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Climate Change Division

Ismael Nobre
Andrea Margit
Carlos A. Nobre
Maritta Koch-Weser
Adalberto Veríssimo
Ailton Fabrício Neto

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The Amazon Third Way Initiative | A3W

AMAZONIA 4.0

Cupuaçu ACL Cacao

Amazon Creative Labs

ISMAEL NOBRE
ANDREA MARGIT
CARLOS A. NOBRE
MARITTA KOCH-WESER
ADALBERTO VERÍSSIMO
AILTON FABRÍCIO NETO

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instituto arapyaú
www.arapyau.org.br

Imazon
Instituto do Homem e Meio Ambiente da Amazônia

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Instituto de Estudos Avançados da Universidade de São Paulo

FOREWORD

Contribution of the Amazon 4.0 Project to the Scientific Panel for the Amazon (SPA)

The Scientific Panel for the Amazon (SPA) is an unprecedented initiative convened under the auspices of the Sustainable Development Solution Network (SDSN). The SPA is made up of more than 160 prominent scientists and researchers from the eight Amazonian countries, French Guiana and global partners, who came together to debate, analyze and gather the accumulated and collaborative knowledge of the scientific community, the wisdom of indigenous peoples and other actors who live and work in Amazonian countries.

The SPA's main objective is to provide a comprehensive, objective, open and transparent platform to systematize information for a rigorous scientific assessment of the state of the Amazon's ecosystems. Based on this information, the SPA will examine trends and implications for the region's long-term well-being, as well as explore relevant policy options and opportunities for conservation and sustainable development in the Amazon.

To contribute to decision-making based on clear and reliable data, this rigorous scientific framework throughout the Amazon will explore public policy recommendations, based on the accumulated and collaborative knowledge of the scientific community, indigenous peoples and other stakeholders who live and work in Amazonian countries. It will also be the first time that a comprehensive scientific assessment of the entire Amazon Basin has been conducted.

There is an urgent need for a new sustainable development paradigm for tropical forests, with an innovative bioeconomy based on science of standing forests and flowing rivers, combined with capacity building policies for local communities with knowledge, education and technical skills. It will also evaluate innovative ways of valuing and combining traditional knowledge with scientific knowledge to further empower the Amazonian population.

The SPA explores potential sustainable solutions to advance sustainable development trajectories for the Amazon. Several members of the SPA advocate an innovative transformation in the Amazon with the vision of providing knowledge based on science, technology, innovation and strategic planning for the development of an economy of forests standing with rivers flowing, a bioeconomy driven by the rich socio-biodiversity of the Amazon. This innovative economy must have deep roots in the Amazon and should stimulate local and diversified bioindustries and value-added products throughout the value chain, generating jobs and social inclusion.

This innovative transformation seeks to combine the economic potential of Amazonian socio-biodiversity with new technologies and possibilities emerging from the Fourth Industrial Revolution, combining digital technologies, biotechnologies and materials science. It provides for: i) combining advanced scientific and traditional knowledge, ii) new business models and responsible consumers and iii) new forms of production based on intelligent technologies. This requires assessing the implications of a bio-economy of standing forests and flowing rivers, driven by their unique biodiversity. For instance, by training forest dwellers with tools to take advantage of the bioactive of the rainforest, for example, knowledge of the genomes of plants, animals and microorganisms. Or advanced industrial processing of numerous products from terrestrial and aquatic ecosystems.

This also implies demonstrating the viability of nature-based solutions, such as large-scale forest restoration as a natural mitigation action against climate change and for the protection of biodiversity, highlighting the many other ecosystem services. For example, forest restoration to reduce the risk of spreading pathogens that can generate successive pandemics.

The network of more than 160 scientists and other stakeholders, including some indigenous leaders - 2/3 of them from Amazonian countries - intends to propose and carry out the necessary research for a sustainable future in the Amazon. This goes beyond the launch, in the first half of 2021, of the Report with the rigorous scientific evaluation and will seek to make the Panel a permanent tool towards a resilient and sustainable Amazon.

In seeking solutions for the emergence of a new bio-economy of standing forests and flowing rivers, it is relevant to demonstrate that there is such a potential in biodiversity products. In this sense, the Initiative Third Via Amazonian and its implementation project Amazon 4.0 constitute an element to demonstrate how to add value to value chains of the immense Amazon biodiversity and how to enable Amazonian populations to master bioindustrialization technologies of forest assets. The following example deals with the potential to develop bio-industries in the value chain of two forest products with high potential: cupuaçu and cocoa through the development of the so-called Amazon Creative Laboratories (ACL). The SPA aims to create conditions for the full development of comprehensive sustainable solutions involving numerous activities such as those exemplified here for the immense variety of biological and biomimetic assets of the forest and rivers.

The Solutions Space will be addressed in Part III of the Report, which will bring solutions / recommendations based on the scientific knowledge brought in Part I and the lessons and challenges presented in the other parts of the Report, and experiences of the Amazonian peoples. Thus, the report will go beyond a synthesis of published scientific knowledge to include a discussion of sustainable solutions for the region and recommendations for policy makers on sustainable development strategies that contribute to public deliberations on the Amazon's environmental and social problems. In particular, Part III of the SPA Report has a specific Working Group to discuss models of a new bioeconomy of standing forests and flowing rivers, including the role that adding value via modern technologies can contribute.

Therefore, the ongoing development of the Amazon Creative Labs of the cupuaçu-cocoa chain, whose detailed project is presented in this document, will serve as an important experiment to guide several proposals being elaborated by the SPA. In addition, the implementation of the Laboratory for training exercises for Amazonian communities — planned for 2021, will bring important lessons on how to empower local populations to participate and directly benefit from the new bioeconomy model being proposed. Empowerment proposals for these populations is the theme of another Panel Working Group.

EXECUTIVE SUMMARY

1. The Amazon Third Way (Terceira Via Amazônica): a proposal for a vibrant standing forest bioeconomy with its rivers flowing, driven by Amazon sociobiodiversity.

The main objective of the Amazon Third Way/Terceira Via Amazônica (A3W) is to provide knowledge based on science, technology, innovation and strategic planning for developing a standing forest economy with its rivers flowing, a bioeconomy driven by the rich Amazon biodiversity. This innovative economy must have deep roots in the Amazon itself and not simply view the region merely as a producer of primary inputs for bioindustries elsewhere. It must also generate local and diversified bioindustries and products with added value in the value chain that provide employment and social inclusion.

2. Amazon 4.0: assets of Amazon sociobiodiversity + 4th Industrial Revolution Technologies.

To operationalize that innovative transformation, the "Amazon 4.0" concept was developed seeking to join the economic potential of Amazon sociobiodiversity with the new technologies and possibilities arising from the Fourth Industrial Revolution. These involve the use of modern technologies from that industrial revolution that is underway – the union of digital technologies, biotechnologies and material sciences. Such a differential drives "innovation ecosystems," planned associations of (1) advanced knowledge, both scientific and traditional, (2) new types of businesses and consumers and (3) new forms of production and intelligent equipment provided by the Fourth Industrial Revolution.

3. ACL – Amazon Creative Labs: a tool for immersive capacity-building.

Under the Amazon Third Way paradigm and its implementation strategy – Amazon 4.0 – the Amazon Creative Labs (ACL) were conceived, as a tool for training and for testing proposed concepts. The ACLs are grouped by themes, with specificities for each productive chain or level of biodiversity that one wishes to translated into a value chain. This study details the design and the technologies for a Amazon Creative Laboratory for the Cupuaçu and Cacao value chains – ACL C-C.

4. Creative Amazonian Cupuaçu-Cacao Laboratory

a. Overall context of the cacao and cupuaçu value chain

This work provided broad research into statistical data in the territories that lead production of cacao and cupuaçu beans in natura, leading to prioritization of planning for 4 Amazon states: Pará, Amazonas, Rondônia and Amapá – as well as Bahia. Together, those states account for 96% of Brazilian production of both fruits. Despite the large absolute numbers, the product is relatively insignificant in the current Brazilian economy, representing 0.002% of the GDP and employing only around 40 thousand persons.

b. Main conclusions of the analysis of value chains

The main conclusion of the evaluation made of the value chains for cupuaçu in the Amazon is that the fruit is under-utilized. It supplies a frozen pulp industry for food and for the cosmetics industry butter is extracted from the seed. In both cases value addition does not occur in close connection with production regions. Cupulate, which would be the product with the highest added value, is practically not produced on a commercial scale. In the cacao chain, it was found that production is predominantly bulk low-quality cocoa beans that are sold as a commodity to a chocolate industry based outside of the Amazon and Bahia. Production of fine cocoa for fine chocolate, which already exists in a few locations studied, is the main potential for attracting a strong cacao-based economy, using the so-called tree-to-bar production mode

to the Amazon and Bahia. The products should make use of the more than one thousand wild varieties of cacao in the Amazon, incorporating innovative recipes that also use other biodiversity essences for unique flavors and for the nutraceutical product market. Finally, local art may be used in the bars and shapes, making the origin and personality of the product a final and strong layer for adding value.

c. Phases of the productive chain and role of technological innovations

In this study, the Theobroma value chain was divided into four main blocks: fruit production; pre-processing and processing; marketing and logistics. Each stage or "link" in the chain is described as a sequence of processes and products that add value. As for production of the fruit, the base of the chain, techniques and technologies such as the use of GPS for mapping extractive zones and individual trees are arguments for following agroforestry productivity and management.

Pre-processing and processing are essential parts of the chain. They range from harvesting the fruit up till manufacturing cupulate and chocolate bars and involve all of the intermediate stages such as fermentation, drying, roasting, conching and others. Critical stages may be assisted by technological equipment such as digital refractometers (for measuring sugar in the fruit), digital thermometers with wi-fi, microprocessing oven with software controls, digital micrometer, 3D chocolate printer, RFID identification and others. This phase also include production of lyophilized cupuaçu pulp. The technological equipment chosen generally has an interface for digital data, which may be collected at each stage by a point-to-point tracking system.

Commercialization aspects cover innovative technological businesses (startups) for online documentation and processes, as well as digital platforms for sales and business models that produce their own products in laboratories. The logistics will have a theoretical and conceptual approach with demonstration of air transport using drones and cargo tracking systems.

There are various structural or crosscutting factors whose occurrence involves all of the links: sanitation and health aspects for the product and the participants, drinking water provision, waste sanitation and treatment; multiuse equipment; product, process and equipment development; packaging development; internet connectivity and local wi-fi network; clean and renewable energy and tracking equipment and systems. For each of these the ACL C-C will have specific technological solutions, as part of operations and capacity-building.

d. Implementation strategy in the field

In the field, the ACL will provide an exclusive environment for innovations in problem solving based on an approach with four aspects: collaboration, knowledge sharing, experimentation and open spaces for citizens. The target audience will be made up of local residents, especially farmers, women, entrepreneurs from the community or startups, graduate students or recent graduates in connected areas and other stakeholders who can generate combinations of knowledge and availabilities in order to cooperate and mobilize value chains, after the end of the capacity-building stage. This process will be directed towards Interactive Knowledge Fusion.

The laboratory will carry out an innovative training model directed towards incorporating new technologies in productive processes, that will also use cutting-edge technological resources in the teaching process itself. Control over technologies and tools will allow participants to (1) incorporate basic quality into the products, (2) add local knowledge, (3) add artistic and cultural personality, (4) incorporate certification of origin to processed products, (5) modernize business, logistical and communications aspects into their business for marketing.

The teaching strategy – which is an integral part of the Rainforest Business School concept, an element of the Amazon Third Way initiative – will be carried out in local events (in locations such as cities, villages, settlements and indigenous communities) with a duration of approximately of 6 weeks. Each edition will have a specialist from the value chain, a specialist in entrepreneurialism and new business and a teaching and production support technician.

The ACL physical structure contains a temporary modular geodesic building, with environments planned for capacitation and production, containing all of the equipment and technologies contained within the Amazon 4.0 for the Cupuaçu-Cacao chain. The entire Laboratory is made up of portable elements accommodated in containers that can travel by boat, truck or airplane to any locality in the Amazon.

5. Next steps and expected benefits

The immediate next step, given that this study has produced a first and detailed design for the Amazon Creative Lab Cupuaçu-Cacao, is to seek resources for constructing and assembling this ACL (architecture, equipment, pedagogical material of the training content, etc.), bringing together the human resources necessary for the enterprise and begin the activities for implanting the capacity-building experiments of the producing or potentially producing communities (pipeline systems for products, projects and talents, etc.), communities identified by this study.

In the short and medium terms, the plan is to set up a coalition of partnerships directed towards engaging startups, bioindustries, funding agencies, investments for impacting and inducing small and medium-sized sustainable businesses, advanced biology laboratories and technological innovation hubs.

Amazon Creative Labs must become tools for rapidly reducing the knowledge gap for peoples of the forest and also urban communities to bring forth this new forest bioeconomy of standing forests and flowing rivers. Empowerment of poor, mostly marginalized populations, with modern technologies is something disruptive and challenging and not practiced in the Tropics. However, there must be a search for rapid transformations in social and economic systems – the majority lacing tested models to copy – if we wish to leave a fair and sustainable society as our legacy for future generations. Amazon 4.0 is an attempt to show that it is possible to achieve a high stage of human development that combines valuing of tropical forest biodiversity with knowledge.

THEOBROMA

From the Greek *theos* (god) + *broma* (food).

"Food of the gods," was the name that Carl von Linnaeus gave in 1753 to the plant genus coming from the forests of the New World, which won over European palates and gave rise to a prosperous industry that lasts to this day.

At the beginning of the XIX century, the Dutch van Houten family introduced the manufacturing process using cocoa beans, turning them into powder so they could be mixed with milk. This new way of consuming cocoa established a definitive break between the locations with the vocation for producing the raw material and the locations able to manufacture a flavor desired by the market.

CONTENT

CONTACT

The Amazon Third Way - Amazon 4.0
Avenida Shishima Hifumi, 2911 - Sala 401
12244-000 São José dos Campos, SP
Email: poliana.boiba@amazoniaquatropontozero.org.br

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INTRODUCTION

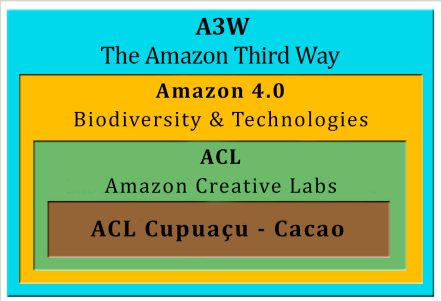
Overcoming the historical dilemma conservation of biodiversity and agriculture and ranching. Placing the Amazon in a position of leadership in technological innovation and bioeconomics. Converting the region into a storehouse of distinct knowledge, which come from the meeting between scientific-technological progress and the experience of peoples of the forest. **The Amazon Third Way represents a new form of organizing and producing knowledge.** It advocates equipping rural and forest producers with technologies, practical and training and environmental prototyping that will empower entrepreneurism for the standing forest.

Technologies for conceiving and manufacturing complex products, with high added value are being rapidly miniaturized and becoming more friendly. It is no longer necessary to have formal education and a large supply of capital in order to appropriate. That is why we can make a non-linear leap in the capacity for generating complex and decentralized economies based on biological diversity.

While inhabitants of metropolitan areas are competing in a market with increasingly scarce conventional jobs, the guardians of the forest have gained a new perspective with the technologies of the 4th Industrial Revolution: the possibility of becoming relevant stakeholders in the innovation industry, with redistribution of gains that can in fact favor a living and prospering forest in a new model for sustainable development that we are calling Amazon 4.0.

The Amazon Creative Labs (ACLs) are mechanisms for inducing that innovation by providing opportunities to learn about, experiment with and adopt technologies that will facilitate the manufacture of new artifacts with materials originating in the forest and invention of more efficient productive processes. With support from the Instituto Arapyaú, we have advanced in detailing an ACL dedicated to the *Theobroma* chain, including the fruits of cacao and cupuaçu..

We are about to begin the process of implementing this ACL. We will thus introduce an innovative and even revolutionary system for popularizing latest generation technologies and experimentation. Working in partnership with entities that encourage entrepreneurialism and strengthen the business environment, the ACLs will identify talents for formulating technological solutions and create pipelines for new products and processes that may become businesses. We hope to move forward on this path together with you.



The Amazon Third Way

AMAZONIA 4.0

Cupuaçu ACL Cacao

DESIGN AND TECHNOLOGIES FOR THE ACL CUPUAÇU – CACAO

MISSION

"Promote valuing of the biodiversity value chains through building capacity among persons of the Amazon for a new and inclusive bioeconomy".

THE CONCEPT OF AMAZON CREATIVE LABS

“Developing capacities for economic transformations that are inclusive and anchored in Amazonian biodiversity”

WHAT ARE THE AMAZON CREATIVE LABS?

• They support the development of a standing forest bioeconomy with its rivers flowing. They enable the discovery and use of Amazonian biological and biomimetic assets with support from the technological tools of the 4th industrial revolution.
• Transportable laboratories assembled for acquiring innovative knowledge and experimentation in countries that are rich in biodiversity.
• They empower local communities for sustainable socioeconomic transformations that value their natural and cultural environments.
• In collaboration with the Rainforest Business School, the ACLs provide case studies on generating value and forming value chains (like the Harvard Business School).

MISSION

“Promote valuing of the biodiversity value chains through building capacity among persons of the Amazon for a new and inclusive bioeconomy.”

VISION

“An integrated, prosperous and sustainable Amazon, driven mainly by its own people and maintaining the integrity of its ecosystems.”

WHY THE AMAZON CREATIVE LABS?

Build the capacity of Amazon populations for developing an inclusive bioeconomy in a sustainable manner

• Explore the potential for a bioeconomy founded on biodiversity, which is very large but not yet developed.
• Offer an option for the current development model based on intensive use of Amazon resources and bring prosperity to the Amazon populations.
• Use the most recent scientific and technological advances to allow the economic use of biodiversity resources within the locally developed value chains.
The Amazon holds the planet’s larges diversity of terrestrial species and is home to hundreds of unique cultures and languages.

FOR WHOM?

• People of the forest and agroforestry systems, potential entrepreneurs, the technological and startup community, favoring women and young people.
• Private sector leaders from local bioindustries.
• Representatives of civil society and the NGOs

TARGET AUDIENCE

• Populations living in the forest, riverbank communities and agroforestry system farmers already involved in an economy based upon biodiversity
• Young undergraduate or graduate students and startup leaders interested in innovation and entrepreneurialism for creating new

businesses in the Amazon.

HOW?

- Adjustable learning for better knowledge retainment
- Semi-structured learning program with flexible and adaptable content
- Personalized according to specific needs and contexts
- With help from technological learning tools, such as virtual and augmented reality
- Providing an environment with creativity, innovation and experimentation
- Exposing participants to equipment and technologies that can add value to local production
- Self-generation of new knowledge, technology and methods, complementing laboratory objectives
- Partnerships with teaching and extension agencies – SEBRAE, SENAI, EMATER, etc.

OPEN KNOWLEDGE AND DIGITAL NARRATIVE PLATFORM

Crowdsourcing methodologies for sharing:

- Experiences
- Good practices
- Success stories
- Solutions for value chains and biodiversity bioindustries

ENCOURAGEMENT FOR SHARED LEADERSHIP AND ENGAGEMENT

- Compelling and reciprocal learning process, through existential experiences.
- Work linked to the major stakeholders involved with Amazon and sustainable development communities.
- Shared leadership and co-development of solutions enables participants to disseminate solutions for their communities.
- Participants co-design and jointly develop prototypes for solutions that work best for the communities.

A MULTI-SECTOR PARTNERSHIP

Government
- Participatory action
- Identification of projects and financing

Public and private research agencies
- R&D oriented towards results

Private sector
- Promoting the program
- Human resources and knowledge
- Training of human resources, systematic training in Rainforest Business

NGOs
- Stakeholder involvement
- Implementation of training activities in the field

Rainforest Business School

- Learning strategies
- Methodological approaches
- Quality assurance and certification
- Knowledge diffusion
- Preparation of human resources along the productive chain in the market

EXPECTED RESULTS FROM WIDESPREAD IMPLEMENTATION OF AMAZON CREATIVE LABS

- Expanded capacities for creating, diversifying and distributing processes and services based on biodiversity with added value.
- Inclusive and improved socioeconomic development anchored in creativity, innovation and integrity for the ecosystems.
- Improved opportunities for partnerships.

Desirable context, outside of the original scope of the project:

- Continuity and follow-up in technology, education and/or legal assistance over the years/long term.
- Existence of a larger system that will encompass these Laboratories and a series of other lines of research and development, such as an "Amazon Bioeconomy Authority."

REFERENCES FOR CUPUAÇU AND CACAO PRODUCTIVE CHAINS THAT THIS ACL PROPOSES TO CHANGE WITH INNOVATIVE CAPACITY-BUILDING AND INCORPORATION OF HIGH-LEVEL TECHNOLOGY

Volatile wealth

Historically, cacao cultivation in Brazil has generated volatile cycles of undistributed wealth. Although was once a major worldwide cacao exporter, the main productive regions continue to be structurally underdeveloped. Regional opportunities for development have always been linked to primary activities, to rural production and pre-processing, meaning the links with the lowest value on the overall cacao value chain. Even in the overall chain, Brazil has never been a significant producer of fine chocolates, despite having all of the conditions for being one. We have never been able to reverse that situation, and today the country must import cocoa beans for internal consumption. In the Amazon, the place where cacao originated, production of cocoa beans in advances, but mostly following the commodity pattern, bringing small local and regional gains and facing stiff market competition from other heavyweight world producers (Africa and Asia). There needs to be, through the supply of local raw material, an enabling of verticalized value chains, with local and regional bioindustrialization. This can generate local businesses and jobs that can drive economic flow for the region.

Wasted potential

In the Amazon there is an abundance of native cacao, occurring naturally in a forest environment, with little or no use in economic activities. Cupuaçu, a fruit than is appreciated and consumed mostly in the Amazon region itself, is used mostly for its pulp (e.g. juices, ice creams, candies), and the seed is used for producing butter for the cosmetic industry, while also being the source for cupulate, a product similar to chocolate, with high added value. And even in terms of cupuaçu pulp, its commercial use is limited by its dependence upon a cold storage chain, due to the material being highly perishable, which restricts the economy of this chain to regional centers for processing and consumption. There is a need for showing a viable and objective way forward for transforming the wealth found in raw material existing in the forest, or obtainable through agroforestry systems, into products with high added value as a source of wealth distributed to populations living in the Amazon hinterland.

Quality and volume issues

Production of cocoa beans in the Amazon, as well as in Bahia, is above all directed towards the large-scale chocolate industry, which normally pays a low price for the raw material, but later corrects problems of quality from batches and suppliers with complex industrial processes. Only a marginal fraction is suitable for the gourmet chocolate market. And an even smaller fraction of local beans are inputs for the complete value chain of fine chocolate, with maximized added value. Seeds from cupuaçu made into cupulate have been used only for demonstrative purposes, although there is some commercial distribution at a few points of sale. With the small scale of local production, it is difficult to break into major markets, which supply large-scale demand for products. It is necessary to make production of cocoa and cupuaçu beans of superior quality and sufficient scale achievable in order to supply major markets for fine chocolate in Brazil and the World. That can be done by bringing together thousands of local producers, as long as the quality from each one is compatible for the same high standard of quality demanded by the market.

Bottlenecks for producing superior quality beans and fine chocolates in the Amazon

Processing of seeds into beans, and later into cupulate or chocolate has stages that because of their delicate or complex nature and considered critical stages. As performed with greater or lesser success, they lead to quite different results that directly impact the possibilities for verticalizing the respective value chains. The **critical quality stages** determine the final quality of the products and their added value, as well as the viability of winning over the market. **Critical creativity**

stages enable innovative products to be developed through transformation techniques, adding not only value and market possibilities, but also cultural aspects of peoples and locations that make the transformations

In terms of quality, if these stages are done with rudimentary techniques or inappropriate equipment, they lead to a great probability of variation in product quality. For these stages to be done with optimum results, there is an extreme dependence upon the personal skill of the producer, who is capable of observing and controlling aspects that are highly subtle, but drastically define results. This expertise is not, as a rule, available for all the regions that could benefit economically from implanting or achieving a qualitative turnaround in the cupuaçu and cacao productive chains.

In terms of creativity, the stages of transforming the beans into chocolate are windows of opportunity for making a differentiated product that is unique in its organoleptic and nutrition aspects. It becomes even more important for this aspect to be used and actively incorporated into local value chains that can provide for use of other inputs from the biodiversity that is broadly and generously supplied by the forest, for nutraceutical formulations, with antioxidant compounds that are rich in flavonoids, vitamins and others, derived from preparations of forest fruits or essences, or flavors and aromas that add unique and appreciated identities and qualities to the local product. Beyond flavor and moldability, chocolate and cupulate also allow the addition of forms, designs, patterns and colors in works produced by the producing community itself, or by artists representing it, in a process in which each piece becomes a cultural vector for export. The local varieties of fruits, authenticity in local production and the possibilities for biodiverse nutritional, flavor, cultural and artistic variations are strong arguments for offering to demanding markets products that have a strongly significant certificate of origin, clearly associated with the "Amazonian" brand.

The injection of new technologies into traditional processes as arguments for Inflection in the enabling of downstream vertical chains

The essential question that this Amazon Creative Labs sought to answer is:

How to transform the reality of low or no use made of the high potential existing for vertical cupuaçu and cacao chains, considering the specific critical variables of quality and opportunity?

And furthermore, how to escape the known and historical impeding factors that the Amazon vastness imposes on traditional and modernizing entrepreneurialism?

The answers come in the form of adding the high technology vector, accessible through the tools of the 4IR to the development equation. But it is not only that; we are also taking care to bring to the field and the local and regional scale technologies currently in use in the industry and the chocolate-making hobby, which will bring profound transformations to the Amazonian reality of producing fine cocoa and chocolate and cupuaçu derivatives. In this design for the Amazonian Cupuaçu-Cacao Creative Laboratory (ACL C-C), we propose a set of principles, equipment and new technologies selected and added to each stage for producing cupulate, chocolate and other derivatives of these fruits, with the potential for change

The intent is always to parameterize and control the transformation processes that affect the quality and standardization of the final product and that also open up extraordinary possibilities for incorporating innovative aspects to the product.

The formulation and tooling for carrying out the ACL C-C have also involved preparation for facilitating the receipt of techniques, knowledge and insights from participants in a process for creating and prototyping a broad spectrum of products obtained from cupuaçu and cacao.

The proposed level of technical incorporation includes:

Conventional mechanization
Machinery and technological instruments and
Systems with very high-level technology.

Two disruptive approaches have been adopted:

(1) using pre-existing technologies, considering that the uniqueness of using them for local production in the Amazon, directed towards communities, is a highly transformative factor.

(2) using state-of-the-art technologies in the processes involved because of the absolute newness of the technology and its intense transformative potential.

The ACL C-C design has sought to absorb already existing technologies for specific chains and also to bring in consolidated technologies from other types of chains or generic technologies to aid the local chain. At the boundaries, the ACL C-C will single out possible adaptations of technologies that exist, but that still demand some specific research and development efforts for use in the cupuaçu and cacao chain, or point out, and demonstrate when viable the newest technologies that are still appearing and may be on the market in a predictable future.

The ACL is a component for applying the Amazon 4.0 concept to the Amazon Third Way project, and is adaptive by design. It is hoped that each round (specific teaching event at a given locality) will bring new perspectives for technological use and that innovative business and commercial initiatives will be developed so that communities and trained persons can organize themselves for sustainable bioindustrialization of the Amazon hinterland and other natural regions, through non-timber inputs from local biodiversity.

The main productive chains covered by the ACL C-C begin with the in natura cupuaçu and cacao fruits and then move to the following market products: cupulate and chocolate, made from the full content of the beans with other possible ingredients being received in formulations; cupuaçu and cocoa nibs; cupuaçu and cocoa butter; cupulate and chocolate powder, produced from cupuaçu and cocoa bean cake; lyophilized cupuaçu pulp.

Fine chocolate from the Amazon and Bahia.

Brazil has great potential as a producer of fine cocoa, especially using the "Criollo" varieties, in which the fruits are large, generally present a thin and rough shell, dark green coloring when unripe, moving to yellow or orange as they ripen. They have large oval seeds, colored white to pale violet, with a great quantity of pulp and give a product of superior quality. The most disseminated varieties, however, dominating 80% of worldwide production and predominating in plantations in Bahia, the Amazon and producing countries in Africa, are from the "Forastero" group. Their fruits vary from calabash to melon-shaped, have flat seeds of an intense violet color and produce a cocoa known as the "basic type".

Figure 1. Cacao varieties: Criollo and oval seed (A), Forastero and flattened seed (B).

"Fine cocoa" refers to cacaos that present original aromas: whether notes (aromas) of fruits, wood, caramel, etc., or a pronounced and delicate cacao aroma. The final aroma present in fine chocolate has three origins:

Constitutive aroma: This is the aroma present in fresh beans. The constitutive aroma of cacao depends upon the variety of the plant (genotypes and phenotypes) as well as characteristics of the soil, terrain and climate where it grows naturally or of the management system utilized, when it is cultivated.

Fermentation aroma: This is the best known of all origins of the aromas, but it is exactly at this phase that the producer has a decisive role. It is known that the fermentation time varies according to the cacao varieties, three days for the Criollos and about six or seven days for the Forasteros. This time and the turning of the cocoa mass are defined by the temperature and by their pH.

Thermal aroma: This is the aroma that develops while roasting the cacao during the chocolate manufacturing process.

Competitiveness of cacao from the Amazon.

In 50 years of research in the Amazon region, CEPLAC in Pará has catalogued 25 thousand genotypes of wild cacao, from only 20% of the existing river basins that have been mapped. Each variety, in theory, can produce a bean with unique flavor, aroma and texture. And in such a biodiverse universe, the probability of finding varieties that allow production of a fine chocolate with strong market appeal is proportionately large. There is also the potential for obtaining a Geographic Indication (GI), seeking to identify the influence of climate, terrain and soil on the aroma and taste of cacao. Finally, Amazonian cacaos can obtain recognition for denomination of origin, as terroir cacao. Small fine chocolate factories in the Amazon are already successfully following that route.

In addition to factors linked to the nature and origin of the fruit, fermentation is a decisive process for making a fine chocolate. During fermentation of the cacao there is the action of microorganisms divided into 3 main groups, as well as others of less quantitative importance. In the Amazon 150 species of microorganisms are involved in the fermentation process, while on average 78 varieties are present in other producing regions. The yeasts alone (alcoholic phase), which begin fermentation, are 12 on average around the world, and 18 in the Amazon, in other words, 50% more. The rich Amazon microbiota are thus another important differential factor for defining an authentic and delicious chocolate, produced by the peoples of the world's largest tropical forest.

In terms of fermentation, some of the variables in the process are natural, depending on the varieties of plants and environmental microbiological characteristics. But another part of the process is totally the result of controlled practices. In that phase one may work to produce a good quality bean for fine chocolates and, more importantly, one may operate variables of fermentation substages in order to create flavor signatures in the resulting beans. To do that it is necessary to have precision fermentation, where the minimum quality parameters are controlled and advanced parameters for varying the process may be tested and established. Considering that fermentation parameters, as well as for roasting, also depend upon entry parameters (plant variety, origin, etc.), the entire set of possible regulated transformations is a blank slate for applying creativity, techniques and technology. From a distance it may look like alchemy, transmuting cacao fruits into black and white gold.

In Bahia, where cacao was taken for planting, the there is a reduced number of varieties available on a large scale, with no comparison to the enormous diversity in the Amazon. Nonetheless, it is still possible to produce fine beans and chocolate with strict cultivation, pre-processing, processing techniques and creative blending. One example of this possible creativity is through production of a chocolate blended with Cambuci, a wild fruit from the Atlantic Forest with a distinct flavor and rich in phenolic compounds and flavonoids. Using lyophilized Cambuci – a form of dehydration that safeguards the properties of the fruit – tests were performed for creating a new type of chocolate, a perfect marriage between a citric and herbal flavor with an intense chocolate taste in the background. The Cambuci chocolate was approved in a public taste test (in Brazil) with a 20 kg sample (AMMA Chocolates Orgânicos – Bahia).

Combinations may be made both to add flavor and aroma as well as nutritional qualities, providing a new market dimension to the product, functional or nutraceutical foods. Other additions can add texture, such as cashew nuts and distinctive colors and shapes for marketing "a product that is healthy for you and for the rainforest." In fact, the creative possibilities for producing chocolates using Amazon and Atlantic Forest biodiversity are practically unlimited and the ACL C-C will be a technical training platform for co-creating and prototyping in that universe. Lyophilization of cupuaçu pulp is one of the processes covered in the ACL C-C. Since the process is similar for most fruits, implementing the ACL can involve incorporating tests of other local ingredients that may be present at each location.

In the proposed model for implementing the ACLs, with training activities for interested communities and with the potential in each location participants will learn and assess the organoleptic quality of cacao varieties existing in the region for the purpose of identifying diverse aromatic properties in the plant, as well as the beans and chocolates it produces. The great variety in cacao and cupuaçu plants is a potential comparative advantage for the Amazon. Through partnerships with research and development centers and universities, one may also perform advanced laboratory analyses of the respective physical and chemical parameters of products in the chain, from the plants to the chocolate (specific techniques, materials and equipment for that type of physical-chemical characterization, performed at discrete and scattered events during the process, are not part of the scope of the ACL C-C training). On the other hand, one of the ACLs being proposed in genomic, which may be used for capacitating communities in determining the genome and other biological properties of cacao and cupuaçu varieties.

We will next describe the main stages in the value chains for chocolate manufacturing, with most of them being identical for producing

cupulate, a new item very little used in the chocolate market. One should note that there are two dimensions involved in transforming cacao into chocolate: industrial, with its own processes, machinery and scales, and traditional, which retains classical knowledge and techniques (such as the use of millstones instead of grinders with metallic pins). The traditional methods, instead of becoming obsolete with the advance of the industry, have been incorporated into the movement for micro-producing fine chocolates known as bean-to-bar (BTB), led by a population of enthusiasts and commercial micro-producers.
In the industrial processes it is common to have standardization of the cocoa components, separation of fat, re-addition of fat (not always from cocoa) broken down into many stages of transformations that regulate and of the physical-chemical, sensory and organoleptic parameters of the resulting product. Thanks to that model it is possible to transform low-quality cocoa beans, the absolute majority produced in Brazil and worldwide, into a product that is certified by the regulations in effect and approved by the consumer market.

In the traditional process, the final product, chocolate in this case, is much closer to and dependent upon the initial product present in the cacao seed. There is only the minimum processing necessary to reveal the natural flavors of the cocoa and naturally remove (conching) the undesirable residues of the original substances in the seed. The chocolate is 100% pure and is basically the fermented and dried cocoa bean mechanically transformed and lightly heated and chilled. During research for this work sensory analysis were made using tastings of that traditional chocolate produced in the Amazon, Bahia and Espírito Santo and the team was impressed in being able to identify particular notes of aromas and flavors in the chocolates. Even in compositions with 70% cocoa, one did not observe high levels of bitterness and astringency, but instead pleasant variations in terroir, as well as smooth compositions with aromas and textures of other Amazon essences, a tendency with local chocolate production.

Considering that the ACL C-C has the objective of facilitating local transformation of forest or agroforestry products into consumer products with high added value, involving small or medium scale industrialization, the traditional means of production was chosen as the focus for capacity-building. That technique and traditions also add desirable factors such as manufacture of whole chocolate, minimum additions of inputs such as sugar or even raw cake sugar, considering logistical, economic and product image issues, which maintain its best properties as a healthful food. Nonetheless, ACL C-C incorporates instruments and technologies into the processes to guarantee a quality bean and a fine chocolate as the standard for production, cancelling most factors that contribute towards less than satisfactory results and maintaining the possibility for participants to create their own processes and products. In the theoretical portion of training, participants will learn about all the processes, equipment and technologies available in the chocolate industry as a whole. The practical part will intensely focus on the traditional mode of making chocolate, from bean to bar.

To summarize, the laboratory will provide an innovative model for local capacity-building seeking objective appropriation of advanced knowledge of value chains connected to cupuaçu and cacao. The innovation with the ACL comes from the disruptive possibilities provided by new 4IR technologies for local and regional development of such chains. Technical mastery of techniques and tools will enable

(1) incorporation of basic quality into the products,
(2) adding of local knowledge,
(3) adding artistic and cultural personality,
(4) incorporation of certification of origin for the processed products and
(5) modernization of logistical and communication aspects for marketing.

The ACL C-C begins, in practice, with harvesting the fruits. Knowledge linked to cultivating cupuaçu and cacao trees in the forest environment will be the object of the theoretical portion, above all to understand the relation of those practices with the availability of fruits in the quantity and quality necessary for supplying the local processing chain.

Below is a succinct description of the various phases for processing cacao and cupuaçu, with a special focus on technological innovations proposed for the ACL C-C. More complete descriptions of the stages of processing cacao for producing chocolate can be found in the following references: Barel 2009; Ferreira 2013; Nazaré 1990 and Scudeller 2009.

PHASES FOR PROCESSING CHOCOLATE / CUPUAÇU

Although the details, types of machines and techniques vary from one chocolate manufacture to another, the basic foundations for making chocolate are described below (Stone Hill 2019).

There are two main stages that the cacao seeds need to pass through in their journey towards becoming chocolate, which are: Pre-processing and Processing (Figure 2). However, the Pre-processing stage consists of 2 substages, Pre-harvest and Post-harvest.

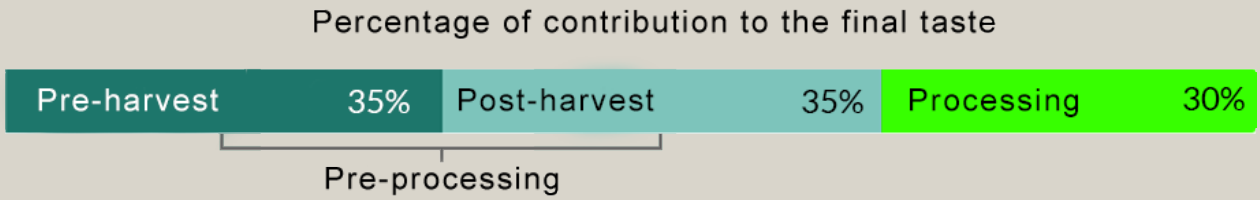


Figure 2 - Phases of chocolate manufacturing as a percentage of contribution to the final taste.

The pre-harvest and post-harvest stages each contribute approximately 35% to the final result with chocolate, while processing contributes the remaining 30%.

PRE-HARVEST

This stage mainly involves the agricultural side of cacao production, which includes selecting varieties, cultivating plants, applying fertilizers and controlling pests and diseases. The pre-harvest stage also involves the existence of wild varieties, a differentiating factor that is especially important in the case of the Amazon, where Cacao is native to the forest and grows in different types of soil and climate regimes.

POST-HARVEST

This stage mainly involves treatment of fresh cacao pods in order to turn them into fermented dry cocoa beans and prepare them for processing, which includes fermentation, drying and storage.

PROCESSING

This stage refers mainly to processing the dry fermented cocoa beans into chocolate, which includes roasting, breaking, cutting, grinding, conching, tempering and molding the chocolate.

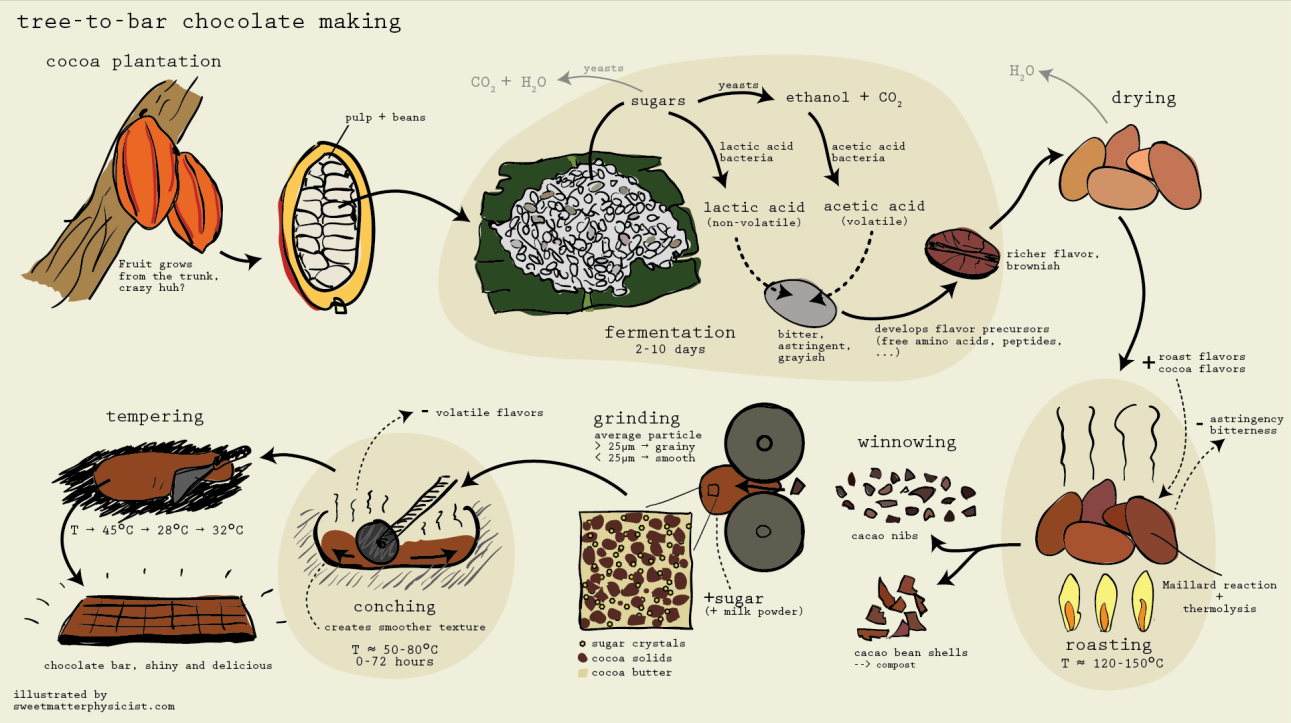
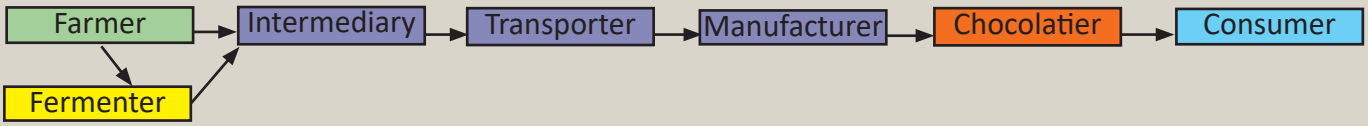


Figure 3 - Schematic diagram of the main phases of transforming cacao into chocolate (Sweet Matter 2019).

