through certifications and by-products are key to achieving these goals.

Sustainable Agricultural Practices for Increased Value

Adopting sustainable agricultural practices improves the quality of cocoa and enhances its attractiveness in niche markets. Some key practices include:

- **Agroforestry:** Integrating cocoa into agroforestry systems, where cocoa crops are combined with native trees, improves biodiversity on the farm, protects the soil, and reduces erosion and the effect of radiation. It also provides alternative sources of income from the sale of timber or fruit and strengthens the family's nutritional supply.

- **Efficient water management:** Implementing practices such as rainwater harvesting or the efficient use of irrigation can be key to increasing producers' profitability by reducing operating costs. In regions with excessive rainfall, it is important to design drainage channels that do not affect production in times of drought.
- **Use of bio inputs**: Replacing agrochemicals with biofertilizers and natural pesticides promotes healthier soils and facilitates exports to markets with strict regulations on chemical residues, such as the European Union.
- **Carbon sequestration and climate resilience**: Implementing soil conservation practices and carbon-fixing crops can improve crop sustainability and generate financing opportunities for environmental services.

Transformation of Cocoa into Higher Value Products

To maximize revenues, producers can diversify their offerings and develop finished products that capture more profitable markets.

- **Cocoa powder and cocoa butter**: Essential inputs in the food and cosmetic industry, with marketing potential both domestically and internationally.
- **Premium artisanal chocolate**: The production of high-quality chocolates enables the entrance into niche markets with higher profit margins. However, this process requires investment in training and technology.
- **Cocoa with differentiated sensory profiles**: Through controlled fermentation and good post-harvest practices, it is possible to develop cocoa with unique flavor notes, highly appreciated by prestigious chocolatiers.

Harvest and Postharvest Optimization

Correct management at these stages improves cocoa quality and allows access to markets that value higher standards:

- **Quality certifications**: Complying with fair trade, organic production or fine and aromatic cocoa standards increases competitiveness and allows for better prices.
- **Diversification of derivative products**: Well-processed cocoa is the basis for producing gourmet chocolates, cocoa butter, and natural cosmetic products, which are highly valued in high purchasing power markets.

To successfully achieve the required value-added, a solid productive base must be created, with good agricultural practices, sustainable crop management, and efficient post-harvest processes. Without this preparation, producers may face high costs without achieving the

expected yields, jeopardizing their financial stability. Implementing value-added strategies progressively and with the support of strategic partners can ensure a successful transition to a more profitable and sustainable cocoa.

Value Chain Recommendations

1. Strengthening technical training:
    - Creating theoretical and practical training programs on harvesting, fermentation, drying, and storage.
    - Encouraging the involvement of young producers in these training courses to ensure generational replacement.
2. Establishing basic infrastructure:
    - Building community fermentation and drying stations in the main producing areas.
    - Promoting the use of innovative and low-cost technologies, such as solar dryers and fermentation monitoring systems.
3. Facilitating access to financing:
    - Developing specific lines of credit to improve post-harvest infrastructure.
    - Introducing incentives for producers to adopt standardized and sustainable practices.
4. Strengthening commercial alliances:
    - Promoting guaranteed purchase contracts that reward quality and good harvest and post-harvest practices.
    - Establishing direct links with specialized markets for high-quality cocoa.

7. STRATEGIC FRAMEWORK FOR ADAPTATION

Strategic Adaptation Framework for Cocoa Growers

The cocoa sector faces multiple challenges in the face of climate change, including productivity, quality, and sustainability due to variations in rainfall, increased temperatures, pests and diseases, and soil degradation. A comprehensive approach is essential to enable producers to adapt, strengthen the resilience of their crops, and ensure long-term sustainability. This strategic framework lays the foundation for developing a climate adaptation and mitigation plan that addresses challenges from the farm level to the landscape, ensuring a holistic and coordinated approach.

The vision of this framework is to foster more resilient, sustainable, and inclusive cocoa production systems by encouraging regenerative agroforestry practices and promoting landscape conservation. The goal is to increase the capacity of producers to cope with climate impacts, improve productivity, and protect key natural resources. Through a combination of technical training, landscape restoration, climate monitoring, and access to markets, it seeks to ensure that cocoa plantations can thrive, even in a changing environment.

This framework is organized around four fundamental strategic axes in the priority themes defined by the key stakeholders, the proposed axes are:

- Sustainable productive transformation
- Integrated landscape management
- Climate resilience and adaptation
- Strengthening the sustainable value chain

Each strategic axis is articulated in concrete lines of action and associated measures aimed at strengthening local capacities, restoring degraded ecosystems, protecting water sources, and promoting sustainable agricultural practices. These actions seek not only to mitigate the effects of climate change, but also to generate long-term economic and social benefits, thus contributing to the well-being of cocoa-growing communities and environmental conservation. It is proposed that ECOM and stakeholders of the cocoa platform in each region will be in charge of leading it.

Description and objectives of each strategic axis:

Strategic focus	Description
1. Sustainable Productive Transformation (Led by ECOM)	It focuses on improving practices within production units, by adopting regenerative, agroecological, or climate-smart production models. It seeks to optimize the use of resources, sustainably increasing productivity and reduce dependence on external inputs, promoting productive diversification and the well-being of rural communities.
2. Integrated Landscape Management (led by ECOM).	It addresses the interaction of productive activities with surrounding ecosystems, promoting biodiversity conservation and ecological connectivity. It also promotes a landscape approach that balances production

	with the restoration and conservation of key areas, ensuring the sustainability of ecosystem services.
Climate Resilience and Adaptation (led by the dialogue platform, for example: MAG, INDER, CNE and the municipalities participating in the cocoa platforms in each region).	It focuses on strengthening the capacity of productive units and communities to adapt to the effects of climate change. It promotes practices that increase resilience to extreme events such as droughts, floods, or emerging diseases, ensuring food security and economic stability.
4. Strengthening of the Sustainable Value Chain (led by the dialogue platform, e.g. producer associations, universities and NGOs).	Its goal is to improve the competitiveness and sustainability of value chains, promoting innovation, traceability, and access to differentiated markets. It seeks to add value to products through certifications, strategic alliances, and the development of products with a focus on fair trade and circular economy.

