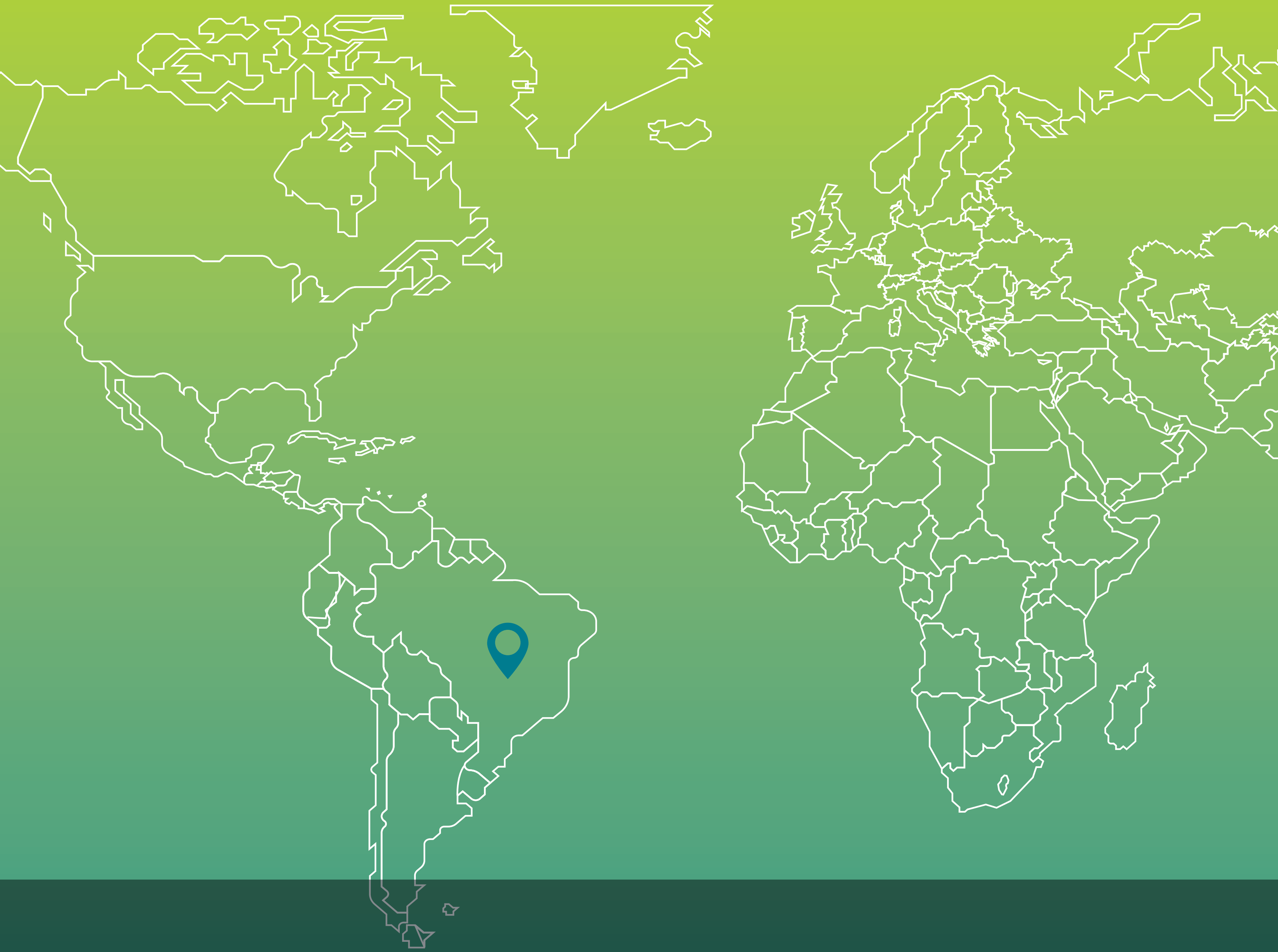
Building a Sustainable Macauba-Based Silvopastoral System and Value Chain in Brazil