IDENTITY IN THE TRANSFORMATION CHAINS: TREE-TO-BAR CHOCOLATE

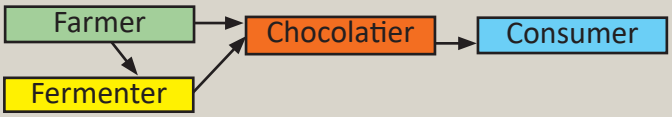
There are 3 main categories and one subcategory of chocolate in which the final product is not produced by large-scale industry, based on supplying the material:

Bulk-to-bar:



Also known as industrial chocolate, this is how almost all the world's chocolate is made. Dry cocoa beans of various origins from around the world are brought to a single large factory where they are processed into blocks of chocolate. A chocolatier then melts those blocks of chocolate, adds his or her personal touch to it, tempers it and molds it for distribution and consumption. The tile of the bulk-to-bar manufacturer begins with the finishing stages of the chocolate. Because it comes from all over the world, bulk-to-bar is almost always available with highly consistent quality thanks to the standardized industrial value chain. However, this also means that unique varieties of beans may be lost. Furthermore, because the supply comes through the merchants who are led to buy in large quantities, a commercial system is formed that is generally unfavorable for small farmers and extractivists.

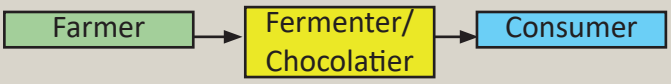
Bean-to-bar:



The growing consciousness of consumers in recent years has led to the Bean-to-bar type of chocolate, sometimes referred to as niche chocolate. With bean-to-bar, the chocolatiers, who manufacture the chocolate, go straight to the sources: the farmers themselves. They buy beans from the farmers or ferment and process the beans into chocolate. They can dispense with the merchants and intermediaries and offer the farmers a much better price. At the same time, they can have the luxury of being more selective, buying only from farmers with quality products, which can offer fair working conditions for their employees and family members.

Bean-to-bar manufacturers may employ traditional methods and equipment for manufacturing chocolate, such as a small oven for roasting and a millstone. The role of the chocolatier begins at the processing stage. Although most of the characteristics of the cocoa have already been established, they can still strongly influence the results with their products though their choice of suppliers, method for roasting the beans and method for processing the chocolate. Bean-to-bar products made from a single source are called Single Origin Chocolate. Although it is not totally documented, it is estimated that only 1% (probably less) of the world's chocolate is produced in this crafted manner.

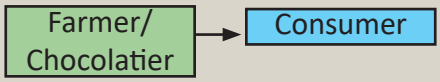
Pod-to-Bar:



This is the middle way between Tree-to-Bar and Bean-to-Bar, where the chocolatier, the chocolate manufacturer, also operates as the fermenter. This allows the chocolate manufacturers to have major control, since they can develop and apply their own fermentation techniques and recipes, creating a batch of dried fermented cocoa beans that are signed by the chocolate manufacturer. This difference in the development of the precursor to the aroma by the chocolate manufacturer will be transferred during processing.

The role of the chocolate manufacturer in "pod-to-bar" chocolate begins at the start of the post-harvest phase. The chocolate manufacturer buys fresh pods from the farmers, and then ferments, dries and processes the beans.
AThe reason why pod-to-bar is a sub-category is that it is so rare as to be almost nonexistent. Because of the logistical difficulties with transporting fresh cacao pods, chocolate manufacturers prefer using bean-to-bar, in which farmers do the fermenting and drying while the chocolate manufacturer handles the processing.

Tree-to-Bar:



This is considered the 1% of the 1%, given that less than 0.01% (probably much less) of the world's chocolate is tree-to-bar. In tree-to-bar, the farmer is the manufacturer of the chocolate. That reduces the entire supply chain to a single point. Since they farmer and the manufacturer are one and the same, he or she has total control over what to plant, what to use as fertilizer, how to care for employees, the trees, what to spray, how to ferment, dry, store and process the cacao. To sum up, they have total control over the value chain (Figure 3).

By design, Tree-to-Bar is at least a single origin, if not a single farm. That puts the burden of responsibility for quality, consistency and standards exclusively on the farmer/chocolate manufacturer. The farmer/chocolate manufacturer needs to have extensive knowledge of the entire supply chain, including growing practices, post-harvest protocols and know-how for processing chocolate. That is the objective of the ACL C-C and it will be enabled for the reality of Amazon and Atlantic Forest communities with the help of the new technologies that the ACL incorporates.

VALUE CHAIN FOR *THEOBROMA*

For this study the value chain for Theobroma has been broken down into four main blocks:

1) Producing the fruit
2) Pre-processing and processing
3) marketing and
4) Logistics

Each stage or "link" in the chain is described as a sequence of processes and products. The focus of the ACL C-C is on technological innovations that will enable production of products with high added value through use of non-timber products from biodiversity. The teaching strategy involves local events with approximately 6-week duration. Thus, the main load of content and activity falls on Link 2, during which practically all of the stages up to the desired products can be completed. Link 2 will be described in greater detail from pages 20 to 37.

Link 1 is the agroforestry and extractivist portion. Capacity-building for this stage is a long-term activity. The key aspects in this stage will be dealt with as theoretical content about the nature and relevance of the actions. There will be training in some techniques and technologies, such as using GPS for mapping harvesting zones and individual trees in order to track productivity.

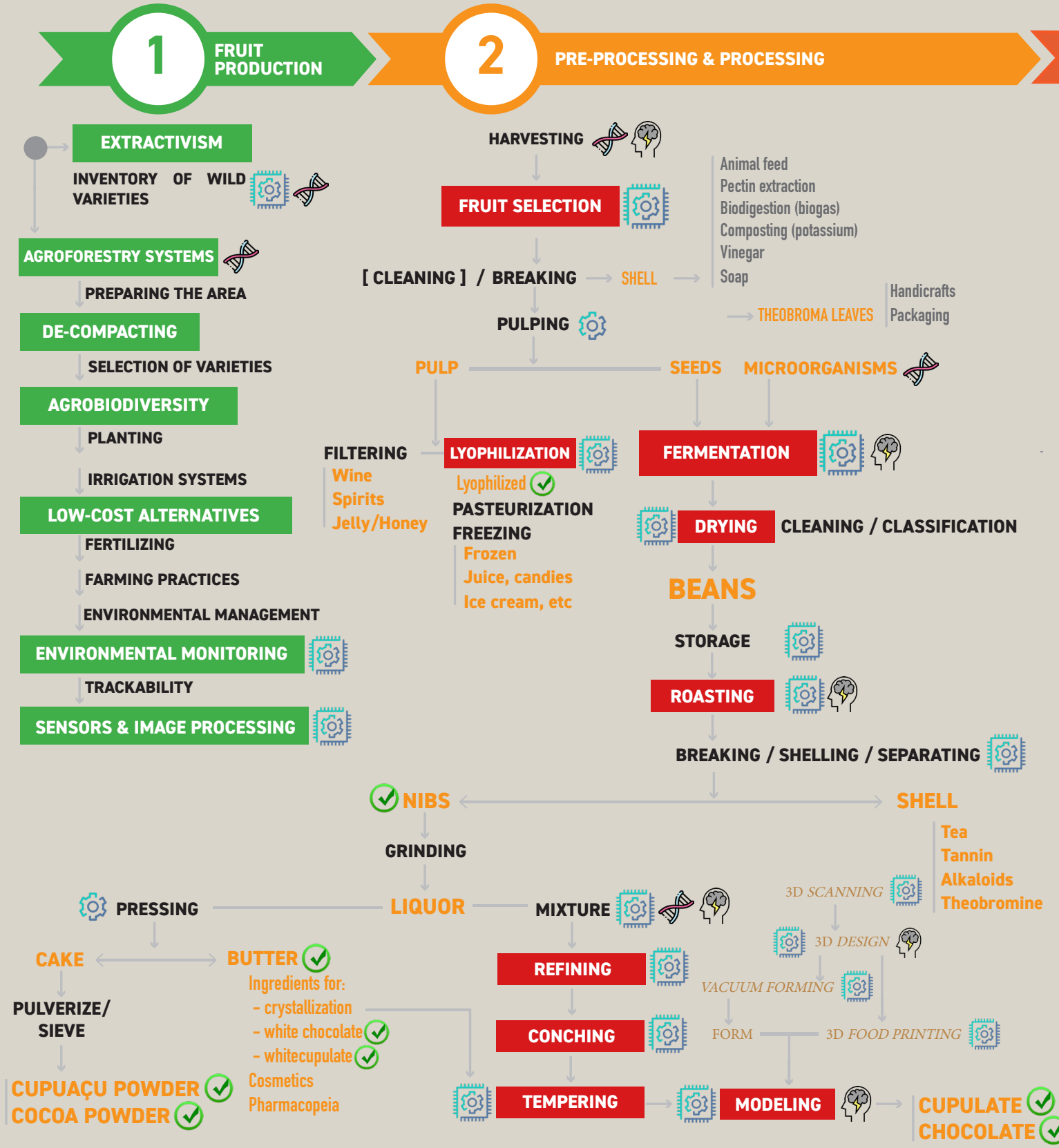
Link 3 will be approached the same way. Documentation technologies and online processes will be the focus for training, as well as existing commercialization platforms and models with the products actually prepared in the laboratory. Marketing in itself is a process that depends on factors that are not generatable during the ACL; it is a result expected to occur after appropriation of knowledge and actions later on by the participants and other typical actors (funders, business forming, startups, etc.).

Link 4, logistics, will have a conceptual part and a theoretical part, with demonstration of air transport using Drones and load trackability systems.

There are a number of factors that are defining or cross-cutting, their occurrence involves all of the links: potable water provision, sanitation and waste treatment; multi-use equipment, product, process and equipment development, internet connectivity, clean energy and trackability equipment and systems. For each one of these the ACL will have specific technological solutions, as part of its operation and training.

The diagrams on pages 22 and 23 show the main elements of the *Theobroma* value chain.

THEOBROMA VALUE CHAIN



3 MARKETING

GENERATING DEMAND

- BUSINESS INTELLIGENCE

BUSINESS FORMALIZATION AND MANAGEMENT

- ONLINE DOCS AND PROCESSES

MARKETING SYSTEMS

- PLATFORM APPROACH

BRAND MANAGEMENT

- GEOGRAPHICAL IDENTIFICATION

4 LOGISTICS

TRANSPORTATION

- CARGO DRONES
- LOGISTICAL GROUPING SYSTEMS
- CARGO TRACKABILITY

COMMUNICATIONS

- NEW WIRELESS SYSTEMS

Legend

LINKS IN THE CHAIN

PROCESSES

CRITICAL PROCESS

→ PRODUCTS

By-products

DEFINING OPPORTUNITIES

- Product with added value, a preference for the ACL C-C
- Processing requalified with 4th Ind. Rev. technology
- Introduction of Mechanization
- Addition of Resources from Amazon Biodiversity
- Addition of Local/Amazonian Creativity and Identity

MULTIUSE EQUIPMENT

PACKAGING DEVELOPMENT

TRACKABILITY EQUIPMENT AND SYSTEMS

TECHNICAL ASPECTS OF PROCESSING IN THE ACL C-C

Pre-processing phases for Cupuaçu and Cacao

Choice

Before harvesting, it is necessary to choose the ripe fruits. It is important to observe if the fruit is really ripe, since the indicative visual characteristics differ between varieties. Each cacao variety has a specific volume of pulp, as well as a specific quantity of sugar available in the medium, which varies according to climate conditions and the degree of fruit ripeness. The amount of sugar is the first control parameter for producing fine cacao seeds, since it will influence later fermentation processes. The correct ripening of the fruits also defines the presence and concentrations of chemical compounds in the seed that will compose the aroma and taste of chocolate at the end of the chain.

Technological Innovation. There are devices that can measure the concentration of sugar present in the cacao pulp, such as the manual refractometer. This is very much used in the pulp and fruit candy industry. The measurement is determined by the level of soluble solids present in the pulp (º Brix). The ACL C-C will use digital refractometers to generate tracking data for the controllable factors that influence the quality of products in the chain.

Harvesting

To harvest cacao for manufacturing fine cocoa, it is recommended that the appropriate tool be used (pruning hook), so as not to injure the tree and also to not damage the fruit; any crack in the fruit pod will allow air to enter and begin fermentation, which will lead to a mismatched fermentation and a final product that is "not uniform." Consequently, the fruit on the ground should not be picked up by sticking the machete point into the fallen fruits to lift it into the basket (a common practice). One should use a grapple with a shaft or some other tool that can collect the fruit from the ground without interfering in the integrity of the shell.

Selection

The first selection can be made in the harvest area itself where one separates the "not conforming" fruits from the fruits in ideal conditions, in other words, one makes clearly marked piles, with fruits that are visually "perfect" ripe fruits, separated from others that present some kind of disease, such as "black pod rot" (Phytophora spp. Fungus), "witch's broom" (caused by the fungus Moniliophtora perniciosa, previously called Crinipellis perniciosa) – or fruits cracked by the harvest fall, bored into by animals and birds, unripe, half-ripe or overripe fruits, etc. Infected fruits are separated from the healthy ones. Infected or diseased fruits do not produce quality beans. As many piles as necessary should be made. This selection ideally should be made in a hut near the fermentation shed, among other things because we can make a chain of custody, leading to new subsidiary chains, such as using the shells for composting, or for animal feed, for isolating pectin or for making soap. Cacao fruits without any holes can stay in the cacao pile for up to four days (at the most) until being taken for fermentation; this practice helps to concentrate the sugars in the pulp and thus improve the quality of the cacao.

Breaking

This consists of opening the fruit in order to remove the seeds for fermentation, and may be done with a machete, club or mechanically. Ferreira et al. (2013) also recommend that the cracking open be done at a site protected from the rain; be done over a plastic tarp or banana leaves to avoid undesired contamination; that on opening the fruit, one must assess the shine and viscous consistency of the pulp, removing all the seeds from the shell by hand, pulling them from the inside out; that the seeds be poured into clean containers, which can be plastic bags appropriate for soft cacao, milk jugs or plastic boxes with lids, which will transport the cacao to the fermentation sites; that during breaking, wastes such as the "sibira," a film covering the seeds and pieces of shell or peduncles. What should go on for fermentation is exclusively the seeds covered by the pulp; so that the plastic bags or whatever material is utilized should be closed to avoid air contact with wet cacao.

Selection

After breaking we observe the characteristics of the seeds and the pulp, because it is at this moment that the first selection will be proven valid or not, since some fruits have colors that visually trick the harvester as to their ripeness or there may be diseases or even germination). Ferreira et al. (2013) note that, after cracking, the wet cacao must be taken immediately to fermentation; that one must not mix soft cacao from fruits cracked on different days (there is a loss of quality, because of lack of homogeneity in the batch); that one should avoid contact of the soft cacao with rainwater. In the case of rain, the cacao must be immediately covered with plastic tarps, as should be done with the area where the breaking open is being done; that it is necessary to gather the cacao shells (right after breaking) in a single pile at a distance from the trunks of the cacao trees; if the breaking is done at the plantation, one must cover up the shell pile to avoid development and spread of diseases among the cacao trees.

Fermentation

Fermentation of cacao is defined as a microbiological process, of enzymatic action and improvement of flavor, a decisive stage in the process of making fine cocoa and in determining the sensory characterization of the chocolate. The beginning of fermentation happens with the yeasts (alcoholic phase), which metabolize the sugars in the cacao pulp and transform them into carbonic gas and alcohol, when the temperature of the mass of seeds in the trough rises to 34o C, almost always in 2 to 3 days. It is the ideal working temperature for the anaerobic lactic bacteria, which produce lactic acid, which is a residual substance, meaning that it will not leave the product, not even during conching, during the chocolate-making process. So, to keep this group from doing its work, the mass is turned over at least once a day until the end of fermentation, thus promoting entry of air into the mass and inhibiting the development of lactic bacteria.

At the same time, the acetic bacteria, which produce acetic acid or vinegar, develop and transform the alcohol produced by the yeasts into acetic acid, which promotes a crack in the "brow" of the beans and allow a range of substances and metabolites to enter the cotyledon. These, for their part, set off another group of biochemical reactions, which form substances called aroma and flavor precursors. This process peaks in seven days on average. The troughs where the fermentation occurs are usually made of wood, and are cubical, rectangular or even round, like a wine barrel, but may be made of polyethylene, metal or other materials.

To perform precision fermentation the ACL C-C will use the thermometer methodology (Barel, 2009), which consists of doing the first turnover when the internal temperature of the mass reaching 31-32o C. After that, it is necessary to continue measuring the temperature (for example, every 12 hours). Every time the temperature drops significantly, the mas should be turned over. On the fourth or fifth day after the fermentation process begins, one can see emerging from the inside of the beans a dark, reddish liquid popularly called the "blood" or "bile" of the cacao. This liquid ("blood") indicates that fermentation is proceeding correctly and that after one or two more days the beans will be ready for drying. During the last days of the process (sixth or seventh day), one should due the cutting test (longitudinal) on 50 fermenting cocoa beans in order to observe: 1. Formation of a dark-colored ring around the bean (on the edges). 2. Transformation of the internal coloring of the beans that will be from violet (beginning of the process) to brown (end of the process). 3. The appearance of channels or veins inside the beans (beginning of compartmentalizing). The whole of those factors, added to a significant drop in the temperature of the cacao mass, indicates the final point of the fermentation process and the beginning of drying. This is one of the most important moments in fermentation, because after this point, the cacao can begin to over-ferment, which can generate products with disagreeable aromas and tastes.

The temperature of the cacao mass is generally measured by inserting a digital thermometer with a shaft, and it its necessary to tabulate the control data so as to accompany development of the cacao mass throughout the fermenting process. Automatic temperature measuring is a resource generally restricted to major cocoa processing plants. In most locations in the Amazon where this stage of processing is done methods are used that prescribe a fixed routine of procedures according to the type of cacao being processed.

Introduction of Technologies. In this ACL C-C, moving the logic for using high tech to small and medium-scale local production, an electronic temperature sensor with a Data Logger and data transmission via wi-fi network with online and offline operation will be used. The equipment stores the data collected and sends them to a local server or one on the web. It can be configured for the desired measurement interval and to send e-mail or SMS alerts when changes in temperature occur (e.g. when it is necessary to act directly in the fermentation process). In this ACL C-C automatic measurement of a basic parameter together with the Internet of Things technology (IoT) is a demonstration of the possibilities provided by the 4IR to enable bioindustries that use biodiversity assets. One can see on the horizon a relatively short research and development path towards automatic the turnover of the cacao mass with mechanical paddles or servo-actuated rotating cylinders with the possibility for precisely controlling the atmosphere (airtight lids

and air circulators) to establish manageable aerobic/anaerobic fermentation curves with induced variations in order to create specific aromas and flavors in the chocolate. It should be noted that any and all technology developed by the ACL C-C team will be open and available to any and all communities that wish to use it. On the other hand, technologies and traditional knowledge coming from the communities will be recorded in a blockchain system. As a result of the ACL training activities it is expected that several startups, companies and bioindustries will appear and will also develop technological advances.

Regarding pre-processing of cupuaçu, from which the pulp is removed beforehand from the seeds, several methodologies are employed. There is fermentation similar to that of cacao, taking into account temporal peculiarities of the species, there is fermentation with the addition of sucrose to the mass of seeds, but there is also, as was discovered during the research that informed this planning, the possibility of not using fermentation. This innovative technique was learned during a visit to the Women's Association in Belterra, PA. There, the raw seed is submitted to drying and then roasted, still containing fragments of the pulp removed. Cupulate obtained with this process was produced experimentally by the De Mendes chocolatier in Belém, PA, and presented excellent texture and a distinct fruity aroma. The ACL C-C proposes to explore this method for producing cupulate, since simplifying process while maintaining or increase quality is a guiding concept of the Amazon 4.0 concept, which drives our planning.

Technological Innovation. In the case of using cupuaçu, the fruit will be pre-washed, washed in chlorinated water, cracked open, the seed will be removed from the fruit with a motorized mechanical pulper, and next lyophilized in a specific machine. The final product can be used in chocolate or cupulate formulations or be one of the options for a product with greater added value in the ACL model for local verticalization of productive chains. Lyophilization increases the time the product can be stored compared with the fresh fruit from hours to months, does not need a logistics system requiring cold storage and reduces the weight of the material by about 90%, helping solve transportation logistics issues. Lyophilized cupuaçu pulp has wide-ranging uses in other value chains for beverages, candies, ice creams, dairy products and others. The lyophilized product simply needs to be rehydrated to return to its original state, with preservation of its structure, appearance and most of its nutrients. The same lyophilization equipment for the pulp can also be used for other fruits from the region, for creative compositions with chocolate or other possibilities that may arise.

Drying

At the end of fermentation, the cacao, with 40 to 50% moisture, goes to the drying stage. During the drying of the cacao this moisture is reduced and some enzymatic reactions (begun with fermentation) which will give the beans the characteristic flavor of cocoa and chocolate are finalized. Drying is done in plastic heating chambers or flat surfaces heated by sunlight, which take about 5 days to reach 6 to 8% moisture, and may last up to 12 days. During the process the beans are periodically turned over for uniform drying. This is a critical phase of the process; slower drying allows one to eliminate the compounds that give the bean lower astringency. On rainy or cloudy days one most intensify turning over of the beans to avoid mold forming on the cacao mass.

Technological Innovation. For this phase the ACL C-C will use a precision instrument for measuring the moisture of the cocoa beans. The precise moisture of the beans (7%) is critical for concluding the drying phase. It also serves for learning the drying profile for each environment and climate condition. The moisture level is part of the trackability history for each batch of cacao, together with the parameters and records verified during fermentation.

Processing beans for manufacturing Chocolate/Cupulate

Roasting

Roasting is a delicate phase of the process for making fine chocolate, since the precursor substances for aromas and flavors formed during fermentation are transformed into aromas and flavors and making this happen depends on knowing as much information as possible about the material one is going to roast, such as moisture, acidity, cacao variety, product to be produced and even the consumers. During roasting the reaction of sugars and peptides known as the Maillard reaction occurs; these reactions form more than 500 new compounds, consolidating the chocolate's sensory profile. Considering these factors, one chooses the time and temperature for roasting. Another crucial factor is the technology of the roaster; there are several, varying in size, heating sources and sensors.

Technological Innovation. Because this is a critical stage for quality, the ACL C-C will incorporate the use of a specific oven for Cocoa beans, which can also be used for Cupuaçu. It is an intelligent, micro-controlled oven, equipped with a K thermocouple system with software for the roasting curve.

Shelling
A simple step, though one must take into account losses during tests, which cannot exceed 11%. It consists of breaking open the bean and separating the skin, resulting in the Cocoa or Cupuaçu Nibs.

Technological Innovation. The ACL C-C will use an automated shelling unit, with a cyclone filter system made entirely of stainless steel to crush the beans and separate out the nibs.

Pre-Grinding
This consists of grinding the materials or ingredients to be used in the formulation, such as sugar, which as a rule is an abrasive for the equipment. Depending on the size or production capacity of the factory, the technology can range from a blender to powerful cutting mills.

Technological Innovation. The ACL C-C will use a high-performance stainless-steel commercial blender.

Mill
This also depends on the production scale in order to apply the best technology, and will vary in quality, size and time. There are various technologies, ranging from the classic melangers, which consist of wheels and a hard granite bottom. These were the first mills used in the industry and are still very much used by the bean-to-bar movement, but there are also roller, ball and pin mills. The function of this stage is to grind the cocoa and sugar particles down to a size below 32 microns. In the case of melangers, they shear, conch and refine all at the same time. The ACL C-C will use a melanger exclusively for all these activities. The melanger was chosen because it is an instrument still used for small-scale manufacturing and because it is compact, in line with the ACL mobility concept. The model chosen has a variable electricity demand function to reduce electricity consumption at night, when the Laboratory will run on batteries with the solar panels not operating. Its typical usage regime is 24 to 36 hours, during which it must not be turned off, since it operates with melted chocolate that under no circumstances may be allowed to chill and harden.

Conching
Except for the melangers, the other milling techniques need a conch, which is a system for moving the chocolate mass with controlled hear, for the main purpose of eliminating the metabolites produced in fermentation that can produce an unpleasant taste in the chocolate, such as alcohol, water and acetic acid. On the other hand, it produces emulsion and shearing in the mass. Technologically, it is a relatively simple device. The conch can be longitudinal to transverse in terms of moving the mast and it can have an exhaust fan. The chocolatier and the quality of the cocoa will determine the conching time.
Tempering – or pre-crystallization, consists of putting the chocolate mass at a temperature close to 450 C in movement and reducing it at a rate of 2.20 C/minute until it reaches a temperature of around 270 C, depending on the type of chocolate. It involves seeking the most stable ways to crystallize the cocoa and cupuaçu butter, in order to add luster and resistance to melting. There are some technologies available for this equipment that can set controls over temperature, time and movement.

Technological Innovation. The ACL C-C will use a Fixed Temperature Unit, a micro-processed technological device that stabilizes the crystal in the cocoa butter. This same device is used for heating the forms for the chocolate. Cooling – depending on the scale, one can use a domestic refrigerator or a cooling tunnel with a conveyor belt. It is vital that the temperature in the production room be perfectly controlled so that there is no difference greater than 100 C between the ambient temperature and the chocolate piece, because that can make the water in the air bead over the piece and the chocolate will become blotched and viscous.

Melting
After it is ready, the chocolate can be melted and molded. For melting it is important to use equipment with precise temperature control and a mixer, which will guarantee complete homogenization of the chocolate mass as it melts. That way one obtains a totally liquid mass, free of solid chunks.

Technological Innovation. The ACL C-C will use equipment that includes a mixer and a high-precision programmable controller (PID), in whose tank the chocolate will be always kept at the right temperature.

Formatting
At this stage the chocolate or cupulate receive their final form. In the classical style the melted mass is placed into pre-molded forms that can be made of various materials. Next, the forms are carried to a machine that applies a controlled vibration that eliminates the air bubbles inside the forms, so that the chocolate bar will perfectly adhere to them.

Technological Innovation. At this stage of production, the ACL C-C will offer the possibility of the forms being produced in a creative and artistic process, by the participants themselves, and to that end will have new technologies available. Through 3D design software or a 3D scanner, volumetric sculptures can be created in CNC sculpting machines and then transferred by thermal vacuum technology into plastic chocolate forms. The idea is to make the chocolate and cupulate made at the site a means for expressing the biodiversity and also the social, cultural and artistic traits that make up the socioenvironmental whole of the place where the product was conceived and produced. Also, in the formatting environment for the final product, the ACL C-C will have a 3Dprinter for the chocolate, that will directly print the design developed by the participants onto the edible piece (+ Packaging).

Cocoa and cupuaçu butter

Separation of the whole mass of cocoa or cupuaçu into butter and the so-called cocoa/cupuaçu liquor or cake will also be done at the ACL C-C.

Technological Innovation. For this process we will use an extruder entirely made of stainless steel. The use of this material is crucial for preventing oxidation and proliferation of pathogens in the processing machinery. The butter is used to make white chocolate/cupulate and the liquor is used to produce powdered and partially defatted chocolate and cupulate. All of these byproducts can be local products of the local chain, for which there has traditionally been a demand or produced by other processing companies.

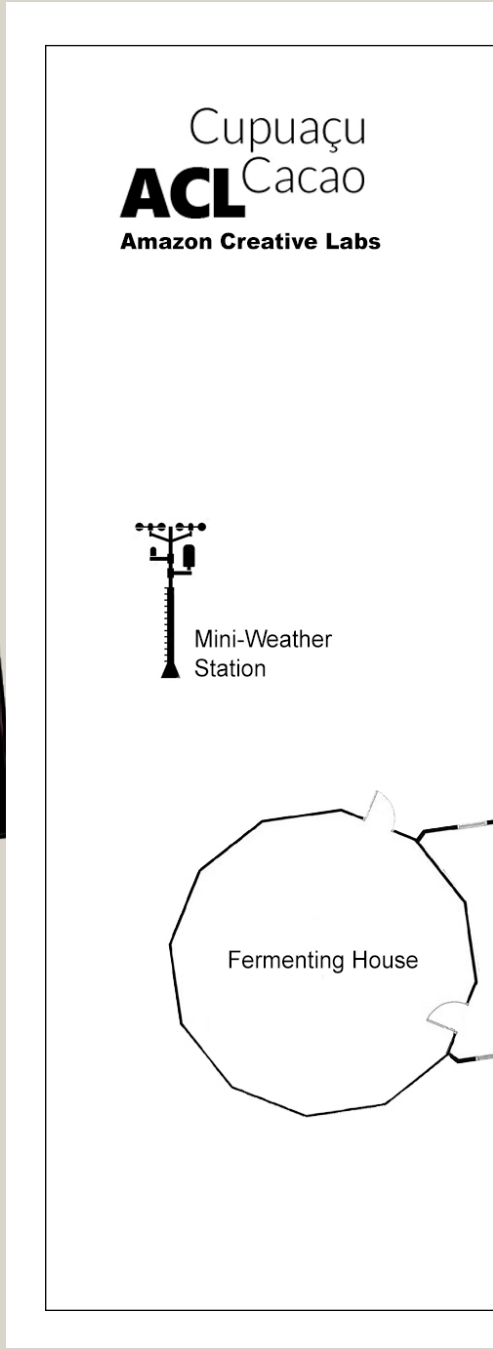


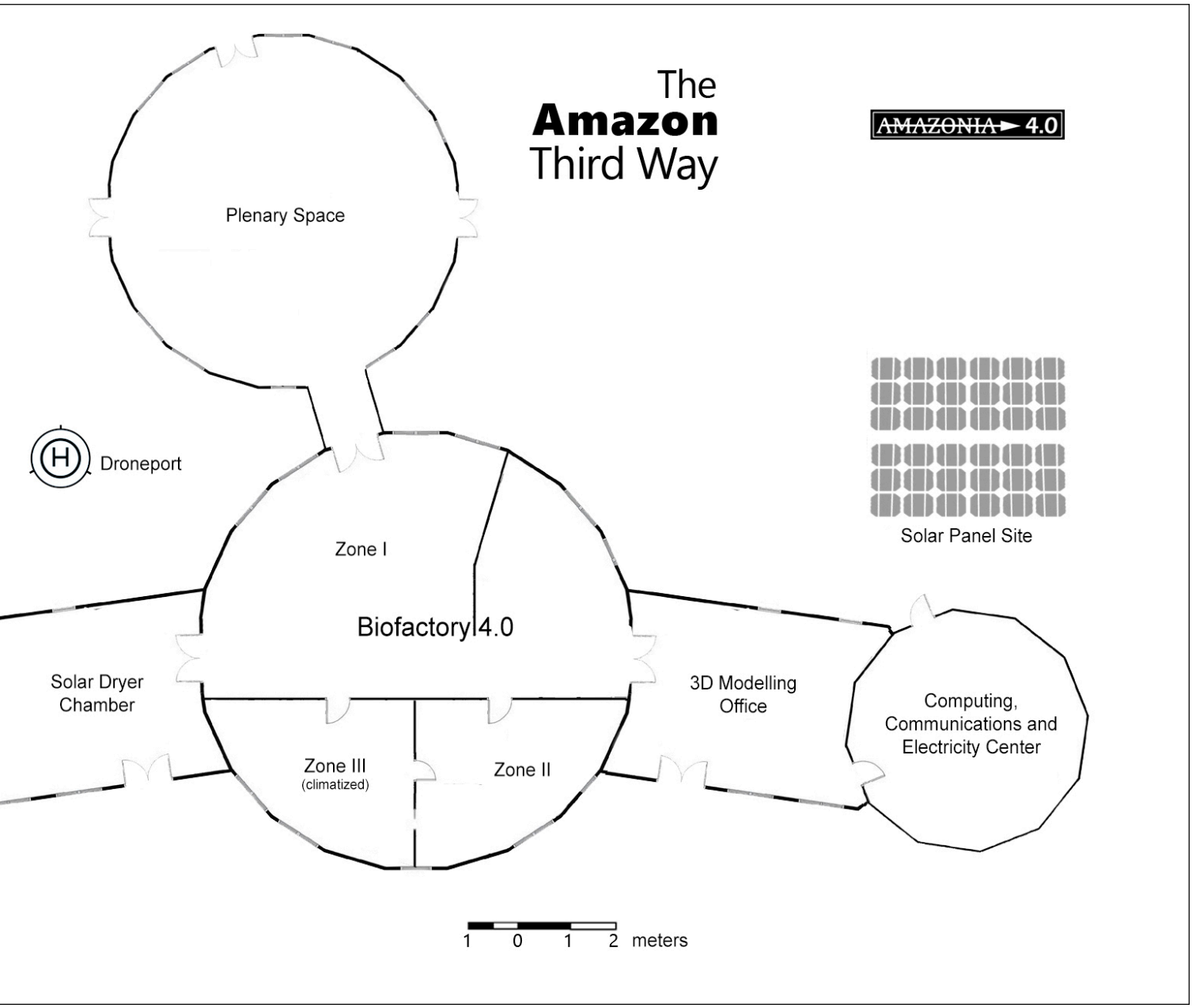
Figure 4: Diagram illustrating the layout of the A

The same goes for the fine cocoa nibs. The idea at ACL C-C is to have the greatest added value typical for the chain, but any previous phase can also generate new local business, better than merely pro-processing of low quality (bulk) cacao as is usually done

ACL CUPUAÇU – COCOA STRUCTURE AND INFRASTRUCTURE

Environments

The ACL C-C will supply the covered environments necessary for the entire training process. They are made up of six modules: the "plenary" module, the Production Laboratory module (Biofactory), the Solar Dryer Chamber module (drying phase), and the Fermentation Shed module, the 3d Modelling module and the Computing, Communications and Energy Center module. The plenary houses all the participants all together, and is equipped with tables and chairs, and electronic blackboard, projector and large screen. There is an option for replacing this module with a local and available building (a schoolroom during vacation periods, community center, etc.). The Production Laboratory module will concentrate the technological equipment that produces the effects of the chain and will have 3 closed and combined environments (Zone I wing, normal heated, Zone II wing, heated aseptic and Zone III wing, refrigerated aseptic), thus divided to minimize the demand for refrigerating the environment and for electricity (Figure 4).



CL C-C laboratory and artistic representation and an outside and inside view of a module in the facility.

Clean renewable energy

Practically all productive activities aided by modern technological resources depend on electricity. The ACL C-C will use electro-voltaic solar panels, an inverter and batteries to supply the needs for lighting, refrigeration and operation of the machinery and equipment utilized in value chain transformations. The planned electrical system will solve the most emergent situation, when the community does not have electricity, but will also solve the electricity need in communities whose main source comes from diesel generators, usually associated with a temporary and irregular supply. In the ACL C-C there is a need for 24-hour electricity because of the operation of the communications system, ambient cooling, the refrigerator, lyophilization equipment and chocolate mill and the melanger, which cannot have its operation interrupted during the operating cycle, which may reach 24 or even 36 hours.

Communications

The entire ACL C-C environment will be covered by wi-fi networks to connect all participants with each other and with teaching resources and control over processes such as connecting some production equipment items equipped with IoT capacity. The local networks will be connected to the Internet by a communications service available at each locality chosen. The options include (1) data services from public telecommunications services that already serve the principal localities in the Amazon; (2) data services via satellite, with a worldwide coverage from the "Internet for All" program, with a greater geographical reach, linked to the new Brazilian satellite (Geostationary Satellite for Defense and Strategic Communications); (3) the new fiber optic networks for the Amazon interior ("Connected Amazon" project) or (4) international commercial data services already available for any location in the Amazon.

Basic Sanitation

The ACL will be self-sufficient in terms of treated water and sanitation, and will also have a space for dissemination of technologies for distributing water, sewerage and connectivity adapted to the Amazon context.

Mobility

The ACL C-C is designed for mobility, for use in an itinerant manner, with each cycle in the campaign lasting up to 2 months. The structure, infrastructure and the processing equipment of the value chain chosen are appropriate for that purpose, and available on the market. They have their volumes, weights and electricity demands sized for portability, with modular elements that can be disassembled and with light and sturdy materials. Since they are of a demonstrative nature, the nominal volumes processed in the equipment are compatible with experimental production. The entire laboratory shall be packed in rigid boxes (or standardized containers) compatible with transportation via highway (trucks), river (regular riverboat lines) and commercial airlines. The same ACL may go by any one of those means, depending on where the capacity-building demand is.

CAPACITY-BUILDING STRATEGY FOR THE ACL CUPUAÇU – CACAO

Specific objective: Teach how to go through all the stages for producing cupulate and chocolate in bars and powder form, cocoa and cupuaçu butter and lyophilized cupuaçu pulp.

The participation process is two-directional and interactional, involving experimentation and effective execution of complete production cycles within the community itself. Participants are invited to bring their experiences and visions for incrementing new potentials to the database. At the end, each individual, each group and each community may find their specific path, as well as the knowledge of available support, towards being valued stakeholders in a new scenario for socioeconomic development strongly based upon products derived from Cupuaçu and Cacao.

To achieve these objectives, the ACL C-C is based upon three capacity-building pillars:

Local action, global presence.

This module begins the ACL and is dealt with recursively during the entire process, and will also close out the experience with the ACL. It promotes the exchange of knowledge between all members of the ACL, in order to be able to locate them in many dimensions of space and time, familiarize them with technological transformations, especially those of the 4IR, and its effects on societies, cultures, work, production, trade and consumption, in various periods. It is formatted so that the participant can dream, conceive and innovate. This comprehensive scope of the (new) world will be consolidated throughout the experience, interacting completely and directly with the elements that are molding a post-industrial revolution world, as experienced in all of the modules of the ACL. At the end of the ACL experience, each participant will have a privileged vision of her or his position in the world, his or her strategic closeness to the wealth of Amazon biodiversity and the real potential for virtuous placement in new economic and sustainable cycles in bioeconomy. In this final stage, the participants and their group or community can prepare a script for actions to transform new dreams, ideas, concepts and innovations into achievable realities.

Superadded Value

This module enables and presents tools for local, technological and specialized production of creative products derived from Cupuaçu and Cacao. The initial entry is always the fruit, harvested from agroforestry systems of extracted from nearby forests. Since this is a cross-cutting activity for the ACL, the socioenvironmental practices adopted are observed and widely discussed in order to value good practices or improve their standards. The ACL promotes the adoption of best patterns of practices for each one of the links in the value chain chosen. Therefore, the basic products of the value chain for Cupuaçu and Cacao (such as pulp, nibs, cupulate, chocolate, etc.) and the creative variations to be developed (such as nutraceutical cupulate and chocolate, with bars in decorative formats and patterns created locally, etc.) are chosen or planned and idealized (already based on a broader vision of inserting those products in wider consumer chains). Afterwards the products are totally developed all the way to the packaging. In this phase, the knowledge and the possibilities brought about by appropriating the contents prescribed by the ACL C-C through instruction and intervention of the instructors and the dynamics of the formal laboratory classes are blended with the knowledge and ideas of the participants themselves, giving rise to creative production.

Production in itself and the training processes are done with the help of the most cutting-edge knowledge, equipment and technologies. The practical objective is to demonstrate how, with creativity and technical assistance that are already available or spreading rapidly, one can take steps for adding value in places and by stakeholders traditionally involved only with the first and less valued links in the chain, rebalancing the chain and thus achieving a more just distribution of value that is more directed to the populations that have the initial access to the products of the forest.

All aspects of the value chain are prepared with an emphasis on innovation and quality practices for the product, for certification later on (Organic, UTZ, etc.). This stage also deals with and emphasizes the use of byproducts from the main processes as inputs for secondary and complementary value chains. Production of lyophilized Cupuaçu illustrates this topic particularly well. The reach of new technologies employed in the ACL C-C includes activities for training and learning that use the computing power of tablets and smartphones, which are tools for ACL activities.

Ecobusiness Action Plan

This deals with preparation of effective business plans for products produced local from biodiversity inputs in the 4IR age. Just as the production and training stages for production are redefined by the use of technological tools, the types of market demand, the forms of trade and logistics also reflect the impacts of this technological era. In that context, the ACL does intense and interactive training to model a business plan for the products that have been created and prototyped. This training includes not only the tools and practices of business planning, but also the ways for obtaining outside assistance or help with production, commerce, (means of access to markets, partnerships), innovative and cooperative entrepreneurialism and access to specific sources of information of key instances of knowledge chains (universities, research centers, etc.) associated with local production potentials. The model includes know-how for dealing with administrative and regulatory governmental issues related to taxes, tariffs, health, environment and labor, certificates and so on, involved in placing the planned and developed products on the market, including knowledge regarding access to the world of investments in sustainable businesses.

