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Amazon Region

Introduction

The Amazon has long been regarded as a land of myths and wonder. Even today, it still has the image of being a uniformly green mantle that covers vast areas of the Earth's surface. But behind this image lies an impressive geological and natural diversity that is so varied, it could be said that many "Amazons", exist. Indeed, the whole region represents a variety of landscapes that is unique in the world¹.

The entire basin encompasses numerous geological formations. Its diverse soils include Holocene sediments—the youngest at less than 10,000 years old—found in flood-prone areas such as those of southern Brazil. The oldest soils are found in the Guiana Highlands, a geological formation that is part of the Guiana Shield, itself underlying six countries. These ancient areas of clayish sediments and pre-Cambrian rocks have been worn down over 1700 million years to a height of only about 700 m.

The Amazon Basin itself represents one-third of South America's land area. It extends through nine countries, covering 75% of the territory in each of Bolivia and Peru, 60% of Brazil, 45% of Ecuador, and 36% of Colombia. It also covers part of the territories of French Guiana, Guyana, Suriname, and Venezuela.

1. Amazonia sin Mitos [*Amazonia Without the Myths*]. 1992. Published by the Commission on Development and Environment for Amazonia, Inter-American Development Bank, United Nations Development Programme, and the Amazon Cooperation Treaty.

Biodiversity is perhaps the Basin's most important characteristic, that is, 7% of the Earth's land area carries about one quarter of its terrestrial species. From the air, the heterogeneity of species seen in the "green mantle" is amazing; each species is adapted to a habitat, generating a mosaic of different habitats and mutual interactions.

Yet, this biodiversity is being lost at ever-increasing rates. Already, more than 100 million hectares—that is, 16%—of this complex of ecosystems has been deforested. Such loss has led to the degradation of significant environmental services, for example, the conservation of biodiversity, storage of CO₂, regulation of regional and global climates, and regulation of water cycles. The main reason behind such deforestation is extensive agricultural production of such low productivity that, within a few years, it loses what little productive capacity it had.

Such inefficient land use has led to the degradation and abandonment of more than 30 million hectares, and to the continuous expansion of the agricultural frontier at the expense of forests. This scenario is exacerbated by climatic phenomena. Diverse studies have demonstrated the Amazon Region's vulnerability to climate change. They have also highlighted the importance of conserving the transitional landscapes between the Andes and the Amazon Region for mitigating and adapting to climate change.

Strategies to prevent degradation and abandonment in the Amazon Region will therefore be fundamental to the

conservation of both regions. In light of this panorama, three major and complementary strategies are possible: (i) resource conservation, (ii) restoration of degraded areas, and (iii) the design and implementation of eco-efficient land use.

CIAT has worked in the Amazon Region for more than 30 years. It has helped develop eco-efficient crop and livestock production systems; improve markets for small farmers; monitor and analyze deforestation; and understand and find ways of mitigating and adapting to climate change. These activities were conducted in collaboration with a strong network of entities, including those that had been strengthened by CIAT's participation in the Amazon Initiative, a multidisciplinary international consortium made up of more than 30 national, regional, and international institutions.

CIAT's knowledge and experience therefore give the Center a clear opportunity to develop high-impact activities in the Amazon Region. The pressure to conserve and sustainably use the Region demands action based on a strategic framework that lies on the essential concept of carrying out collaborative efforts with external actors. These efforts would focus on two general criteria. The first is to understand the Amazon Region's dynamics and monitor the environmental, social, and economic changes of its different landscapes. From the findings, future scenarios can then be visualized in the context of climate change. The second criterion is to work in the most degraded areas of the Amazon Region, where the forests were replaced many years ago, and there promote models of intensified land use through eco-efficient production systems.

The Amazon Region has a population of more than 34 million inhabitants, who need to consolidate a life model that incorporates the challenge of maintaining this Region. The attention to food security must be part of the strategy, as specifically demanded by the inhabitants. This focus must also counteract trends towards large landholdings and agroindustrial investments, as these would generate an agroexport model that would assume livestock-raising without trees and would also encourage monocultures of soybeans, cereals, and even of forests. CIAT therefore sees as fundamental those activities that show that restoring Amazonian landscapes is feasible and that, through them, the environmental services they provide can also be restored.