Vision of the adaptation plan.

The vision of this strategic framework is to foster resilient, sustainable, and inclusive cocoa production systems, which are capable of meeting the challenges of climate change while promoting landscape regeneration, natural resource conservation, and farmer well-being.

Through the adoption of innovative agroforestry practices, capacity building, and the development of sustainable value chains, this approach seeks to ensure cocoa productivity and quality, contributing to a balance between environmental, social, and economic sustainability in a constantly changing environment.

Proposed vision

*"To ensure **climate resilience**, **sustainability,** and **inclusive growth** of cocoa agroforestry systems, by promoting regenerative agricultural practices, equity in the value chain, and conservation of the productive landscape."*

This vision establishes a clear and aspirational purpose that guides the development of the cocoa sector towards a more sustainable future. It reflects a commitment to environmental regeneration, adaptation to climate change, and improvement of the quality of life of the producing communities.

It also guides the implementation of comprehensive measures to ensure productivity, promote biodiversity, and strengthen social cohesion, marking a path towards a resilient, inclusive, and environmentally friendly cocoa sector.

General Objective:

To strengthen climate resilience, sustainability, and social inclusion in cocoa agroforestry systems by promoting regenerative agricultural practices, technical capacity building, conservation of the productive landscape, and equity in the value chain, contributing to climate change adaptation, improved productivity and quality of life of the producing communities.

Strategic adaptation actions

Given the challenges posed by climate change, the implementation of adaptation actions is necessary to ensure sustainability, resilience, and inclusive growth of cocoa agroforestry systems. These actions are aimed at strengthening the capacity of producers to cope with climate impacts through regenerative agricultural practices, landscape restoration, and equity in the value chain.

Through an integrated and coordinated approach, this strategy contributes to the productivity and quality of farms and encourages biodiversity conservation and community values, promoting balanced development between the environmental, social, and economic dimensions.

Below is a table with a proposal of theoretical exercises, suggestions and applicable scenarios. In the case of periods, it is recommended to consider five-year term estimates as an example.

Table I. Theoretical exercises, suggestions and applicable scenarios for a climate adaptation plan for the national cocoa sector.

Strategic focus	Sustainable Productive Transformation.	
Specific objectives	To improve the productivity and sustainability of cocoa plantations by strengthening technical capacities, efficient resource management, and the adoption of regenerative practices that increase resilience to changing climatic conditions.	
Line of action	Associated measures	Indicators

Integrated Pest and Disease Management:	Implementing an annual program of practical workshops on biological pest control. Establishing demonstration plots with decoy trees to attract pests away from the main plantations. Promoting the use of bioinputs (fungicides and natural fertilizers).	60% of the farms implement biological pest control. 10 Bioinput biofactories in operation. 30 hectares with diversified agroforestry systems.
Strengthening Soil Health:	Conducting soil analysis every six months and developing specific fertilization plans for each farm. Supporting and promoting community biofactories to produce organic fertilizers and biofertilizers. Promoting the application of compost, bokashi, and worm tea, or any other formulations evaluated in each zone, as standard practices.	
Promotion of Agroforestry Systems:	Encouraging planting of shade species (timber and fruit trees) on at least 60% of the farms. Training 200 producers in the implementation of diversified agroforestry systems.	
Resilient Infrastructure:	Building 10 drip irrigation systems on pilot farms. Designing roads with sustainable drainage to improve access to farms during the rainy season.	
Strategic focus	Integrated Landscape Management.	
Specific objectives	To restore productive landscapes through reforestation, protection of water sources, and strengthening biodiversity, by promoting coexistence between agricultural production and ecosystem conservation.	
Line of action	Associated measures	Indicators

Reforestation and living fences:	Planting 25,000 native trees on public/communal lands and non-productive areas of farms. Establishing live fences or pollinator islands on 50% of the participating farms.	20% increase in reforested areas. 30 springs protected with forest strips. 50% of the farms with established live fences.
Conservation of Water Sources:	Developing and protecting 15 hectares of forest strips around springs and rivers. Implementing rainwater harvesting systems in 30 farms.	
Soil Protection:	Implementing terraces and covering crops in steep slope areas. Conducting awareness campaigns on erosion and the importance of vegetation cover.	
Strategic focus	Climate Resilience and Adaptation	
Specific objectives	To reduce the vulnerability of cocoa plantations to extreme weather events through the implementation of early warning systems, adaptive infrastructure, and regenerative agricultural practices.	
Line of action	Associated measures	Indicators
Early Warning and Climate Monitoring Systems:	Installing 6 weather stations at strategic points in the region. Developing or leveraging weather alert mechanisms for producers (news chain, mobile application, etc.).	5 operational climate monitoring stations. 200 producers enrolled in agricultural insurance programs.
Resilient Infrastructure:	Building drainage systems and water channels in 15 farms vulnerable to flooding.	
Weather Insurance:	Designing a pilot climate insurance plan in collaboration with the financial sector.	
Strategic focus	Strengthening the Sustainable Value Chain	
Specific objectives	To strengthen the competitiveness and sustainability of cocoa production by diversifying markets, obtaining certifications, and promoting the empowerment of women and young people in the value chain.	
Line of action	Associated measures	Indicators

Certification and Fair Trade:	Training 100 producers in sustainable production, related certifications, and fair trade. Developing associative methods to finance 50% of certification costs for small producers and cooperatives.	40% of farms under sustainability programs or certified under sustainability seals. 30% increase in revenues from access to differentiated markets.

8. IMPLEMENTATION STRUCTURE

This implementation structure is designed to address the main barriers that affect the effectiveness of the adaptation plan, such as financial constraints, resistance to change, lack of access to technology, and scarce information. This structure integrates adaptive strategies, innovation in production practices, and a participatory approach that ensures the inclusion of producers and other key stakeholders. The implementation of the plan is organized into four fundamental pillars - governance and coordination, development of strategic axes, financing and strategic alliances, and monitoring and evaluation.