SUMMARY OF THE PRINCIPAL TECHNOLOGIES ADOPTED IN THE ACL C-C

Advanced Sensors, Computing

The ACL Cupuaçu-Cocoa will employ sensor technologies at various stages. Temperature sensors will be employed for the critical processes of fermentation and roasting. In fermentation, the temperature sensor will be associated with a wi-fi transmitter that will feed a software platform, in real time, informing and memorizing the changes in phase that characterize fermentation. At the exact moments when the process requires management (aeration and interruption), the program will issue alerts (by sound or message). Each fermentation cycle will have a record of the temperature curve over time, as an advanced component of the quality tracking system. With the precision from temperature measurements, fermentation can be repeated loads (same grove of trees or extractive area) produce beans with the same characteristics, providing temporal consistency for the product. The same technology that provides precision for temperature measurements in fermentation may be deliberately used to modify the process (lengthening or extending the aerobic or anaerobic phases), with the objective of achieving controlled differentiated characteristics of the fine composition and flavor of the resulting beans

During roasting, the thermal sensor is coupled to the oven and software that controls the entire operation, capable of applying a roasting curve and varying the temperature over time. This ability enables precise and controlled roasting to achieve characteristics that are always similar or desirably differentiated for fine composition and flavor of the resulting beans. A moisture sensor will be used during the drying stage, to guarantee that the beans have been dried at the ideal rate and, at the end, are up to the correct standard for storage.

Internet of Things

Internet of Things (IoT) is one of the most transforming technologies for enabling precise controls of the processes involved. Devices with this technology have the ability to communicate automatically among themselves and with process control systems. A system with IoT may have data outlet in real time and conditions for issuing alerts. For the ACL C-C native IoT and prepared IoT devices have been identified. The first type is already connected to a wi-fi network and transmits data and parameters for a wide range of subsequent uses (apps on mobile phones, tracking systems, automatic e-mails, control and automation systems, etc.). The second type consists of microprocessing devices (intelligent) with a computer interface, generally via USB or serial ports, for transferring the digital data generated in the operations. Using a computer coupled to these devices, with a relatively small effort it is possible to create layers of programs (as drivers) that turn the data received into inter-operative data, which can then move, in variable measure, to typical usability with natively IoT devices. This is a natural outcome of the creation of demand for new equipment and the updating of equipment in the chain to native IoT.

3D Printing

The use of 3D technologies in the ACL C-C is linked to processes for attributing form to the final product, whether as traditional bars or as sculptures. One component of this technology will incorporate 3D printing with cupulate or chocolate using computerized 3D models, generating edible sculptures. The other component will use creation of sculptures made with a CNC Router device, which will be used for manufacturing plastic molds for shaping the cupulate or chocolate from computerized 3D models. The models will be created with modelling software, converting 2D or 3D designs or capturing real forms with a 3D digital scanner. The inclusion of this technology is for the purpose of creating a channel for cultural and artistic expression that values the local producers and adds value from their origins to the final product.

Drones

Drone or unmanned aerial vehicle (UAV) technology will be used to demonstrate the resolution of a logistical problem for transporting the final products of the value chain with high added value and low weight and volume. It this ACL C-C we will use a delivery model

drone as part of the current reality of development of this technology, which is still demonstrative. The model will have a load capacity of up to 8 kg and flight autonomy of up to 40 minutes, approximately, with a range of up to 20 km. The difference with this drone is in its capacity for totally autonomous flight, independently of a remote operator. It is only necessary to program beforehand the route it will travel. The use of a drone in this project is still demonstrative; the technology is still evolving and increasing its operational capacity while reducing in price. There are already models being certified with a load capacity of 300 kg and there is a technological race for viable models capable of transporting people. When drones reach commercial maturity, they may be able to solve a crucial problem in the Amazon, which is transporting out of isolated communities or areas that are days away by boat. Relatively small and valuable cargoes mat be transported over the forest in a straight line until intermodal logistical points (fast boats on the major rivers or regional airports). The same drone that takes can also bring. On its reverse route it can take spare parts to the community for equipment used in the productive chain or even medicines and other useful items compatible with the drones for each period

Identification and Trackability

A key element for adding guaranteed quality to a value chain is the trackability of each stage and stakeholder involved in the processes. The ACLs are designed to provide total trackability; all of the parameters and intelligent devices and the management applied in production are parameterized, compared and stored. Total trackability makes it possible to identify when an original or intermediate input does not meet the minimum (or maximum) parameter established, and allows one to correct it or remove it from the processing line so as not to affect the final quality. To add automation to trackability, electronic identification technologies will be used in products of the chain. These are the QR code and RFID systems. This system can store an identification code or other information, that will articulate through being stored in database and incorporated in control systems. RFID tags have an embedded electronic circuit and are read automatically. One planned use is to place them on the openings of bags of dried cocoa or cupuaçu beans, prepared for extended storage. When those beans enter production, tracking already has the entire story of transformations applied up to that point, which can, in fact, determine specific parameters for subsequent production stages.

Records of knowledge and Innovations

Traditional populations in the Amazon who process cupuaçu or cacao have already developed their own processing technologies (such as producing cupulate without fermenting the bean). How can one protect the intellectual property of that traditional knowledge? The ACL will develop a blockchain application to assure the recording of that traditional knowledge, respecting the legal framework developed by the Nagoya protocol and by the national laws of the Amazon countries with respect to access to traditional knowledge and sharing of benefits.

DEMONSTRATION EQUIPMENT FOR TECHNOLOGIES AVAILABLE TO THE ACL C-C

Below are presented specific devices, available on the domestic or international market that cover the main production stages for the Theobroma chain that are the focus of the ACL C-C. For each device there is a description of the technology present and how it helps or is necessary for making bio-industrialization of cacao and cupuaçu directly viable in small communities and towns in the Amazon interior or Atlantic Forest. One may not that this equipment is mostly small-scale, workbench size, for small-scale production, considering that the ACL C-C is demonstrative. For potential businesses resulting from training and encouragement of entrepreneurialism, the equipment should be or larger size and production volume.

Digital Micro-processed Refractometer

Equipment for measuring sugars (Brix), used to measure ripening of the harvested Cupuaçu and Cacao fruits. Readings are made in normal or simplified manner, with pre-configured scale, temperature and storage of data, with results saved alongside predefined limits that can be used as an auditing tool. The data generated can be saved or exported in PDF, via USB or Ethernet connection. Generates objective data for trackability of quality starting with the first stage of the value chain.

Model RFM960-T; measurement range: 1.30 – 1.70 RI; 0-100 °BRIX ±0.1; four decimal place resolution; colored high definition display; supports regulation 21 CFR Part 11 of the FDA.

The Amazon Third Way
AMAZONIA 4.0
Cupuaçu ACL Cacao
Biodiversity Value Chains \
\ Addition of Technological Modernization:

Microprocessed Digital Temperature Sensor

Intelligent temperature sensor that serves for monitoring (and controlling, if couple to other devices) the temperature inside the Cacao mass fermentation tank. Control and programming are done by smartphone/tablet anywhere, using wi-fi. It is possible to monitor the temperature measured by the sensor in real time, enabling the exact management of the fermentation phases, which are a critical stage for manufacturing fine chocolates using the tree-to-bar modality. Generates objective data for tracking each stage of the value chain.

Type: Thermocouple; temperature range: -55 ° C a 125 ° C; immersion: waterproof; length of cable: 1 meter; sensor diameter: 6 m; manufacturer; Sonoff; product: TH10; model: DS18B20

Microprocessed grain moisture meter

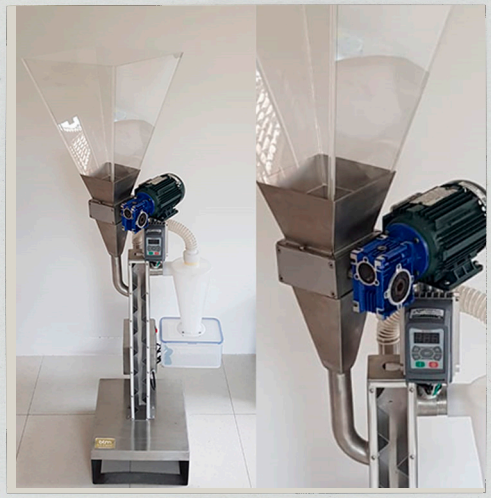
With Temperature Compensation Algorithm, corrects moisture in terms of temperature and density, without using tables. Its program performs all the necessary calculations, resulting in reliable and repeatable readings. Performs automatic adjustment and checking of proper working of all electronic circuits. Has digital alphanumeric LCD display and direct two-way communication portal to computer. Used for precise moisture control in the bean drying process, a critical stage in manufacturing fine chocolates with the *tree-to-bar* modality.

Moisture measurement range from 1% to 50% ± 0.01%; RS 232 C Serial data interface; electronic scales for 1,000 g ± 0.3 g; dimensions (L x H x D) 345 x 311 x 192 mm; weight 5.7 kg; operating temperature of 0 º to +50 ºC; power supply 90 to 240 VAC/4 VDC; manufacturer: GEHAKA model: G810 STD

Microprocessed programable roasting oven

Technological oven for roasting beans, with K thermocouple system with software for roasting curve; micro-controlled; automated; electric; digital; connective. Roasting of Cupuaçu and Cacao beans is a critical stage for the entire chain. This micro-controlled oven enables perfect roasts that follow roasting curves. The embedded digital technology guarantees quality through precise and systematic control of this stage and enables application of controlled variations to create roasting standards for products with distinct organoleptic characteristics

Capacity: 3 kg; use regime: 20 minutes; power: 3000 W; voltage: 220 V; weight of product: 30 kg; product volume: 60x60x60 (cm); manufacturer: BTM; model: WICTORY; origin: Brazil.



Grinder / Nib separator

2-in-1 equipment for grinding the beans and separating the resulting nibs from the film that falls off. Uses a system with a cyclone filter to achieve complete separation, in order to assure the flavor and texture of the resulting chocolate. The device is totally made of stainless steel, an adaptive characteristic for working in the Amazon region, with its high rates of air humidity, because it: reduces the need for changing parts and eliminates the formation of internal rust and proliferation of bacteria in the parts that come in contact with the food, which would be a serious sanitary problem.

Typical use regime: 1 hour; capacity: 15 kg; weight of device: (approximate) 25 kg; volume of device: (approximate) 1.2 x 0.5 x 0.4; power: 1/4 hp + 1400 watts; voltage: 220v; manufacturer: BTM; origin: Brazil.

Melanger

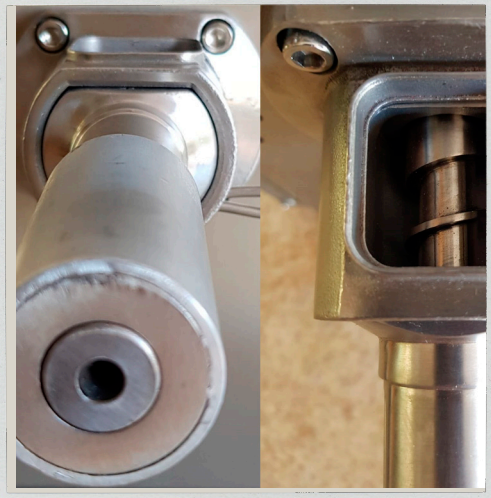
Chocolate mixer or melanger is a 3-in-1 device for manufacturing cupulate or chocolate, performing the functions of grinding, mixing and conching. It is a traditional device in the chocolate industry, that has been replaced by specific equipment in large-scale factories. It is recommendable for small or medium-scale production and is ideal for training and demonstration in an ACL. The model selected is programmable for operating on low power at night (without solar power generation), given that the device cannot be turned off (cooled) before the cycle is complete.

Typical use regime: 36 hours; capacity: 6 kg; weight of device: (approximate) 21 kg; volume of device: (approximate) 0.7 x 0.4 x 0.3; power: 1/2 hp; voltage: 220v; manufacturer: BTM; origin: Brazil.

High Precision Digital Micrometer

The High Precision Digital Micrometer is used after grinding to measure the sizes of the particulate solids present in the chocolate. This is also a defining factor in chocolate quality. This parameter will be felt and assessed at the moment of tasting the finished product. The micrometer model allocated to the ACL has high precision and digital data outlet through a USB cable. That resource makes it possible to include granularity measurement data in the arrangement of objective trackable quality parameters, for each batch processed in the melanger

Range: 0 to 25 mm; resolution: 0.0001 / 0.0005 mm; precision: ± 0.5µm; Zone: 03.2 mm; Mass: 400 g; power source: lithium battery (CR2032) x 1 (approximately two years of battery life); manufacturer: Mitutoyo; model: High-Accuracy Digimatic Micrometer; order no. 293-100.



Extruder

Extracts the cupuaçu and cocoa butter. The butter is used as a raw material for cosmetics or for manufacturing white chocolate or cupulate. In its crystallized form it is also used for tempering brown chocolate. The device is totally made of stainless steel, an adaptive characteristic for working in the Amazon region, with its high rates of air humidity, because it: reduces the need for changing parts and eliminates the formation of internal rust and proliferation of bacteria in the parts that come in contact with the food, which would be a serious sanitary problem.

Typical use regime: 1 hour; capacity: 3 L; weight of device: (approximate) 13 kg; volume of device: (approximate) 0.3 x 0.3 x 0.3; power: 1/2 hp; voltage: 220v; manufacturer: BTM; origin: Brazil.

Fixed temperature unit

The fixed temperature unit stabilizes the cocoa butter crystal and also heating of the forms for the chocolate. Crystallized cocoa butter is used in the main chocolate chain during the critical tempering stage. The correct hardness of the final bar, resistance to melting and the characteristic sheen and texture come from this stage. The device has a microprocessor and controller that adjusts the temperature and controls its drop in an exact time ration, down to a lower level, promoting precise crystallization.

Has a proprietary Digital System; Typical use regime: 24 hours; capacity: 5 kg; weight of device: (approximate) 6 kg; volume of device: (approximate) 0.4 x 0.4 x 0.4; power: 12 W; voltage: 220v; manufacturer: BTM; origin: Brazil.

Vibrating Table

During the normal handling process with chocolate, bubbles are formed and need to be eliminated after the chocolate is placed in the form, in order to make chocolate bars with a perfect appearance. The vibrating table is a stainless-steel device, develop to perfectly remove those bubbles. It provides greater durability for the forms, since they do not need to be tapped on the table to remove the air bubbles. It has power regulation, and may be adjusted according to the type being used. Easy to clean in order to meet hygiene regulations.

Energy consumption: 0.25 kW, voltage: 220 V; dimensions: L 500 mm, W 350 mm, H 250 mm; dimensions of the device: L 320 mm, W 421 mm, H 266 mm; net weight: 12 kg; manufacturer BTM; model: Viber; origin: Brazil.

3D Chocolate printer

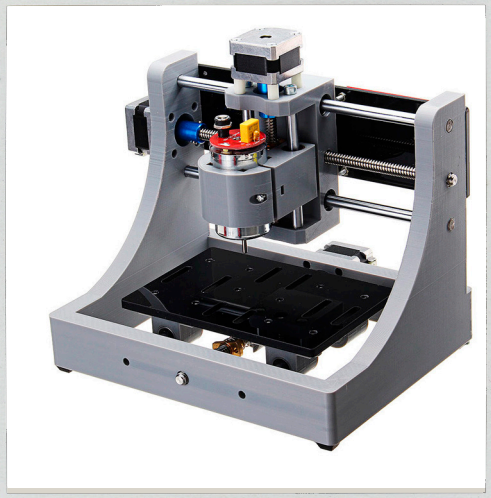
The model for the 3D chocolate printer evaluated to be part of the technological tools for the ACL Cupuaçu – Cacao can print directly using chocolate grains (it does not need chocolate cartridges). The printer uses temperature control to correctly melt the chocolate grains. The models for printing can be ready-made or developed using 3D software. In the near future new models will be appearing for the industry and consumer

Volume of the printing bed: 16x12x15 cm; uses standard gcode and STL files; Interface: by the computer and the colored screen, with touch-sensitive panel; manufacturer and model: Mmuse Touchscreen Chocolate 3D Printer. origin: China.

Multifunctional 3D Portable Scanner

Multifunctional 3D Portable Scanner with 4 digitalization modes: HD portable digitalization / quick handheld digitalization / automatic digitalization / fixed digitalization. This is a technological argument for freeing and leveraging creativity among participants in chocolate forms (bars, objects). Using forms from the reality of the participants, digital models are created that can be worked on with 3D modelling software and then become models or drawings for the CNC router (and from there into chocolate forms) or direct 3D printing on cupulate and chocolate.

Speed of digitalization: HD portable digitalization: 90,000 points / sec.; rapid portable scanning: 550,000 points/sec.; auto scan: <2 s; single-shot precisions 0.1 mm / 0.3 mm/ 0.05 mm/ 0.5 mm; manufacturer: EinScan-Pro; product: Multi-Functional Handheld 3D Scanner.



CNC Triaxial Router

The CNC Router is a milling machine with Computerized Control Number (CNC in Portuguese). It is used in high/low relief work with wood, plastic, rubber, non-ferrous metals, foam and others. It works together with 3D software that offers several functions and allows one to insert or change a layout that is difficult to transfer to the piece being worked on. This equipment will be used in the process of fabricating customized forms, with designs developed during the ACL C-C. The sculpture will give the final form to the chocolate bars.

Work area: 120 X 80 x 16 mm; etches on wood, plastic, acrylics, PCB or similar material; 3 movable axes, 6000 rpm; laser module; weight 3.4 kg; USB interface; entry tension 100-240 V 50/60 Hz; work tension 12 V; current 3 A; shaft diameter 3.175 mm.

Desktop Vacuum Forming Machine

A machine for making plastic forms for chocolate with high resolution digital PLC (Programmable Logic Controller) and touch-sensitive screen with graphic display and easy to understand icons, intuitive control, with memory for 20 project programs. Planned for students, designers and inventors of today. Has quartz heaters with 4 zones (rapid response and high energy efficiency). Vacuum control with manometer (pressure in Hg/bar) and freeing with forced air between the mold and the leaf (to help with freeing). For prototyping the ideas for bar formats.

Form area: 430 mm x 280 mm; max.; depth of mold 160 mm max.; thickness of material: 6 mm; net weight: 75 kg; total area W x W x H 639 x 986 mm x 525 mm; tension: 230 V 13; power 2.3 kW; manufacturer: Formech Model: 450DT; origin; UK

Lyophilizer

The lyophilizer that will be used in the ACL has the purpose of adding value to the cupuaçu pulp, which is abundantly generated by separating it from the seed that will go to the cupulate chain. The model evaluated has a programmable processor with intelligent sensor, USB and network connections with cable for visualizing lyophilization using a smartphone, tablet or computer. Stores batch and real data. Lyophilized cupuaçu pulp weighs about 1/10 as the fresh fruit, lasts for months without refrigeration and maintains the structure of the material and its nutritional properties.

Capacity: 5 trays, with 4 gallons of material per lot and 6 liters of sublimated ice; vacuum pump without oil; voltage: 110 V; manufacturer: Harvest Right; model: Scientific Lyophilizer; Origin: USA

Autonomous cargo drone

The drone evaluated for performing a technological demonstration at the ACL Cupuaçu – Cacao is a product already on the market, designed and built to be a dedicated system for delivery and transport, with up to 40 minutes of flight time without risk and with payloads of up to 8 kg. The delivery drone can achieve high remote precision on transportation missions, flying autonomously for up to 20 km. There are drones capable of lifting up to 300 kg. Drone technology is still being developed, but one can already consider them a desirable and possible logistical solution for the Amazon.

Flight time with: max. load: ± 40 min – payload of 2 kg: ± 67 minutes; max. range.: 20 km; max. speed: 54 km/h; max. height: 5,000 m; max. wind velocity: ± 10 m/s; operational temperature: - 5°C to + 50°C; manufacturer: Airborne; model: WALKER; origin: UK

WORK PROCESS

FRAME OF REFERENCE

WITH OUR FEET ON THE GROUND AND OUR GAZE ON TOMORROW, LEARNING TOGETHER HOW TO EXPLORE AND APPLY THE POTENTIAL OF TECHNOLOGIES FROM THE 4TH INDUSTRIAL REVOLUTION

The concept of the Amazon Third Way/Amazon 4.0 and the Creative Laboratories began to be delineated when Carlos Nobre, at the time in his position of president of the Coordination for the Qualification of Higher Level Staff became convinced that there was a need for "moving from warnings to a space for solutions."

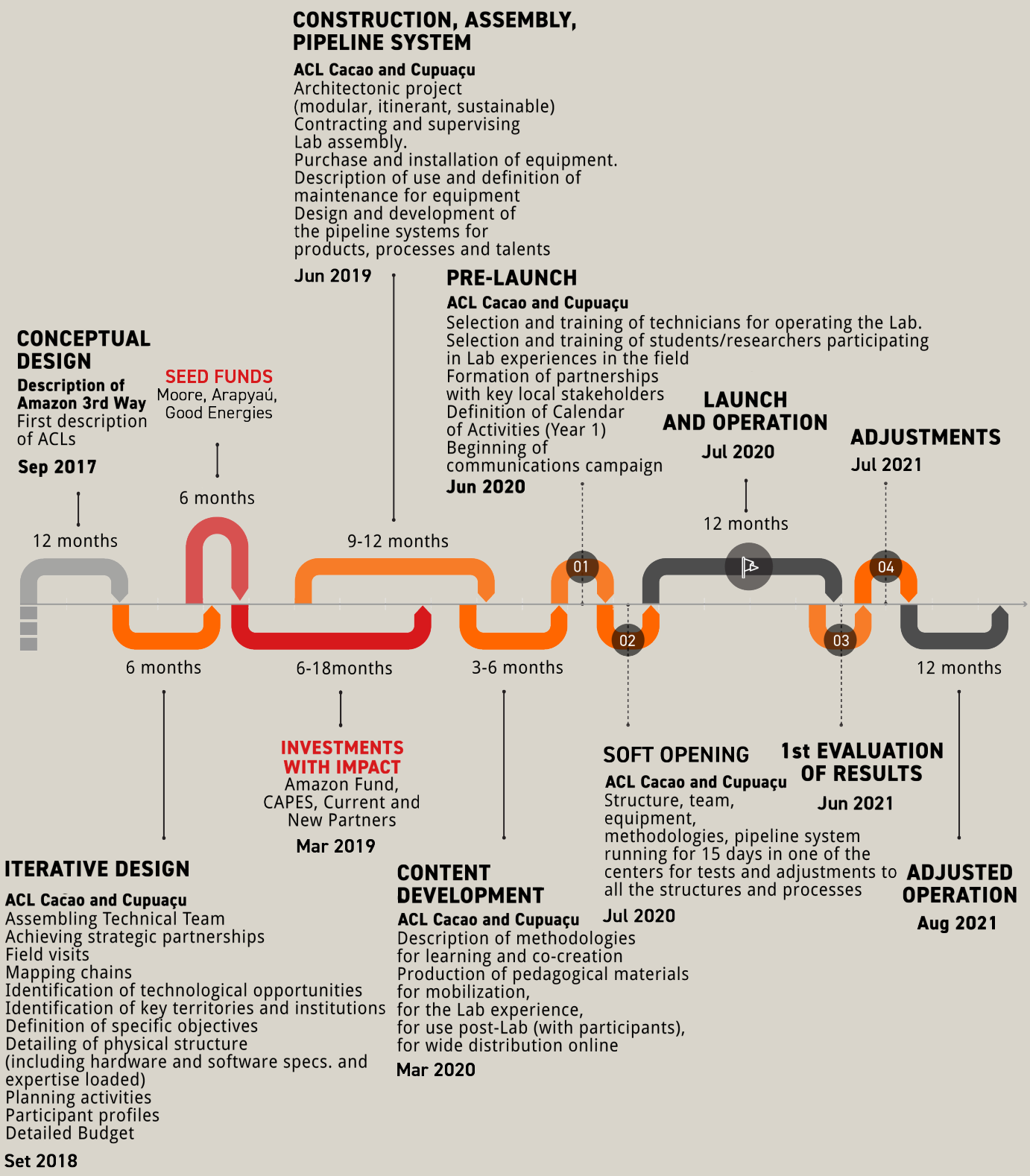
After several decades carrying out pioneering studies on the climate impacts of deforestation in the Amazon on global warming and coordinating research projects and centers for monitoring the terrestrial system – such as LBA, CPTEC and CCST, the last two at INPE, Carlos began a pilgrimage around the most varied circles, from academia to philanthropy, to show that the convergence of the physical world with the technologies that the 4th Industrial Revolution offer achievable alternatives for reinventing the economy of tropical forests.

CONCEPTUAL DESIGN
"move from warnings to solutions"

More than a new warning, however, Carlos has laid out a path for revolutionizing the Amazon production model, incorporating the singularity of the Amazon brand into products with high added value, empowered by technologies of the 4th Industrial Revolution. With his brother, biologist Ismael Nobre, he has produced articles such as "*The Amazonia Third Way Initiative: the Role of Technology to Unveil the Potential of a Novel Tropical Biodiversity-Based Economy*" (Nobre et al. 2018).

SEED FUNDS. In order to move from the concept of modelling the mechanisms for inducing this transformation, we have been supported by groups of organizations such as the **Climate Land Use Alliance (CLUA)** and philanthropical institutions such as the **Moore Foundation** and the **Instituto Arapyaú**. In 2019, the **Good Energies Foundation** also joined the project, which made it possible to allocate part of the work group to developing a proposal for the Amazon Fund of the BNDES, giving the project scale.

FRAME OF REFERENCE FOR THE PROJECT



The Cacao and Cupuaçu Laboratory is the first to have a detailed design, among the 6-10 Labs that will be implemented over the next three years. The Iterative Design Phase involves several actions, as shown in the Project Frame of Reference on the previous page. Several of the components of this phase are described in detail in this document.

First of all, we have put together a team made up of persons with wide Amazonian experience, including:

CESAR DE MENDES
Specialist in Cacao and Cupuaçu Chains

ANDREA MARGIT
Curator of Knowledge Networks

CARLOS NOBRE
Climatologist and co-author of the project

ISMAELNOBRE
Biologist and co-author of the project

BETO VERISSIMO
Ecologist and project manager

SEBRAE

EDICLEIDE NOBRE
Economics and Innovation Management

PATRICIA DE OLIVEIRA
Agronomic Engineer and Professor at UFOPA

certi

BIOTEC AMAZÔNIA

DIEGO KURTZ
Engineer and Knowledge Manager

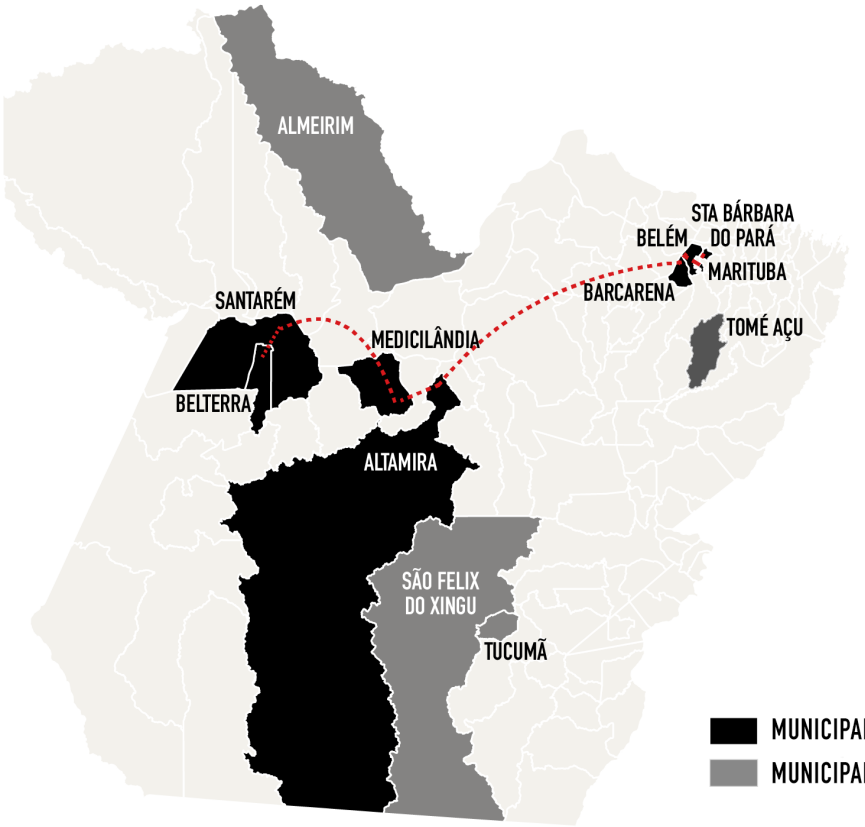
Imazon
Instituto do Homem e Meio Ambiente da Amazônia

ITERATIVE DESIGN with people and entities who know the Amazon reality

The Working Group as it is now composed was formed in October 2018 and has been consolidated during visits to regions with agroforestry and extractivism for *Theobroma* in the state of Pará, from 19-24 November, 2018. Since then the group has been communicating systematically to exchange technical and institutional references on cacao and cupuaçu in the Amazon. The resources obtained so far in this stage of the project have made it possible to remunerate the technical work of the first five members of the group. The team from BioTec Amazônia, Fundação CERTI and SEBRAE Sustentabilidade are providing support for this phase of the project without financial consideration.

During the development of the first stages of the project, we have also received relevant contributions from other members of:

Fundação CERTI	Marcos da Ré, Diretor Executivo do Centro de Economia Verde Manuel Steidle, Diretor de Tecnologia em Mecatrônica Luciano Benvenuti Roncalio, Diretor do Instituto Sapientia
BioTec Amazônia	José Seixas Lourenço, Diretor-Presidente
Conexsus	Valmir Ortega, Diretor Executivo
SEBRAE Sustentabilidade	José Guilherme Barbosa Ribeiro, Diretor



During the trip, the group met with 12 distinct entities seeking to map out the principal landscape technologies where cacao and cupuaçu production is situated in the Amazon, as well as the profile of the stakeholders involved in the *Theobroma* chain.

MUNICIPALITIES VISITED DURING THE FIELD TRIP

MUNICIPALITIES OF RELEVANT INTEREST TO THE PROJECT

2 associations of rural producers

2 agroforestry producers

1 municipal public manager

3 Amazonian chocolatiers

1 trader

2 research and tech entities

1 entrepreneur *restaurateur*

LINDALVA
AMABELA
BELTERRA

SAULO JENNINGS
CASA DO SAULO
SANTARÉM

CHICO
NATIVE CUPUAÇU
SANTARÉM

SYLVIA NASCIMENTO
SEMA
ALMEIRIM

IVAN DANTAS
CACAUWAY
MEDICILÂNDIA

ELIDO TREVISAN
CACAO PRODUCER
MEDICILÂNDIA

XIBA
BOM JARDIM
BARCARENA

CESAR
DE MENDES
STA BARBARA

FERNANDO MENDES
CEPLAC
MARITUBA

SEIXAS LOURENÇO
BIOTEC
BELÉM

LUCIANA CENTENO
NAYAH
BELÉM

FERNANDA
100% AMAZÔNIA
BELÉM

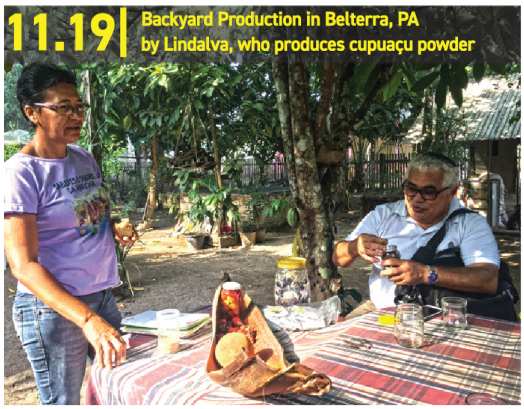
The field visit made it possible to observe in practice the ecological and socioeconomic benefits of *Theobroma* in the Amazon landscape composition. The ecological benefits are due to its being intercropped with other native forest species (poly-cropping) – which is very favorable for restoring degraded areas and thus maintaining environmental balance. The socioeconomic benefits are because these are plant species in high demand on the market, and can bring financial returns to extractivists, family producers and farmers and ranchers with more extensive areas for cultivation (Mendes, 2017).

Researchers from the Executive Commission of the Cacao Crop Plan (CEPLAC), in Marituba/PA, report that cacao production in the Amazon generally happens on properties that are small (up to 10 hectares) and medium-sized (10-20 ha). According to data from IBGE/SIDRA, for the 2018 harvest, the North region recorded an area harvested for cacao of **139 thousand hectares**, compared to 430 thousand in the Northeast region. The states of Pará and Rondônia account for more than 99% of the production of dried cocoa beans in the North region (more than **59 thousand tons or 38% of Brazilian production**), involving more than **21 thousand establishments** (Mendes, 2017).

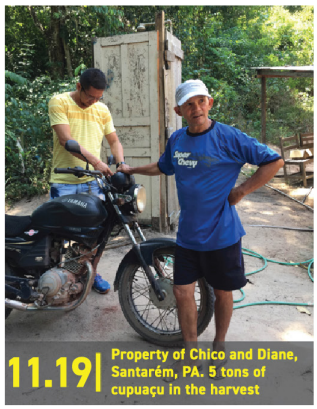
The cupuaçu chain, on the other hand, is considerably less structured, with a total production of **19 thousand tons of pulp in the North region**. The states of Amazonas, Pará and Rondônia appear as the main producers, concentrating **70% of national production**. The demand for the product is still mostly limited to Amazonian palates, requiring efforts for developing products and marketing that will increase appreciation of cupuaçu in other consuming markets. One should consider that Bahia has expanded its cupuaçu planting, and currently accounts for 22% of the harvest.

The visits to a broad spectrum of stakeholders involved in the cacao and cupuaçu chains have allowed us to define three different groups of producers with whom the ACLs will be able to interact:

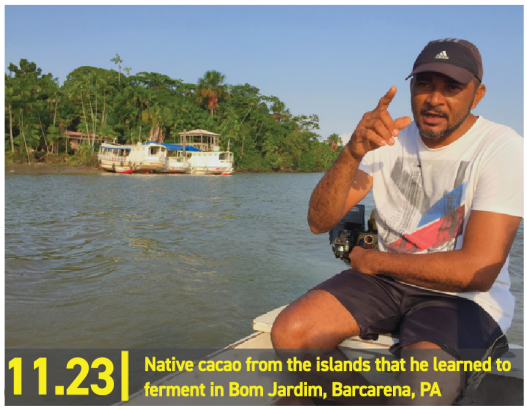
SMALL-SCALE



11.19 Backyard Production in Belterra, PA by Lindalva, who produces cupuaçu powder



11.19 Property of Chico and Diane, Santarém, PA. 5 tons of cupuaçu in the harvest

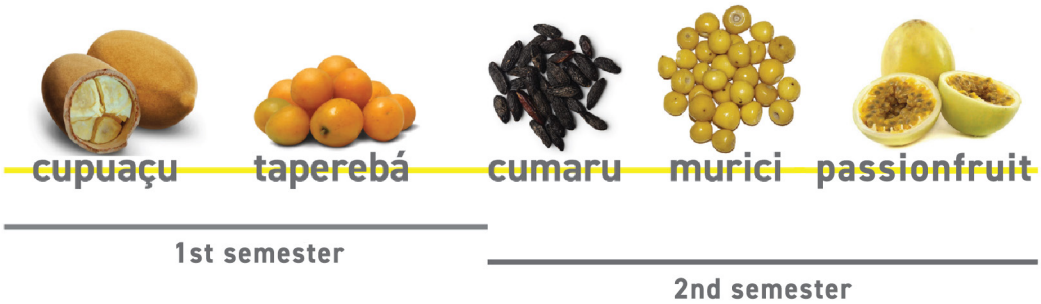


11.23 Native cacao from the islands that he learned to ferment in Bom Jardim, Barcarena, PA

Family producers and small-scale associations represent a great potential for creating more sophisticated products through design sprints and access to distributed technologies. They have long experience living in the native environment for Theobroma. They are accustomed to creating solutions with scarce resources and are not intimidated by difficulties. Necessity has taught them how to be enterprising. In this segment, women are exercising a growing role in the family economy.

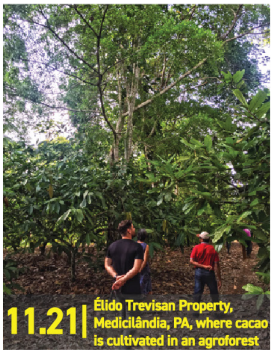
In the approach with family farmers and small-scale associations, the ACL must take into account that the group operates with a very diversified productive calendar, as exemplified by the rural proprietor couple of Francisco Galvão and Diane Medeiros in Santarém. They produce 5 tons of cupuaçu during the harvest, but also generate income with a varied portfolio of products during the year.

PRODUCTIVE CALENDAR FOR CHICO AND DIANE



The capacity for generating products with more added value must go hand in hand with maintaining production of a diversity of products that meet food security needs for the family and the community.

AGROFORESTRY



11.21 | Élido Trevisan Property, Medicilândia, PA, where cacao is cultivated in an agroforest

11.21 | Mr. Élido talks about productivity, pests and the more human environment in the agroforest

The second profile of potential users for the ACL Cupuaçu-Cocoa are the **medium and large-scale producers**, connected to global markets. In the Xingu and Tomé-Açu regions, particularly, there is a commitment to valuing Amazon cocoa beans and improving processing activities, in an effort to overcome the perception of a low-quality product – Low Grade Type – which makes the product not very competitive on the commodities market. According to economist Fernando Mendes, of CEPLAC, Amazon cacao has all the attributes for achieving more recognition and better prices, not only because of its intrinsic characteristics, but because its period of production occurs during the African off-season.

Many producers in this segment cultivate cacao using the cabruca system, where the cacao grows in the shade of other forest trees. Technicians from CEPLAC Marituba have informed us that, since 1994, the institution has supplied seeds almost only to producers who practice reforestation. Around 80% of cacao in the Amazon is produced in the TransAmazon region. However, in recent years São Felix do Xingu and Tucumã have appeared as major production centers. They receive approximately one million seeds per year from CEPLAC and have a research, experimental and production field unit in Tucumã.

Among the producers we met during the field visit, we observed strong enthusiasm for diversifying the products derived from cacao and cupuaçu, such as with Mr. Élido Trevisan, in Medicilândia. Besides seeking to improve their processing, logistics and marketing structure for placing their beans on the market, the more organized producers are structuring themselves to manufacture products that are well accepted in the region, such as jellies, honey, vinegar, frozen pulp, ice cream and others.

But one must take into account that, in general, the production and marketing system for cacao in the Amazon faces the challenges of dispersal, the vast distances from centers for dispersal and the lack of funds among their agents, which facilitates the excessive advantages for intermediaries in commercial relations that are exposed to high risks due to price fluctuations in international exchanges (Mendes, 2017).

INDUSTRY


11.20 Cocoa bean processing with Helia Felix and Ivan Dantas

11.20 Meeting with COOPATRANS who own the Cacauway brand Ademir Venturini (Bel)


11.23 At the initial stages of chocolate production with De Mendes, Sta Barbara, PA


11.24 Production of cupulate and chocolate, BioTec, Belém, PA

The third group is made up of small chocolate industries in the region that are interested in valuing native cacao varieties. These entrepreneurs are committed to producing a "different" and authentic chocolate, that will more the Amazon bean from the periphery to the center for consumption of original chocolates. They thus operate in a quite experimental context, creating new aromas, textures and combinations of ingredients that must be frequently tested in new consuming markets.

Even the larger-scale chocolate industries in the region lack the necessary structuring in terms of logistical and marketing systems. Cacauway in Medicilândia, for example, employs 15 workers and produces 100 kg of chocolate every day. It has a store at the factory, in the

downtown area of the neighboring city of Altamira, in Belém and in São Paulo. However, the managers of the business recognize that it is difficult to leverage sales for the product without more investments in marketing, packaging and new business platforms.

Cacauway is the only chocolate industry in the Amazon that verticalizes the entire production process, from cultivating the cacao, done by the 40 associates of Coopatrans (Agroindustrial Cooperative of the Transamazon), to grinding the beans to marketing of the final product. Today, Coopatrans produces up to 800 tons of cocoa beans per year. But industrialization of the chocolate consumes fewer than 1% of the beans produced by the cooperative members. That happens with all of the states. According to the Agência Pará, more than 90% of the cocoa beans produced go to the large industrial centers installed in Bahia, Espírito Santo, São Paulo and Rio Grande do Sul, where they are transformed into cosmetics, candies, sweets and chocolates. The largest share of added value happens outside the Amazon.

The state government has been encouraging verticalization of production through the Pará 2030 Program, which calls for initiatives for attracting new industries; training, technical assistance and rural extension; certification; research and development; and support for productive social organizations. The history of the chocolate industry is recent and has not yet generated enough demand to attract industries for equipment and technologies to the region. The need to import means of production from other Brazilian states or from outside of the country burdens and sometimes hinders installation of small processing units.

AT CACAUWAY
"Advertising and pretty paper help with sales"

Some of those chocolatiers exploit the potential of cupulate, as does Luciana Centeno, director and founder of Nayah, a company that is incubated at the Technological Park of the Federal University of Pará. Two other pioneering industries in producing chocolates in Pará deserve to be highlighted: Chocolates De Mendes, which has specialized in the diversity of varietal chocolates from the Amazon, and Amazônia Cacau, which mostly focuses on the vegan market, using raw materials that are mostly certified and organic.