The Center's work strategy for the Amazon Region is summarized below.

General objective

Because CIAT's general mission is to promote eco-efficient agriculture to reduce poverty, the central objective of the work to be carried out in the Amazon Region is to promote eco-efficient landscape² models.

Areas of action

CIAT will focus its areas of action in the Amazon Region on three closely related topics: (i) monitoring the Amazon Region; (ii) optimizing land use systems in deforested areas; and (iii) mitigating and adapting to climate change.

First, using existing geographical information tools, CIAT will focus on supporting countries in monitoring the Amazon Region from the perspective of land use change and generation of economic, environmental, and social indicators that, together, can contribute elements for decision-making.

Second, the Center will emphasize degraded areas, where its experience in soil restoration and sustainable intensification may have added value. To generate models for the restoration and intensive and sustainable management of degraded areas, CIAT will focus on agroecosystems, using its experience in crop and soil management, crop-forage rotations, access to markets, and economic impact analyses, thus improving farm productivity in an integrated way.

The third axis of activity for CIAT in the Amazon Region is to foster activities for mitigating and adapting to climate change.

These three areas of action will access cross-cutting strategies to generate information and provide training. CIAT sees as fundamental the generation of platforms that will enable access to information needed for informed decision-making. At the same time, it will develop training strategies at different levels to promote development strategies that fit the principles of

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2. In concrete terms, landscapes are described at different scales, from the farm (group of different types of land use that form a mosaic) to the river watershed and its different ecosystems. A landscape is described according to its composition (percentage of land covered by different types of use) and structure (connectivity, fragmentation, and forms of fragments of types of use).

eco-efficiency and sustainable development. This will be possible through collaboration with different partners in the Amazon Region.

The three areas of action are described below.

Area 1

Monitoring the Amazon Region:

Decision-making tools and methodologies

The transformation of Amazonian landscapes has been so fast in recent years that monitoring it precisely has been difficult. Although governments maintain statistics on the economic, social, and environmental variables of the Amazonian regions of their respective countries, recording and visualizing the entire basin is difficult.

The lack of reliable information on issues such as deforestation has motivated CIAT to create an online information tool called Terra-i. This tool provides, at a resolution of 250 m and in almost real time, information on changes in land use for the entire Amazon Region³. Terra-i is one of the few tools that provide good spatial and temporal resolution while monitoring changes in land use in the Region. It can also measure specific objectives in eight Amazonian countries, thus generating comparable statistics.

CIAT also designed the IAVIEWER information platform. This tool integrates socioeconomic and biophysical information, including richness of biodiversity and carbon sequestration. It analyzes scenarios that imply risks of loss of ecosystem services and estimates of opportunity costs in preventing deforestation.

Both tools represent CIAT's potential to:

- Become a research center that specializes in monitoring changes in the Amazon Region
- Generate scenarios
- Support the monitoring by REDD+⁴
- Monitor landscapes, including deforested areas and land uses (e.g., pastoral, agropastoral, silvopastoral, and agrosilvopastoral systems)

3. www.terra-i.org

4. REDD refers to Reducing Emissions from Deforestation and Forest Degradation; REDD+ is the same, but includes conservation, sustainable management of forests, and enhancement of forest carbon stocks. Both programs are part of the UN-REDD Programme, that is, of the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries. See website at: www.un-redd.org/AboutREDD/tabid/582/Default.aspx

- Provide reliable, high-quality information, suitable for practical analysis and decision-making by Amazonian countries.

Advances in information systems are rapid.⁵ One CIAT strategy is to tap alliances with information generators to interpret their information with tools such as Terra-i or IAVIEWER, and thus convert it into a language that is understood by decision-makers. CIAT will also specialize in measuring greenhouse gas emissions (GHGE) from the conversion of forests to agricultural systems, and their reversion through the generation of intensive production models. (The Center will begin this activity when it takes up its new role as coordinator of the Consultative Group on International Agricultural Research's Research Program on Climate Change, Agriculture and Food Security (CCAFS).