Governance and Coordination

Governance is critical to ensure effective coordination and continuous monitoring of the plan's actions. A strong and participatory institutional framework enables collaboration among key stakeholders, ensuring that strategies are implemented in an aligned and efficient manner.

Objective: To consolidate a participatory institutional framework and ensure the coordinated implementation and monitoring of the plan, in line with Costa Rica's National Cocoa Plan.

- Associated Measures:
    - **Strengthening or creation of the Cocoa Climate Change Adaptation team led by ECOM:** This team, located within the framework of the regional cocoa platforms, will bring together producers, government institutions, NGOs, and private sector representatives for joint decision-making.
    - **Formalization of strategic agreements:** With and among institutions, universities and companies such as ECOM, the Cornell Lab of Ornithology and More People More Trees, and other valuable stakeholders such as NGOs,

cooperation agencies, local organizations, and the private sector, to share resources and knowledge.

- **Development of a digital platform:** This tool will facilitate real-time monitoring of actions, access to relevant information and smooth communication among all stakeholders. The most effective mechanisms for sharing data and information will be identified and assessed, adapting to the specific needs of each user and offering various formats, such as newsletters, general information and other necessary materials.

- **Key Indicators:**
  - An operational team established during the first year of implementation.
  - At least 3 formalized collaboration agreements with strategic stakeholders.
  - 80% of producers trained using the monitoring mechanism.

Implementation of Strategic Axes

The implementation of the plan is based on four strategic axes designed to address the sector's most urgent challenges and transform production practices toward sustainable models.

Axis 1: Sustainable Productive Transformation

Specific Objective: To increase the productivity and sustainability of cocoa agroforestry systems through regenerative practices, efficient resource management, and productive diversification.

- **Lines of Action:**
  1. **Strengthening of Agroforestry Practices:** Creation of demonstration plots and promotion of shaded cocoa systems with native species.

Table II, Native species recommended for cocoa agroforestry in the northern zone

Name	Scientific name	Use (in addition to shade)	Advantages for Biodiversity	Resilience in the Northern Zone
Jobo	*Spondias mombin*	Fruit and water retention	Food source for birds and mammals	High
Black Madero	*Gliricidia sepium*	Medicinal, nitrogen fixation	Summer flowering provides nectar for pollinators	High

Soursop	*Annona muricata*	Fruit	Food source for birds and mammals	High
Monkey pod tree	*Samanea saman*	Wood	Nesting of large birds, insect food (food for migratory birds)	High
Cedro Macho (Caobilla)	*Carapa guianensis*	Wood, medicinal	Tepezcuintle and agoutis feed	Limited
Guácimo	*Guazuma ulmifolia*	Medicinal	Food for parrots and parakeets	No information
Achiote	*Bixa orellana*	Food and medicinal	Bird food	No information
Tamarindo	*Tamarindus indica*	Fruit, Medicinal	Bird and mammal feed	No information

2. Use of bioinputs: Establishment of community biofactories and/or access to standardized bioinputs and training in integrated pest management.
3. Optimization of Natural Resources: Implementation of drip irrigation systems and soil analysis to adjust fertilization.

- Key Indicators:
    1. 40 hectares diversified with agroforestry systems.
    2. 50% of producers adopt the use of bio inputs.
    3. 10 community biofactories in operation in the Northern Huetar and Brunca regions.

    ...

Axis 2: Integrated Landscape Management

Specific Objective: To restore productive landscapes, protect key natural resources, and strengthen biodiversity.

- Lines of Action:
    1. Conservation of remnants
    2. Reforestation and Restoration of Biological Corridors: Planting of 30,000 native trees and establishment of live fences for ecological connectivity.
    3. Protection of Water Sources: Installation of rainwater harvesting systems and forest strips around springs.
- Key Indicators:

1. 25% increase in reforested areas.
2. Installation of catchment systems in 50% of the participating farms.

Axis 3: Climate Resilience and Adaptation

Specific Objective: To reduce climate vulnerability through adaptive infrastructure, access to climate insurance, and monitoring systems.

- Lines of Action:
    1. **Early Warning Systems:** Installation of weather stations and development of a mobile application for weather alerts.
    2. **Climate Insurance and Green Finance:** Pilot climate insurance and credit lines adapted for small producers.
- Key Indicators:
    1. 6 operational weather stations.
    2. 200 producers enrolled in weather insurance programs.

Axis 4: Strengthening the Sustainable Value Chain

Specific Objective: To increase the competitiveness of Costa Rican cocoa through certifications, strategic alliances, and empowerment of women and youth.

- Lines of Action:
    1. **Joint Producer Certification and Fair Trade:** Partial financing of certifications for small producers.
    2. **Access to Differentiated Markets:** Promotion of alliances with international buyers and marketing strategies.
    3. **Empowerment and Training:** Workshops in leadership and agricultural management for women and youth.
- Key Indicators:
    1. 40% of farms are under sustainability programs or are certified with sustainability seals.
    2. 30% increase in the income of certified producers.

Financing and Strategic Alliances

Adequate financing and strategic alliances are essential to ensure the implementation and sustainability of the plan.

Objective: To mobilize financial resources and establish key partnerships to ensure the viability of actions.

- Associated Measures:
  - Leveraging funding from national and international non-reimbursable funds (e.g. Global EbA Fund, IDB, Darwin Initiative, etc).
  - Involving the private sector as exporters and international cocoa buyers.
- Key Indicators:
  - 75% of the insured budget in the first two years.
  - 50% of producers accessing green financing.

Monitoring and Evaluation

Ongoing monitoring and participatory evaluation ensure that the plan's objectives are met and that it is adjusted as necessary.

Objective: To evaluate the impact of actions, ensure compliance with objectives, and promote continuous improvement.

- Associated Measures:
  - Implementation of a monitoring system with indicators aligned to the strategic axes.
  - Conduct annual participatory evaluations with direct feedback from producers.
- Key Indicators:
  - 90% compliance with the evaluated objectives.
  - Publication of annual reports accessible to all stakeholders.