There are opportunities for consolidating partnerships by ACL with this segment, not only with the companies described here, who already enjoy market recognition, but also with other small entrepreneurs from the food industry who are still at the cottage mini-factory stage. We know that because of the high cost of milk and sugar in the Amazon, the distinctive trademark for chocolate from the region, at least for several more years, will be its high cocoa content, which adds a more accentuated taste of the fruit when compared to the chocolate consumed in the southern and southeastern markets in Brazil.

The talks with chocolatiers during the field visit make it clear that the ACL must emphasize its proposal for adding value to this group, making the dynamic of services provided and the possible results to be enjoyed by its users clearer and more tangible. For all segments, but especially for them, efficiency in work and access to new technologies – such as equipment that is not yet widely disseminated in the Amazon context – will be determining factors for their buying in. This is a very selective segment.

MAPPING AND ANALYSES OF TECHNOLOGICAL, PRODUCTIVE AND INSTITUTIONAL OPPORTUNITIES

Where can ACL Cupuaçu-Cocoa be most immediately relevant? What technological and innovation challenges should it prioritize? With whom should we associate in order to achieve the largest possible scale in Amazon communities and guarantee sustainability of actions? These are the questions that this section seeks to answer

"Will mass production be the final word in industrialization? Or is there a more advanced modality?" asked Jane Jacobs in the chapter "Some patterns for future development in *The Economy of Cities*, a book written in 1969 "A rural economy with all its eggs in one basket is bound to lose out from changes in markets. In economic development, productive diversification always increases; never diminishes."

01

Value chain and technological opportunities

After the field visit, the technical team outlined a diagram for the *Theobroma* productive chain, divided into **4 major links**: production of the fruit, processing, marketing and logistics. In each one of those links, we identified the main activities performed by the actors involved in the chain, and also the opportunities for improving and developing the technologies or innovations relevant to each one of their activities. In its initial phase, ACL Cupuaçu-Cocoa intends to focus primarily on the opportunities associated with **Link 2 (Processing and Industrialization)**, considering the urgent need for increasing the quality of the pre-processed Amazon product and diversifying the supply of byproducts derived from *Theobroma*.

02

Analysis of the productive panorama

Using data from the Censo Agro 2017, we identified the territories that lead production of cocoa and cupuaçu beans *in natura*. We prioritized **4 states in the Amazon** – Pará, Amazonas, Rondônia and Amapá, **as well as Bahia**. Together, those states account for **96% of Brazilian production of both fruits**. Marketing of cupuaçu is limited to the Brazilian territory, predominantly in the North region. To win new markets, one must present products that are trustworthy, in terms of hygiene, nutritional properties and guaranteed supply. **As for the worldwide production of cocoa beans, it has increased more than 40-fold since the beginning of the XX century** (from 100 thousand tons to 4 million tons). But the production is not very significant in the Brazilian economy, representing 0.002% of the GDP and around 40 thousand persons employed (CEPLAC).

03

Mapping of producing institutions

To rapidly achieve a broad scale of work, the ACL Cocoa-Cupuaçu needs to establish partnerships with workers already linked to those chains and collectively organized. Because of that, we have gathered the information collected in the fell with a recent mapping by the non-profit organization Conexsus, which provides an **overview of forest-based and agroforestry community businesses in Brazilian territories**. In the information voluntarily provided by the managers of cooperatives and associations one notes a group of **78 entities producing cacao and cupuaçu** in the territories of interest: **Pará (25)**, **Amazonas (11)**, **Rondônia (4)**, **Amapá (22)** and **Bahia (27)**, with which we can begin cooperation. Based on that information, we have generated a preliminary itinerary for implementing the project in the field.

BRAZILIAN PRODUCTION OF *THEOBROMA*

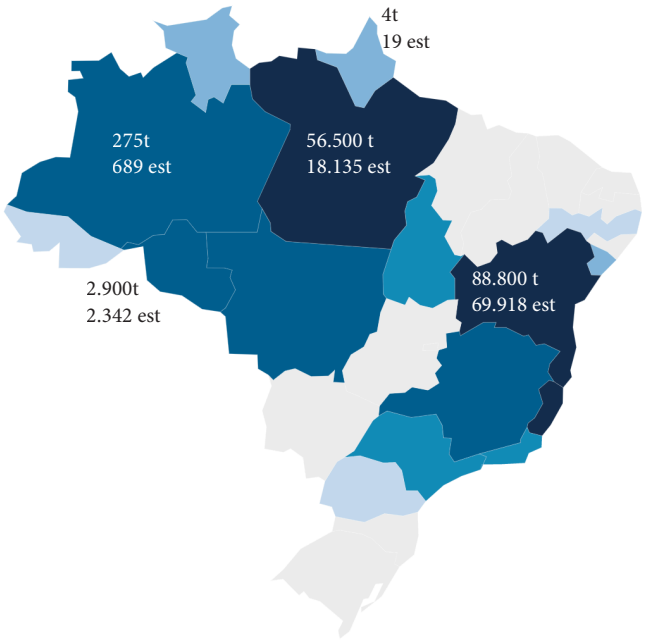
BRAZIL
155 thousand tons
93,205 establishments

COCOA BEAN

tons

- 0,400 - 3,078
- 3,242 - 5,890
- 7,430 - 9,890
- 38,030 - 2.854,821
- 6.076,447 - 88.809,950
- No information

* establishments with more than 50 trees on 09/30/2017



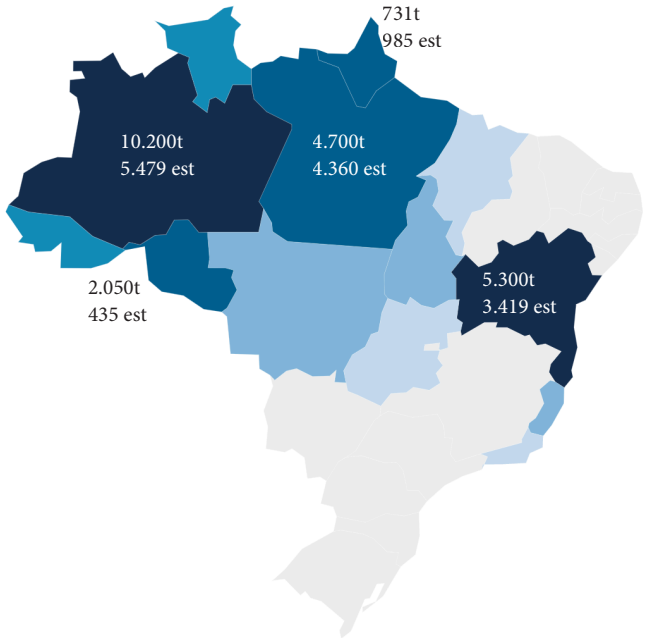
BRAZIL
24 thousand tons
15,739 establishments

CUPUAÇU

tons

- 0,115 - 25,560
- 109,205 - 150,248
- 241,025 - 397,544
- 730,810 - 4.687,274
- 5.327,965 - 10.178,296
- No information

* establishments with more than 50 trees on 09/30/2017



Source
IBGE Censo Agro 2017

We begin with a production overview of the genus *Theobroma*, trees native to tropical ecosystems located between latitudes 20 degrees north and south. There is a large list of species, but two have economic value, ***T. cacao*** (cacao) and ***T. grandiflorum*** (cupuaçu) and are the focus of this ACL.

The maps present the products of the cacao and cupuaçu trees at **different stages of processing**. In the case of cupuaçu, the production of **pulp** is monitored. As for cacao the Censo Agro monitors the **bean**, given that the pulp has less significant economic value.

We chose to initially implement the ACL Cocoa-Cupuaçu in the 4 Amazon states that combine the largest number of producers of both species. As for Bahia, we plan to make visits there in partnership with the Center for Innovation in Cacao and promote synergy between research and development of new products.

ECONOMIC COMPLEXITY

Connectio

Based on State Pr

The diagram of the value chain for *Theobroma* on pages 18 and 19 shows that there is a need for coordinating a great diversity of knowledge and mechanisms for converting the fruits into products with high added value. However, the necessary know-how for carrying out the various stages of processing cacao, for example, is restricted to different geographies. We have mentioned previously that around 90% of the beans produced in the Amazon are sent to industrial facilities in the South and Southeast of Brazil, as well as to southern Bahia. Those different knowledge and action networks are expressed more clearly when we examine the co-exportation of products at different stages of processing.

The diagrams below show the connection of co-exported products, a method for visualizing data used in the Economic Complexity study (Hidalgo and Haussman, 2007), and reveal that the areas that export cocoa beans also export other primary products such as natural rubber, or byproducts of cocoa at intermediate stages of processing, such as butter, paste and cocoa powder. As for the areas that export chocolate, they also export a much more diversified range of industrialized products, not only in the food sector, but also in the segments for metal, paper, cement, wood and plastic in their first degree connections, which, for their part, connect to a series of other productive activities of the second degree (the outer ring) indicated that the export-type chocolate is part of a highly complex knowledge and entrepreneurial environment

THE COMPLEXITY OF AN ECONOMY IS RELATED TO THE SET OF KNOWLEDGE INTEGRATED TO IT, IN THE FORM OF PRODUCTS AND SERVICES THAT CRYSTALLIZE THE IMAGINATION AND THE CULTURE OF A SOCIETY. THE SOCIAL ABD ECONOMIC PROBLEM THAT WE ARE TRYING TO RESOLVE IN THAT OF MOBILITY AND OF ADDED NEW AND MORE COMPLEX KNOWLEDGE AND KNOW-HOW

The clustering of that knowledge has direct reflexes on the local economies. The tree-maps beside this page compare economic activities (formal jobs) in the municipality of Medicilândia (PA), (the largest scale of cocoa beans in Brazil at the municipal scale), and Gramado (RS), the leading municipality in producing crafted chocolates). With equivalent population sizes – Medicilândia with 27,328 inhabitants and Gramado with 32,273 inhabitants according to the 2010 IBGE census – the municipalities present totally distinct economic and employment structure configurations; Medicilândia having a strong dependence of the public sector for maintaining employment, while Gramado has a vigorous participation in the private sector for a number of activities.

Exports and Comparative Advantage of the Cacao Chain in Brazil

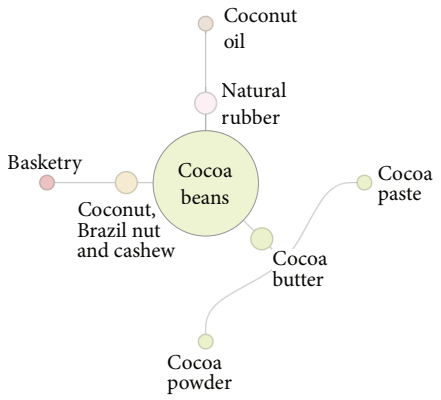
Product	Amount Exported 2017 (million USD)	Comparative Advantage
Cocoa beans	3,1	0,025
Cocoa paste	26,9	0,36
Cocoa butter	173,0	2,38
Cocoa powder	65,8	2,027
Chocolate	101,0	0,28

The following table shows the cacao segment products with which Brazil has a Revealed Comparative Advantage >1 (Balassa, 1965), meaning that it exports for than the "fair share" of foreign trade expected for the size of the country. For example, in 2008, soy represented 0.35% of all products exported in all the world, for a total of USD 42 billion. In that year, Brazil accounted for USD 11 billion in soy exports. Since that year the country exported USD 140 billion, soy represented 7.8% of the total exported, or around 22 times the fair share of soy that would be expected for Brazil (7.8% / 0.35%). Likewise, although at a lesser scale, the country has a comparative advantage in exporting cocoa butter and powder. But it does not have the same advantage with any of the other products associated with that productive chain (on the following page see the position and destination of Brazilian exports of cocoa beans and chocolate in 2017).

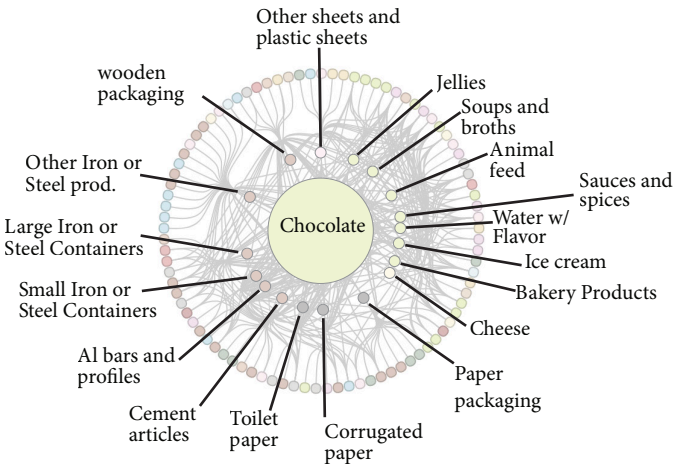
This analytical graph is quite relevant for the ACL in that it exemplifies some of the conditions of location of knowledge gaps in processing cocoa byproducts that it will have to deal with.

RELATED PRODUCTS

TO COCOA BEANS



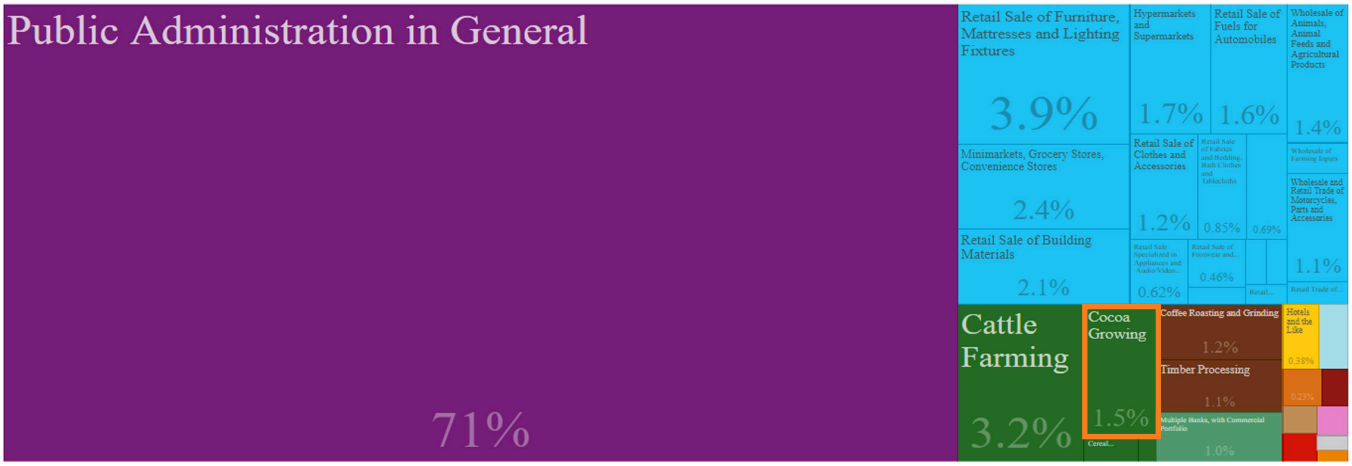
TO CHOCOLATE



Source
DataViva 2014, with data from SECEX

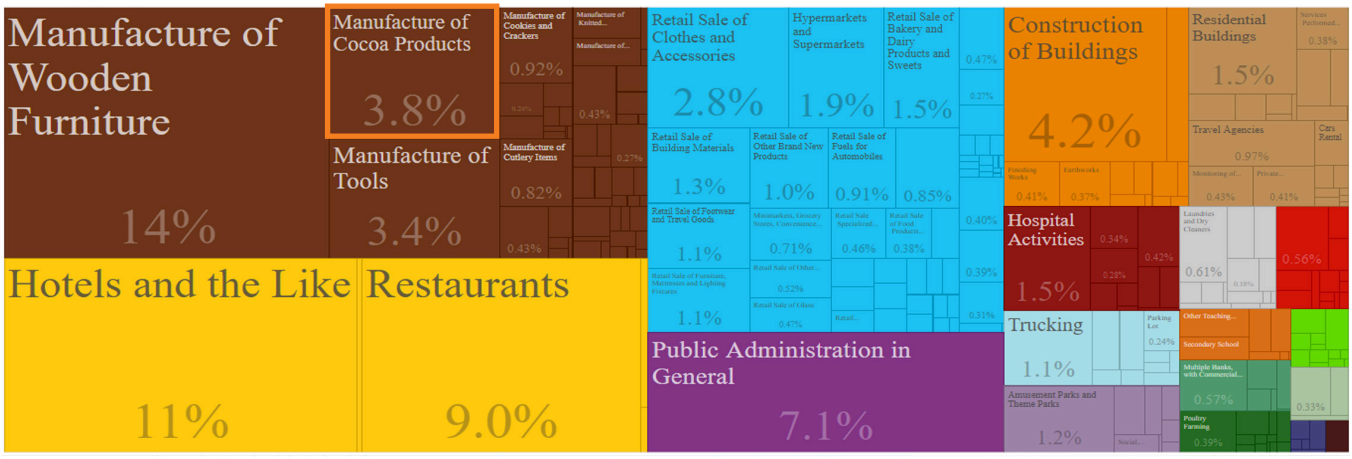
ECONOMIC ACTIVITIES | MEDICILÂNDIA

Total formal jobs: 1.3 thousand (2013)



ECONOMIC ACTIVITIES | GRAMADO

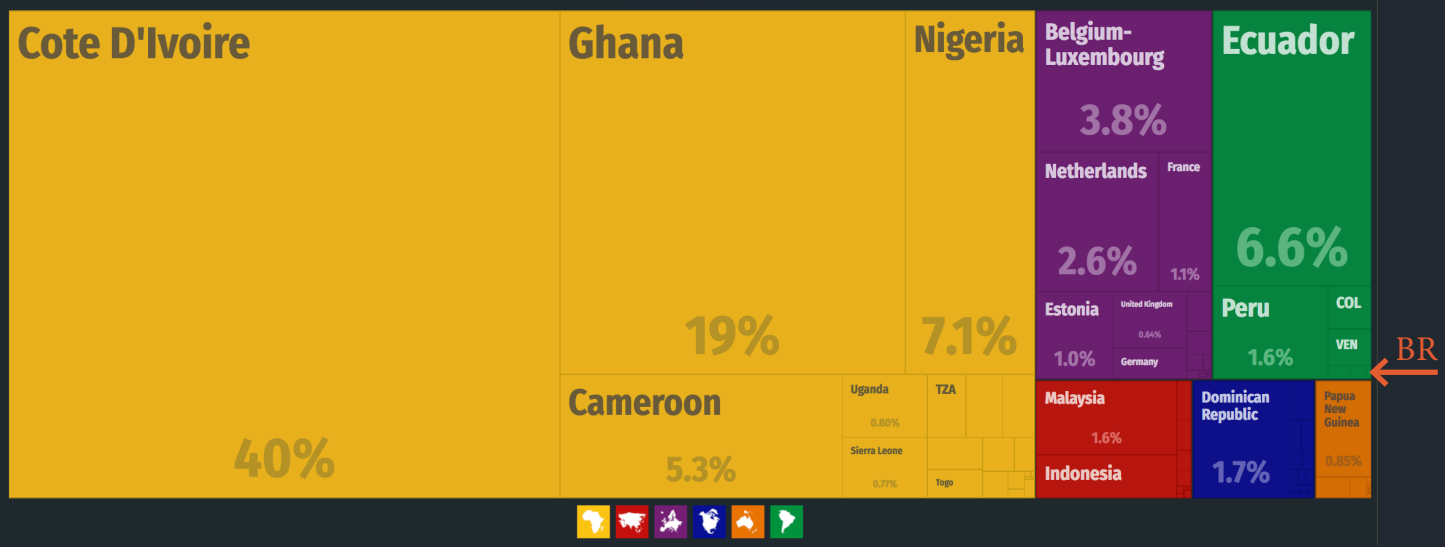
Total formal jobs: 16.9 thousand (2013)



Source
DataViva 2014, with data from RAIS, Ministry of Labor

WORLDWIDE EXPORTS (2017)

$9.35B USD

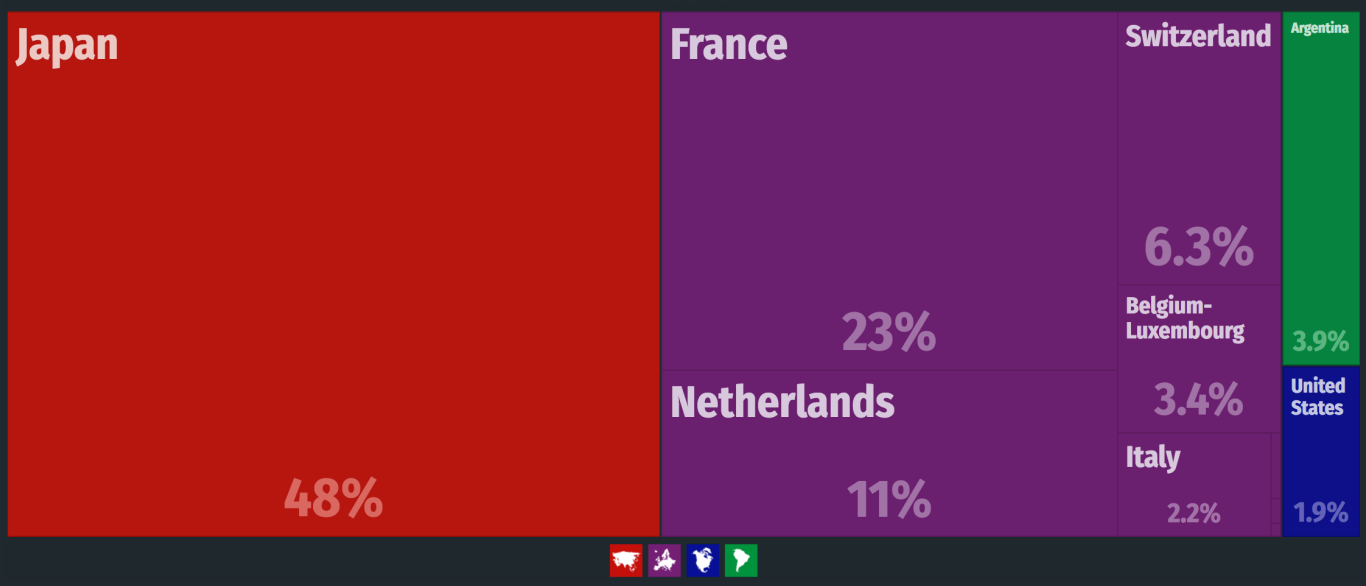


BRAZIL
Cocoa beans

3.13M USD
0.033% of worldwide exports

EXPORT DESTINATIONS (BR)

$3.13M USD

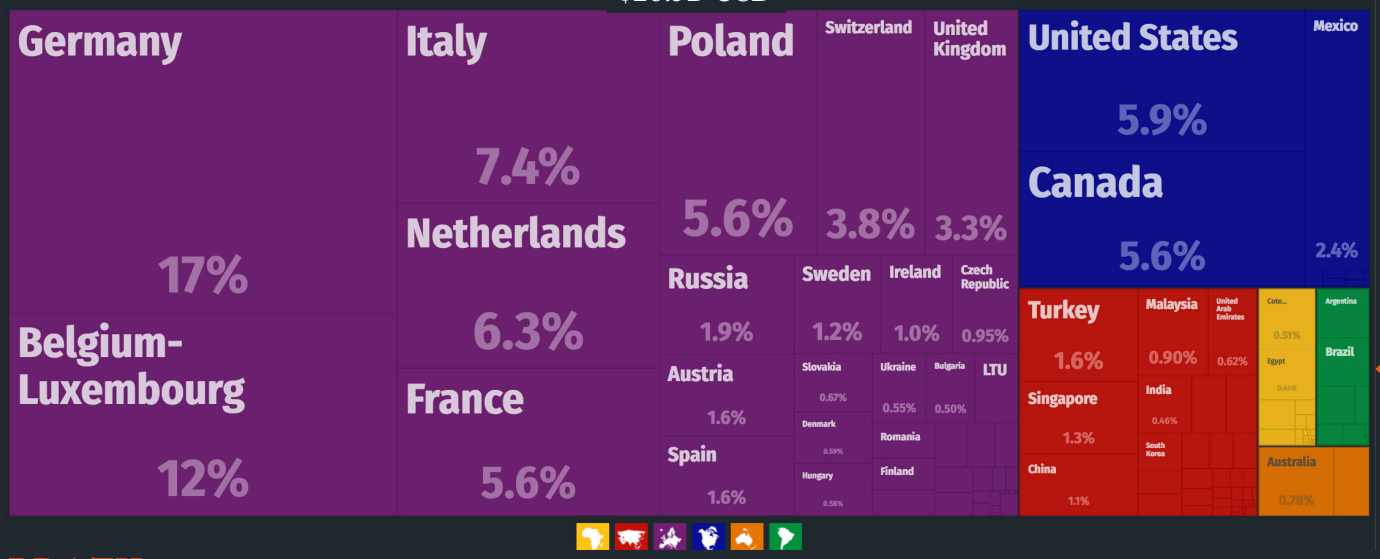


BRAZIL
Cocoa beans

Destinations for exports of Brazilian cocoa beans vary considerably from year to year. However, they have been concentrated on the European continent since 1999, when Brazil lost the USA as their main buyer. Since then, Japan and other Asian countries have become relevant commercial partners, with greater emphasis during the last two years. It is important to say that some years, Brazil actually imports about 50 times more cocoa beans than it exports. That is because domestic production is not able to supply demands by the industry, whose grinding capacity is 275 thousand tons. In 2017, Brazil imported USD 160 million in cocoa beans from Ghana. For an overview n the bilateral trade in cocoa and related products, consult the Observatório da Complexidade Econômica.

WORLDWIDE EXPORTS (2017)

$26.5B USD



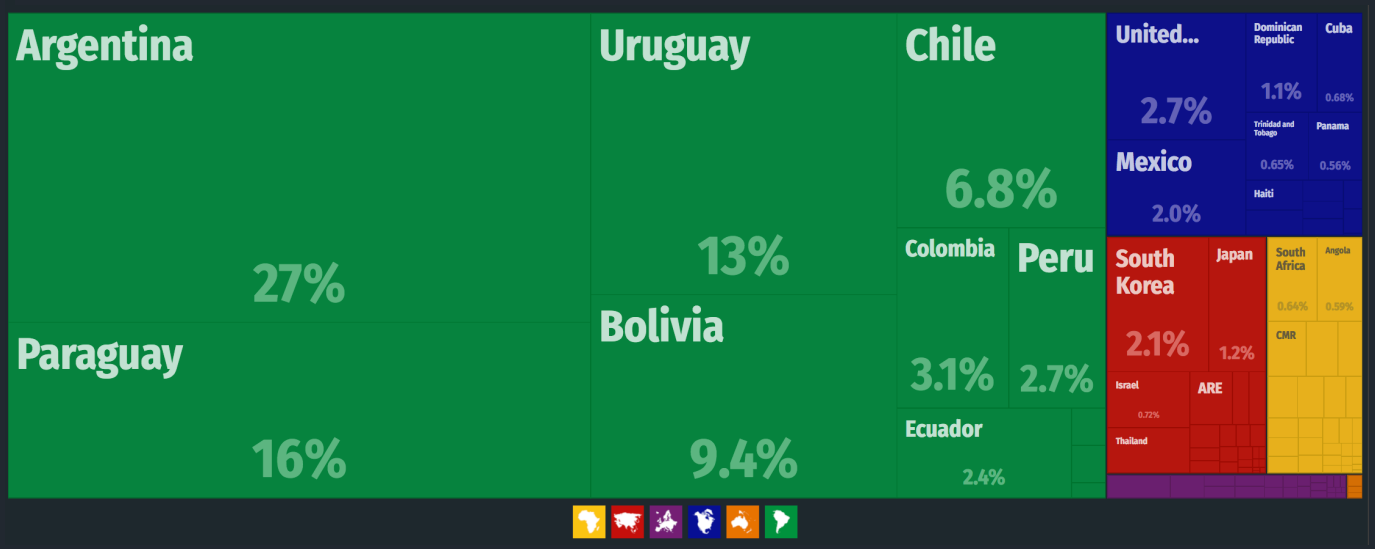
BR

BRAZIL
Chocolate

101M USD
0.38% of worldwide exports

EXPORT DESTINATIONS (BR)

$101M USD



BRAZIL
Chocolate

The main consumers of Brazilian chocolate have historically been the South American countries. In the last 25 years, our neighbors have imported more chocolate than any other continent, except for a period from 2002 to 2006, when North America emerged as the main consumer market. Only three inputs derived from cocoa processing in Brazilian territory had a favorable balance in 2017: cocoa butter with exports of USD 173M (USD 2.1M imported); cocoa powder, whose exported value was USD 65.8M (USD21.9M imported); and cocoa paste, with USD26.9M exported as opposed to USD 18.8M imported. During the last decade, Brazilian imports of European chocolates have recommenced their growth and have been topping USD 100M annually.

STATE AND MUNICIPAL PRODUCTION

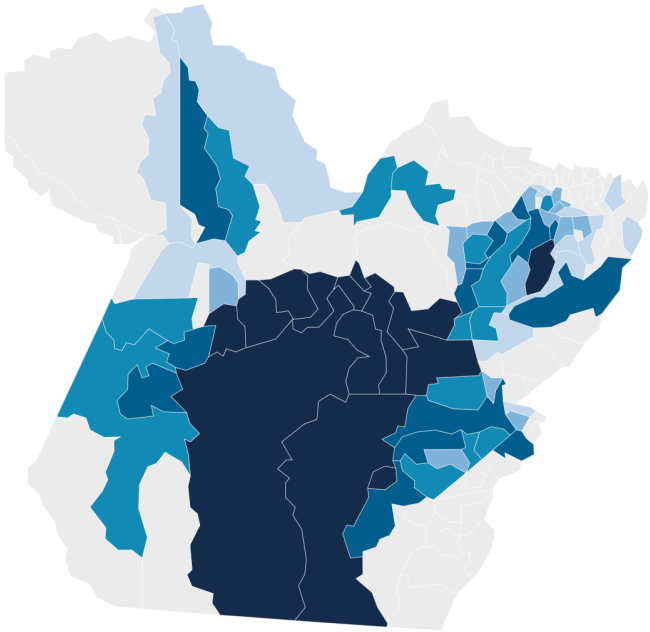
PARÁ
56 thousand tons
18,135 establishments

COCOA BEANS

tons

- 0,030 - 2,080
- 2,275 - 7,840
- 7,915 - 26,644
- 34,992 - 540,841
- 709,141 - 16.454,815
- No information

* establishments with more than 50 trees on 09/30/2017



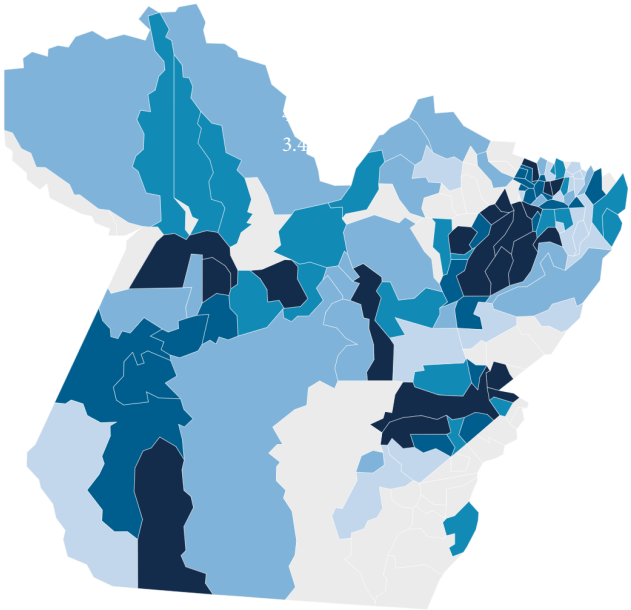
PARÁ
4.7 thousand tons
4,360 establishments

CUPUAÇU

tons

- 0,060 - 2,050
- 2,250 - 5,560
- 5,680 - 13,940
- 14,020 - 34,495
- 34,650 - 1.802,998
- No information

* establishments with more than 50 trees on 09/30/2017



Source
IBGE Censo Agro 2017

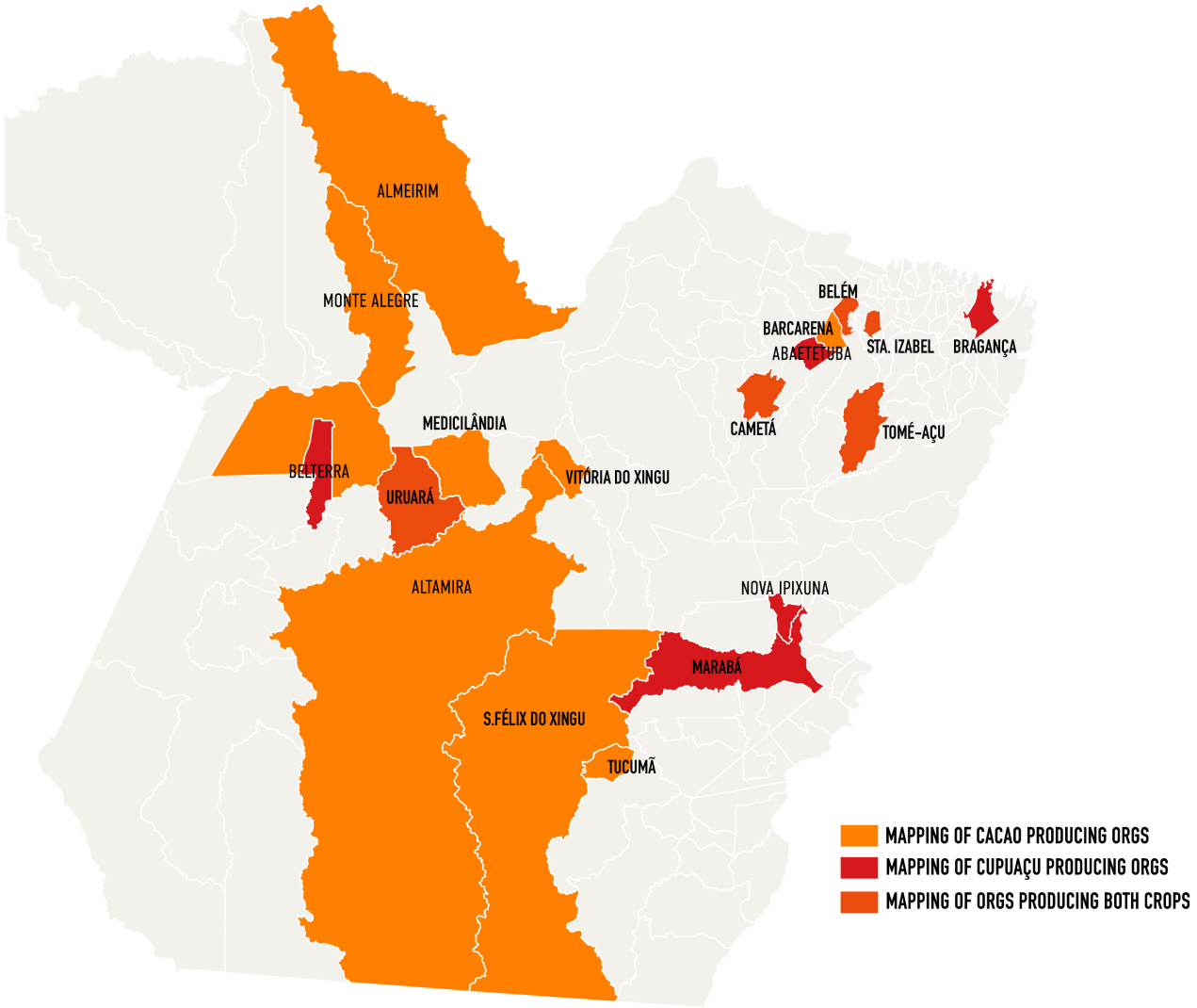
Pará is the second largest producer of cocoa beans and cupuaçu pulp, which assured annual sales on the order of BRL 30 million in ICMS (sales tax) (CEPLAC/2011). The area planted in cacao covers 110 thousand ha and has a production cost that is considered low, USD 800 per ton. The Transamazon territory concentrates 77% of the state cacao production, but one should also note the municipalities in the Bragantina Cacao Production Area, in the more northeastern portion of the state and islands regions influenced by the Tocantins river, while the southern part (São Felix do Xingu and Tucumã) have highly fertile soils, the so-called purple earth.