Furthermore, CIAT will support the Center for International Forestry Research (CIFOR), the World Agroforestry Centre (ICRAF), and Bioversity International in coordinating the CGIAR Research Program on Forests, Trees and Agroforestry: Livelihoods, Landscapes and Governance when monitoring Amazonian forests and other activities derived from CCAFS.

For CIAT, monitoring the Amazon Region will be the logical support for decision-making at regional and national levels. It will also guide the Center's future work with its partners by providing real indicators for visualizing and knowledge sharing.

Area 2

Optimizing land use systems in deforested areas

The Amazon Region has areas that were deforested several years ago and which today can either continue as such or undergo the challenge of becoming productive once again. At the same time, other areas have been recently deforested or are in imminent danger of being so.

CIAT has many years of experience in:

- Improving crops and forages for their adaptation to biotic and abiotic stresses
- Soil management

5. The new Google tool, *Earth Engine*, gathers information from satellite systems that have taken trillions of measurements over the last 25 years. This tool is available to scientists, researchers, and governments who need to detect land use changes and trends happening on the Earth's surface.

- Developing eco-efficient agricultural models that help establish land use schemes to improve the quality of life of Amazonian populations and restore the Region's landscapes.

In this context, CIAT will work in two fields: improving land use systems and improving access to markets.

Improving land use systems

- *Agroecosystem level*

To develop sustainable food production systems and ecosystems implies understanding farms as dynamic systems. That is, farms are composites of interactions of all kinds: biophysical, ecological, economic, and sociocultural. These interactions determine the acquisition and maintenance of food production, and generation of employment and income. They now need to include the minimizing of the adverse impact of these processes on the environment.

In the complex of Amazonian landscapes, understanding the specific functioning of each agroecosystem, with its characteristics and options, is essential. Research—from understanding the biodiversity existing in the soil to generating integrated models that optimize livestock-raising—will, at once, lead to less deforestation of the Amazon Region and thus to an increase in the number of ecosystem services.

CIAT has begun to model various Amazonian landscapes, arriving at an eco-efficiency index for the Region. The index will help analyze different components and parameters of change in the diversity of situations found. These exercises were performed, using a participatory approach, with landowners and in the ambience of regional markets and policies.

In this context, CIAT's strategy will be to continue generating landscape restoration models for diverse areas of the Amazon Region that have been deforested. The goal will be to evaluate impact on economic development; conservation of biodiversity; production of ecosystem goods and services; and mitigation of, and adaptation to, climate change.

To develop these models, CIAT will integrate its knowledge on specific crops and forages—as discussed in the next section—with strategies for the

intensive management of agroforestry, agropastoral, silvopastoral, and agrosilvopastoral systems to allow the integrated improvement of soils. These interventions will be performed on farms, where intensification models imply the use of mixed systems of crops, forages, shrubs, trees, and forests.

The objective is to rebuild eco-efficient landscapes; that is, to use a much more eco-intensive model for the Amazon Region. This means changing the extensive grazing model for one that is much more intensive, reduces the burning and felling of forests over large areas, and stabilizes an Amazonian agricultural and livestock model that will not only generate options for its inhabitants, but will also preserve environmental services and support schemes for mitigating and adapting to climate change.

- *Crop level*

CIAT has experience and has conducted research with several crops, some of which have formed part of its mandate since its foundation (beans, cassava, tropical forages, and rice). Many crops are predominant in the Amazon Region and may contribute significantly to generating intensive models that support the conservation model for the Amazon Region. In this context, CIAT will particularly focus on the following crops to generate options for degraded farms and the surrounding agroecology, following an eco-efficiency perspective:

- **Cassava:** The Amazonian cropping map displays cassava as being the most extensive. This crop forms the basis for subsistence and income, and even for generating local markets, for numerous inhabitants, both rural farmers and indigenous populations. CIAT is host to the world's largest cassava germplasm bank. Its strategy is to focus on developing varieties and production systems that are resistant to pests and diseases, and tolerant of abiotic stresses and the consequences of climate change.
- **Forages:** A major reason for deforestation in the Amazon Region is the use of inefficient extensive livestock production models. CIAT's experience in generating genetic options, and pasture and forage management will be applied in the development of eco-efficient intensive models with mixed livestock-and-cropping systems. This work will integrate a mixed model for scaling out to silvopastoral and agrosilvopastoral systems.