9. CONCLUSIONS

The Northern Huetar, Huetar Atlantic, and Brunca regions account for almost all national cocoa production, contributing not only to the rural economy, but also to environmental conservation and strengthening the autonomy of local communities. However, these regions face complex challenges related to climate change, such as variations in rainfall, increased temperatures, and the proliferation of pests and diseases, which affect the sustainability of cocoa plantations and the quality of life of producers. These challenges highlight the urgency of implementing strategic, consensual actions adapted to the agroecological, socio-cultural, economic, and climatic particularities of each region.

Costa Rica has recognized cocoa as a strategic crop for climate change adaptation and sustainable rural development. Plans and initiatives such as the *National Cocoa Plan 2018-2028*, the *Regional Action Plan for Climate Change Adaptation*, and the *Regional Cocoa Strategy 2022-2032* integrate innovative approaches that combine environmental sustainability, landscape regeneration, and strengthening the competitiveness of Costa Rican cocoa. These strategies seek not only to address climate impacts, but also to boost the economic and social development of cocoa-producing communities.

The analysis of the solutions proposed in this document evidences an integrated approach that articulates technical, social, and environmental actions. This approach includes the regeneration of productive landscapes, the conservation of natural resources, and the development of more resilient and inclusive communities. Although the Northern Huetar and Brunca regions share some challenges, such as climate vulnerability and value chain constraints, their unique characteristics require differentiated solutions, such as technical capacity building in Northern Huetar and economic diversification in Brunca.

The coordinated and participatory implementation of strategies -such as those proposed in projects like *"Removing Barriers to Access Finance from the National Cacao Plan in Costa Rica"*- offers an efficient response to the needs of producers. This approach promotes climate resilience, landscape restoration, and inclusive economic development, maximizing impact in these regions. It also recognizes the importance of improving harvest and post-harvest practices to ensure a high-quality product, capable of competing in premium markets and generating greater added value.

Finally, a comprehensive approach that combines technical training, infrastructure development, access to financing, and the creation of strategic alliances will position Costa Rican cocoa as an international benchmark of quality and sustainability. This path not only benefits the producing communities but also strengthens the country's economic

competitiveness and environmental resilience, consolidating cocoa as a model of climate adaptation and sustainable rural development.

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11. ANNEXES

PHOTOGRAPHS
WORKSHOP NORTHERN HUETAR REGION

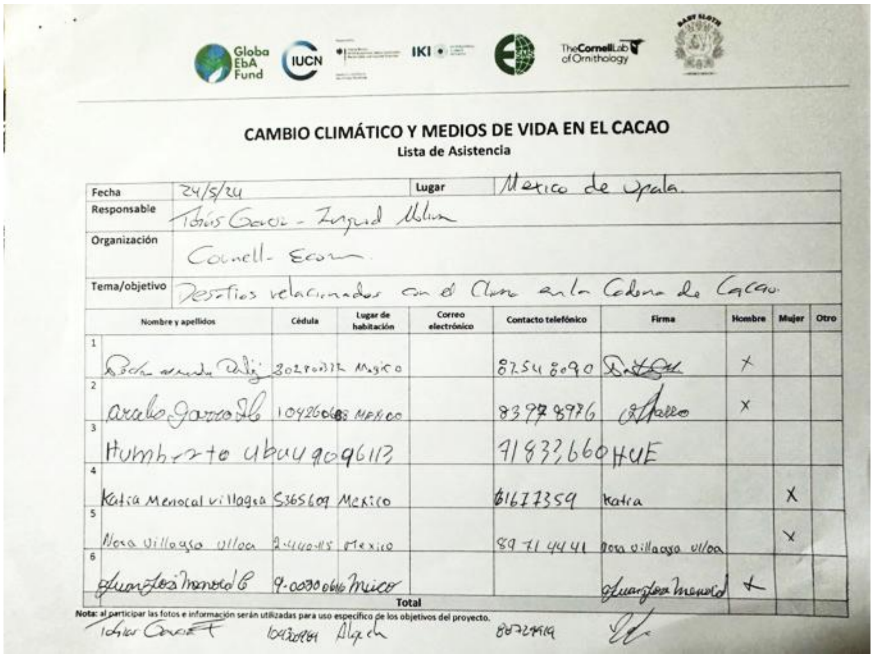



PHOTOGRAPHS
BRUNCA REGION WORKSHOP

PHOTOGRAPHS

INTERVIEW AND TOUR OF PRODUCERS

LIST OF WORKSHOP PARTICIPANTS



CAMBIO CLIMÁTICO Y MEDIOS DE VIDA EN EL CACAO

Lista de Asistencia

Fecha	24/5/24	Lugar	Mexico de Upala.
Responsable	Tobías García - Ingrid [illegible]		
Organización	Cornell- Ecom.		
Tema/objetivo	Desafíos relacionados con el Clima en la Cadena de Cacao.		

	Nombre y apellidos	Cédula	Lugar de habitación	Correo electrónico	Contacto telefónico	Firma	Hombre	Mujer	Otro
1	[illegible]	302800372	Mexico		87548090	[illegible]	X		
2	Arcelio Garro [illegible]	104260683	Mexico		83978976	[illegible]	X		
3	Humberto Ubau	909611?			71837660	HUE			
4	Katia Menocal Villagra	5365609	Mexico		61677359	Katia		X	
5	Nora Villagra Ulloa	2-440-115	Mexico		89 71 44 41	Nora Villagra Ulloa		X	
6	Juan Carlos Menocal G	9-0030-0646	Mexico			Juan Carlos Menocal	+		
	Total								

Nota: al participar las fotos e información serán utilizadas para uso específico de los objetivos del proyecto.