Around 40% of the state's cupuaçu is produced in Tomé-Açu (1800 tons). Other neighboring municipalities are relevant producers, such as Acará, Moju and Aurora do Pará. Two other regions can be considered producing areas, Marabá and Santarém, potential targets for the ACL

THE ORGANIZATIONS BELOW WERE VISITED OR ARE PART OF THE CONEXSUS REGISTRY OF COMMUNITY BUSINESSES

Organization		Municipality	Year Founded	Associates
COFRUTA	Fruit-Growers Cooperative of Abaetetuba	Abaetetuba	2002	From 51 to 100 persons
ASMIPPS	Association of Micro and Small Rural Producers and Extractivists of the Repartimento dos Pilões Community	Almeirim	1994	From 0 to 20 persons
CEPOTX	Central Cooperative for Organic Production of the Transamazon and Xingu	Altamira	2014	From 101 to 200 persons
MMIB	Women's Movement of the Islands of Belém	Belém	2002	From 21 to 50 persons
MANIOCA	Manioca Food Commerce of the Amazon, Ltd.	Belém	2009	From 0 to 20 persons
D.Nena (Izete Costa)	Production of Organic Chocolate on Combu Island	Belém (Ilha do Combu)	2006	-
AMABELA	Association of Women Rural Workers in the Municipality of Belterra	Belterra	2014	From 51 to 100 persons
COOMAC	Mixed Cooperative of the Family Farmers of the Caetés	Bragança	2010	From 101 to 200 persons
CART	Resistance Agroextractive Cooperative of Cametá	Cametá	1995	From 51 to 100 persons
AMA	Agroextractivist Association of the Ajú Residents	Cametá	2007	From 0 to 20 persons
AMIGA	Association of Beekeeping Men and Women of the Municipality of Igarapé-Açu	Igarapé-Açu	2005	From 21 to 50 persons
FECAT	Federation of Family Agriculture Cooperatives of Southern Pará	Marabá	2003	From 0 to 20 persons
COOPATRANS	Agroindustrial Cooperative of the Transamazon	Medicilândia	2010	From 21 to 50 persons
ASA	Serra Azul Settlement Associatione	Monte Alegre	2006	From 101 to 200 persons
CORRENTÃO	Worker's Cooperative of Nova Ipixuna and Region	Nova Ipixuna	1993	From 21 to 50 persons
AMOREAP	Residents' Association of the Arióca Pruanã Extractive Reserve	Oeira do Pará	2005	More than 201 persons
COPRAASIP	Agroextractive Açaí Producer Cooperative of Santa Izabel do Pará, Inhangapi and Bujaru	Santa Izabel do Pará	2011	From 0 to 20 persons
Francisco Galvão	Rural Proprietor	Santarém	1970	From 0 to 20 persons
CACUXI	Agricultural Credit Bank of the United Colonists of the Xingu	São Felix do Xingu	1985	From 21 to 50 persons
CAMPPAX	Mixed Alternative Cooperative of the Small Producers of Alto Xingu	São Félix do Xingu	2014	From 101 to 200 persons
CAMTA	Mixed Agricultural Cooperative of Tomé-Açu	Tomé-Açu	1949	From 101 to 200 persons
APRAFAMTA	Association of Producers and Rural Producers of Family Agriculture in the Municipality of Tomé-Açuv	Tomé-açu	2005	From 21 to 50 persons
COOBA-Y	Ba-Y Kayapó Cooperative of Forest Products of Tucumã	Tucumã	2012	From 101 to 200 persons
AMDOR	Dom Oscar Women's Association	Uruará	1997	From 51 to 100 persons
COPOTRAN	Organic Producer's Cooperative of the Transamazon	Vitoria do Xingu	2008	From 21 to 50 persons

INSTITUTIONAL MAPPING



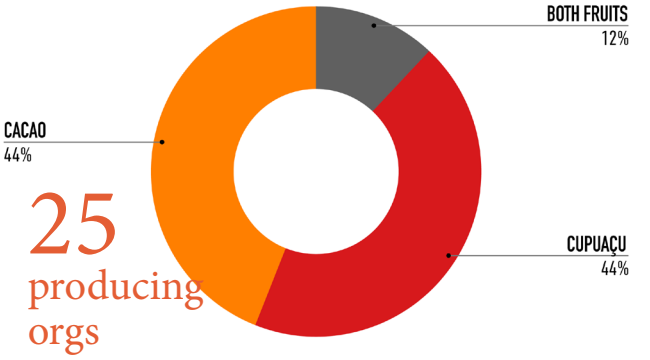
AMONG THE ORGANIZATIONS MAPPED

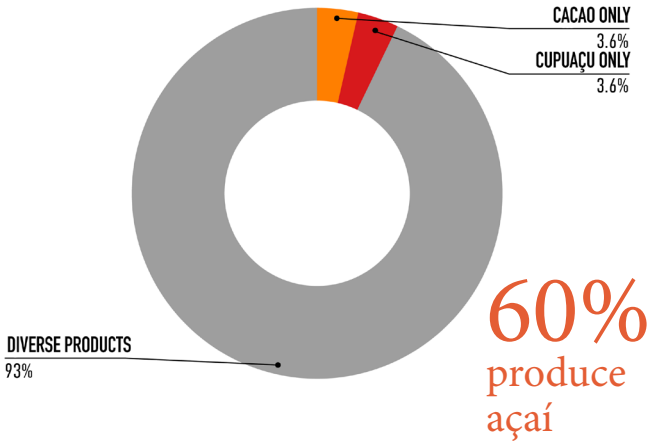
68% HAD WOMEN PARTICIPATING ON THE BOARD OF DIRECTORS

44% HAD YOUNG PEOPLE PARTICIPATING ON THE BOARD OF DIRECTORS

AND ONLY **12%** ACCESS DOMESTIC AND/OR INTERNATIONAL MARKETS

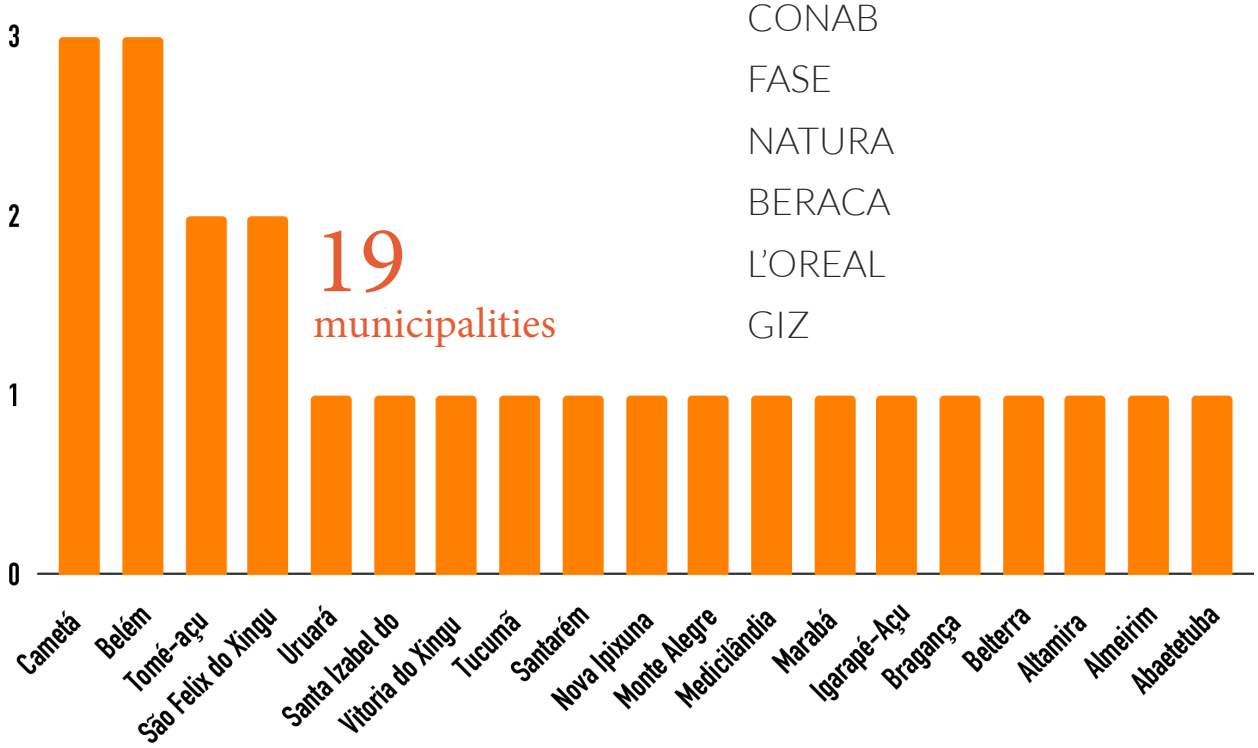
PRODUCING ORGANIZATIONS MAPPED | PARÁ





The entities that are frequently cited as part of the network of productive organizations in Pará are:

EMATER
UFPA
IFPA
UFOPA
UEPA
UFRAM
SEBRAE
CEPLAC
EMBRAPA
ICMBIO
MUNICIPAL GOVERNMENTS
IMAFLORA
ISA
IIEB
RURAL WORKER UNIONS
CONAB
FASE
NATURA
BERACA
L'OREAL
GIZ



STATE AND MUNICIPAL PRODUCTION

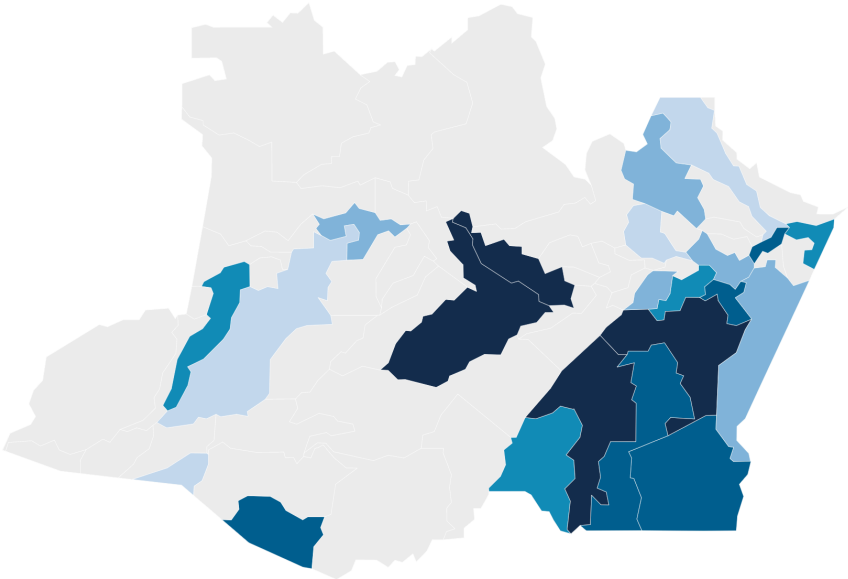
AMAZONAS
275 tons
689 establishments

COCOA BEANS

tons

- 0,050 - 0,400
- 1,650 - 4,151
- 5 - 8,564
- 10,520 - 18,190
- 19,995 - 89,455
- No information

* establishments with more than 50 trees on 09/30/2017



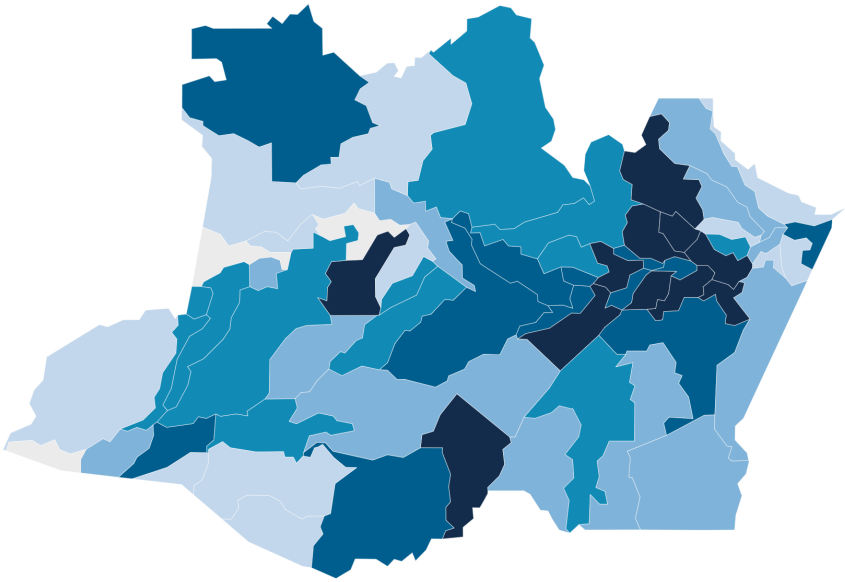
AMAZONAS
10.2 thousand tons
5.479 establishments

CUPUAÇU

tons

- 0,400 - 3,830
- 3,860 - 11,875
- 12,470 - 22,605
- 23,180 - 67,923
- 85,750 - 4.155,493
- No information

* establishments with more than 50 trees on 09/30/2017



Source
IBGE Censo Agro 2017

10 LARGEST CUPUAÇU-PRODUCING MUNICIPALITIES

tons

1. Nova Olinda do Norte	4.155,493
2. Presidente Figueiredo	1.653,843
3. Autazes	926,292
4. Itacoatiara	778,610
5. Manaus	584,443
6. Rio Preto da Eva	396,372
7. Careiro	325,250
8. Beruri	251,166
9. Manacapuru	123,864
10. Canutama	97,610

establishments

1. Presidente Figueiredo	654
2. Careiro	597
3. Autazes	544
4. Itacoatiara	471
5. Manaus	399
6. Nova Olinda do Norte	363
7. Rio Preto da Eva	300
8. Beruri	218
9. Manaquiri	203
10. Manacapuru	163

* establishments with more than 50 trees on 09/30/2017

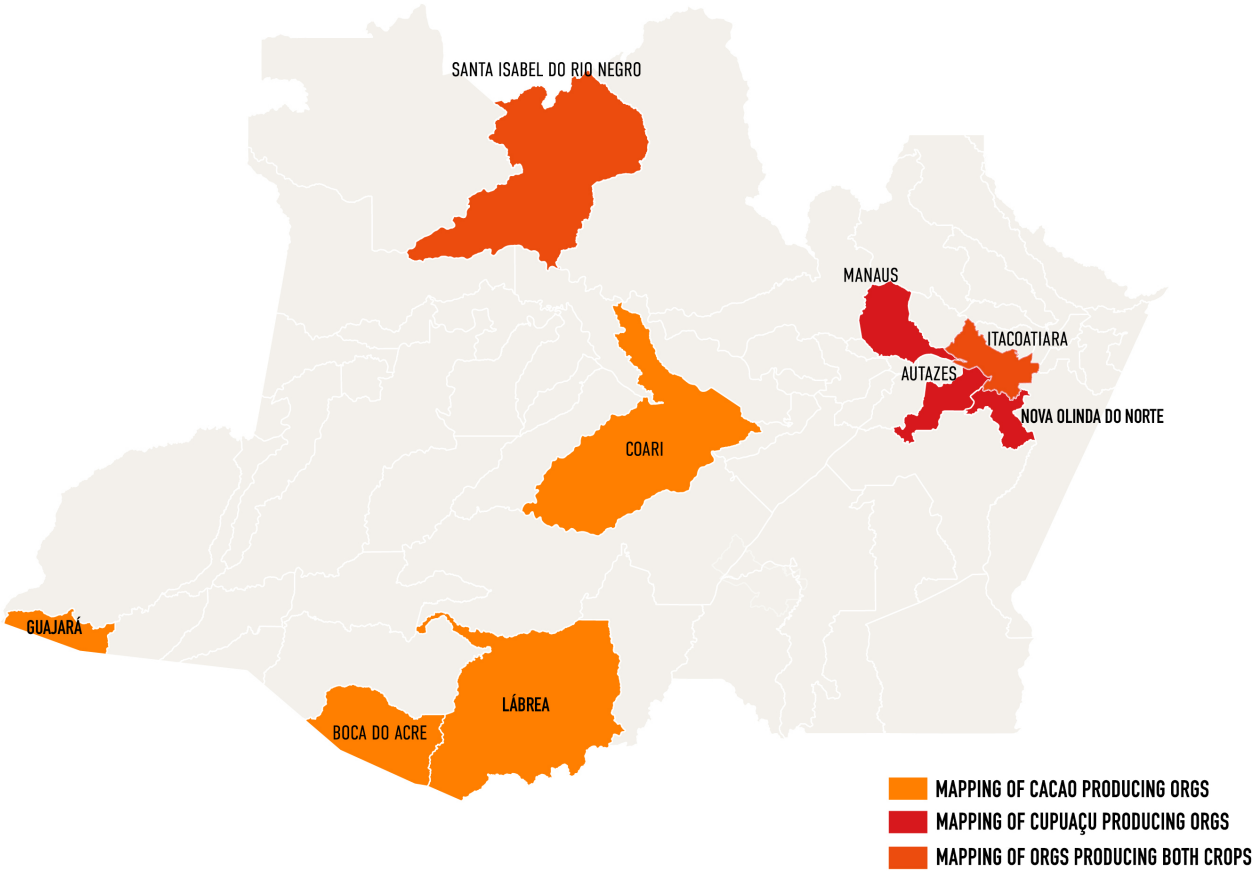
THE ORGANIZATIONS BELOW ARE PART OF THE CONEXSUS REGISTRY OF COMMUNITY BUSINESSES

Organization		Municipality	Year Founded	Associates
ACIR	Association of Indigenous and Riverbank Communities	Santa Isabel do Rio Negro	2008	More than 201 persons
AFPAP	Association of Farmers and Family Members of the Paquequer Settlement	Nova Olinda do Norte	1999	From 51 to 100 persons
APITPAD	Association of Tikuna Indigenous Peoples of Paraná do Duruna	Coari	2009	From 101 to 200 persons
APREA	Association of Producers and Rural Extractivist Producers of the Arapixi Reserve	Boca do Acre	2013	From 101 to 200 persons
ASTA-RIO ARARI	Association of Craftwork Producers and Family Farmers of Baixo Arari	Itacoatiara	2005	From 21 to 50 persons
ATAMP	Association of Agroextractivist Workers of the Médio Purus	Lábrea	2005	More than 201 persons
COOPAFJA	Cooperative for Family Agriculture of Jatua	Autazes	2013	From 21 to 50 persons
COOPANORE	Agriculture and Ranching Cooperative of Novo Remanso	Itacoatiara	2010	From 51 to 100 persons
COOPERAR	Agroextractivist Cooperative of Mapiá and Médio Purus	Boca do Acre	2003	More than 201 persons
COOPERATIVA MISTA DOS PRODUTORES RURAIS DO TARUMÃ MIRIM	Mixed Cooperative of Rural Producers of Tarumã Mirim	Manaus	2008	From 21 to 50 persons
NOVO HORIZONTE	Association of Extractive Workers of the Novo Horizonte Community	Guajará	2017	From 51 to 100 persons

Wild cacao is a common species along the banks of the brown-water (muddy) rivers in Amazonas, but records of its production are underestimated, according to CEPLAC, whose studies in the field indicate a real production of around 3.7 thousand tons.

Where the state of Amazonas really stands out is in cupuaçu production. According to IBGE data it accounts for more than 42% of Brazilian production. The cupuaçu tree is well adapted for shading and because of that is a favorable species for interplanted reforestation with larger trees, such as rubber, mahogany, Brazil-nut and other forest fruit trees. Both the fruit and the seed have good market potential. Analyses of the pulp reveal high levels of vitamin C and phosphorus. The pulp is used for producing juices, ice creams, jellies, candies and yoghurts. The seed is being used for extracting a butter similar to cocoa butter, with food and especially cosmetic properties. Since the 1980s, EMBRAPA Eastern Amazon has been studying cupulate, which today is part of the product line of some chocolatiers.

INSTITUTIONAL MAPPING



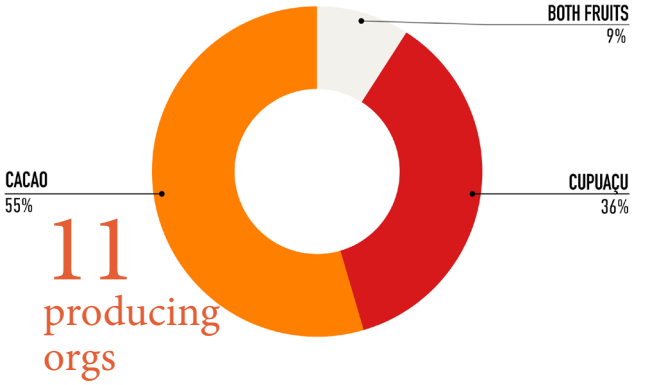
AMONG THE ORGANIZATIONS MAPPED

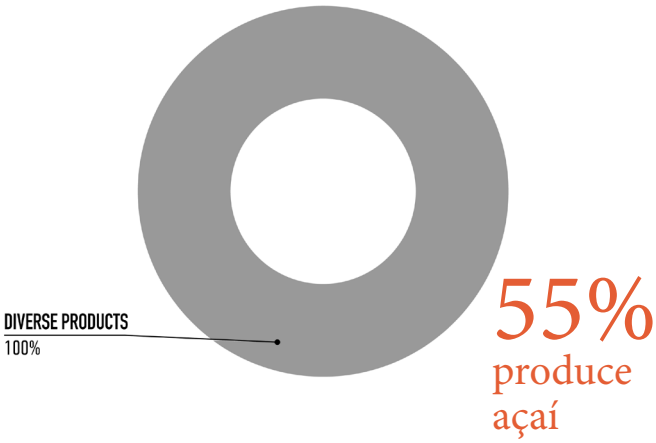
73% HAD WOMEN PARTICIPATING ON THE BOARD OF DIRECTORS

36% HAD YOUNG PEOPLE PARTICIPATING ON THE BOARD OF DIRECTORS

AND ONLY **18%** ACCESS DOMESTIC AND/OR INTERNATIONAL MARKETS

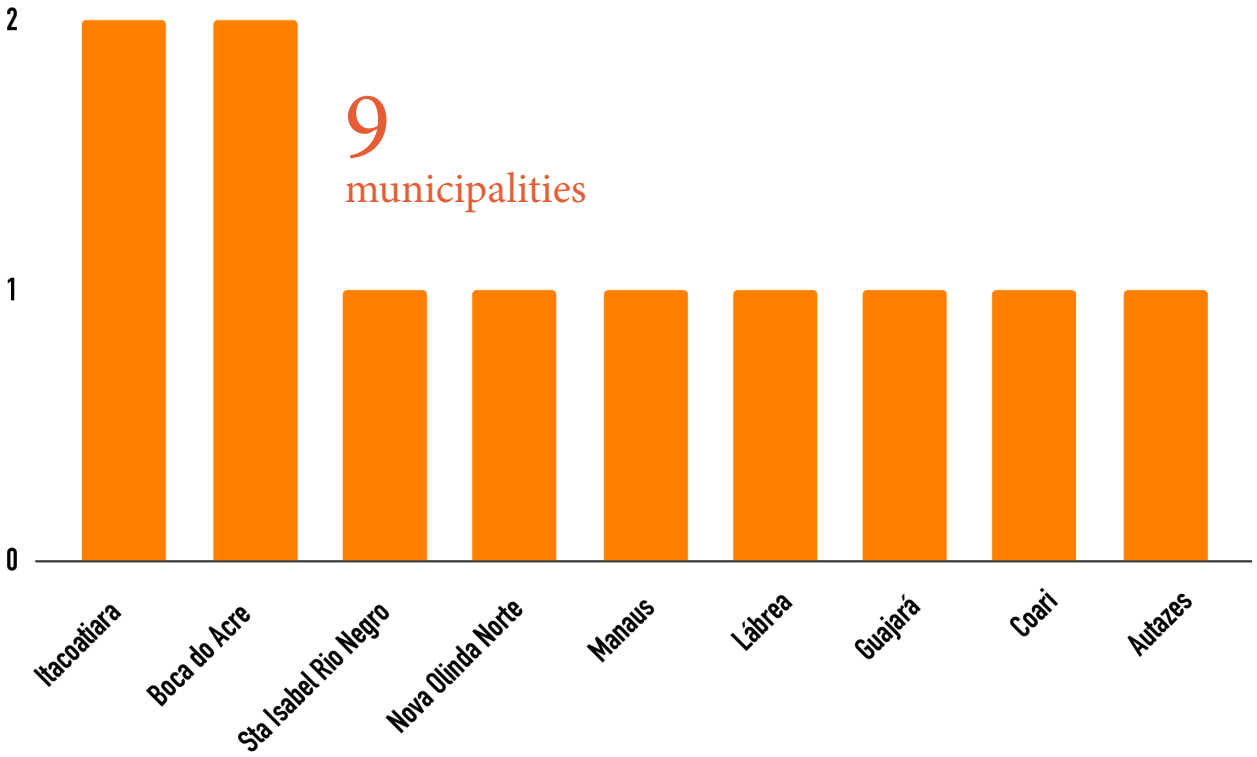
PRODUCING ORGANIZATIONS MAPPED | AMAZONAS





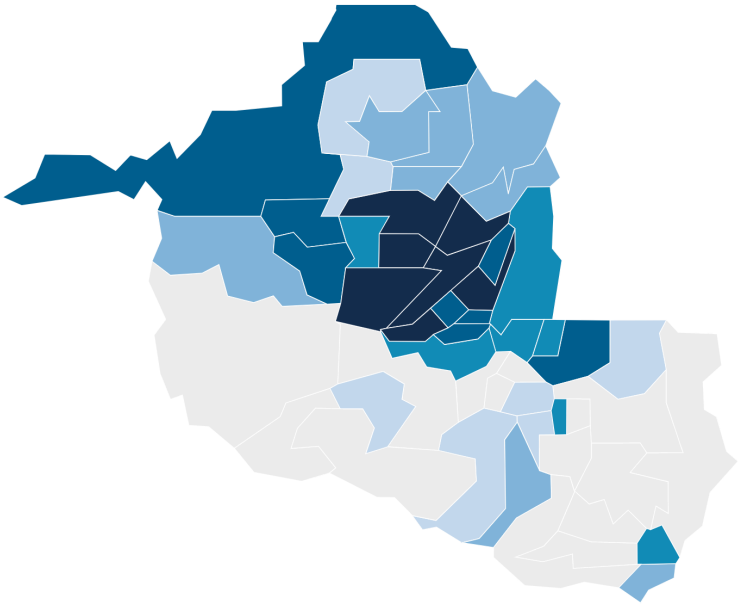
The entities that are frequently cited as part of the network of productive organizations in Amazonas are:

FOIRN
FUNAI
ISA
IDAM
UFAM
UEAM
IFAM
ADS
SEBRAE
ICMBIO
PREFEITURAS
IIEB
SINDICATOS RURAIS
CONAB
GIZ



ESTATE AND MUNICIPAL PRODUCTION

RONDÔNIA
2.9 thousand tons
2,342 establishments



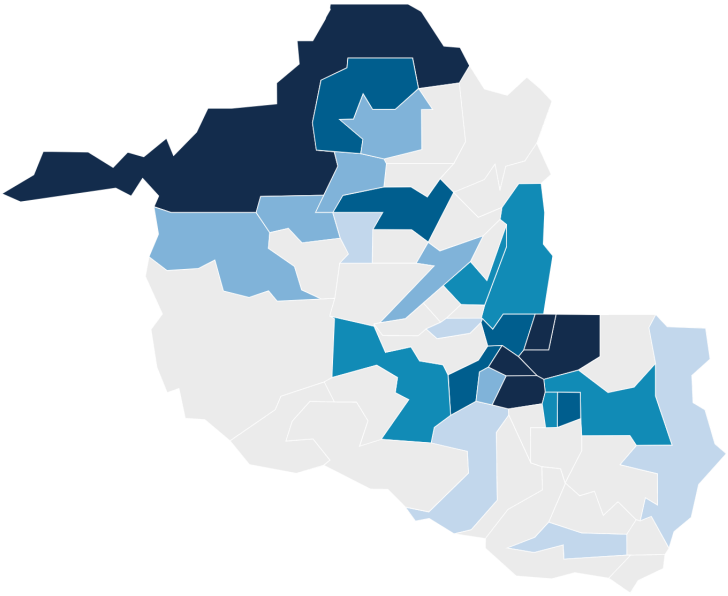
COCOA BEANS

tons

- 0,580 - 1,915
- 2,040 - 11,590
- 13,511 - 37,585
- 42,023 - 73,021
- 73,925 - 826,805
- No information

* establishments with more than 50 trees on 09/30/2017

RONDÔNIA
2 thousand tons
435 establishments



CUPUAÇU

tons

- 0,031 - 3,030
- 3,200 - 11,080
- 13,860 - 18,128
- 22,830 - 51,800
- 105,474 - 1.249,688
- No information

* establishments with more than 50 trees on 09/30/2017

Source
IBGE Censo Agro 2017

10 LARGEST CUPUAÇU-PRODUCING MUNICIPALITIES

tons

1. Porto Velho	1.249,688
2. Ministro Andreazza	137,500
3. Castanheiras	136,600
4. Cacoal	108
5. Rolim de Moura	105,474
6. Primavera de Rondônia	51,800
7. Ariquemes	41,851
8. Presidente Médici	31,730
9. Candeias do Jamari	26,600
10. Nova Brasilândia d`Oeste	22,830

establishments

1. Porto Velho	200
2. Candeias do Jamari	26
3. Ariquemes	24
4. Rolim de Moura	21
5. Presidente Médici	14
6. Ji-Paraná	14
7. Castanheiras	14
8. Ministro Andreazza	10
9. São Miguel do Guaporé	9
10. Cacoal	9

* establishments with more than 50 trees on 09/30/2017

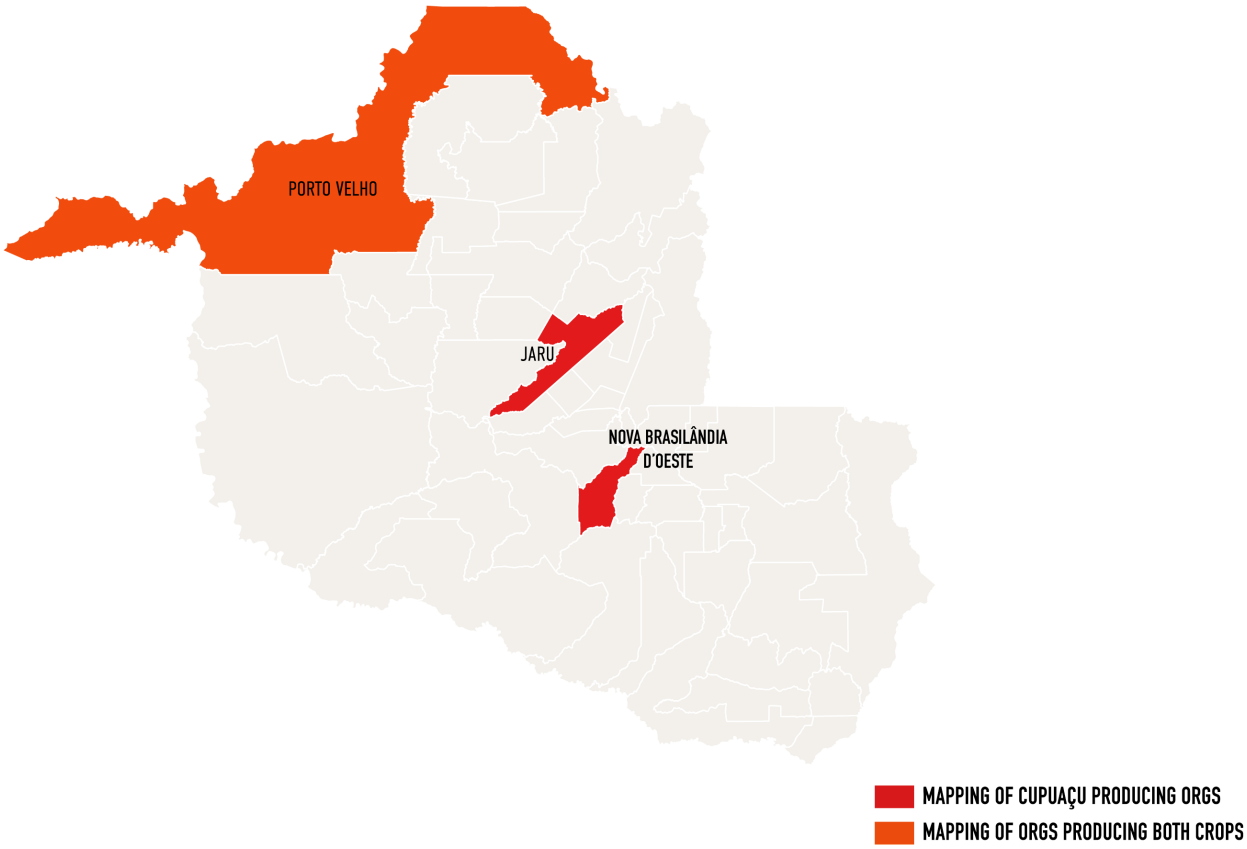
THE ORGANIZATIONS BELOW ARE PART OF THE CONEXSUS REGISTRY OF COMMUNITY BUSINESSES

Organization		Municipality	Year Founded	Associates
KANINDÉ	Kanindé Association for Ethnoenvironmental Defense	Porto Velho	1992	From 0 to 20 persons
COAJAR	Cooperative of Rural and Family Farmer Producers of Jaru and Region	Jaru	2013	From 21 to 50 persons
COOPABRAS	Agriculture and Ranching Cooperative of Nova Brasilândia D´Oestett	Nova Brasilândia D'Oeste	2014	From 51 to 100 persons
COOPER RECA	Agriculture and Ranching Association of the RECA Project	Porto Velho	2006	From 101 to 200 persons

Rondônia has been investing in revitalizing its cacao crop through clonal cacao, which is resistant to the witch's broom disease. According to the IBGE, the largest share of production is concentrated in the municipalities of Governador Jorge Teixeira, Jaru, Ariquemes and Ouro Preto do Oeste. Our preliminary mapping, however, was not able to identify the main cacao producing organizations in those municipalities. Over the next few months, the Working Group intends to refine this mapping by identifying producers who operate in agroforestry systems in Rondônia.

The organizations identified during the first mapping justify implementation of the ACL in Rondônia state, and especially in the municipality of Porto Velho, because of the appearance of cupuaçu production in the region. There are two distinct profiles of organizations. On the one hand there is the presence of the RECA organization, located in the Nova Califórnia district, where around 500 small producers grow cupuaçu intercropped with peach balm and Brazil nut. The Cooperative already has an agroindustry that processes cupuaçu pulp and seeds, and may experiment with developing new products with the ACL. Equally relevant is the presence of the Kanindé Association for Ethnoenvironmental Defense, which supports plans for management, agriculture and productive systems for the Uru-eu-wau-wau, Suruí and Arara indigenous peoples and is thus an opportunity for integrating indigenous peoples with the ACL and learning from that experience.

INSTITUTIONAL MAPPING



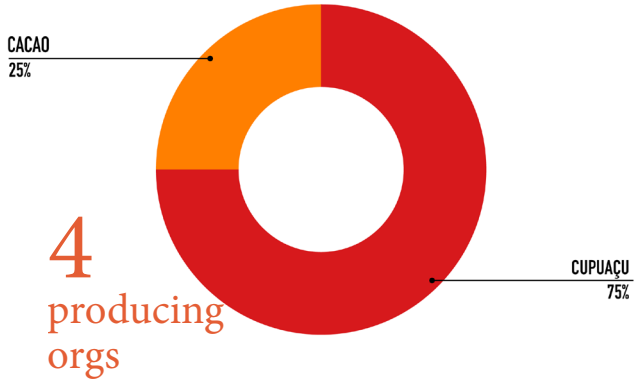
AMONG THE ORGANIZATIONS MAPPED

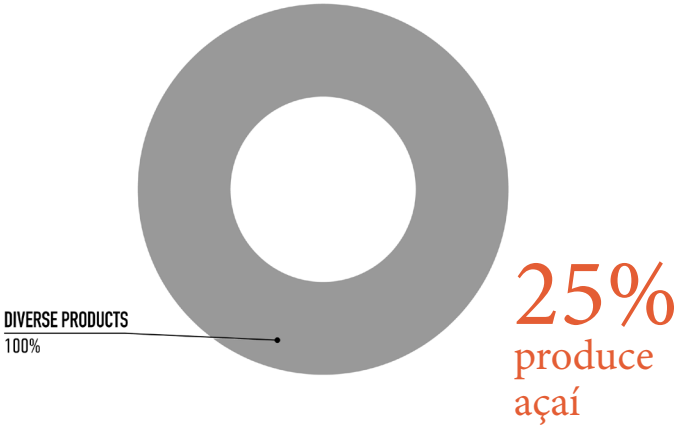
75% HAD WOMEN PARTICIPATING ON THE BOARD OF DIRECTORS

35% HAD YOUNG PEOPLE PARTICIPATING ON THE BOARD OF DIRECTORS

AND ONLY **25%** ACCESS DOMESTIC AND/OR INTERNATIONAL MARKETS

PRODUCING ORGANIZATIONS MAPPED | RONDÔNIA





The entities that are frequently cited as part of the network of productive organizations in Rondônia are:

EMATER

EMBRAPA

ASSOCIATION OF THE URU-EU-WAU-WAU INDIGENOUS PEOPLE

METAREIÁ ASSOCIATION OF THE SURUÍ INDIGENOUS PEOPLE

ASSOCIATION OF THE ARARA INDIGENOUS PEOPLE

SANTO ANDRÉ INDIGENOUS ASSOCIATION

MUNICIPAL GOVERNMENTS

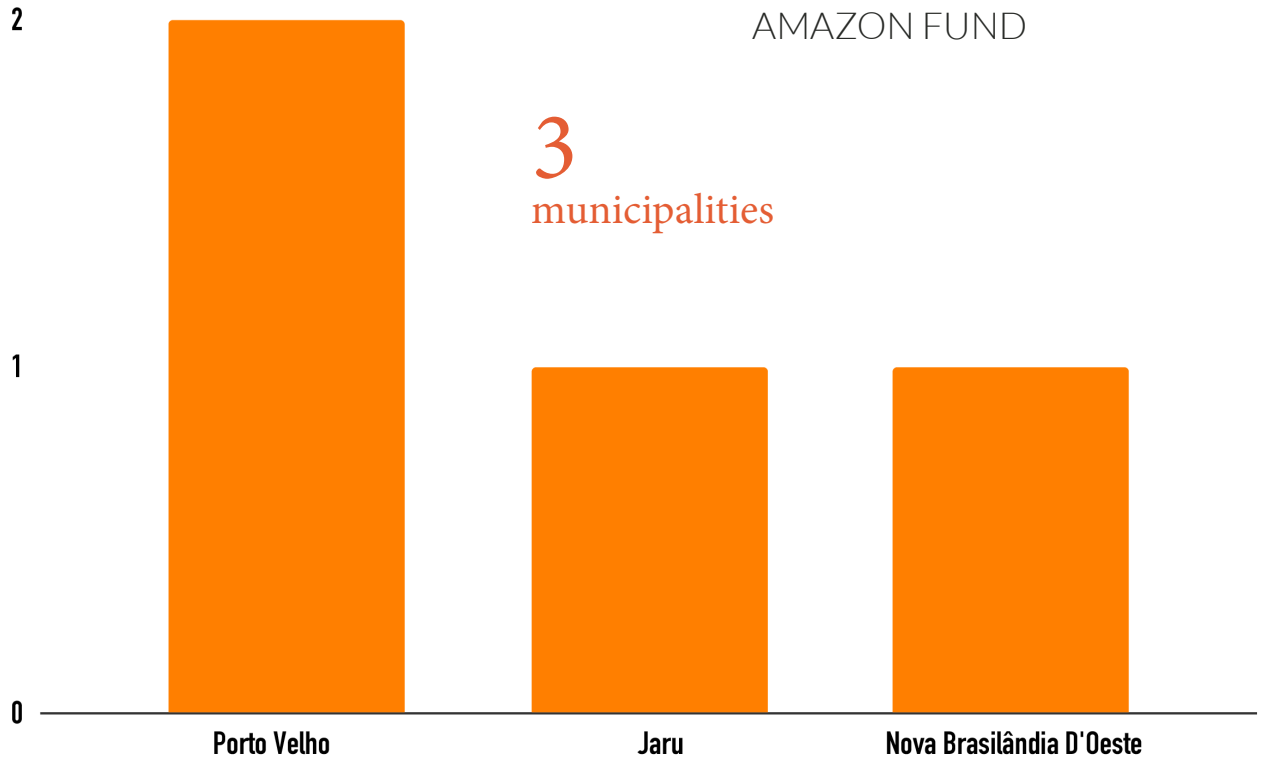
STATE GOVERNMENTS

RURAL UNIONS

NATURA

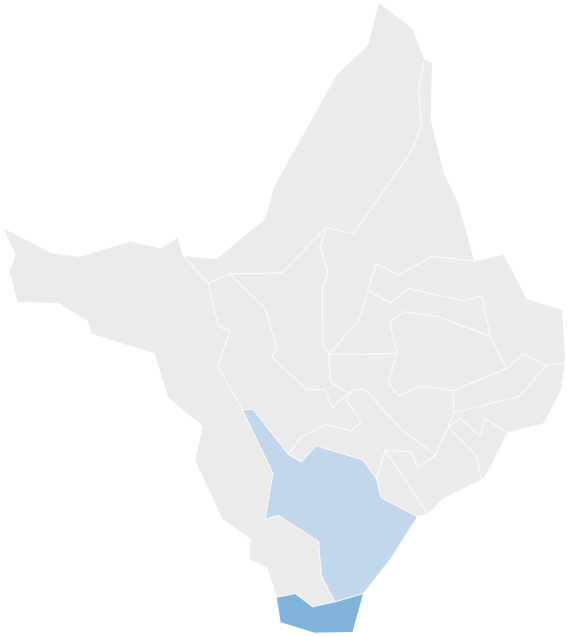
PETROBRÁS

AMAZON FUND



STATE AND MUNICIPAL PRODUCTION

AMAPÁ
3.6 thousand tons
19 establishments



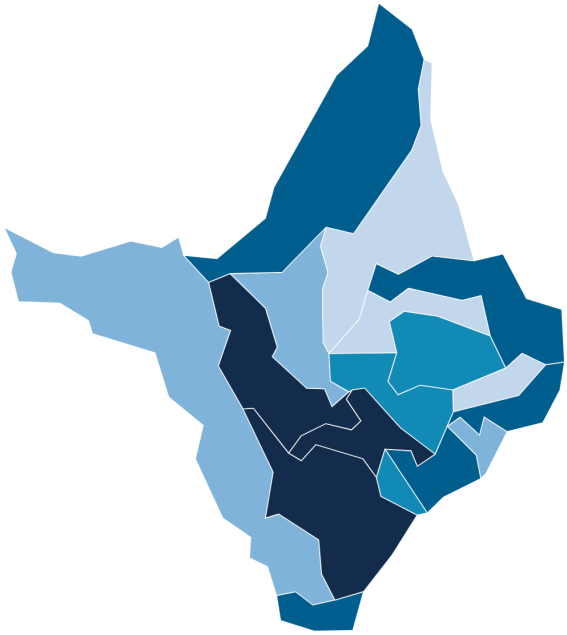
COCOA BEANS

tons

- 1.382
- 1.711
- No information

* establishments with more than 50 trees on 09/30/2017

AMAPÁ
730 tons
985 establishments



CUPUAÇU

tons

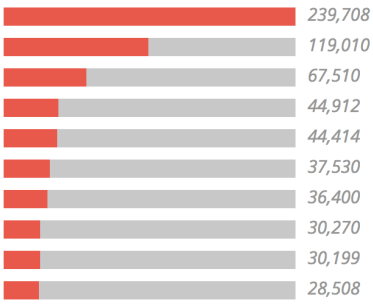
- 0,650 - 4,870
- 7,460 - 24,300
- 28,508 - 30,270
- 36,400 - 44,912
- 67,510 - 239,708
- No information

* establishments with more than 50 trees on 09/30/2017

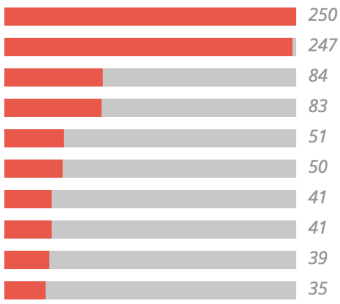
Source I
BGE Censo Agro 2017

10 LARGEST CUPUAÇU-PRODUCING MUNICIPALITIES

tons



establishments



* establishments with more than 50 trees on 09/30/2017

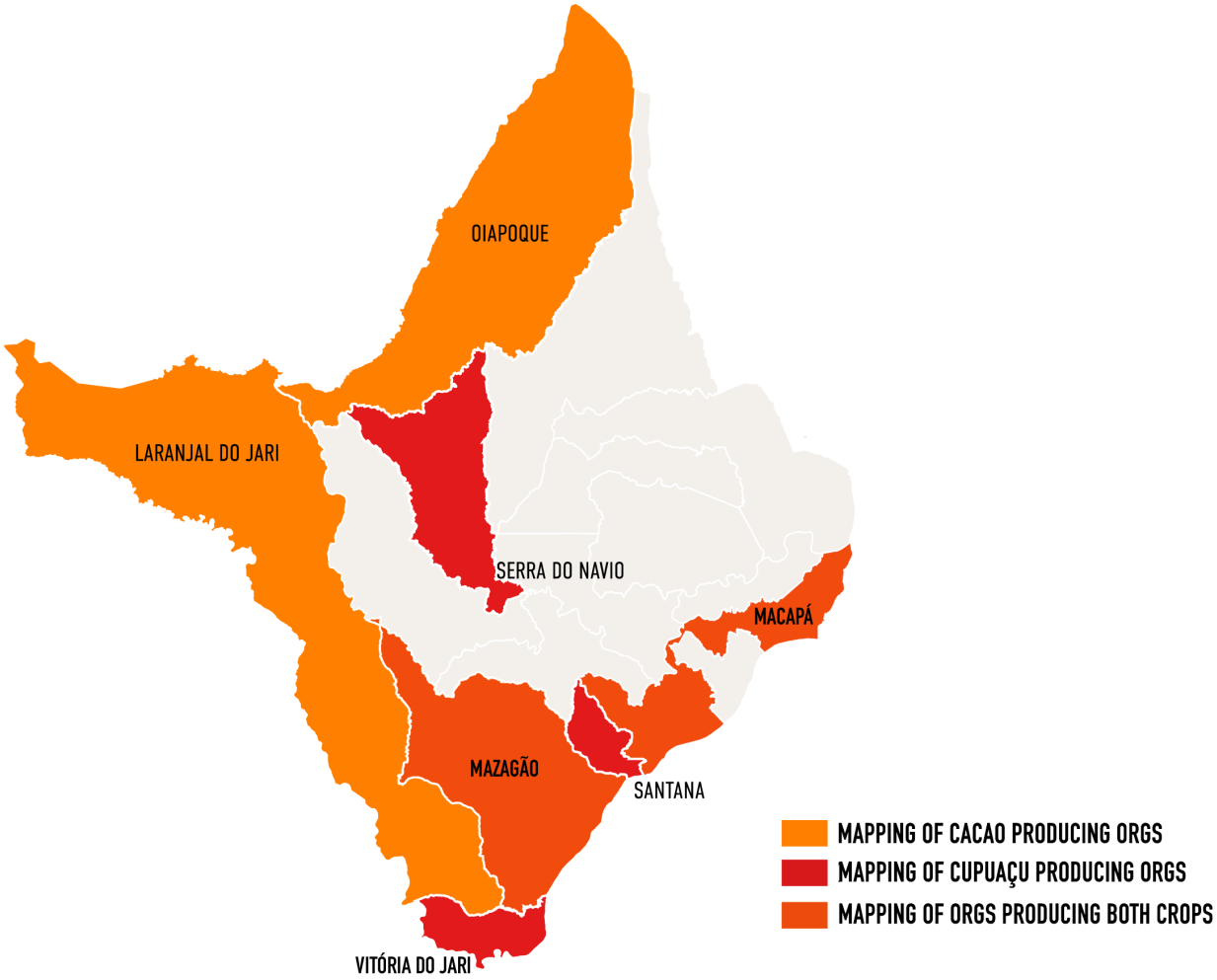
THE ORGANIZATIONS BELOW ARE PART OF THE CONEXSUS REGISTRY OF COMMUNITY BUSINESSES

Organization		Municipality	Year Founded	Associates
COOPERATIVA ILHA DE SANTANA	Cooperative of Agroextractivist Producers of Ilha de Santana	Ilha de Santana	2016	From 21 to 50 persons
COOPERFLORA	Mixed Agroextractivist Cooperative of the Vale do Jari Producers	Laranjal do Jari	2010	From 21 to 50 persons
AGROIGARAPÉ	Agroextractivist Association of the Nossa Senhora da Conceição do Igarapé dos Porcos Community	Macapá	2006	From 101 to 200 persons
COOPAMAIS	Agroindustrial Production Cooperative for the Environment and Social Incentives	Macapá	2011	From 21 to 50 persons
AAMARP	Association of Agroextractivist Workers of the Médio e Alto Rio Preto	Mazagão	2007	From 101 to 200 persons
AMPAFOZ	Association of Women Agroextractivist Producers of Foz do Rio Mazagão Velho	Mazagão	2002	From 101 to 200 persons
ASECOM	Association of Extractivist Agrobusinesses of the Maracá Communities	Mazagão	2014	More than 201 persons
ASSOCIAÇÃO RIO CAJARI	Association of Agroextractivist Residents of the Rio Cajari	Mazagão	1999	More than 201 persons
CASSIPORÉ	Cassiporé Agroextractivist Cooperative	Oiapoque	2015	From 21 to 50 persons
COOPEFAS	Cooperative of Extractive Producers	Serra do Navio	2017	From 21 to 50 persons
COOPERVITORIA	Cooperative for Fishing, Ranching and Extractivism of Southern Amapá	Vitoria do Jari	2016	From 21 to 50 persons

In quantitative terms, Amapá production of cacao and cupuaçu might not justify implementation of ACL activities in the State. However, there are two reasons that encourage us to defy the statistical evidence. First, there is the density of productive organizations that emerged from the preliminary mapping, a total of 11 located in 7 municipalities. There are curious cases, such as the municipality of Serra do Navio, which, despite a recorded production of only 14 tons, has a tradition in growing and using cupuaçu, with an annual festival that brings together cultural, tourism and consumption of the fruit in several recipes

Second, keeping Amapá in the ACL may favor the inclusion of participants from the municipality of Almeirim (PA), which is isolated from the highway network and might be able to use Amapá as a more viable logistical option. During the field visit, Municipal Environmental Secretary Sylvia Nascimento expressed her alignment with the ACL values and her commitment to support productive organizations interested in capacity-building and experimental activities.