CIF-GDI DELIVERY CHALLENGE CASE STUDY - MAY 2020

CIF CLIMATE INVESTMENT FUNDS



PROJECT DATA

PARTNER ORGANIZATION
Inter-American Development Bank (IDB)

ORGANIZATION TYPE
Private sector

DELIVERY CHALLENGES
- Project finance
- Project design
- Stakeholder engagement

DEVELOPMENT CHALLENGES
- Climate change & Deforestation
- Lack of income-generating opportunities

COUNTRY AND REGION
Brazil, Latin America and Caribbean

Cover Photo: INOCAS

PROJECT TOTAL COST
US$5,969,000 (including US$3 million from the Climate Investment Funds [CIF] under its Forest Investment Program [FIP])

PROJECT DURATION
2017–2022 (expected) with an equity investment of 8-10 year time frame.

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CONTENT

Photo: INOCAS

EXECUTIVE SUMMARY

Photo: INOCAS

This case study examines a project to develop a macauba-based silvopastoral[1] system and value chain in Brazil. The project was funded in part by the Climate Investment Funds' (CIF) Forest Investment Program (FIP) through the Multilateral Investment Fund of the Inter-American Development Bank (MIF/IDB) Lab.

The macauba palm tree, native to Brazil, is a productive, oil-producing plant with high potential for biofuel production, especially in dry tropical regions. The tree yields similar oil to the African oil palm, but has several advantages.[2] These include better resistance to drought, viability in areas without rainforest conditions, and suitability for planting in existing pastures. The macauba tree could produce oil to sustainably meet rising Brazilian and global biofuel demand without the need for clearing more land, and without reducing pastures for cattle grazing. This

1 Silvopastoral systems are agroforestry arrangements that combine fodder plants with shrubs and trees for animal nutrition and complementary uses.

2 African palm oil (Elaeis guineensis) originates from West Africa, but is widely cultivated across tropical regions of the world. African palm is the main source of palm oil. Indonesia and Malaysia are responsible for about 85 percent of the global palm oil production.

presents an alternative to traditional monoculture palm plantations, which tend to negatively impact the environment by contributing to land degradation and deforestation.

The project's executing agency is a private start-up company called INOCAS, a spin-off from a European Union-funded research project on biofuels for the airline industry. After a successful feasibility study between 2012 and 2014, the project started in 2017 in the Brazilian Cerrado biome. The project was intended to tackle development challenges including climate change and deforestation, and a lack of income-generating opportunities.

This case study describes three main delivery challenges that emerged during implementation, and how the project team overcame them and learned from the experience.

1. **Project finance.** The project had a total financing volume of US$6 million, of which US$3 million was non-grant funding endorsed by the FIP and initially designed as a loan. The MIF/IDB Lab was unable to find partner financial institutions on the ground to channel the loan, as the perceived risk was too high. After conducting an analysis, the MIF/IDB Lab decided to provide US$3 million to INOCAS as equity capital. This was the first time that MIF/IDB Lab used this financing mechanism with FIP funds, as other FIP projects are usually funded through loans. This solution would allow MIF/IDB Lab to directly assume the risk of the project, without needing to have a third-party financial entity as a partner. Furthermore, INOCAS was able to find local partners who made a total of investment commitments of over US$1 million in the project.

2. **Project design.** During the project design, the macauba germination rate was expected to be unrealistically high. This rate came from controlled conditions of laboratories at research centers working on the macauba plant. Once project implementation started, it was impossible to reach such high germination rates in local nurseries, which focused on large-scale production of the plant and had natural environmental conditions. This problem was compounded with a timing issue for planting. The macauba planting period runs from October until February. By the time the project started, it was already October, and there were not enough saplings to plant. To mitigate these problems, INOCAS partnered with two local universities and a local nursery, which were able to provide technical guidance and significantly increase the success rate of the seed-to-sapling process. Through the partnership with the local nursery, the project was able to secure enough saplings for the next planting season.