Tobías García 104320764 Alajuela 88729919 [illegible]

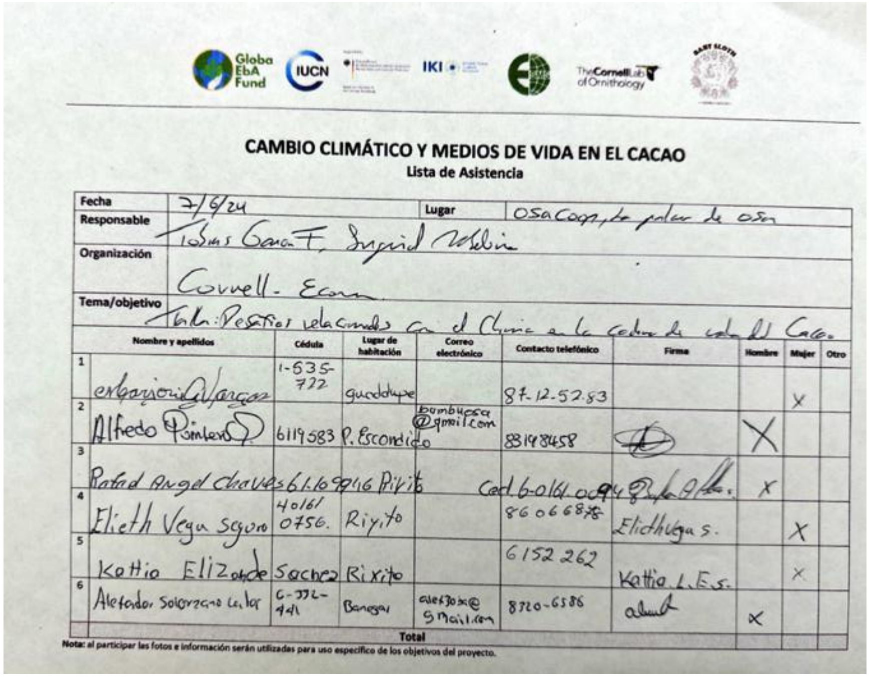
CAMBIO CLIMÁTICO Y MEDIOS DE VIDA EN EL CACAO

Lista de Asistencia

Fecha	24/5/24	Lugar	Salón Comunal Mexico de Upala.
Responsable	Tobías García, Ingrid [illegible]		
Organización	Cornell, Ecom.		
Tema/objetivo	Taller: Desafíos relacionados con el clima en la cadena de Valor del Cacao.		

	Nombre y apellidos	Cédula	Lugar de habitación	Correo electrónico	Contacto telefónico	Firma	Hombre	Mujer	Otro
1	Juan Fco. López	7786 155802	Mexico		64344440	Juan Fco López	✓		
2	Bismark Obando S	2-192 917	Mexico		86 66 96 70	Bismark Obando S.	+		
3	Angel Ortiz Hernández	52125 078000 22	Mexico		86181313	[illegible]	+		
4	Rosaura Miranda D	2339755	Mexico		83978976	[illegible]		+	
5	Laura [illegible]		Manzano			[illegible]		+	
6	Karla González	208220592	Manzano		71-82-42-04	Karla G. U		x	
	Total								

Nota: al participar las fotos e información serán utilizadas para uso específico de los objetivos del proyecto.



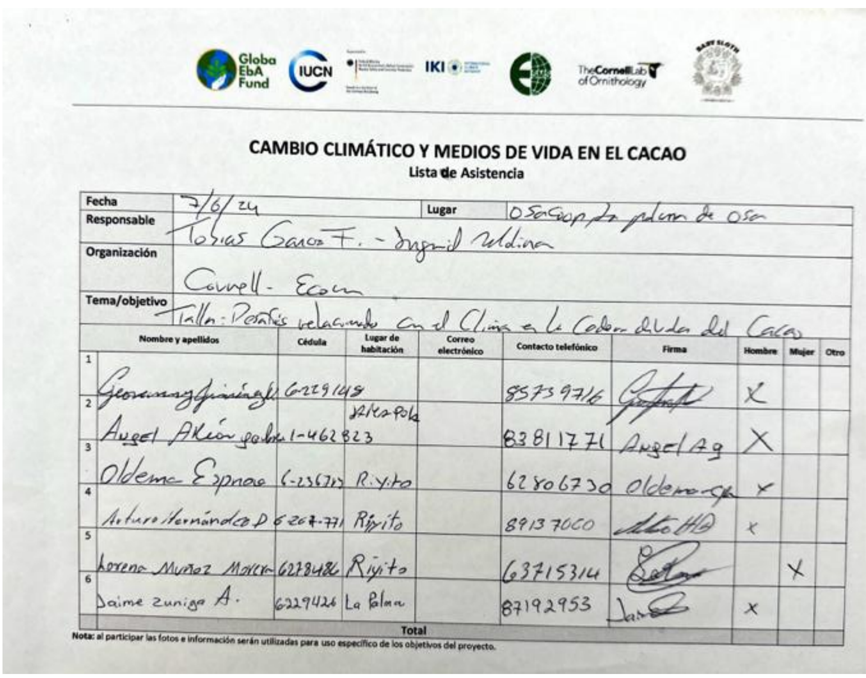
CAMBIO CLIMÁTICO Y MEDIOS DE VIDA EN EL CACAO

Lista de Asistencia

Fecha	7/6/24	**Lugar**	OsaCoop, La palma de Osa
Responsable	Tobías Garcia F, Ingrid Medina		
Organización	Cornell - Ecom		
Tema/objetivo	Taller: Desafíos relacionados con el Clima en la Cadena de valor del Cacao		

	Nombre y apellidos	Cédula	Lugar de habitación	Correo electrónico	Contacto telefónico	Firma	Hombre	Mujer	Otro
1	Gregorio Vargas	1-535-722	Guadalupe		87-12-52.83			X	
2	Alfredo Pimentel	6119583	P. Escondido	bombucsa@gmail.com	83198458	[signature]	X		
3	Rafael Angel Chaves	61.169046	Rivito		Cel 6-0161-0094	Rafa A.	X		
4	Elieth Vega Segura	40161 0756.	Riyito		86066878	Eliethvega s.		X	
5	Kattia Elizondo Sanchez		Rixito		6152262	Kattia L.E.S.		X	
6	Alejandro Solorzano Calvo	6-332-441	Banegas	alejo30x@gmail.com	8720-6586	[signature]	X		
				Total					

Nota: al participar las fotos e información serán utilizadas para uso específico de los objetivos del proyecto.