One specific approach is to capture the potential of improved forages to mitigate climate change by reducing GHGE and maximizing carbon sequestration. CIAT will work to restore degraded areas, far from primary forest areas, to prevent intensification promoting increased deforestation.

- **Rice:** Rice is another important product in the Amazonian diet and economy. Within the CGIAR, CIAT has the regional mandate for research on rice in Latin America and the Caribbean (LAC). In the last 4 decades, the Center's Rice Program has contributed to the development of 60% of the 400 improved varieties released in LAC. The Program's work was centered on increasing productivity and decreasing production costs, while generating environmental benefits through increased eco-efficiency. In this context, one line of action will be to establish rice crops in the Amazon Region in an eco-efficient way while supplying the inhabitants' needs for food and income.
- **Fruits:** The variety of Amazonian fruits indicates high potential for developing green markets and, thus, sustainable production schemes. In Belém (Brazil) alone, more than 120 flavors of Amazonian ice cream—unique in the world—can be found. However, this potential requires a particular focus on management, from knowledge of species and their cultivation to the development of market schemes that are consonant with Amazonian reality.

Most fruits and palms are perennial crops that permit the creation of multi-strata systems, with annual crops in the lower stratum, for the more efficient use of resources and space. Diversified multi-strata systems contribute to the mitigation of, and adaptation to, climate change by improving the efficiency of use of inputs (e.g., water and nutrients such as nitrogen) and sequestering carbon. CIAT's Tropical Fruits Program aims to extend its research, in collaboration with partners, to develop sustainable options for the production of Amazonian fruits that adapt to climate change and possess a low carbon footprint.

Improving access to markets

- *Agricultural products*
A major obstacle in various parts of the Amazon Region is to generate markets for produce from

eco-efficient farms, while deflecting the trend to convert them into extensive monocultures, as happened for soybeans. Generating market demand implies understanding the Amazonian barriers, including seasonality, low production volumes, and lack of production chains adapted to regional schemes that ensure inhabitants receive equitable and fair benefits for their products.

In this context, for CIAT, what is fundamental is to improve access to markets to generate, not only eco-efficient farms, but also substantial increases in the quality of life for the Region's inhabitants⁶. The Center's strategy will continue to involve, from the beginning, communities in its research through participatory and interactive exercises, which encourage them to learn as they construct and develop valid market options.

Meanwhile, CIAT has generated tools for developing rural businesses, which have been used by partners such as CODER⁷ and others. The Center's strategy will be to work with local partners who are using these tools and generating market research and development for the Amazon Region.

- *Environmental products*
Rebuilding eco-efficient landscapes implies generating environmental services, including the conservation of biodiversity, climate regulation, and carbon sequestration.

Currently, few markets exist that give added value to the conservation of the Amazon Region by recognizing the environmental services it provides. However, mechanisms of payment for environmental services (PES) may be an option for recognizing some of these services or a group of them. In particular, a significant challenge, and opportunity, lies in studying the contributions, or potential contributions, of environmental services found, not

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6. Markets that take into account the carbon footprint are progressively becoming more important in those countries that are increasingly concerned about climate change. CIAT therefore seeks to generate market options for agricultural products with low carbon footprints, so that they may have greater market viability.
 7. The Corporation for Rural Business Development or CODER (its Spanish acronym) is an NGO that was created by CIAT's Rural Agroenterprise Development Project. CODER's mission is to help prepare and develop programs with a market and entrepreneurial focus. It also provides market orientation to small organizations of rural producers.

only in Amazonian forests but also in areas that could be restored through eco-efficient production systems.

The expectations surrounding these new options are high, including, for example, those generated by PES schemes within the framework of the carbon market (such as REDD+). Within this framework, in Amazonian areas already deforested, sustainable livestock production schemes can be part of REDD+ project activities, to the extent that these could reduce the pressure on remaining forests. In addition, more efficient production systems can play an important role in carbon sinks, if higher absorptive capacity of CO₂ and reduced emissions of other greenhouse gases can be demonstrated. The same is true for schemes that move from water markets to models of green markets and agro-ecotourism.