3. **Stakeholder engagement.** The project had to overcome lack of interest from local farmers and resulting low participation rates that jeopardized overall project success. Limited buy-in by farmers stemmed from previous failed attempts by other organizations to engage them in similar projects. To resolve this issue, INOCAS conducted extensive outreach to farmers to find champions who had successfully grown macauba trees and could inspire others. Through identifying and using early adopters, the project team built a critical mass of farmers interested in taking part.

The project established the first sustainable macauba-based silvopastoral agroforestry value chain in the world. The experience and challenges surmounted offer lessons for implementing similar agricultural supply chains in other countries.

INTRODUCTION

Photo: INOCAS

This case study examines the experience of the project 'Development of a macauba-based silvopastoral system and value chain' in Brazil, funded in part by the CIF's FIP and channeled through the MIF/IDB Lab.[3] The study looks at the period between May 2017, when project started, and March 2020, when this case study was conducted. The original expected completion date of project execution is 2022.[4]

3 In 2018, the MIF became the innovation laboratory of the IDB Group.

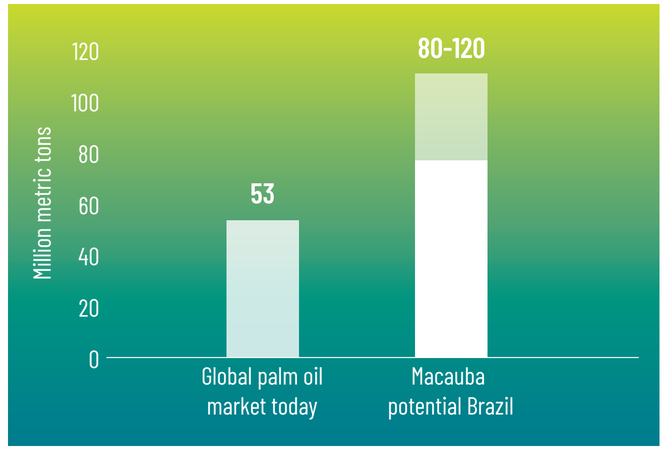
4 The project is expected to continue after FIP funding project implementation timeframe. In 2023, INOCAS will start harvesting the macauba in the planted areas and will set up a large industry for the production of oil.

The project was conceived as part of a research platform at a German university innovation incubator. It developed concepts for the sustainable production of biofuels for the airline industry and the commercial implementation of those concepts. In 2011, the European Union provided the platform with EUR 2.7 million to determine the feasibility of a new sustainable vegetable oil from the macauba palm tree in Brazil. INOCAS, a private start-up company, was responsible for implementing the concepts developed by this research.

Between 2012 and 2014, INOCAS conducted a feasibility study that demonstrated the economic viability of macauba, and its significant positive social and environmental impacts, such as increased incomes for harvest workers and farmers.[5] The study also demonstrated that the production potential of macauba palm trees planted in silvopastoral systems in the Brazilian Cerrado[6] could exceed current global palm oil production if half of the pasture area (approximately fifty million hectares) was converted into silvopastoral systems combining fodder plants with shrubs and trees, including macauba trees (see figure 1).[7]

The project in this case study represents the first sustainable macauba value chain intended for mass commercialization. The goal was to establish a profitable flagship project showcasing the scalable potential of silvopastoral macauba to sequester carbon dioxide and reduce pressure on existing forests and other important ecosystem hotspots in the Cerrado region in Brazil. Specifically, the project intends to achieve the following objectives: establish 2,000 hectares of silvopastoral macauba plantations with 300 trees per hectare, collect 1,500 tons of macauba fruits per year, sequester 300,000 tons of carbon dioxide equivalent, and train 120 farmers on agroforestry systems.