CAMBIO CLIMÁTICO Y MEDIOS DE VIDA EN EL CACAO

Lista de Asistencia

Fecha	7/6/24	**Lugar**	OsaCoop, La palma de Osa
Responsable	Tobías Garcia F. - Ingrid Medina		
Organización	Cornell - Ecom		
Tema/objetivo	Taller: Desafíos relacionados con el Clima en la Cadena de valor del Cacao		

	Nombre y apellidos	Cédula	Lugar de habitación	Correo electrónico	Contacto telefónico	Firma	Hombre	Mujer	Otro
1	Geovanny Jiménez	6229148			85739716	[signature]	X		
2	Angel Alcón Pablo	1-462823	Riyito Pola		83811771	Angel Ag	X		
3	Oldema Espinoza	6-236717	Riyito		62806730	Oldema	X		
4	Arturo Hernández D	6207-771	Riyito		89137060	[signature]	X		
5	Lorena Muñoz Mora	6278486	Riyito		63715314	[signature]		X	
6	Jaime Zuniga A.	6229426	La Palma		87192953	[signature]	X		
				Total					

Nota: al participar las fotos e información serán utilizadas para uso específico de los objetivos del proyecto.

MAPS PRODUCED

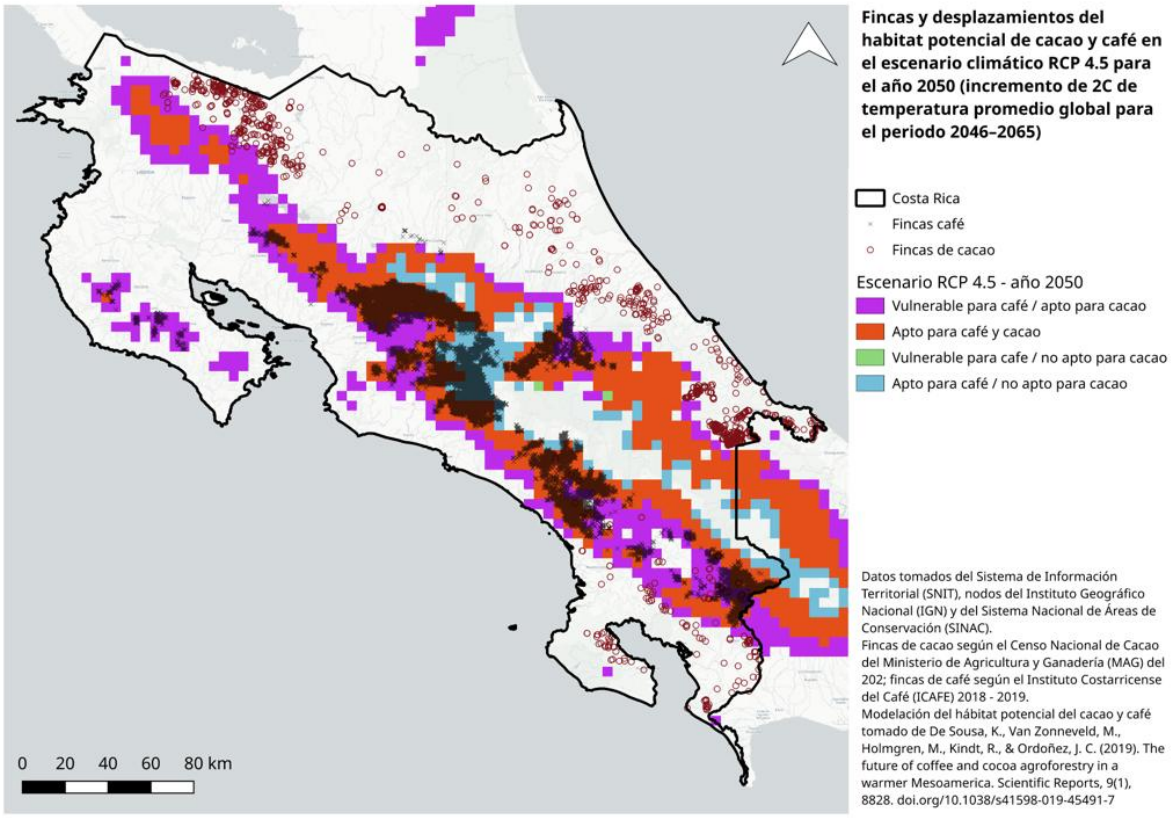


Figure 5. Location of current coffee and cocoa farms in Costa Rica, overlaid on the projection for the year 2050 in an RCP4.5 scenario of vulnerable zones for coffee and cocoa.