INSTITUTIONAL MAPPING



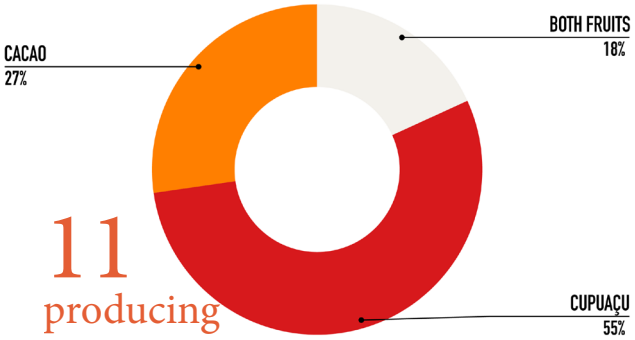
AMONG THE ORGANIZATIONS MAPPED,

55% HAD WOMEN PARTICIPATING ON THE BOARD OF DIRECTORS

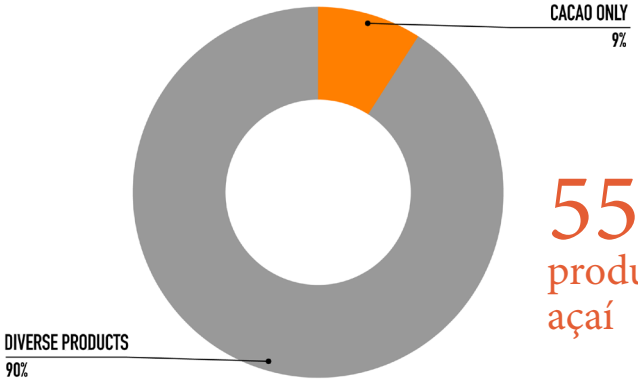
36% HAD YOUNG PEOPLE PARTICIPATING ON THE BOARD OF DIRECTORS

AND NONE ACCESS DOMESTIC AND/OR INTERNATIONAL MARKETS.

PRODUCING ORGANIZATIONS MAPPED | AMAPÁ



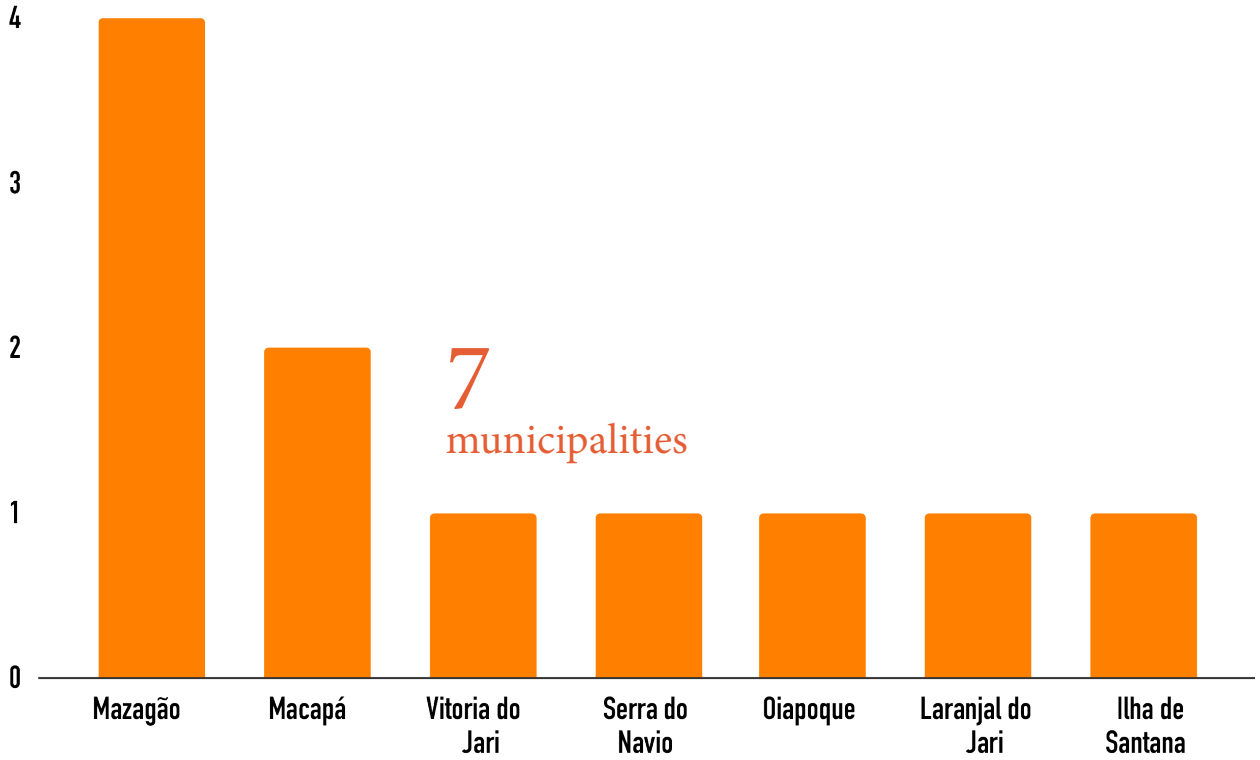
11
producing
orgs



55%
produce
açaí

The entities that are frequently cited as part of the network of productive organizations in Amapá are:

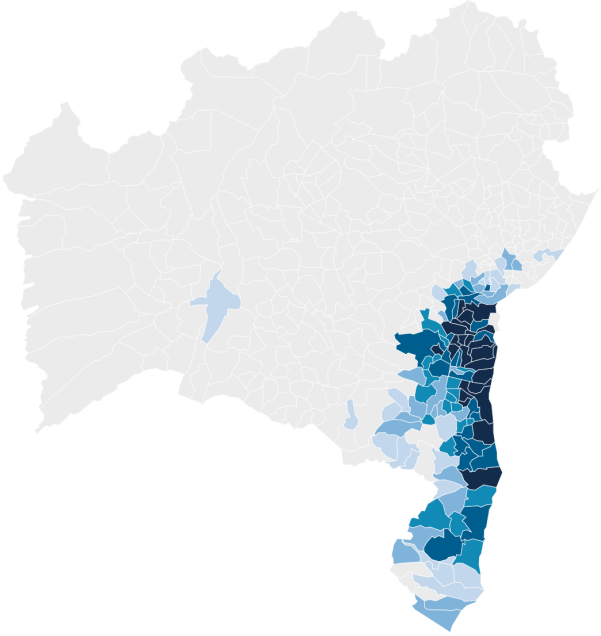
EMBRAPA
MUNICIPAL GOVERNMENTS
STATE GOVERNMENTS
RURAL WORKER UNIONS
OCB/AP
RURAP
PESCAP
SESCOOP
CONAB
IMAFLORA
BANK OF BRAZIL
BANK OF THE AMAZON
SEBRAE
JARI FOUNDATION



7
municipalities

STATE PRODUCTION

BAHIA
88,8 thousand tons
68.918 establishments



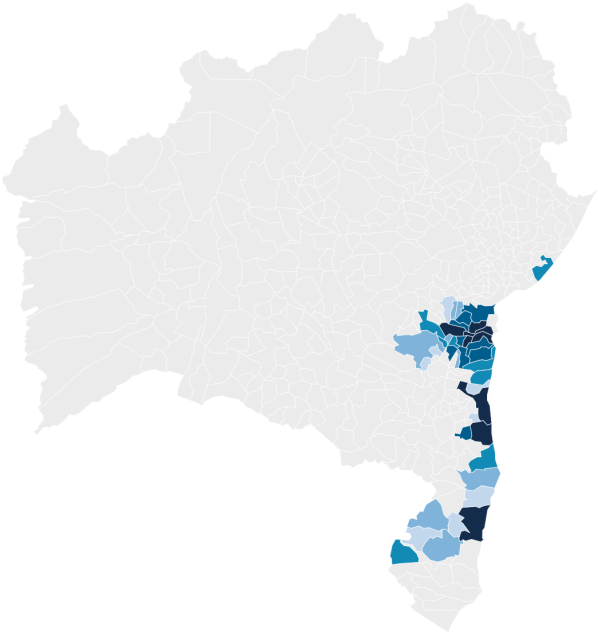
COCOA BEANS

tons

- 0,015 - 18,455
- 21,720 - 162,488
- 167,020 - 543,109
- 553,734 - 1.709,680
- 1.788,238 - 7.287,435
- No information

* establishments with more than 50 trees on 09/30/2017

BAHIA
5.3 thousand tons
5,479 establishments



CUPUAÇU

tons

- 0,200 - 1,350
- 1,620 - 5,750
- 6,700 - 20,700
- 26,235 - 146,232
- 171,925 - 1.446,379
- No information

* establishments with more than 50 trees on 09/30/2017

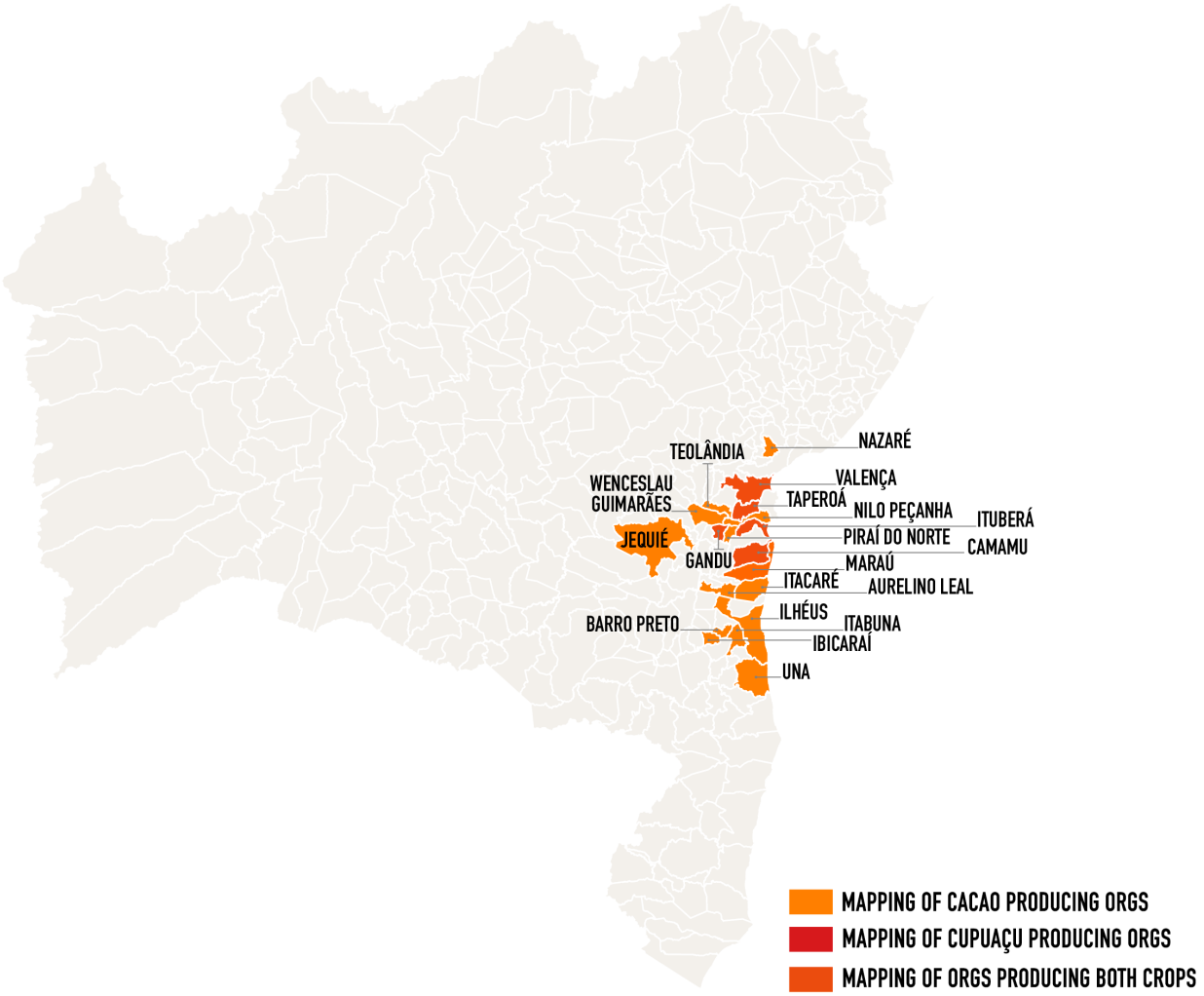
Source
IBGE Censo Agro 2017

For more than two decades, the most traditional Brazilian cocoa-producing region has been facing the challenges of plant diseases and low profitability of its farms. But the crisis with raw material has not affected the chocolate-producing sector, which continues to grow. There are, for example, public programs that encourage industrializing cacao by producers, such as the Sector Chamber for the Cocoa Value chain that continues to be active. However, according to Federal Institute of Bahia Professor Almir Martins dos Santos, the producers who belong to the program are unaware of the tendencies in the chocolate market in Brazil and the world. Besides the more obvious indications of an appetite for a higher cocoa content and valuing of origin cocoa in market niches, other studies point to a preference for new formulations, such as "free of" (trans fats, lactose, sugar, milk, GMOs), beneficial to the digestive tract (probiotics or prebiotics), or certified (organic, fair trade, rainforest). We wish to investigate how the ACL can contribute towards this challenge in the Bahia context. That is why we intend to have at least one round of the ACL in the state during the first year of implementation in order to promote in exchange of experiences and knowledge with specialists in the region.

THE ORGANIZATIONS BELOW ARE PART OF THE CONEXSUS REGISTRY OF COMMUNITY BUSINESSES

Organization		Municipality	Year Founded	Associates
FAZENDA LULIANA	Fazenda Luliana	Aurelino Leal	1945	From 21 to 50 persons
MODAKA CACAU	Botelho Comércio e Indústria	Barro Preto	2012	From 0 to 20 persons
ASS. JETIMANA E BOA VISTA	Association of Small Producers and Quilombo Remnants of the Community of Jetimana and Boa Vista	Camamu	1996	From 21 to 50 persons
ASS. RONCO E ABÓBORA	Association of Small Producers of the Quilombola Community of Ronco and Abóbora	Camamu	1996	From 21 to 50 persons
ADEBASUL	Association for Development of Baixo Sul	Gandu	1999	More than 201 persons
COOPADESBA	Agricultural Cooperative for Sustainable Development of Southern Bahia	Gandu	2017	More than 201 persons
COOPFESBA	Cooperative for Family Agriculture	Ibicaraí	2010	From 51 to 100 persons
ASSOCIAÇÃO CACAU SUL BAHIA	Association of Cacao Producers of Southern Bahia	Ilhéus	2014	More than 201 persons
COOFASULBA	Cooperative for Sustainable Development of Family Agriculture in Southern Bahia	Ilhéus	2004	More than 201 persons
COOPESSBA	Cooperative for Sustainable Services of Bahia	Ilhéus	2008	From 101 to 200 persons
COOPERCENTROSUL	Cooperative for Small Producers of Cacao, Cassava and Banana of the Center-South of the Cacao Region	Itabuna	1999	From 51 to 100 persons
DOCES SEGREDOS DA FLORESTA	Association of Small Rural Producers Doces Segredos da Floresta	Itacaré	2014	From 0 to 20 persons
AACAF	Agency for Advising and Marketing of Family Agriculture	Ituberá	2003	From 0 to 20 persons
ADSCAF	Agency for Sustainable Development and Marketing of Family Agriculture	Ituberá	2012	More than 201 persons
AQCBGI	Quilombola Association of the Community of Brejo Grande Ituberá	Ituberá	1996	From 0 to 20 persons
RENASCER	Renascer Association	Ituberá	1995	From 0 to 20 persons
ARPDBFE	Rural Association of Producers of Candies and cookies of Florestal and Emiliano I	Jequié	2005	From 21 to 50 persons
BARRO VERMELHO	Association of Quilombola Remnants and Producers of the Community of Barro Vermelho	Maraú	2006	From 0 to 20 persons
COOMTRATA	Cooperative of Small Producers and Workers in Agriculture and Ranching	Nazaré	2000	From 101 to 200 persons
CFAF	Agroforestry House of Lower South of Bahia	Nilo Peçanha	2005	From 101 to 200 persons
SELVA E PAZ	Selva e Paz Produtos e Serviços Ltda.	Piraí do Norte	2013	From 0 to 20 persons
ASS. RURAL DE PEDRA BRANCA	Rural Association of Pedra Branca	Taperoá	2007	From 0 to 20 persons
ASS. QUILOMBO DO PARAISO	Association of Small Rural Producers of the Remnant Quilombo Community of Paraíso	Teolândia	2006	From 0 to 20 persons
COOPAFEBA	Cooperative of Land Reform Settlers and Family Farmers of the State of Bahia	Una	2010	From 21 to 50 persons
APROBATC	Association of Small Rural Producers of Baixão Tremendal and Cariri	Valença	1990	From 51 to 100 persons
CENTRAL MATA ATLÂNTICA	Cooperative for Family Agriculture and Economics with Solidarity	Valença	2015	From 0 to 20 persons
ASSOCIAÇÃO NOVA ESPERANÇA	Association of Farmers and Quilombola Remnants, Community of Nova Esperança	Wenceslau Guimarães	2014	From 0 to 20 persons

INSTITUTIONAL MAPPING



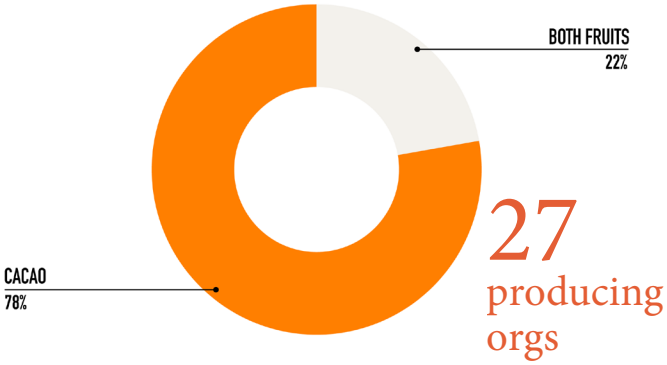
AMONG THE ORGANIZATIONS MAPPED

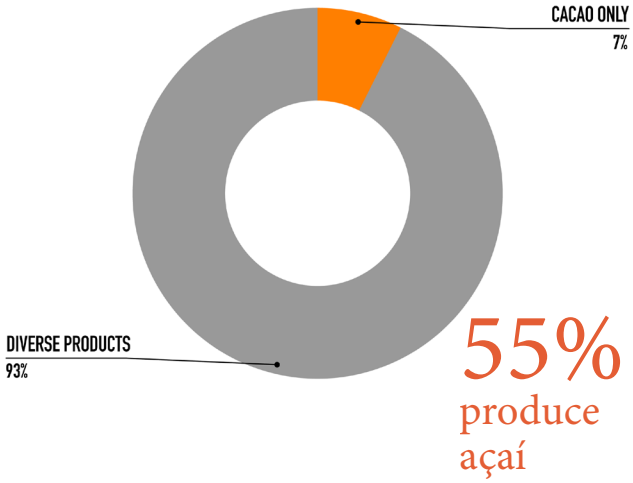
96% HAD WOMEN PARTICIPATING ON THE BOARD OF DIRECTORS

48% HAD YOUNG PEOPLE PARTICIPATING ON THE BOARD OF DIRECTORS

AND **26%** ACCESS DOMESTIC AND/OR INTERNATIONAL MARKETS

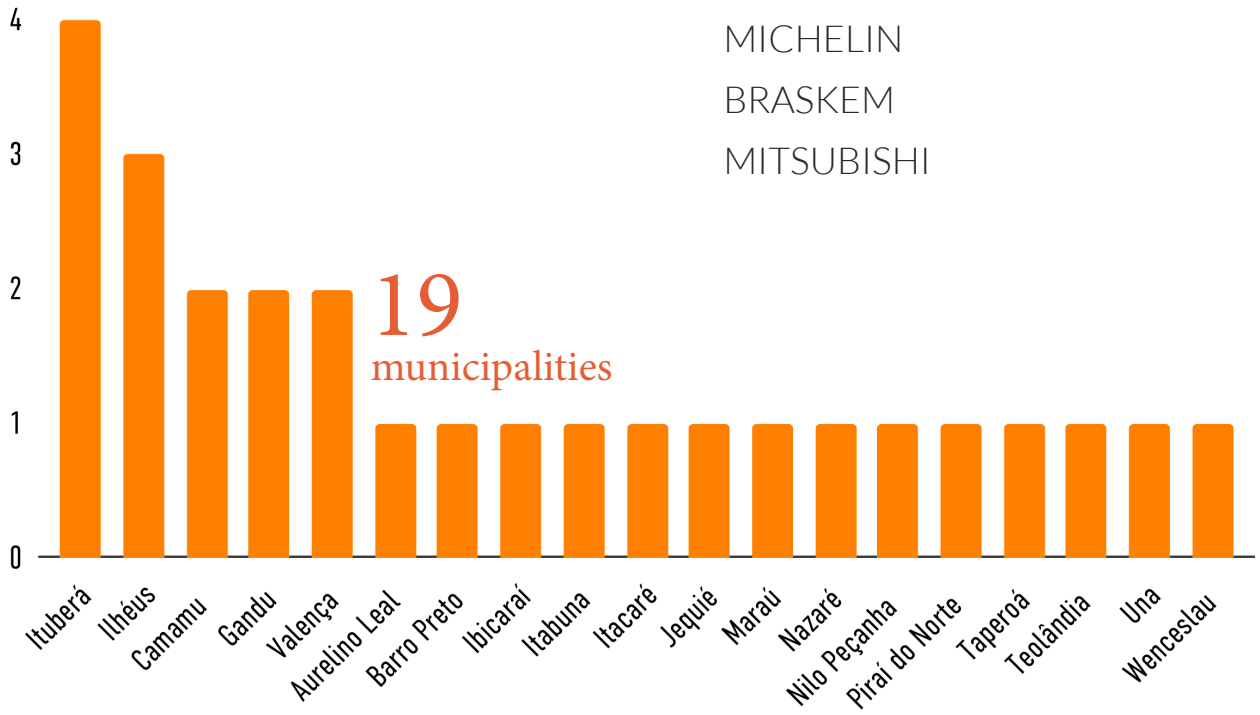
PRODUCING ORGANIZATIONS MAPPED | BAHIA



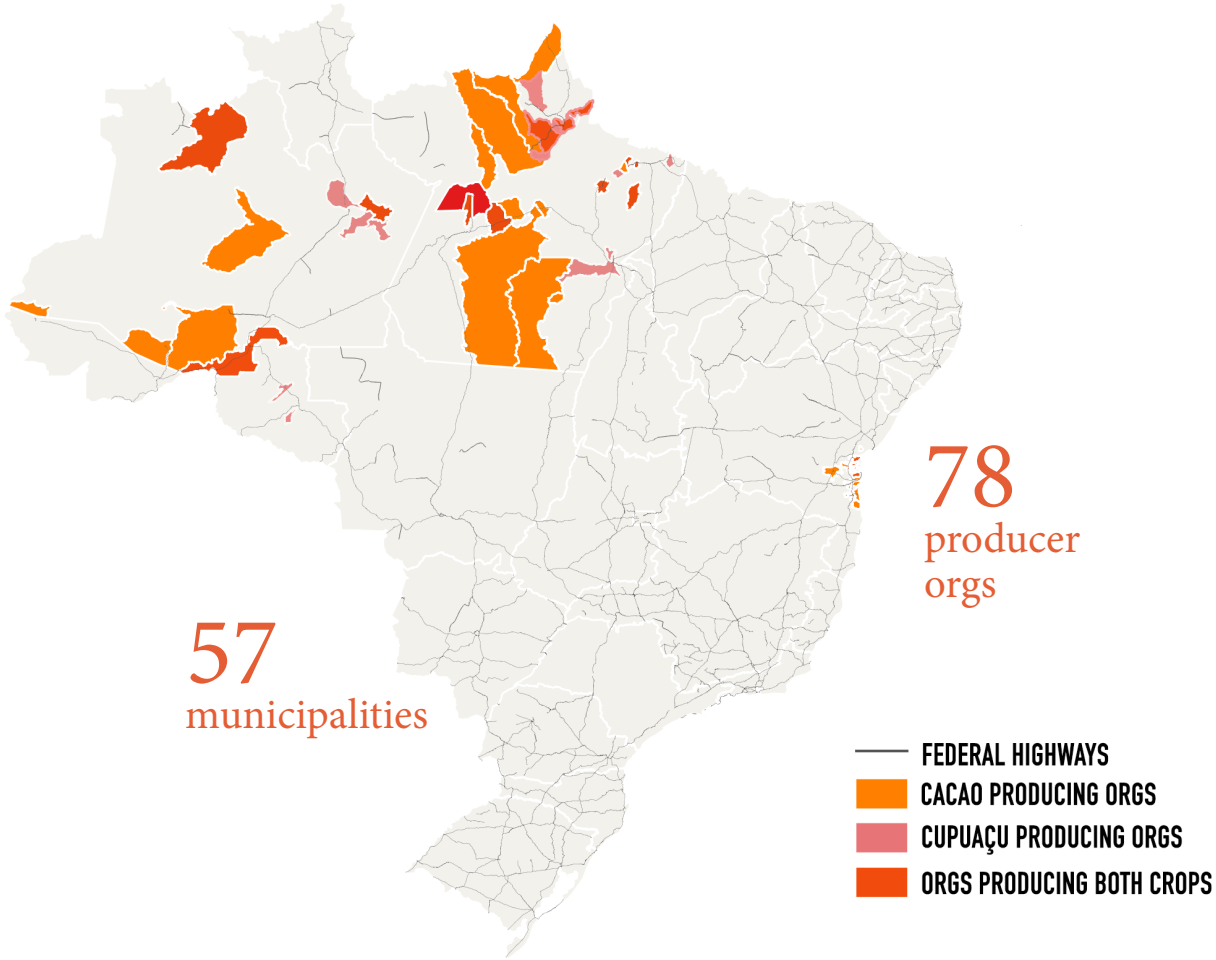


The entities cited as part of the network of productive organizations in Bahia are:

BAHIATER
CEPLAC
UESC
CIC
UFSB
EMBRAPA
CICOQ
SASOP
MUNICIPAL GOVERNMENTS
STATE GOVERNMENT
UNIONS
CONAB
COOPERATIVE CLEARING-HOUSE
CREDIT COOPERATIVES
SEBRAE
FLORESTA VIVA INSTITUTE
ARAPYAÚ INSTITUTE
MICHELIN
BRASKEM
MITSUBISHI



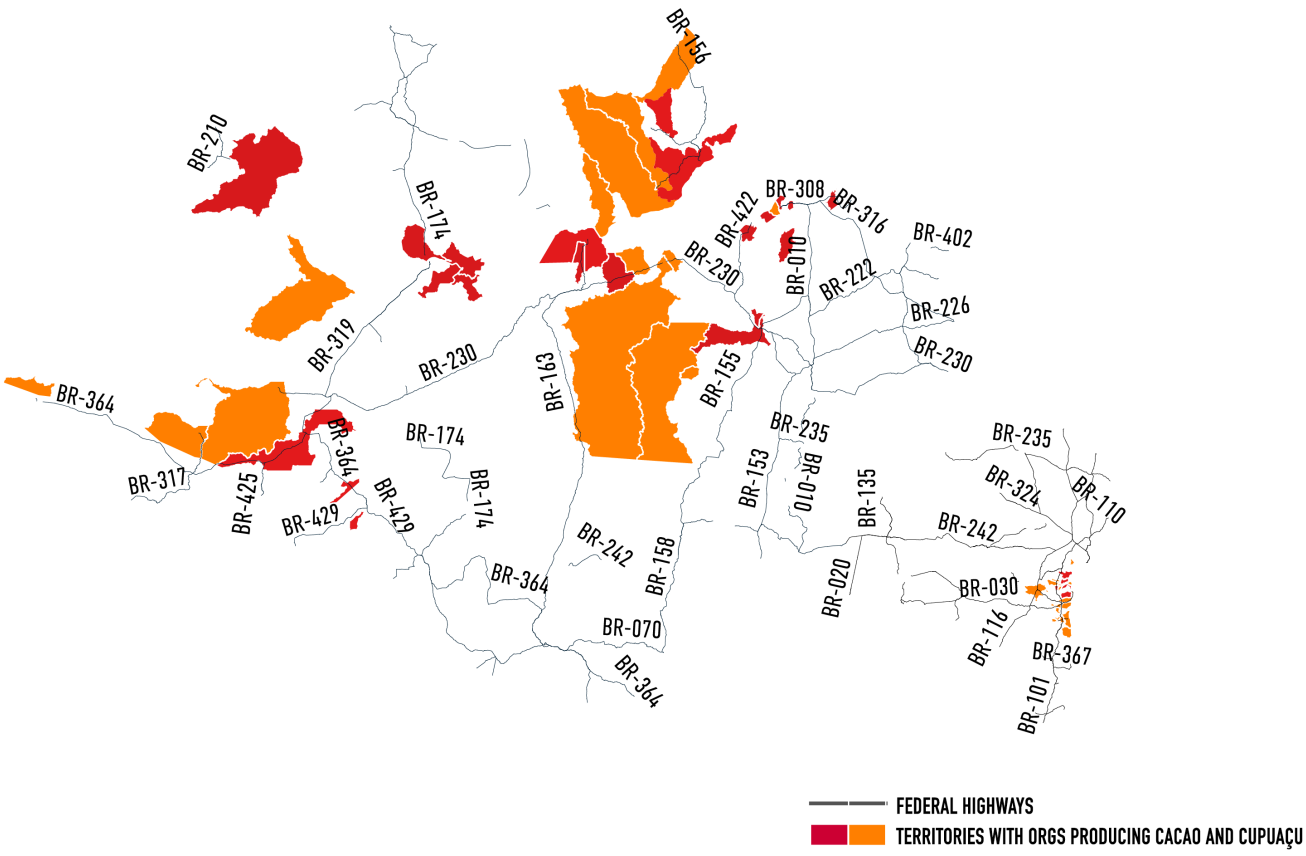
SUMMARY OF INSTITUTIONAL MAPPING



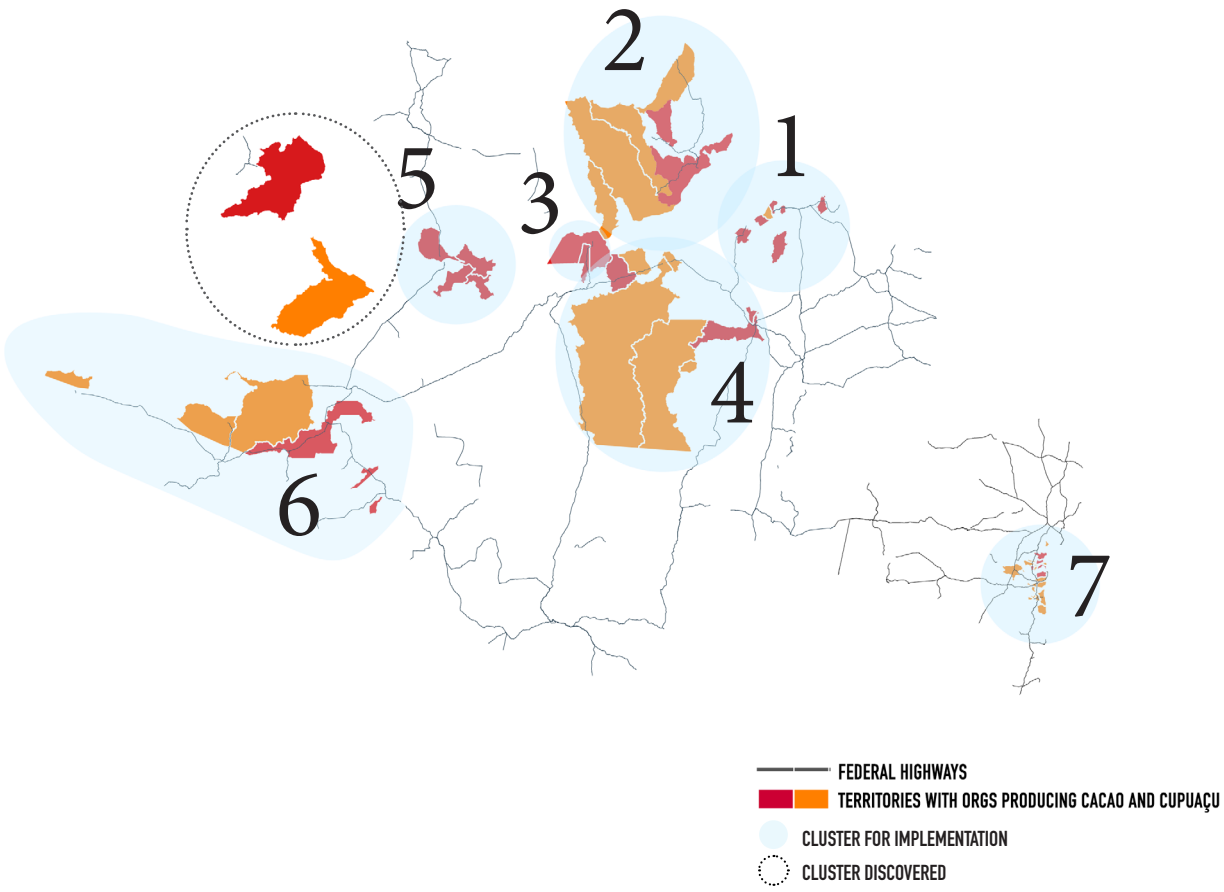
The map above consolidates all the municipalities where we have already identified potential participants for the first two years of the ACL. At the outset, we will make two efforts at articulation. We will submit this study to organizations that have been working with producing agents in the *Theobroma* chain – from CIC to CEPLAC, including NGOs such as ISA, IPAM, Imaflora, Idesam, IPE, Conexsus, IIEB – to verify gaps and more appropriate ways to communicate and implement the ACL. Additionally, we will compare this list of organizations with the portfolio of projects supported by the Amazon Fund / BNDES to whom we intend to submit a project on the project line for promoting sustainable productive activities in the Amazon.

This mapping allows us to visualize the possible routes for operation of the ACL Cocoa-Cupuaçu. From all of the evidence, it seems this ACL would be best adapted to implementation primarily along highway routes, with 7 distinct clusters, according to the sequence described in the map below, beginning in Belém and concluding the first cycle in southern Bahia. That way, the itinerant Laboratory could have a modular structure. Set up in one of the implementation clusters, it could safely and comfortably handle to expected activities. At the end of the work, the structure is broken down into several parts that become small containers holding all of the equipment and material for transportation to the next cluster.