Figure 1.
MARKET POTENTIAL (MILLION METRIC TONS)



Source: INOCAS

5 Katharina Averdunk, Thilo Zelt, Philipp Golka, Malte Höpfner, Corina Müller, and Ilka Bettermann, "Macauba: Sustainable Palm Oil Results of the Feasibility Study of the Leuphana University of Lüneburg," executive summary, Leuphana Incubator.

6 The Cerrado biome is a savanna ecosystem covering more than 2 million square kilometers, second only to the Amazon in terms of size.

7 Pasture area in Brazil totaled 170 million hectares in 2010. If 50 percent of those pastures were converted into silvopastoral systems with 200-300 palms per hectare, Macauba oil production could exceed today's global palm oil production (United States Department of Agriculture, Foreign Agricultural Service, 2013, *Oilseeds: World Markets and Trade*, Washington, DC).


Photo: INOCAS

CONTEXTUAL CONDITIONS

A growing demand in Brazil for palm oil has resulted in rising import costs and the clearing of large tracts of forestland for African palm plantations. This case study focuses on the production of the macauba or macaw palm tree (*Acronomia aculeata*), native to Brazil. This species is a very productive oil-producing plant with high potential for producing biofuels, especially in dry tropical regions.[8]

The species grows outside of typical rainforest zones and can be planted in agroforestry schemes (including existing pastures). This represents an alternative to traditional monoculture palm plantations, whose expansion generally pressures the environment through land degradation and deforestation.

The macauba produces similar oil to the African oil palm, but the macauba is more drought resistant and does not require rainforest conditions. The macauba fruit is processed into plant oil and animal feed. An environmental advantage is that the macauba can produce palm oil to sustainably meet rising domestic

8 L. A. dos Santos Dias, 2011, "Biofuel plant species and the contribution of genetic improvement," *Crop Breeding and Applied Biotechnology* 1: 16–26, http://www.sbmp.org.br/cbab/siscbab/uploads/c8eb9792-df3f-def3.pdf.

and global demand without land use changes,[9] and without reducing the yield of pastures for cattle grazing. Indeed, research found that grass in pasture grows better in the light shade of the palm.[10] Moreover, once the oil is extracted about half of the dried fruit is used as animal fodder, which adds to the total fodder yield of the pasture.

The macauba can produce about 1 metric ton of oil and 1.8 metric tons of fodder per hectare,[11] which is a higher yield than soy, the main plant used for biofuel in Brazil. Soy produces only 0.6 metric tons of oil per hectare.[12] Although macauba productivity is lower than the average for palm oil in Brazil (2 tons per hectare), research shows that the macauba yield can increase to between 2.5 tons of oil per hectare planted with 400 trees and 5 tons per hectare with seed selection[13,14].

Even though macauba naturally grows in Brazil, it remained largely unexplored as it lacked a structured commercial value chain. Approximately 200,000 hectares of silvopastoral macauba plantation would be required to cut Brazil's palm oil imports to zero.[15] If this market could be proven, it could be scaled up nationally and globally, and dramatically disrupt the global palm oil market.

9 This conversion means simply adding trees to the land with no deforestation.

10 Cristóbal Villanueva et al., 2008, *Disponibilidad de Brachiaria brizantha en potreros con diferentes niveles de cobertura arbórea en el trópico subhumedo de Costa Rica*, Grupo Ganadería y Manejo del Medio Ambiente, Centro de Agricultura Tropical de investigación y Enseñanza, Turrialba, Costa Rica.

11 Confirmed by the INOCAS feasibility study.

12 Refer to: https://www.bbc.com/portuguese/brasil-39788968.

13 Seed selection refers to the practice of selecting a portion of the seeds from one year's crop based on the desired criteria and utilizing them to plant a crop for the next year.