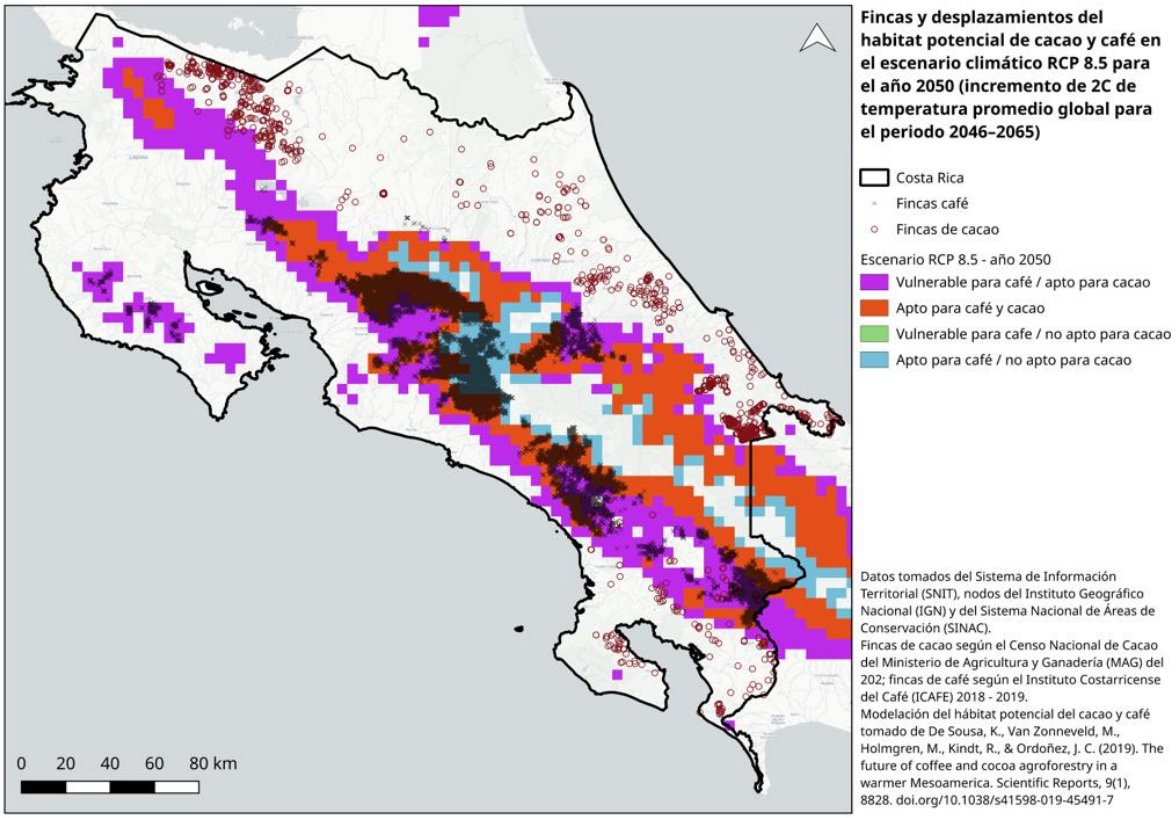


Figure 6. Location of current coffee and cocoa farms in Costa Rica, overlaid on the projection for the year 2050 in an RCP8.5 scenario of vulnerable zones for coffee and cocoa.

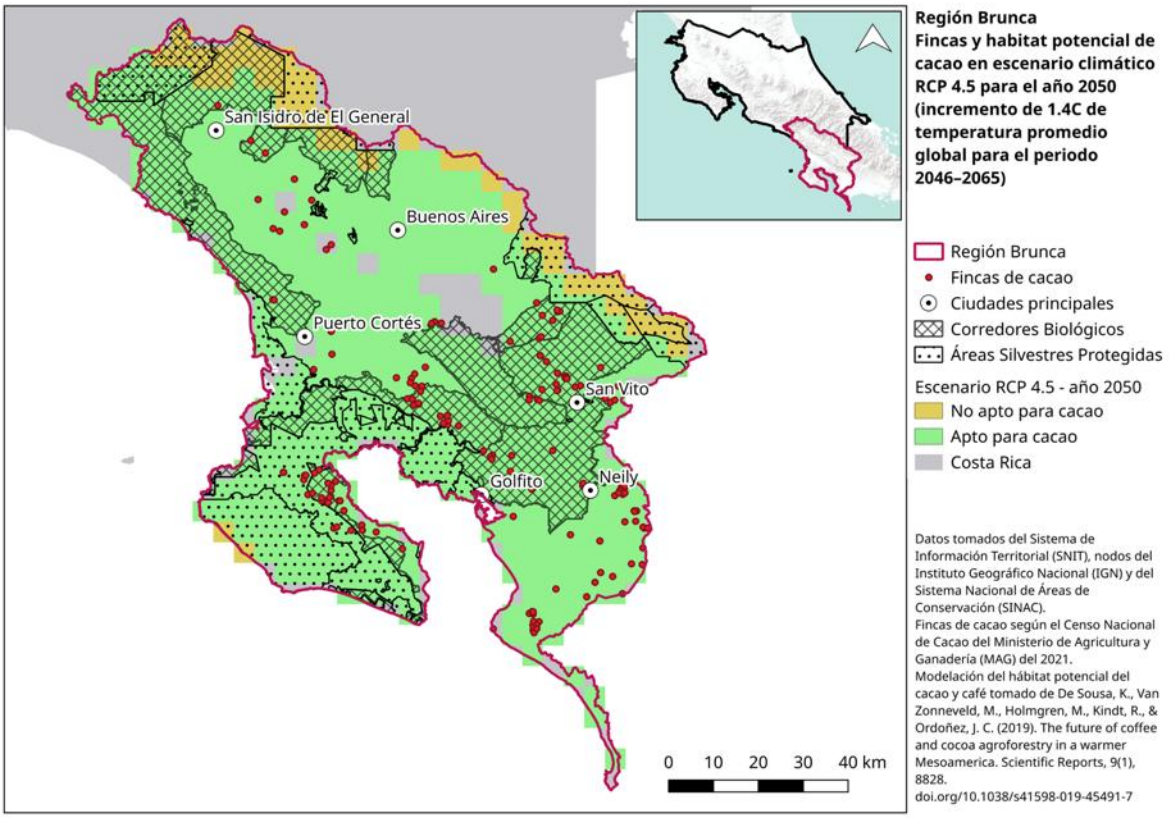


Figure 7. Location of current cocoa farms in the Brunca Region, superimposed on the projection for the year 2050 in an RCP4.5 scenario of unsuitable areas for cocoa and protected wild areas.