Any of these options should be explored for their potential to influence the adoption of eco-efficient alternatives, equity in the distribution of benefits, and their effect on the quality of life of small farmers. In addition, CIAT, through its research team on environmental impact and services, can help estimate the services generated, their value, and the costs of their conservation. In this regard, CIAT can also estimate the costs of reducing deforestation and forest degradation (total abatement costs), and those of conservation and increased carbon in agrosilvopastoral and agroforestry landscapes. Also crucially important to emphasize, in financial and economic terms, is the need to conserve and efficiently manage Amazonian landscapes.

Area 3

Mitigating and adapting to climate change

The most efficient strategy for mitigating climate change in the Amazon Region is to stop deforestation. Thus, options such as REDD+ have become significant for the Region, involving both potential and risks. One risk is the generation of false market economies that will affect the ancestral vision of indigenous populations for protecting nature and create inequities in the distribution of profits. In areas already deforested, the challenge is to mitigate climate change in systems such as extensive livestock production by converting them into intensive and sustainable agrosilvopastoral systems. The hydric functions of ecosystems—the support of primary production—by maintaining chemical fertility and biodiversity, can affect climate in one way or another.

Moreover, several studies suggest that climate change will seriously affect Amazonian landscapes, limiting the generation of several ecosystem services from the Andean piedmont. Indeed, the climatic phenomena of the last 4 years in the Amazon Region have been so dramatic that the flow of the Amazon River has substantially decreased, to the point where the lack of water is affecting the management of all traditional farming systems in flood-prone areas during the dry season. As a result, developing strategies of adaptation to climate change is priority for the Amazon Region, where more than 30 million people live and who depend on the ecosystem services provided by this great area.

Hence, CIAT will, in its research and monitoring projects on the Amazon Region, help implement models that aim at both mitigating and adapting to climate change, activities that go together in the case of the Amazon Region.

Cross-cutting strategies: Information generation and training

The three areas of action described above will make direct demands on CIAT's capacity to offer training in topics at every level of eco-efficient Amazonian landscapes. They will also call on the Center's capacity to transform its research into language that both decision-makers and the Amazonian inhabitants can understand. In this context, each area of action will include training programs and projects, from workplace training, through establishing eco-efficient systems on farms with local inhabitants, to distance-learning courses on the Internet on topics relevant to the mitigation of, and adaptation to, climate change.

Furthermore, CIAT will develop an information strategy that will allow the general public access to monitoring tools; and generate readily available publications in Spanish and Portuguese. These publications would use simple and direct language, and both electronic and written formats to help generate change in the Amazonian view of eco-efficiency and the sustainable development of this rich part of the world. CIAT will also emphasize work with young scientists interested in studying and promoting ecosystem services and eco-efficient landscapes. Finally, CIAT will work with governments and strategic partners in the Region to ensure that research results on eco-efficient Amazonian landscapes will be relevant to policy decision-making.

Our partners

CIAT's work in the Amazon Region will be successful to the extent that concrete programs and projects are developed through strategic partnerships with various institutions in the Amazonian countries. These research partners may include those with whom CIAT has worked for several years such as the NARIs of the Amazonian countries; the Brazilian Agricultural Research Corporation (Embrapa); CGIAR research centers; NGOs such as the Center for Research on Sustainable Agricultural Production Systems (Cipav), the Corporation for Rural Business Development (CODER), and Tropenbos International; universities; and the Amazonian communities themselves. Also significant is collaboration with the Amazon Initiative, of which CIAT is an active member, and which is currently managed by the Cooperative Program on Agricultural Research,