14 Carlos Augusto Colombo, Luiz Henrique Chorfi Berton, Brenda Gabriela Diaz and Roseli Aparecida Ferrari, 2018, "Macauba: a promising tropical palm for the production of vegetable oil," *Oilseeds and Fats, Crops and Lipids* 25: 1, https://doi.org/10.1051/ocl/2017038.

15 CIF, "Concept Note for the Use of Resources from the FIP Competitive Set-Aside."

DEVELOPMENT CHALLENGES

Photo: INOCAS

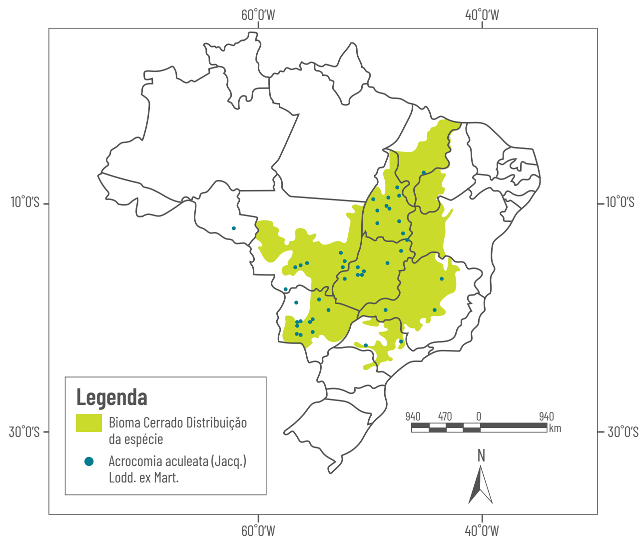
The macauba oil project is implemented in the Cerrado region, in the state of Minas Gerais, as shown in figure 2. This region, characterized by low socioeconomic indicators, suffered from the problems listed below, which the macauba project intended to address.

Climate change and deforestation. A biodiversity hotspot, the Cerrado comprises a diverse mix of grasslands, shrublands, and woodlands.[16] This tropical savanna stocks 9 gigatons of carbon in its primary vegetation, hosts 4,200 endemic species, is the birthplace of two-thirds of Brazil's hydrographic regions, and is responsible for 12 percent of global soybean production.[17] Nevertheless, the Cerrado region suffers higher deforestation rates than the Amazon. As of 2018, nearly half of the Cerrado has been converted to pasture (29.5 percent) or cropland

16 Praveen Noojipady et al., 2017, "Forest carbon emissions from cropland expansion in the Brazilian Cerrado biome," *Environmental Resource Letters* 12(2).

17 IPAM, 2018, "Cerrado: The Brazilian savanna's contribution to GHG emissions and to climate solutions," policy brief.

Figure 2.
AREAS WHERE MACAUBA IS CULTIVATED IN BRAZIL



Source: INOCAS

(11.7 percent).[18] Between 2016 and 2017, the region lost 14,185 square kilometers of native vegetation.[19]

Furthermore, smallholder farmers in the project region of Minas Gerais are increasingly exposed to the negative impacts of climate change (heat, drought, worsening soil fertility, and other socioeconomic impacts). They depend on monoculture cattle farming due to the topography, which impedes use of agricultural machines. The lack of diversification and non-agricultural economic opportunities encourages deforestation to increase pasture sizes, and makes smallholder farmers even more vulnerable to pests, soil degradation, and income volatility. Cattle farming also negatively impacts the environment, as land degradation and deforestation reduce carbon dioxide capture by forests and soil, increase water runoff, and add to erosion.

Lack of income-generating opportunities. Local harvest workers face seasonal unemployment due to a lack of jobs during the low season for coffee production, reducing incomes and making the population migrate to other areas. An estimated 200,000 people work in the coffee sector in Minas Gerais during the harvest period. Afterwards, unemployment rates go up significantly. The macauba harvest (October to January) takes place after the coffee harvest, creating off-season income opportunities. The 2012-2013 feasibility study determined that the macauba harvest workers in the project area reported earning on average more than twice the minimum wage and significantly more than in potential alternative jobs during the off-season. An average household's income is R$814 per month during the year from non-macauba activities, with the minimum wage being R$622 per person per month[20]. During the macauba harvesting season (typically October to January), the average income from macauba was R$1,606 per person per month[21].