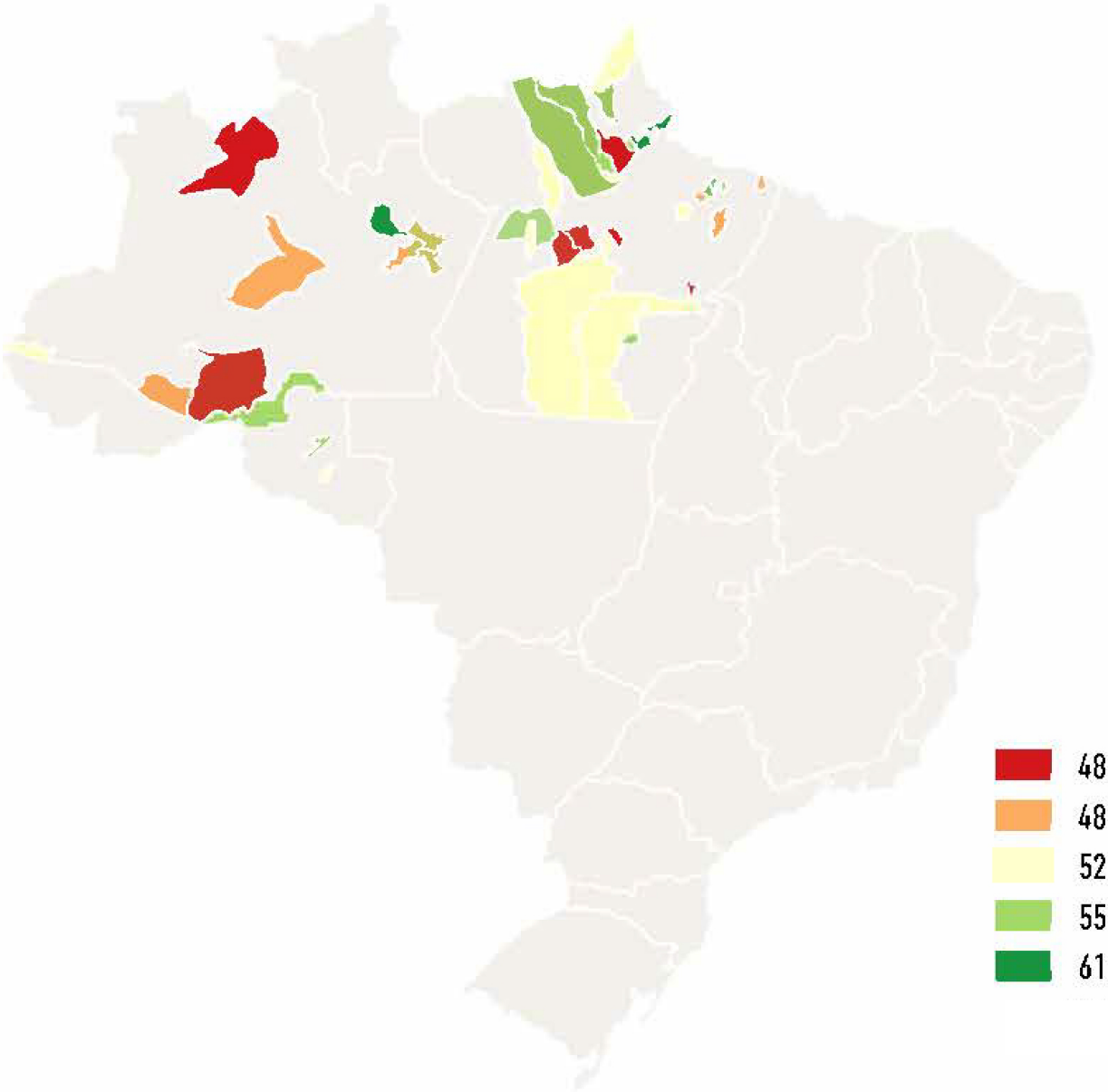
FEDERAL HIGHWAY NETWORK | THE AMAZON + BA



PRINCIPAL CLUSTERS FOR IMPLEMENTING THE ACL



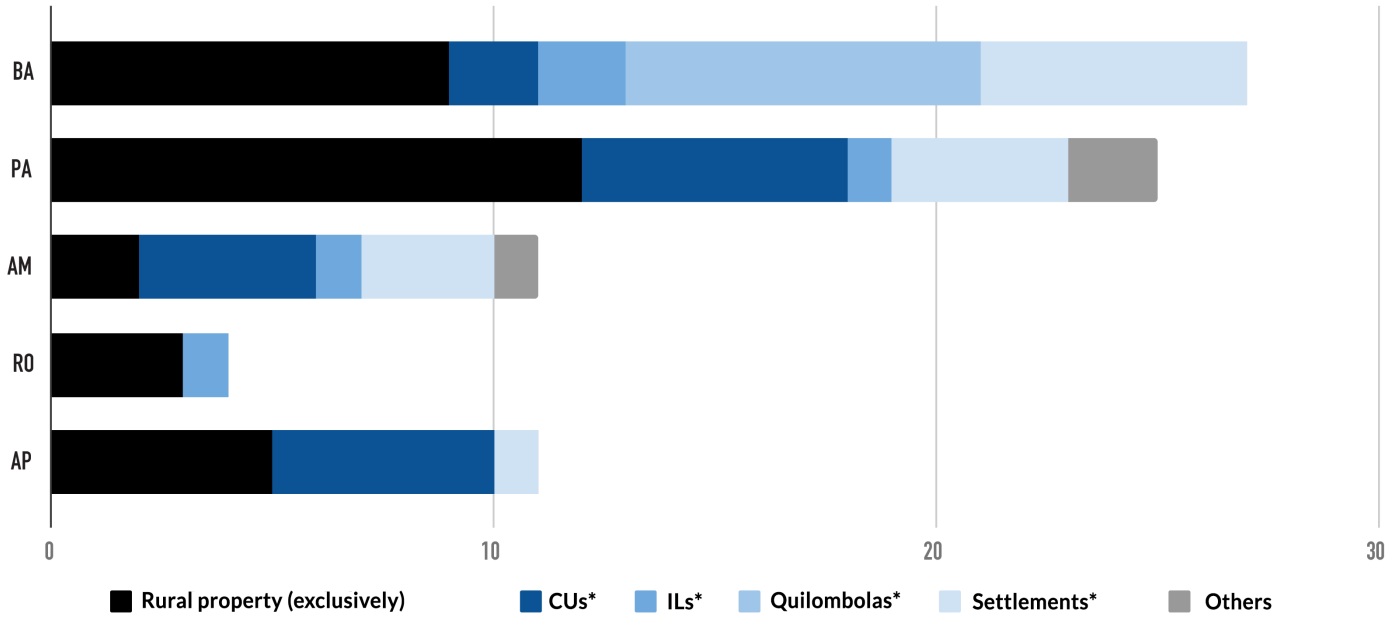
OVERLAP OF THE SPI IN THE AMAZON (2014)



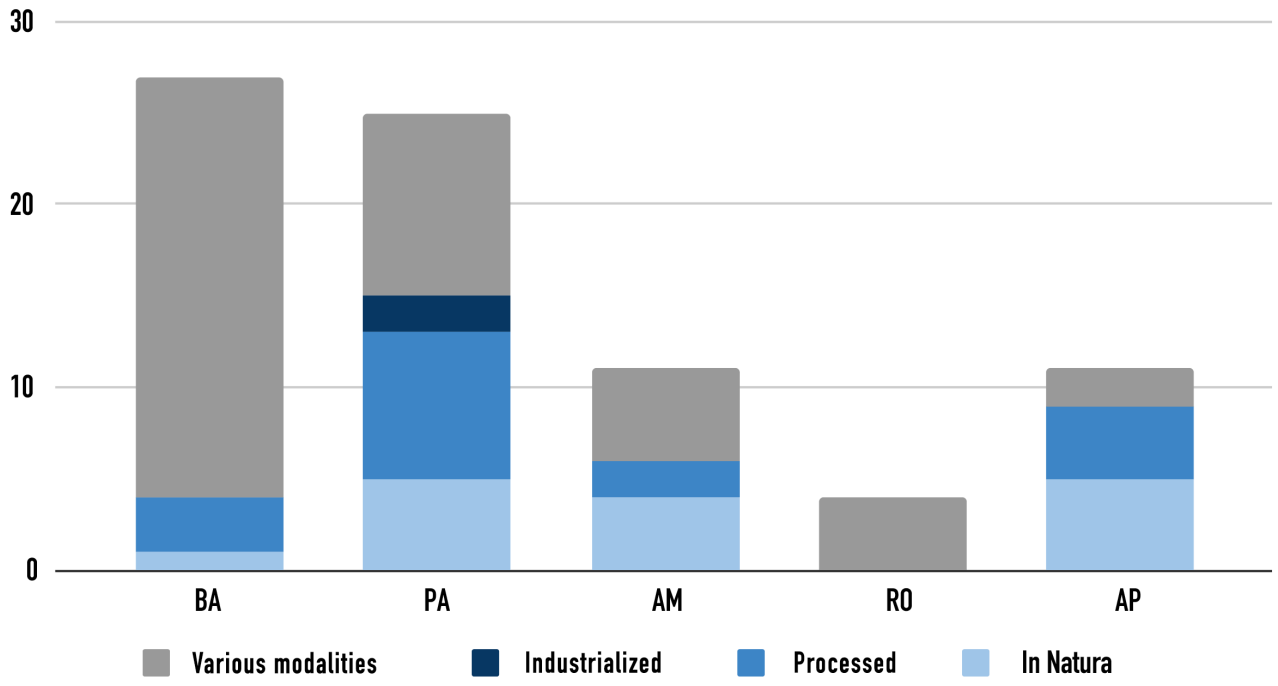
The Social Progress Index, more specifically the IPS Amazon, adapted and coordinated by Imazon at the subnational scale, gives an overview of the level of meeting the **Basic Needs** (water, housing, nutrition, medical care and personal safety) of the **Wellbeing** condition (access to information and communication, basic knowledge, health and environmental quality), and of access to **Opportunities** (higher education, individual rights, freedom of choice, tolerance and inclusion) in each municipality where the ACL may carry out activities.

The IPS classifies the municipalities into five groups, with performance gradients. In green are the municipalities with the best indicators. In red are the municipalities with the lowest levels of social progress, with two being in the state of Amazonas (**Lábrea** and **Santa Isabel do Rio Negro**), four in Pará (M**edicilândia, Uruará, Vitória do Xingu** and **Nova Ipixuna**) and one in Amapá (**Mazagão**) for which the ACL will have to prepare even more carefully and operate with great flexibility.

CLASSIFICATION OF THE AREA OF ORIGIN OF THE PRODUCTS



PROCESSING OF THE PRODUCT TO BE SOLD



Finally, we investigated two additional dimensions of the organizations with which we plan to work during the first years of implementation. Among those associated with community businesses presented here, there is a considerable group of producers in Sustainable Use Conservation Units, Indigenous Lands, Quilombolas and Settlements. Except for the state of Rondônia, less than half the production occurs exclusively on rural properties. The states of Pará, Amazonas and Amapá more clearly require building a culture for processing products, whereas the organizations in Bahia and Rondônia may be prepared for longer leaps towards economic diversification

MARKET OPPORTUNITIES

We compared the structures of agribusiness in Brazilian states to understand possible paths and challenges for enriching the peoples of the Amazon region through agriculture.

When analyzing the agribusiness value chain, comparing the most modern state of São Paulo (20% Agriculture | 45% Agroindustry | 35% Retail and Foodservices), with others of an economy based on Agropecuária, such as Mato Grosso (60% Agropecuária | 10 % Agroindustry | 20% Retail and Foodservices), we see that the big difference lies in the absence of an expressive Agroindustry.

Brakes, opportunities and solutions for socioeconomic development of people living on Extractive and Agroforestry culture.

On the other hand, industrialization requires technology, investments in productive means, infrastructure, logistics, skilled labor and other unimaginable resources in a dense forest.

In our contact with entrepreneurs from regions such as the Amazon, we identified a sequence of **NEED BY THE SUPPLIER OF OFFER** of products derived from cocoa and cupuaçu, generally evolutionary with the size of the businesses:

(1) farmers who need technology to increase their productivity or resources to expand cultivated land

(2) extractivists and artisanal producers who need support to take their products to more distant consumer markets with greater purchasing power

(3) semi-industries that would like to expand their production capacity, supplying ingredients to other industries or directly to the consumer

(4) artisans who seek to consolidate their embryonic businesses through brands, patents, new products, new formats; which require investments in new production lines, packaging, new technologies, distribution logistics and marketing platforms.

(5) reasonably successful cooperatives that need investments to expand and modernize their industrial park to expand product offerings step by step with new market demands, or gain competitiveness with international companies, or review their process for obtaining raw materials to suit sustainability requirements.

It is worth noting that the cooperative system and family farming are two important pillars for the perennial development of the peoples of the Amazon and should be discussed and encouraged in their most modern and effective ways during the realization of the **ACL Cocoa Cupuaçu.**

While the above aspects are largely **BARRIERS** for the development of the peoples of the Amazon, the new situation in the consumer markets, the result of greater awareness and communication, brings **OPPORTUNITIES** to this project.

We can summarize this greater connection and consumer awareness as an era of **consumption as a purpose**, where it is important to know aspects such as:

- Healthiness and nutritional support of the products we are consuming

- Sustainability of processes used in food production

- Contribution to the food producing community

- Rational and conscious consumption, in smaller quantities

- Contribution to the solution of global problems via modulation in consumption sources

- Possibility of interaction with producers directly

- Direct purchase without intermediaries from several producing locations in the world, etc.

These aspects are fundamental to have a new architecture and vision of the pillars of the future Amazon 4.0 Bioindustry, based in large part on the advances made in recent years in terms of technology and connectivity of purchasing and supply platforms. In addition, the forms of production must use concepts of MVP (Minimum Viable Product), integration of complementary artisanal production units, innovation and startups forum, technology incubators, carbon credits, certification of origin, future commodity exchange and other aspects of forefront that we use in the contemporary food industry.

Characterization of the inhabitants of the Region: Agro-foresters, Extractivists, Farmers, Cooperatives, Industries and Companies linked to the cultivation of Cocoa and Cupuaçu, identifying what can attract and guarantee commitment to the Amazon 4.0 Project.

We have studied many companies in the Amazon region and other successful companies in the Cocoa and Cupuaçu sectors to understand what can spark interest in participating in the project.

We visited and analyzed the companies Harald, Cacau Show, Nestlé, Garoto, CAMTA (Tomé-Açu Cooperative), Chocolates DeMendes, Nahya Chocolates, Belcolade, Barry Callebaut, Ice Cream from the Amazon, IBC (Industria Brasileira de Cacau), Finamac, among others .

The great trend is the creation of products linked to the appellation of origin (AOC - Appellation d'Origine Contrôlée) following the same path followed by wine: region | type of fruit grown | name of the producer.

New and Future Meanings - The Possible Role of CHEFS

We studied the role of Chefs in the use, enhancement and dissemination of products from the Amazon, especially CHEF ALEX ATALA whose NETFLIX program clearly portrays what to do and what not to do in seeking help for the peoples of the region.

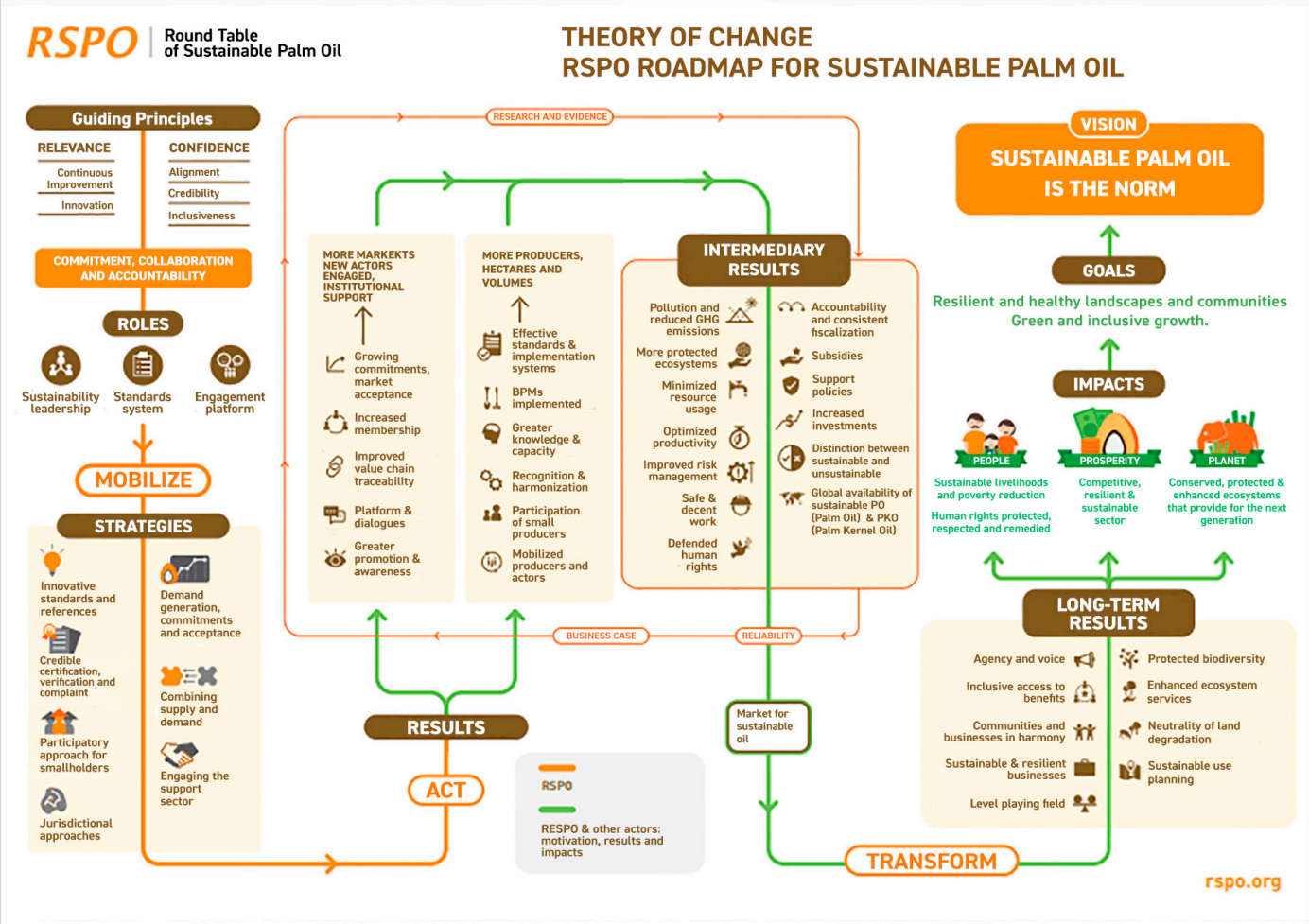
We believe that CHEFS have a great possible role in improving the social condition of producers in the Amazon region and thus there are several developments similar to the Master Chef programs and the Trip Advisor system to be incorporated into the ACL Cocoa-Cupuaçu project.

How to value the products of high added value in the region, with the purchasing industries? Identify successful reference models (national, regional and international) and how to evolve each activity towards Bioindustry 4.0. Design a new Certification process based on the available technology 4.0.

We evaluate the models of valorization of products and producers existing in the world:

RAIN FOREST ALLIANCE CERTIFICATION | UTZ

PALM OIL RSPO (Roundtable on Sustainable Palm Oil) applied in Malaysia and later worldwide.



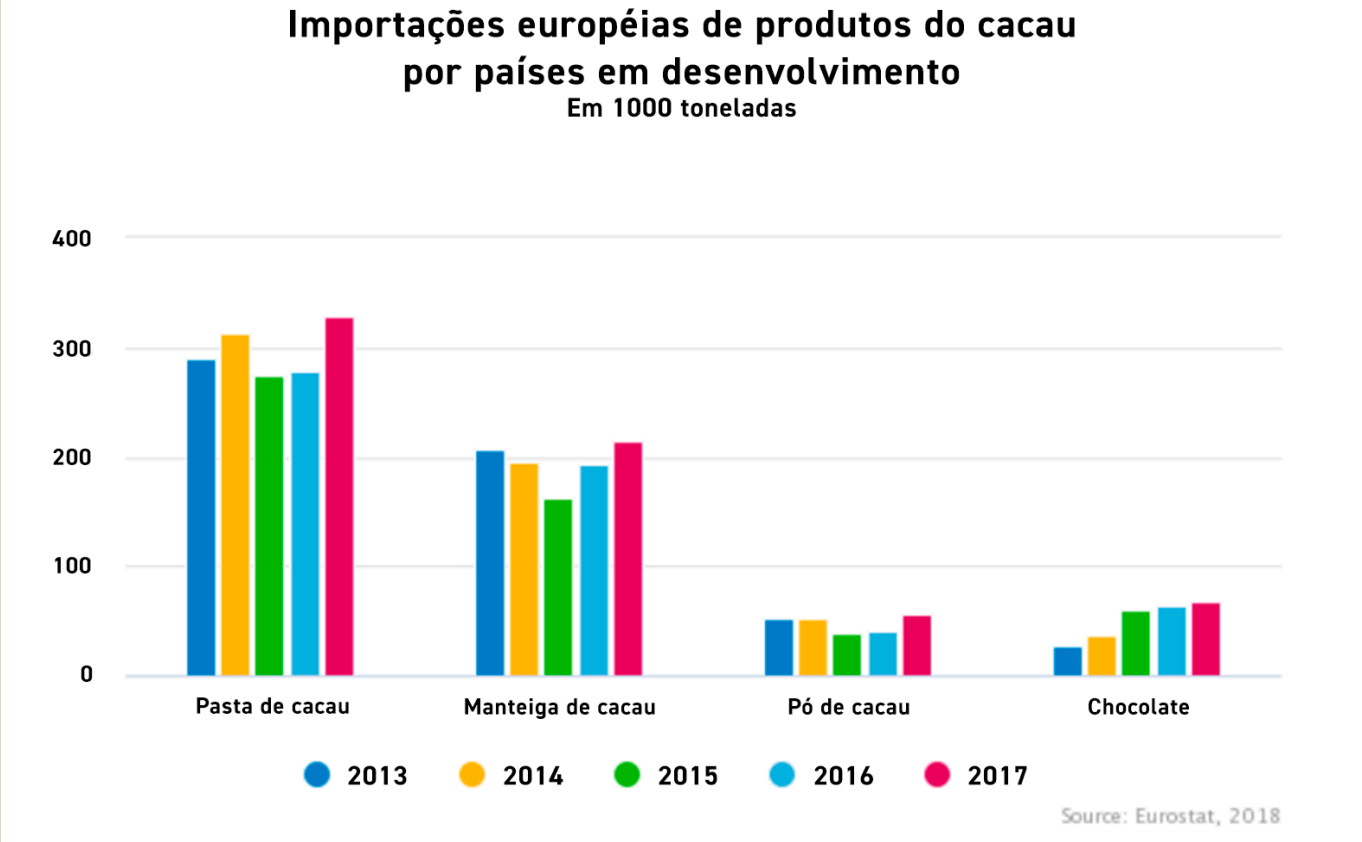
CACAO TRACE by Puratos, applied to assist needy family farmers in several cocoa producing countries (Mexico, Ivory Coast, Vietnam). **The Cacao Trace program is very interesting because it pays the agricultural cooperative a value per kg of origin product sold. This responds to the interest in ensuring that there will be a significant contribution to the Amazon peoples according to the final price of the products in any part of the world.**

We also spoke with an agricultural technology company, especially precision agriculture such as VISIONA in São José dos Campos, Telebrás' Joint Venture with Embraer, which can guarantee an accurate certification of the location of plantations and consequently products of Amazonian origin.

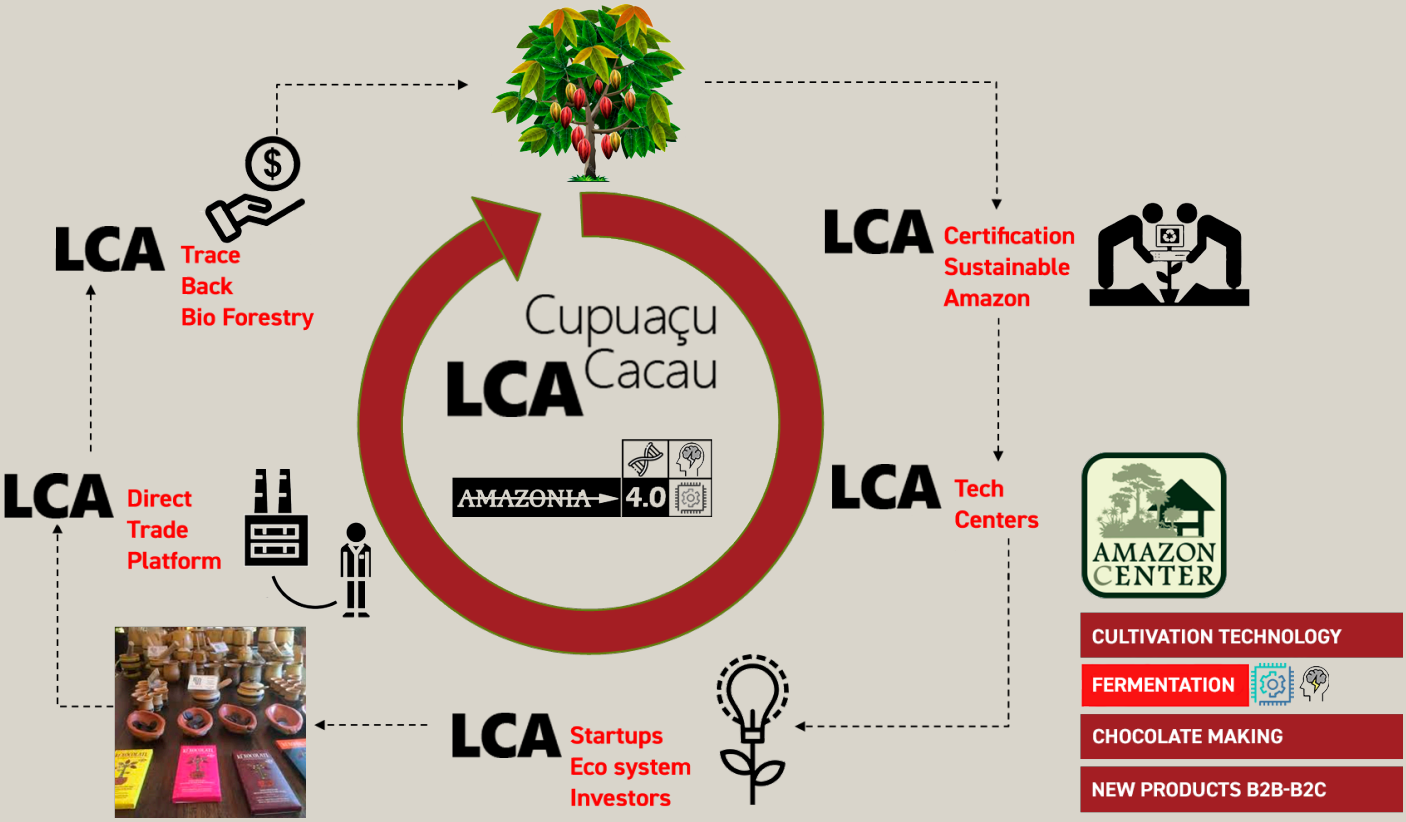
Analyze the activities necessary to help Bioindustry "cross the valley of death" that can characterize innovative companies and technologies during the transformation of knowledge into products (proven viability in the market? Sufficient talents and resources?).

During the realization of the ACL Cocoa-Cupuaçu, there should be a work of integration with companies, entrepreneurs and entrepreneurs interested in acting in the region's project, through the formation of an ecosystem that fosters innovation and development. We have researched that in Israel there are conditions to foster innovation that allow a survival of new businesses far superior to that of Brazil. In Israel, 3 startups are created per day, with an average life span of 12 years. This is due to the support, tutelage and development model created. In the same way, we suggest an approximation with that country to discuss exchanges of technology to support future emerging companies in the Amazon in its various stages.

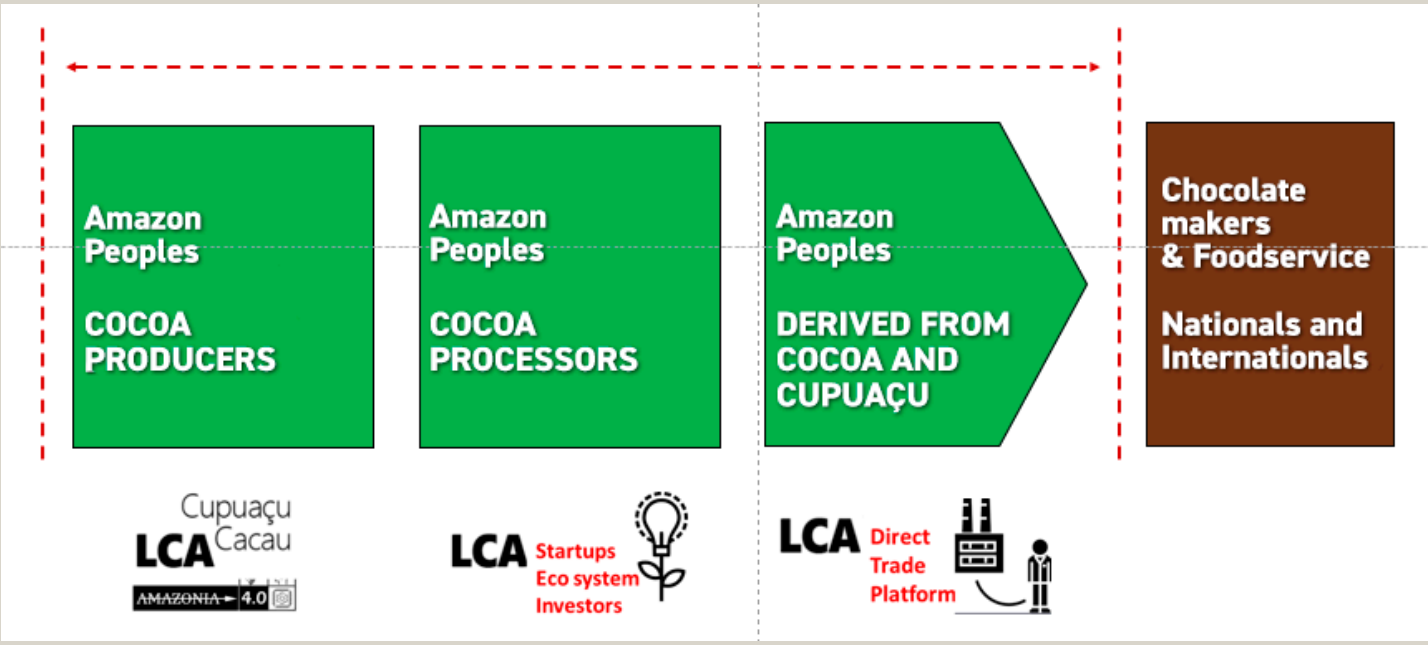
Another important aspect to cross the valley of death is to anchor export activities to other markets, given the close proximity to several international markets. Thus, we began to evaluate the products and volumes imposed by the main markets, which also allows us to measure the possible financial contribution for the peoples of the Amazon region.



THE 5 LCA SUBSYSTEMS FOR VALUING THE COCOA AND CUPUAÇU PRODUCTIVE CHAIN

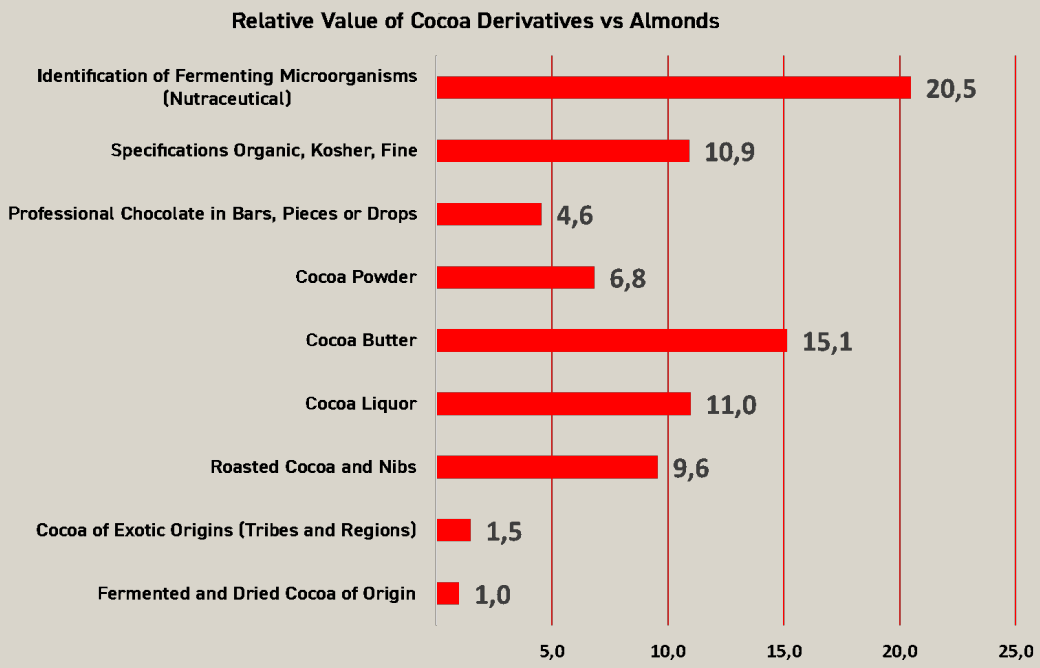


COCOA AND CUPUAÇU DERIVATIVES B2B - NEW AMAZON BUSINESS MODEL



VALUE ADDING SCALE WITH BIOINDUSTRY 4.0

1. Fermented and Dry Cocoa of Origin
2. Cocoa of Exotic Origins (Tribes and Regions)
3. Roasted Cocoa Nuts and Nibs
4. Cocoa liquor
5. Cocoa Butter and Cocoa Powder
6. Chocolate for Professional Use in Bars, Pieces or Drops (400g to 2Kg)
7. Cupuaçu Pulp Concentrate
8. Cupuaçu liquor
9. Cupuaçu butter
10. Derivatives with Organic, Kosher, Fine Specifications
11. Derivatives with Identification of Fermenting Microorganisms (Nutraceuticals)



NETWORK OF PARTNERS

INNOVATION ECOSYSTEM

The Institutional Mapping done at this stage of designing the ACL demonstrates the existence of several organizations that articulate community businesses related to the cacao and cupuaçu value chain, such as the more than 70 associations and cooperatives located in 57 municipalities in 5 states. There is also evidence of recurring relationships of these organizations with institutions from several sectors for the purpose of supporting or expanding their presence on the market. Therefore, for the ACL Cupuaçu-Cocoa to be able to effectively perform its function of inducing creativity, economic diversification and integration if new knowledge into the *Theobroma* value chain, it needs to add value to the pre-existing institutional connections.

The first step in that regard was delineating the network of relations mapped. We adopted the Innovation **Ecosystems model of the CERTI Foundation** to locate the actors at different layers of connections and support for users of the ACL. Those layers are essentially divided into three scales. The **micro** scale is where interactions happen between the producer or individual entrepreneur (such as the associations and cooperatives they belong to, local NGOs, other local entrepreneurs to whom they sell and the local market). There is a **middle** level where relations with service providers and inducers of entrepreneurialism, innovation and technological development occur (here is where SEBRAE, BioGTec Amazônia, ACL and many others who are entering this environment). A **macro** layer encompasses all the others that define infrastructure availability, regulation conditions, trust in transactions, cultural resilience and environmental characteristics, to name several. The ACL and the other innovation inducers will be more effective when they are able to connect the micro and macro layers in order to generate positive economic, social and environmental impacts.

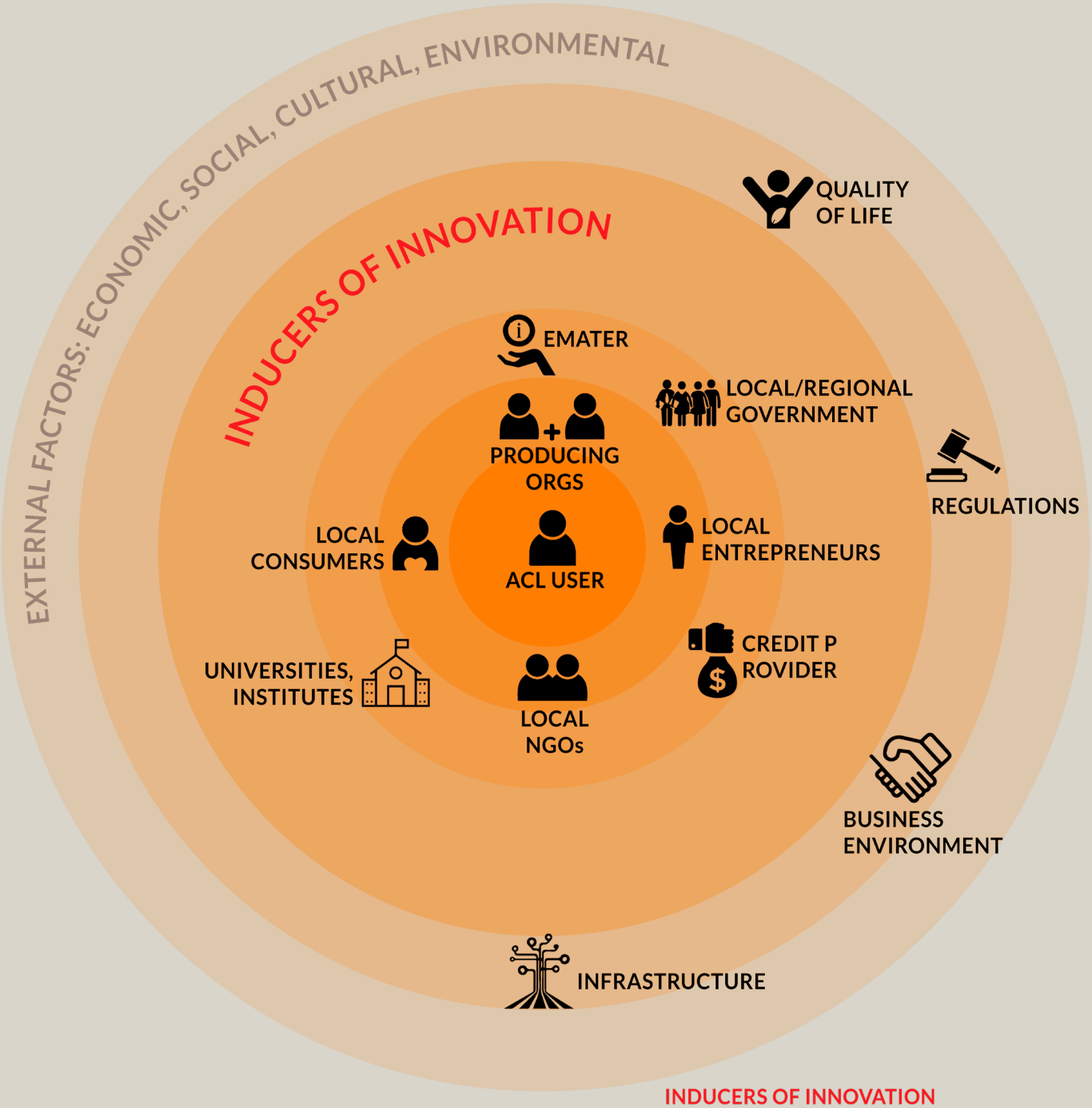
The second diagram shows the cooperation relations that the ACL Cocoa-Cupuaçu wishes to build in order to deliver the expected results. Besides positioning the organizations according to the layers of the Innovation Ecosystem, we also indicate at what moments such organizations are critical for operation of the ACL in pre-immersion, immersion and/or post-immersion.

HOW TO MOBILIZE AND RECEIVE USERS OF THE ACL?

WHO MANAGES THE DAY-TO-DAY ACTIVITIES OF THE ACL AND WHO BRINGS ADVANCED KNOWLEDGE?

WHO MAKES UP THE NETWORK FOR SUPPORTING THE PRODUCER AFTER IMMERSION?

INNOVATION ECOSYSTEM



INDIVIDUAL (ACL USER)
LOCAL PRODUCER, MAKER, INVENTOR, ENTREPRENEUR, STUDENT, ACTIVIST

COMMUNITY
ASSOCIATIONS, COOPERATIVES, SMALL MANUFACTURERS, NGOs, CONSUMERS

SERVICE PROVIDING INSTITUTIONS
LOCAL/REGIONAL GOVERNMENT, UNIVERSITIES/ INSTITUTES, EMATERs (agricultural extension), CREDIT PROVIDERS

Adapted from the Innovation Ecosystem Model for the Amazon, proposed by the CERTI Foundation

INDUCERS OF INNOVATION
SUPPORT SERVICES FOR SMALL AND MEDIUMS ENTREPRENEURS (ACLs) INCUBATORS, ACCELERATORS, FUNDS, TECHNOLOGY PARKS, ICTs, CO-WORKING SPACES, SECTOR ASSOCIATION, INDUSTRIES, TRADERS

LOCAL FACTORS
QUALITY OF LIFE, REGULATION, BUSINESS ENVIRONMENT, INFRASTRUCTURE

EXTERNAL FACTORS
MARKET, ECONOMIC SITUATION, SOCIAL DEVELOPMENT, CULTURAL AND ENVIRONMENTAL RESILIENCE

NETWORK OF PARTNERS

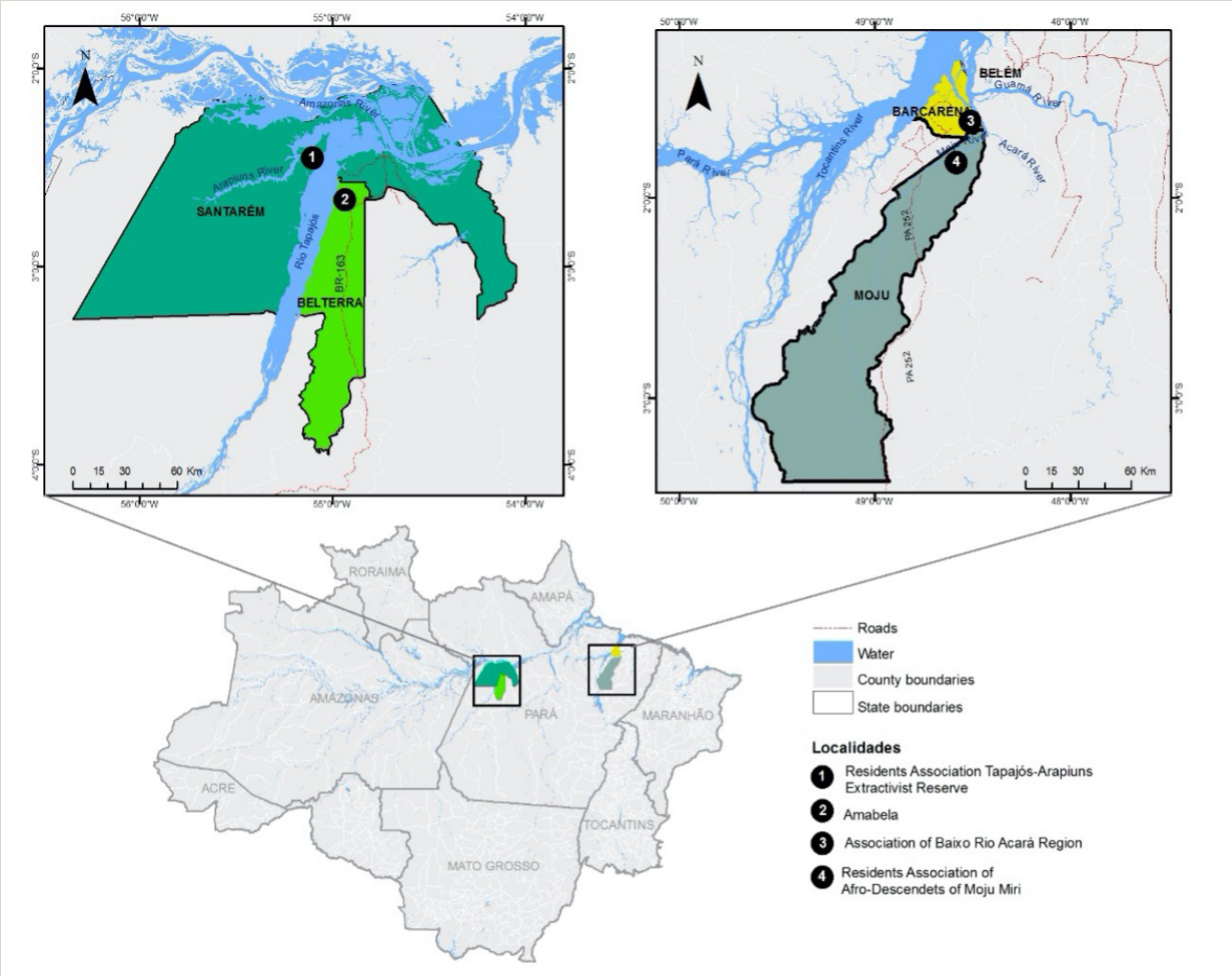
SCALE	ORGANIZATION	PRE-IMMERSION	IMMERSION	POST-IMMERSION	Instruments
MICRO	Associations, Cooperatives and Producers mapped in PA, AM, RO, AP, BA				Partnership Protocol
	Indigenous Associations (Uru-Eu-Wau-Wau, Suruí, Assiza/Gavião, Arara, Santo André)				Partnership Protocol
	ISA				Cooperation
	IPAM				Cooperation
	IPE				Cooperation
	IDESAM				Cooperation
	IIEB				Cooperation
	FAZ				Cooperation
	Sustainable Riverbank Schools/CAPES				Partnership Protocol
	FOIRN/AM				Cooperation
	FUNAI/AM				Cooperation
	Local entrepreneurs (e.g. Saulo Jennings, Luciana Centeno, etc.)				Partnership Protocol
MESO	Municipal Governments				Cooperation
	Municipal/State Environmental Secretariats				
	Development Agencies (ADS)				
	CEPLAC (Amazon and BA)				Partnership Protocol
	RURAP/AP				
	EMATER				
	BAHIATER				
	Embrapa (all states)				Cooperation
	Imaflora				
	Federations of industries				
	Universities/Institutes (UFPA, UFOPA, UEPA, IFPA, UFRAM, UFAM, UEAM, IFAM, UESC, UFSB)				Partnership Protocol
	CIC				Partnership Protocol
	Researchers on correlated themes (foreign universities)				Partnership Protocol
	FASE (Amazon)				
	CICOQ (Bahia)				
	IMAZON (Entrep. Center for the Amazon)				
	Conexsus				
	IPE				
	CERT Foundation				Partnership Protocol
	BioTec				Partnership Protocol
	SEBRAE				Cooperation
	SESCOOP/AP				
	Rural Worker Unions (all states in the Amazon)				
	SASOP				
	Credit Cooperatives				
	Bank of Brazil				
	Bank of the Amazon				
	Jari Foundation				
	Floresta Viva Institute				
	Arapyaú Institute				Contract
	Good Energies				Contract
	Moore Foundation				Contract
	Humanize Institute				Contract
MACRO	CONAB				
	ICMBio				
	100% Amazon				
	Natura				
	Beraca				
	L'Oreal				
	Coca-Cola				
	GIZ				
	Amazon Fund				Contract

The network of partners to be constructed during the first year of the ACL Cupuaçu-Cocoa will in some cases demand some level of formalization. The work in Tis (Indigenous Lands) or in contact with indigenous peoples calls for Free, Prior and Informed Consent, as determined by Convention 169 of the International Labor Organization (ILO), besides approval by the Ethics Council of CNPq, in case of scientific research, and authorization by FUNAI. We know that the development of technologies and innovation in the Amazon arouses curiosity, but also distrust. We will therefore not underestimate the importance of transparent work agreements and construction of a Partnership Protocol with several authors, and, ultimately approved by the communities, production organizers and other entities that induce innovation and wish to participate in the ACL activities. It should be made especially clear that the processes and products developed or prototyped in the ACL can be documented to encourage development of a pipeline for projects, processes in the Amazon. The formulators of those projects will be listed as their authors, when there is some proprietary element.