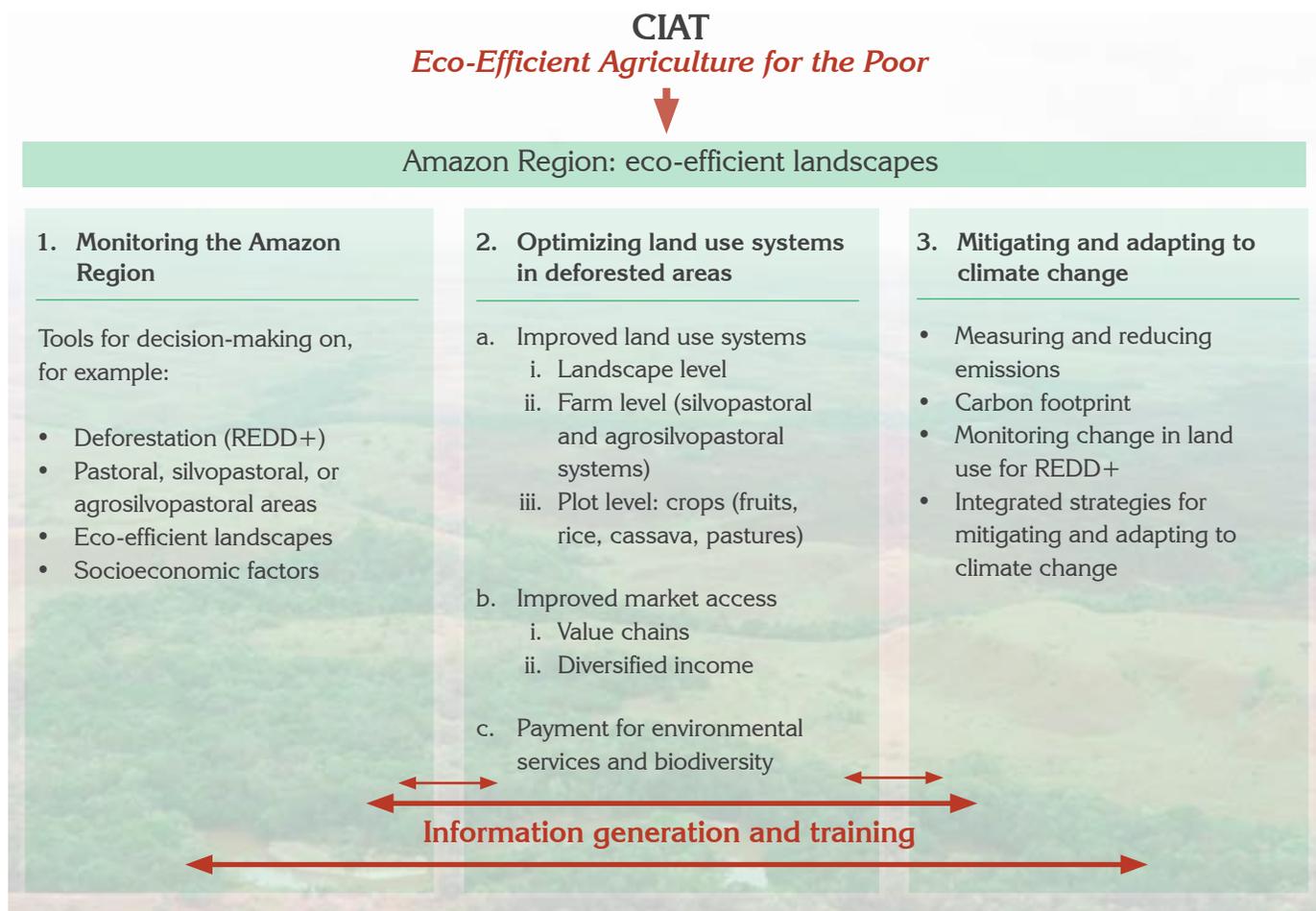
Development, and Innovation for the South American Tropics (PROCITROPICOS), the Tropical Agricultural Research and Higher Education Center (CATIE), Amazonian research institutes, and others.

The Center's objective is to work efficiently by generating shared visions and adding to or complementing activities. Working together with national and regional governments, and providing research results, hopefully, will result in policy decisions that will generate a sustainable development of the Amazon Region.

In summary

Schematic summary of CIAT's action strategy

The following outline synthesizes CIAT's action strategy in the Amazon Region:



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