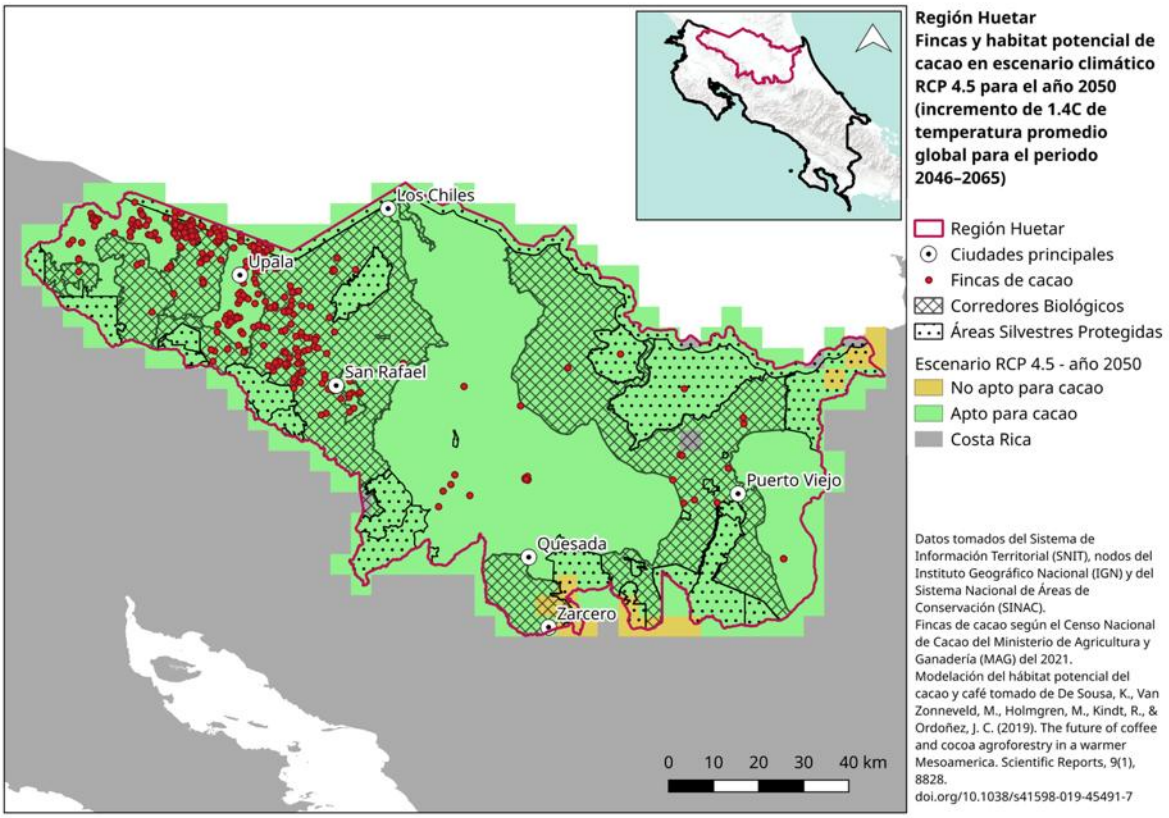


Figure 8. Location of current cocoa farms in the Northern Huetár Region, superimposed on the projection for the year 2050 in an RCP4.5 scenario of unsuitable areas for cocoa and protected wild areas.

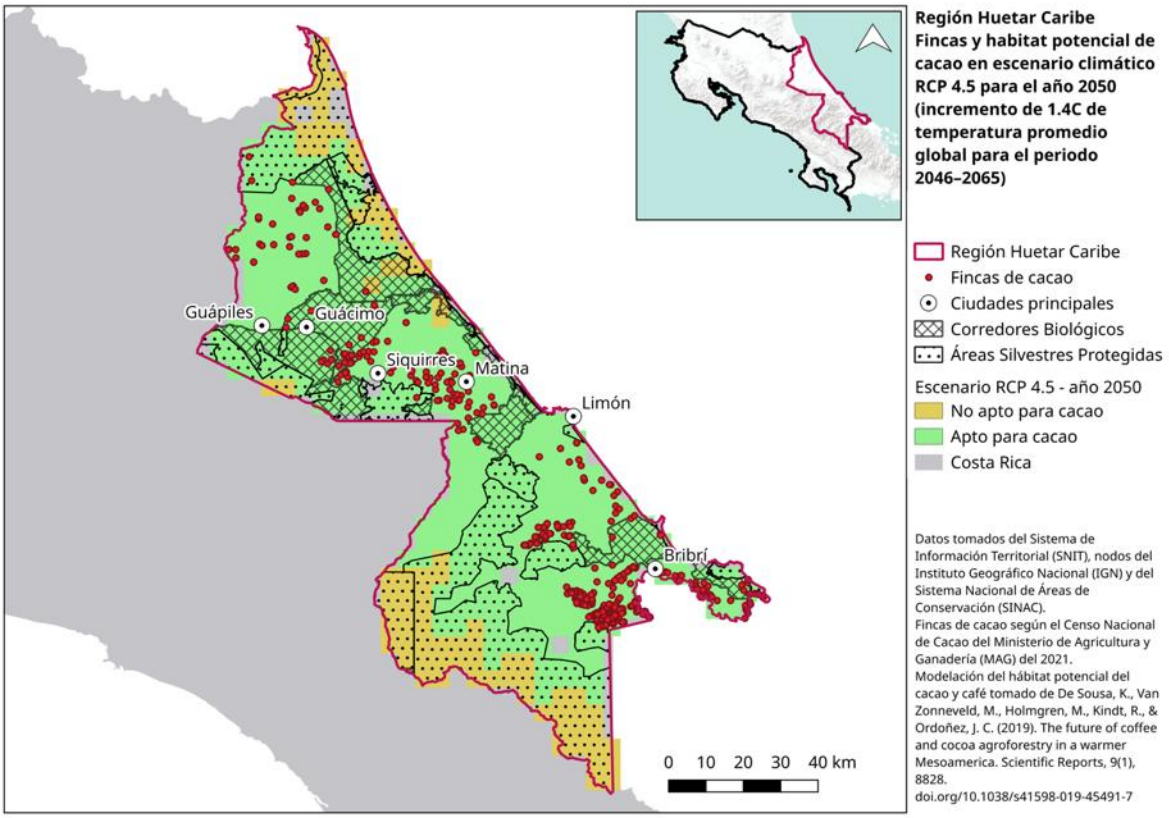


Figure 9. Location of current cocoa farms in the Huetar Atlantic Region, superimposed on the projection for the year 2050 in an RCP4.5 scenario of unsuitable areas for cocoa and protected wild areas.