We will also make Cooperation Agreements with Municipal Governments, NGOs, research centers and universities that formally cooperate with the ACL, and we will also sign contracts with donors.

Associations and Cooperatives of cocoa and cupuaçu producers are important partners in the construction and improvement of the ACL. Among the 70 associations and cooperatives mapped by the project, four Amazonian communities linked to the sustainable production chains of cocoa and cupuaçu have joined the project as partners and beneficiaries, in order to actively participate in the discussion on production processes, adoption of technologies, and search for alternative products, through participatory workshops and training for sustainable business development. The criticisms and suggestions brought by the communities during the workshops will be absorbed in order to create a ACL model replicable in other communities in the Amazon and lasting.

These four communities are located in the State of Pará, which is a leader in deforestation in the Brazilian Amazon and responsible for almost half of the national production (49.3%) of cocoa and more than half of the production of cupuaçu (68% in 2006). The communities are organized into associations, named: Association of Women Rural Producers of the Municipality of Belterra (Amabela), Association of Residents of the Tapajós-Arapiuns Extractive Reserve, Association of Quilombola Residents of Moju Miri, Association of Baixo Rio Acará and, both the first located in the west of the state, and the last two in the east of the state.



Location of partner communities in the implementation of the LCA C-C. Elaborated by Nathália Nascimento.

The municipal human development index (HDI) of these municipalities ranges from 0.548 to 0.643, and the population's vulnerability to poverty, according to the IBGE definition, ranges from 49% to 72% (Atlas Brasil, 2010). Historically, these organizations operate in the productive chains of cupuaçu and cocoa, developing techniques and production mechanisms for processing the products in a very efficient and promising way, but

still on a small scale, with artisanal processes and low added value.

1. Association of Rural Women Producers in the Municipality of Belterra - Amabela

The head office of the Amabela Association is located on Rua Piacá, in the center of the city of Belterra, Pará, Brazil (AMABELA, 2020). The city has 16,318 inhabitants, a territorial area of 4,398.42 km², a population density of 3.71 inhabitants / km² and its Human Development Index (HDI) is 0.558 (IBGE, 2021a). The Amabela is composed of approximately 75 women who work as agroecological rural producers, representing approximately 30 local communities. The association was created in 2015, based on the support obtained through an announcement from the Autonomous Fund for Rural Women of the Amazon "Luzia Dorothy from Espírito Santo" (Dema Fund / Fase Amazônia) (BRAGA et al., 2018) and is coordinated by the farmer Selma Ferreira da Costa. The municipality of Belterra is in the west of the Pará state and part of its territory (47%) (ISA[1]) is occupied by the Tapajós National Forest (FLONA), established in 1974 (ICMBio[2]), one of the oldest in the Amazon. The FLONA is bounded on its entire east side by the BR-163 highway (Cuiabá-Santarém) and to the south by the BR-230 highway (Transamazônica). Large soybean crops represent the predominant land use around the FLONA. As a way of resisting the advance of agribusiness and its unrestrained use of pesticides in the region, Amabela has acted, since 2015, in caring for the environment, by encouraging agro-ecological production, promoting fair trade and empowering women in management and local leadership, in addition to raising awareness of the importance of agroecology (BRAGA et al., 2018; FASE, 2017a; LOBATO et al., 2017) (Figure 1).

The producers use practices associated with agroecology, in addition to producing a wide variety of products, such as cupuaçu sweets, mango, cashew, manioc beiju, snacks, handicrafts, liqueurs, fruit pulps, ornamental plants, free-range chicken (FASE, 2017b), and the **cupulate**. Amabela also assists in empowering the participation of women by addressing issues related to the difficulties faced by women and the feminist movement (FASE, 2017c), something essential for a sustainable bioeconomy that must be inclusive, aiming to reduce inequalities such as gender inequality.

Figure 1: participation of the Amabela rural producers in an agroecological fair, with an awareness campaign about Agroecology and the risks caused using pesticides. Source: DEMA (2017).

1 https://uc.socioambiental.org/arp/653
2 https://www.icmbio.gov.br/flonatapajos/

The Amabela creation project document describes all the richness of natural resources in the region from which the association can benefit: fruits to produce pulps, jellies and sweets; seeds and vines to produce handicrafts and reforestation or restoration of areas degraded. In addition, medicinal plants can be used to produce homemade medicines. Beaches and streams found in the region can aid in the development of basic tourism (AMABELA, 2011). In addition to the available natural resources, women farmers also produce vegetables in their own backyards. They usually use natural seeds, kept by women farmers at each production cycle and collected in the municipality itself (corn, rice, and beans seeds, for example), thus helping agroecological practices and avoiding the use of transgenic and cloned seeds (BRAGA et al., 2018). All this diversity (Figure 2) brings positive aspects to the production and life of the farmers, as evidenced in an interview with the farmer Lindalva Castro (LOBATO et al., 2017). In the interview, Lindalva reports that she does not use any type of pesticide, as the chemicals are harmful to human health, kill the stingless bees that she uses to practice the meliponiculture and are expensive (LOBATO et al., 2017).

Figure 2: production diversity on the property of Lindalva Castro, partner of Amabela: free-range chicken, meliponiculture and agroforestry. Source: LOBATO et al. (2017).

One of the most important events held by Amabela is the Seeds, Flavors and Knowledge Fair, held once a year, in which participants share native seeds, in addition to selling food and other typical products produced by the community, such as free-range chicken, vegetables, cookies and sweets (BRAGA et al., 2018). The knowledge is also shared at the event: where the seed comes from, how it is planted and how the seeds should be collected, to prepare them for the next planting cycle (BRAGA et al., 2018).

Amabela (Figure 3) will be the manager of the cocoa and cupuaçu bio-factory, and the proposed contributions to the improvement of the LCA during the training workshops will be implemented to obtain a consolidated model, to be scaled through the construction of the permanent infrastructure (the bio-factory), in the municipality of Belterra.

Figure 3: Amabela logo. Source: https://www.facebook.com/AMABELABELTERRA/

2. Association of Residents of the Tapajós-Arapiuns Extractive Reserve

The extractive reserve (RESEX) Tapajós-Arapiuns is present in two amazon municipalities, Santarém and Aveiro. The municipality of Santarém, in Pará, has 306,480 inhabitants, one of the most populated in the Amazon (IBGE, 2021b). Santarém has an area of 17,898.39 km², demographic density of 12.87 inhabitants / km² and HDI of 0.691 (IBGE, 2021b); the municipality of Aveiro, also in Pará, has 16,404 inhabitants, an area of 17,074.53 km², demographic density of 0.93 inhab / km² and HDI of 0.541 (IBGE, 2021c). The Tapajós-Arapiuns RESEX was created by a presidential decree on November 6, 1998, after years of struggle by traditional communities in the region against illegal pebble and timber exploiters (ICMBIO, 1998[3]), with an area of 677,513.24 hectares (approximately 34% of the area is in the municipality of Aveiro and 66% in the municipality of Santarém) that extends to the left bank of the Tapajós River (Figure 4). The RESEX is a conservation unit, presenting a detailed and extensive management plan (ICMBIO, 2020), and is inhabited by more than 4,000 families, with approximately 22,000 inhabitants, composed of 75 communities of which 26 are indigenous villages, being one of the most populous in Brazil (SAÚDE E ALEGRIA, 2018, 2020a).

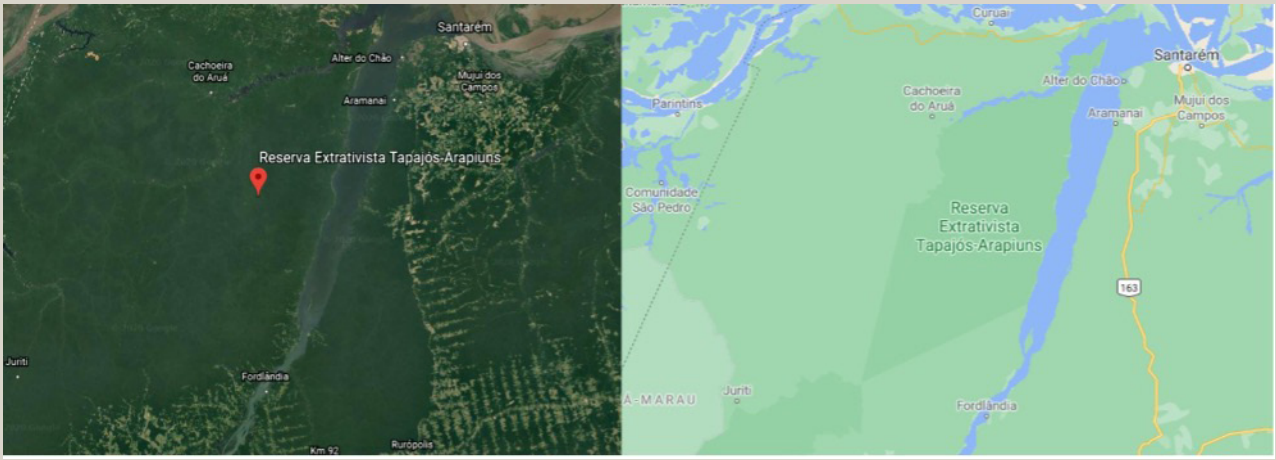


Figure 4: RESEX Tapajós-Arapiuns location. Source: Google Earth and Maps, 2021.

At RESEX Tapajós-Arapiuns (Figure 5), several sustainable activities are permitted, as described in the unit's management plan, such as extraction and production of vegetable oils, honey, açaí and rubber, among other extractive products, such as cocoa and cupuaçu; promotion of the productive chain of straw, vine and bio-jewelry crafts is also allowed; sustainable fishing, fish farming, processing and aggregating value to fish; community gardens and food diversification; handling of wood products; tourism-related activities; research activities aimed at the social area, in addition to the identification of flora and fauna species with economic potential (ICMBIO/MMA, 2014). The communities are diversified in the wide variety of products originating from nature, with a remarkable legacy of latex extraction and manioc production. Community workers also practice fruit extraction, such as Brazil nuts and Andiroba, both with high commercial value.

Among the many communities, those of Santi, Curipatá, Anumã and Carão use agroforestry systems, using forest and fruit species, such as açaí, annatto, andiroba and banana, among others, producing seeds even for reforestation projects (SAÚDE E ALEGRIA, 2020b). The community of Surucuá, with 98 families and 408 residents, practices extensive fishing, both for food and commercial use, in addition to practicing agriculture, producing handicrafts and hunting (SILVA; BRAGA, 2016). In the Tucumã community, women do the extraction and production of handicrafts from the fibers of a palm tree native to the Amazon, the tucumã palm tree (JATI; SANTOS; MAGALHÃES, 2017). They take care not to exhaust the natural resources they use, promoting a rotation between the palm trees used and removing only the straw necessary for production, thus generating income for the community and environmental preservation, guaranteeing the perpetuation of the palm trees (JATI; SANTOS; MAGALHÃES, 2017). Within the RESEX there is also the occurrence of cattle breeding, however on a very small scale, considered as subsistence, being that the main ones supplied by the breeding are

3 Management Plan
https://www.icmbio.gov.br/portal/images/stories/imgs-unidades-coservacao/P_Manejo_Tap-Arap_24nov08.pdf

the communities within the RESEX (SPÍNOLA; CARNEIRO FILHO, 2019).

Figure 5: Tapajós-Arapiuns Extractive Reserve Logo. Source: https://www.facebook.com/ResexTA

3. Association of Quilombola Residents of Moju Miri

According to data from the 2010 census, the municipality of Moju, located in the state of Pará, Brazil, has 70,018 inhabitants, a demographic density of 7.70 inhabitants / km² and an area of 9,094.14 km², with an HDI of 0.547 (IBGE, 2021d). According to the Palmares Cultural Foundation and the extinct Ministry of Culture, there are 251 quilombola communities in the state of Pará (PONTES; STEWARD, 2019). The Moju-Miri quilombola community is one of several quilombola communities present in the municipality, and is located on the banks of the Moju River, close to Belém, the state capital (CARDOSO; PEIXOTO; AMORAS, 2020). According to oral narratives, the quilombo territory has been occupied since 1892, with the creation of the Quilombola Association of Residents of Moju-Miri on March 25, 2000, and the effective recognition of the community as a remnant of Quilombo on December 2, 2008, by the state governor (CARDOSO; PEIXOTO; AMORAS, 2020). On May 16, 2013, Fundação Cultural Palmares signed the self-definition certificate, ending the community's quest for legal recognition as remnants of Quilombo (CARDOSO; PEIXOTO; AMORAS, 2020). The Quilombo has an area of 878.64 ha (ITERPA, 2010) (Figure 6) and is inhabited by approximately 50 families, with each family usually having 1 to 4 sons or daughters (PONTES; STEWARD, 2019). The inhabitants of the Quilombo Moju-Miri are descendants of African slaves and, consequently, endowed with a rich culture and strong connection to the land in which they live (PONTES; STEWARD, 2019).

The community presents a typical Amazonian culture, with riverside practices associated with family farming, such as the cultivation of açaí (*Euterpe oleracea*), manioc plantation (*Manihot esculenta*) and collection of Brazil nuts (*Bertholletia excelsa*), among other food crops (PONTES; STEWARD, 2019). The community also practices artisanal fishing and harvests other fruits, such as cupuaçu and cocoa, and agroforestry production systems are widely used in the community (CARDOSO; PEIXOTO; AMORAS, 2020), and most products are traded directly with middlemen in the community itself (PONTES; STEWARD, 2019).

Men and women contribute to the composition of the family income (PONTES; STEWARD, 2019). The women work collecting seeds from the forest, such as cacao (*Theobroma cacau*) and cupuaçu (*Theobroma grandiflorum*), as well as andiroba (*Carapa guianensis Aubl.*) and muru muru (*Astrocaryum murumuru Mart.*), which can be used for the production of cosmetics, producing handicrafts, taking care of the association's canteen or working for the city hall, among other tasks, demonstrating the importance of female participation in the family income (PONTES; STEWARD, 2019). However, domestic service is still more associated with female figures, which ends up leading the female workforce to experience a double workday in Quilombo, helping both in rural production and being primarily responsible for household chores and family care (PONTES; STEWARD, 2019). Despite the difficulties faced, quilombo women also have the largest number of participants in community political actions and assemblies, showing high interest in the decision-making processes in the community and empowerment to seek recognition for gender equality (PONTES; STEWARD, 2019).

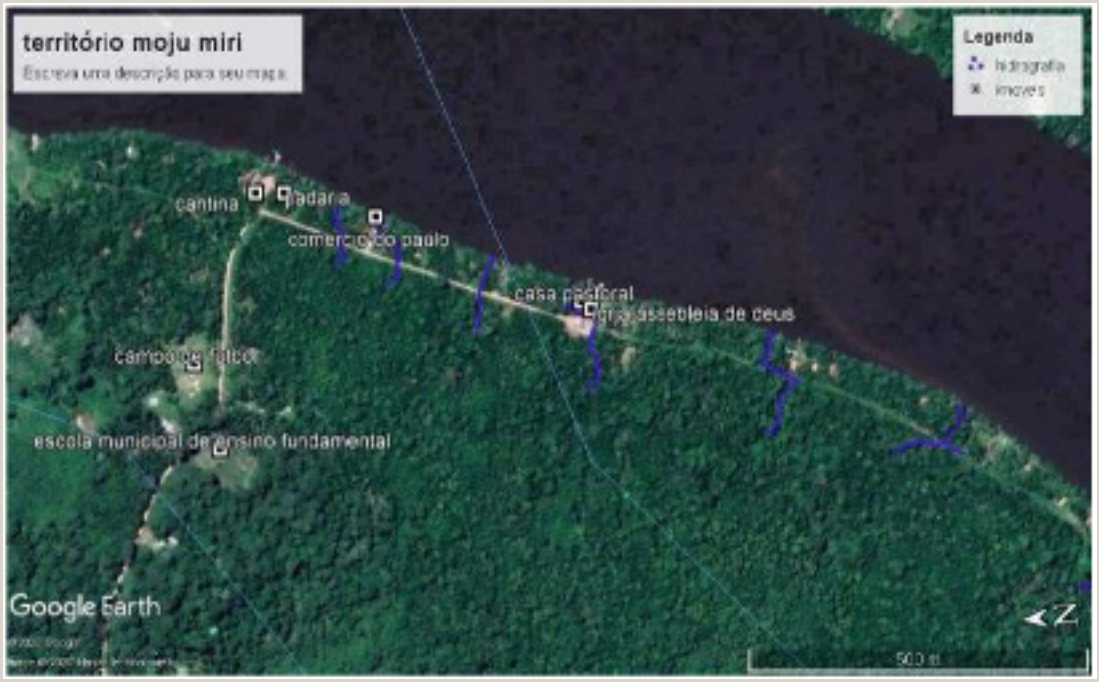


Figure 6: Moju Miri territory map. Source: Cardoso, Peixoto and Amoras (2020).

4. Bom Jardim Community of the Alto Rio Acará Region

The community of Ribeirinhos Bom Jardim is located on the right bank of the Alto Rio Acará, in the city of Barcarena, Pará (Figure 7), with the municipality having 109,975 inhabitants, its territorial extension is 1,310.30 km², its population density is 83.93 inhabitants / km² and its Human Development-HDI index is 0.662 (MAESTRI et al., 2020). The community is composed of 80 families (ARAÚJO et al., 2016) that produce cocoa and cupuaçu, in addition to extracting açaí and peach palm and fishing activities (MAESTRI et al., 2020). The community has a tradition in the production of cocoa beans, with special knowledge in the fermentation process, which is part of the production of chocolate (DEMENDES, 2020a, 2020b), in addition to participating in projects aimed at increasing the inclusion of women in agroecological production (ARAÚJO et al., 2016).

Figure 7: location of the Bom Jardim Riverside Community (Coordinates: 1° 37' 39.06" S | 48° 27' 43.95" O). Source: Google Earth, 2021.

Among the products produced with the assistance of the Bom Jardim community, it is possible to mention the Bom Jardim and Xiba chocolates (Figure 8), with the community contributing to the supply of cocoa, managed in a primary forest, in a lowland environment. Regarding Bom Jardim chocolate, the cocoa produced is of the Maranhão variety, which occurs in the middle of a primary and dense forest. Cocoa, who has a soft touch of

overfermentation, is produced and harvested by brothers Manoel do Carmo Monteiro da Silva, Raimundo Monteiro da Silva and João Monteiro da Silva, leaving the cocoa alkaline and better expressing the nasal and delicate notes. Fermentation softens the astringency and acidity of this variety of cocoa. The resulting chocolate has a complex citrus note, reminiscent of honey and flowers, and is pleasant and pleasurable to the palate (DEMENDES, 2020a). In relation to Xiba chocolate, cocoa is also of the Maranhão variety, and is produced by Manoel do Carmo Monteiro da Silva, popularly known as Xiba, presenting delicate nasal notes, with perfect fermentation, which softens the astringency and acidity of the cocoa of that variety. Like Bom Jardim, it presents complex citrus notes, dried fruits, reminiscent of Bacuri, honey and flowers, and is pleasant and pleasing to the palate. Together, the areas managed by the Silva brothers reach 240 hectares and more than 200 people are directly impacted by cocoa production. In the managed area, the fauna and flora are preserved, resulting in a responsible, solidary and social use of the forest (DEMENDES, 2020a, 2020b).

In addition to cocoa, supplied through sustainable and agroecological practices by the Bom Jardim community, the other ingredient in the chocolate is organic rapadura, supplied by the Vitória-Brasil Agricultural Cooperative (Copavi), located in Paranacity, in the northwest of the state of Paraná. This is the longest-lasting experience aimed at collective and solidary production in Paraná, founded in 1993 from the Santa Maria settlement, with 236 hectares and where 61 people live (DEMENDES, 2020a, 2020b), thus demonstrating how sustainable cocoa production can positively impact people outside of their production location.

The implementation of projects like Organolate (Figure 9) helped women to recognize the importance of their traditional knowledge, in this specific case for the production of chocolate powder natural and organic, developing a higher self-esteem and thus having more active voice and participate in decision-making processes in the community (ARAÚJO et al., 2016).

Figure 8: chocolates produced from the cocoa provided by the Bom Jardim Ribeirinhos Community, Alto Acará, Barcarena, Pará. Source: DeMendes (2020a, 2020b).

Figure 9: A) chocolate drink made with traditional knowledge by a member of the Bom Jardim community and B) Course for the improvement of techniques. Source: ARAÚJO et al. (2016).

BUDGET FOR THE NEXT PHASES

AMAZON CREATIVE LABS – CUPUAÇU-CACAO DEVELOPMENT, IMPLEMENTATION AND APPLICATION

Introduction

Given that the design for the Amazon Creative Labs (ACL) for the Cupuaçu-Cacao value chain described in the earlier chapters of this document has been is completed, this chapter describes a proposed budget for building the first laboratory, developing the material for training, setting up both the construction team and the team that will carry out the training exercises in the field, and, as a result, begin experimentation process for the ACL Cupuaçu-Cocoa in the field.
The material below describes the main items in the budget for beginning the next phases of implanting the Amazon Creative Labs, the heart of the "Amazon Third Way – Amazon 4.0" Initiative.

Budget Proposal for the Various Phases of Constructing and Implementing the ACL Cupuaçu-Coco

1. Construction phase for the Creative Amazonian Library – Cupuaçu-Cacao

Development of the ACL Cupuaçu-Cocoa by contracted consultants and innovation laboratories, using open data, software and hardware whenever possible.

1.1. Result: the ACL built for the Cupuaçu-Cacao value chain, with all of the equipment and Applications duly tested before the field activities; the service life of this laboratory should be approximately 10 years (with technological updates from time to time).

1.2. Human Resources: one leader (technical coordinator), one specialist in the cupuaçu-cacao production chain and suppliers and technicians for assembling the laboratory.

1.3. Deadline: 4 months

1.4. Estimated budget: Amount (USD)

Structure and infrastructures 32K
Geodesic dome, isolated solar electricity system, potable water system, furniture, air conditioning, Telecom systems via satellite and local wi-fi network, containers for transport, among other items.
Capacity-building equipment 62K
TScreen, projector, notebook (semi-rugged, 4 units), smartphones (for all participants), 3D gear, server, audio and video systems, etc.
Specific equipment and technologies for the value chain 60K
Advanced sensors with IoT, digital micrometer, fruit pulp extractor, lyophilizer, micro-controlled oven, melanger, 3D scanner, 3D chocolate printer, drone, crystallizer, vibrating table, melter, extruder, industrial blender, refrigerator, utensils, packaging equipment, GPS, mini weather station, moisture meter, printer and code reader (QR, bar code), machine for making vacuum forms, triaxial CNC router, electric quadricycle and other items.
Customizations, assembly and tests 10K
Adaptations, customizing and tests of all structures and equipment. And a simulator phase for the laboratory, during the bench phase.

Remuneration for the teams involved 50K

Total 214K
Note: this is the cost for physically producing an ACL Cupuaçu-Cocoa – it will last around 10 years and will be used for 50 to 60 training events of six weeks each for up to 40-50 persons.

2. Phase for producing learning and training materials and the applications

Production of (1) appropriate material for supporting learning and training activities; (2) LCApp, the basic software for the laboratory. It integrates content elements with tools for controlling production of the Cupuaçu-Cacao chain. It operates associated with a smartphone (or tablet) that each participant will use every day during training and (3) an intelligent tracking program. Instead of a simple database, that program will have an automatic interface for value chain devices that have digital output.

2.1. Result: material produced and programs tested with the real devices that will be used for implementing the ACL Cupuaçu-Cocoa.

2.2. Human resources: one coordinator, specialists in the cupuaçu-cacao value chain, in business and digital economics and application and program developers (service providers).

2.3. Deadline: 4 months

2.4. Estimated budget: Amount (USD)

Development of training content 30K
All the teaching content for the capacity-building, to apply the ACL teaching method.

Development of training application (LCApp) 30K
The app that will run on smartphones from the laboratory with each participant.

Development of intelligent tracking software 20K
Software that will connect digital equipment and the Internet of Things to fully track the steps in the chain.

Remuneration for coordinator 0K
Coordination of this stage will be done by the technical coordinator for the project.

Total 80K
Note: this is a one-time cost, since these materials and software will be used for the entire ACL Cupuaçu-Cocoa project.

3. Learning and training in the field phase (round of the ACL Cupuaçu-Cocoa)

Field activities: perform the planned capacity development activities in the field (at the level of communities, associations, cooperatives, as well as Amazon university campuses).

3.1. Result: after 6 weeks of training, the ACL will have trained about 40 to 50 people in mastering techniques, equipment and technologies of the Cupuaçu-Cacao value chain, as well as having provided contact with new technologies for members of the communities in general, such as communications, clean energy (solar), water treatment (with UV light), etc.

3.2. Human Resources: two specialists and one technician.

3.3. Deadline: two months

3.4. Estimated budget: Amount (USD)

Transportation 20K
Transportation of the laboratory disassembled and packaged in containers by truck or boat (variable amount depending on the location of the ACL).

Travel 4K
Costs for taking and lodging the team that will apply the training.

Inputs 1K

Necessary inputs for producing the results of the chain: sugar or raw cake sugar, powdered milk, material for packaging, etc.

Data plan 1K
Data contract for operating connection with the internet from the forest, via satellite.

Remuneration of the teams involved 15K

Total 41K
Note: all of these items mean expenses incurred with each round of the laboratory.

Note: When this laboratory is being implemented, this tentative budget will be validated in detail. It is estimated that this amount may vary upward or downward in the USD 50k range.

EXPECTED RESULTS FROM THE PROJECT

One sequence of the actions we are expecting with the ACL exercises is the rise of a chain of investments to provide scale for local production, using modern techniques for capacity-building and production. One of the possibilities will be investments in production factories (bioindustries) – that are now achieving a non-experimental scale like the ACL.

The results expected with application of each ACL C-C event encompass the following aspects: training of the stakeholders involved; recovery of knowledge and values; creation and co-creation; empowerment of local and regional communities; investments with impact on sustainable businesses, social equity via fair trade; dissemination of Amazon third way concepts; outlining of technological challenges and generation of metrics for evaluating the project.

Capacity-building – specific and broad - Applying the ACL C-C will provide specific training for participants in the stages of productive chains linked to cupuaçu and cacao. At the end of the training, participants will have mastered techniques, technologies and handling of equipment for performing stages that transform forest raw materials into final products with high added value, specifically cupulate and chocolate, in bars and powder, cocoa butter and lyophilized cupuaçu pulp.

The training will have two focal points, high quality production and high identity production. For the first there will technological assistance such as innovation for advanced local production. For the second focus, the proposed training will make use of local recipes, with controlled variations in manufacturing and combinations with other biodiversity assets for enhanced appearance, texture, flavor and nutritional quality. Also, in terms of identity, the training will encourage and practice with the use of tools for translating art and culture into characteristics of the product, such as fashioning exclusive and original sculptures and shapes for the bars.

Complementary and necessary for the two focal points connected to production, training at the ACL C-C will familiarize participants in terms of business derivable from the high added value products that can be made locally, also including technological tools from the "4.0 market." This capacity-building will mean the participants are able to know what are and where they can access additional knowledge tools, assistance and support for taking the first steps towards materializing the local potentials connected to the objectives of the laboratory.

Within the scope of broad training, several aspects of the laboratory are not limited to the specific production of products from the productive chains of cupuaçu and chocolate, the domain of creative software or production control, energy and communication aspects and their respective equipment, among others factors that can result in an increase in the quality of life of communities and an increase in the possibilities of insertion in new economic cycles.

Finally, technical training will be a vector for a broader awareness of the value of the forest, the Biome, with its ecosystems that provide varied environmental services at local, regional, national and global levels, as well as for communities that live in balance with natural environments, in rural areas and in Amazon cities. One element of the Amazon Third Way is the development of the "Rainforest Business School" (RBS) and the ACLs will be important field schools for developing the pedagogical content and educational research of the RBS.

Recovery of knowledge and values - The laboratory will make it easier to incorporate knowledge of the environment and its products revealed during the creative and participatory process into the design of the ACLs through collaborative and experiential tools directed towards recognizing the local culture as a cultural value for dissemination and economic use .

Creation and co-creation - Development of ideas and products beyond those initially proposed in formulating the specific laboratory.

Community empowerment - Through encouraging organizational capacity and the perspective of being leading actors in a new and strong local economy.

Investments with Impact - Attracting interest for impacting investments in sustainable businesses, that will seek solid business initiatives with probable economic viability.

Social equity - Social equity through fair trade, by means of revaluing products that are typical of biodiversity and connection with other branches of commerce and business, beyond the basic method represented by a typical intermediary.

Repercurssion - Dissemination of the concepts of the Amazon third way, initially as a result of media coverage and dissemination of training events and their objectives, and later on, with the new productive arrangements derived from appropriated knowledge and experiences in the laboratory.

Rainforest Business School - A complete first teaching module, ready for dissemination through the Rainforest Business School, and a field campus for the RBS.

New technological challenges - Outlining of technological challenges, derived from experiences and demands from stakeholders and environments where the editions of the ACL C-C are held, with the demand for new technological additions from research networks, companies or technological events such as the "hackazon," an event planned for bringing together the young technological and entrepreneurial community and encouraging them to resolve technological bottlenecks using the Amazon 4.0 kin a collective event with awards being given.

Metrics for evaluating the project - This is a final meta-result that will allow use to assess the degree to which ACL C-C implementation is in line with the objectives, the design and the earlier planning. Effectiveness of the ACL will be measured through collection of parametric data such as pre/post event opinion questionnaires (applied to all participants and to a sample from the community) directed towards measuring changes in patterns of values, positions, intended behaviors and behaviors, objective evaluation of the participants at the various stages of the content taught; evaluation of the ACL by participants from various angles (didactics, quality of instructors, infrastructure, equipment, technologies and others); total of volumes and weight of the pre-processed and processed products; quality of final products; functionality of the equipment and technologies used; duration of equipment; failure diagnostics, consumption of electricity and other inputs.

Each day of activities will also be described in a daily video log, recorded by a member of the staff, in which the general operation is commented on and any occurrences in operation or the resulting social interaction are noted. A final written report will be produced with the data grouped and will also contain an analysis of how the creative opportunities of the ACL were utilized, what products they generated; how the products turned out in terms of quality and how the actors in the group with different origins interacted for generating strategic partnerships and businesses.

Number of participants - The plan is that each capacity-building activity in the field with have between 10 and 50 persons and a training period of 6 weeks. On university campuses this number can be much larger, reaching up to 100 participants.

NEXT STEPS

Currently, with funding from the Good Energies Foundation, we are preparing an ambitious proposal for the Amazon Third Way/Amazon 4.0 project for the Amazon Fund. This project will cover development and implementation of six to ten Amazon Creative Labs– ACLs, depending on the volume of funds provided. About ¾ of those funds will be directed towards implementing ACLs relating to existing value chains, with a spatial scale and economic dimension that is already clearly established, such as for açaí, cupuaçu, cacao, Brazil nut, andiroba, copaiba, etc. The remaining funds will be directed towards chains that are less known or disruptive, such as genome, fungi, bio art, and others still to be defined.

Besides the design of each one of the ACLs to be placed in the proposal for the Amazon Fund, we will also be establishing a network of persons, groups, communities and institutions as potential partners for implementing a broader project. That includes, on the one hand, establishing partnerships with networks of private and public technological innovation laboratories, and, on the other hand, identifying and visiting communities that are potentially eligible to participate in the project. The idea is to investigate that status of other value chains as we have done in this first stage with cupuaçu and cacao.

Other production chains

In addition to cocoa and cupuaçu, there are other Non Timber Forest Products (NTFPs) in the Amazon with high potential for the development of sustainable and inclusive bieconomics practices, some with already well-structured production chains, such as açaí and Brazil nut.

Açaí

The açaí is a natural palm from the Amazon that can be found both in areas of igapó and terra firme, but especially in lowland soils. Açaí is of great importance for Amazonian communities both in the countryside and in urban areas, constituting an important source of food that can be consumed in different ways such as pirão (a typical local food), juice, cream, ice cream and sweets. The heart of palm can also be extracted from the stem of the açaí, and the oil can be extracted from the seed, which is widely used in the cosmetic industry and in the manufacture of handicrafts, especially bio-jewelry (WADT et al., 2004).

The açaí production chain has technical guidelines recommended by the Federal Government, which aims to guarantee from the maintenance of the environment in which açaí is produced to the quality of the product following the pre-collection steps (selection, mapping and selection of the productive area), collection (extraction techniques), post-collection (quality screening and transport), conservation (forest management) and monitoring (production monitoring) (MAPA, 2012).

Açaí is the NTFP that most generates revenue in Brazil, generating approximately R $ 4 billion between the years 2012 and 2019, with a production of 1.7 million tons in the same period and R $ 588.6 million in 2019 alone, with a production of 222 thousand tons (IBGE, 2020). In 2019, the state of Pará was the largest producer of açaí in the country, with a production of 151.7 thousand tons (68% of the national production), with a revenue of R $ 465.4 million (80% of the national revenue) (IBGE, 2020). It should be noted that, despite not being a producer of açaí, the United States is the largest processor and exporter of fruit products (30%), followed by Brazil (19%) and Canada (8%) (BEZERRA; FREITAS-SILVA; DAMASCENO, 2016), meaning that Brazil has the potential to make a greater improvement in açaí and thus add more value to its production chain.

Despite the commercial importance, the açaí supply chain still faces major logistical problems, which originates from the agents responsible for the transport and commercialization of fruits, such as scouts and middlemen, making it difficult for açaí producers to have autonomy in the negotiation of their products and leading to an improvement in the quality of life of the communities that survive from the collection of açaí (AMARO et al., 2016).

Brazil nut

The Brazil chestnut tree (*Bertholletia excelsa*) is a large tree with wide occurrence throughout the legal Amazon, especially in the mainland areas. The commercialization of chestnuts constitutes an important source of income for traditional communities that live off the extraction in the Amazon (KRAG; SANTANA, 2017). Chestnut beans are used in a variety of ways and can be consumed fresh, or in the form of flour or milk that are also used in the manufacture of cakes, cookies, ice cream and others (FERBERG et al., 2002), in addition to being a product known worldwide as Brazilian nut (in Brazil, the nut is known as "castanha-do-pará") (MUNIZ et al., 2014). The oil obtained from the chestnut has also been adopted in the cosmetic industry, presenting a high market value (ARRUDA, 2010).

The Brazil nut generated a revenue of R$ 800 million between the years 2012 and 2019, with a production of 280 thousand tons in the same period and R$ 136 million only in 2019, with a production of 33 thousand tons (IBGE, 2020). In 2019, Amazonas was the largest producing state (12,182 tonnes), followed by Acre (7,297 tonnes) and Pará (6,977 tonnes) (IBGE, 2020). Despite being the largest producer of Brazil nuts, the revenue generated in Amazonas in 2019 was R$ 35.9 million, lower than Acre (R$ 36.4 million) and Pará (R$ 37.9 million) (IBGE, 2020).

Despite the small importance in Brazilian and Amazonian exports, its supply chain is very significant, as its collection represents the most important economic activity for several extractive communities in the Legal Amazon (CAVALCANTE et al., 2011). The supply chain may be divided into three main parts: 1-) Production and spatiality: the market needs the raw material that is usually produced in extractive systems in rural or forest areas, by traditional communities or small producers, while the processing and commercialization of the chestnut occurs in the urban area (PICANÇO; COSTA, 2019). 2-) Distribution and circulation: here is one of the major bottlenecks in the chestnut chain, as producers depend on favorable river conditions or roads that are generally in poor condition to transport production, and may resort to intermediaries and middlemen to carry out this step (PICANÇO; COSTA, 2019). 3-) Commercialization and consumption: it can occur in supermarkets, snack bars, bakeries and ice cream parlors, depending on the product consumed, with part of the products being sold in the domestic market and partly exported (PICANÇO; COSTA, 2019).

A second objective of the project with the Good Energies Foundation is clearly convergent with the ACL Cupuaçu-Cocoa study, which is support for developing the project for this ACL, the focus of this report.

The next immediate step, since this study has produced a first and detailed design of the ACL Cupuaçu-Cocoa, is to seek funding for building and assembling this ACL (architecture, infrastructure, equipment, teaching material with the content for the training, etc.), adding the necessary human resources to the undertaking and beginning the activities for implanting the experiments in training producing or potentially producing communities (product pipeline systems, projects and talents, and so on). These communities have been identified by this study and a few of them were visited during the field trip for this study. This experimentation will be extremely useful for demonstrating the potential and feasibility of the Amazon Third Way/Amazon 4.0 in the proposal for the Amazon Fund.

CONCLUSIONS

PATHS TOWARDS SUSTAINABILITY FOR THE PLANET REQUIRE INNOVATIVE SOLUTIONS FOR FACING THE GIGANTIC ENVIRONMENTAL CHALLENGES OF THE PRESENT AND THE FUTURE. IN THE CASE OF THE AMAZON, THIS NECESSARILY INVOLVES CREATION OF A NEW BIOECONOMY WITH SUSTAINABLE PRODUCTION AND CONSUMPTION, A STANDING FOREST ECONOMY.

This requires a disruptive change in our trajectory, involving education that is appropriate for the transition to a knowledge society, but one that is also inclusive and embraces a culture of creativity, especially one making use of the technological tools of the 4th Industrial Revolution.

Amazon Creative Labs can be a tool for rapidly reducing the knowledge gap among peoples of the forest and also urban communities in order to allow this new standing forest bioeconomy to emerge, Empowerment of poor, mostly marginalized populations with modern technologies is something disruptive and challenging and not practiced in the Tropics. However, we must seek rapid transformations in social and economic systems – most of them lacking tested models to copy – and if we wish to leave a fair and sustainable society as our legacy to future generations, Amazon 4.0 is an attempt to show that it is possible to achieve a stage of high human development combined with valuing of tropical forest through knowledge.

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“To add value to the heart of the forest”

Bertha Becker