The scalability of the project, either through the organic growth of INOCAS or through replication of the use of macauba in agroforestry schemes in other regions of the country, can contribute directly to Brazil's climate and environment priorities. Brazil's Nationally Determined Contribution points to ambitious goals of reducing greenhouse gas (GHG) emissions by 43 percent below 2005 levels in 2030. This will require finding alternative crops and agroforestry schemes that address land use change and agriculture emissions as the two largest sources of GHG emissions in Brazil (absolute emissions from the latter grew 50 percent in the last 20 years). At the same time, levels of production and productivity must continue to rise. Brazil is also in the process of implementing new forest legislation, a process that can benefit from experiences with expanding afforestation practices in degraded pastures, especially in cattle-farming zones.[22]

18 MMA Ministério do Meio Ambiente, 2015, "Mapeamento de uso e cobertura vegetal do Cerrado Ibama, Embrapa, INPE, UFG, UFU," www.dpi.inpe.br/tccerrado/index.php?mais=1.

19 IPAM, "Deforestation rate in the Brazilian savanna fell in the last two years" (accessed June 28, 2018), https://ipam.org.br/deforestation-rate-in-the-brazilian-savanna-fell-in-the-last-two-years/.

20 Monthly minimum salary in 2012 (when the due diligence study was conducted) was R$622.

21 P. Golka, M. Höpfner, K. Averdunk, T. Zelt, C. Müller and I. Bettermann. Validation Study on Macauba-Oil from Silvopastoral Systems. Leuphana Inkubator. 2013.

22 IDB, "Development of a Macauba-based silvopastoral system and value chain (BR-T1333 and BR-Q0019)," donors memorandum.

DELIVERY CHALLENGES

Photo: INOCAS

The following three key challenges emerged during project implementation:

KEY DELIVERY CHALLENGE ONE: PROJECT FINANCE

The project has a total financing volume of US$6 million, of which US$3 million (see table 1) is non-grant funding endorsed by the FIP Private Sector Set-Aside (PSSA) and initially designed as a loan. MIF/IDB Lab's efforts to find a financial institution that would be the partner on the ground to channel the loan were unsuccessful because local banks considered the project to be high-risk. In 2014, MIF/IDB Lab started to look for such a partner, continuing until the first half of 2016. The list of entities that it approached for discussions—and in some cases negotiations—on the viability of loan financing included a range of local banks and financial institutions.[23]

These organizations indicated critical challenges to compliance with the requirements of a loan package, given the current risk appetite in the market and the

23 BDMG (a regional development bank), Banco do Brasil, Bradesco, Rabobank, Caixa, Sicoob Credipatos (a local credit union), Sebrae (Medium, Small and Microenterprises support agency), Southpole and Forest Finance (carbon credit developers), Earth Capital Partners, the Moringa Fund, Permian Global and the Althelia Climate Fund.

Table 1.
FINANCING COMPONENTS

SOURCE OF FUNDING	AMOUNT (US$ MILLION EQUIVALENT)
FIP non-grant funding in the form of a loan (later as equity)	3,000,000
Reimbursable technical cooperation	1,000,000
Non-reimbursable technical cooperation	106,000
Other (legal and structuring)	220,000
TOTAL MIF funding	**4,326,000**
Counterpart (local investors)	1,000,000
Co-financing	643,000
TOTAL PROJECT BUDGET	**5,969,000**

Source: IDB[24]

perceived risk of such an innovative approach. The project was perceived as risky because:[25]

- Macauba oil has not been exploited commercially yet, resulting in a lack of experience and knowledge about product risks and opportunities.
- Despite an experienced management team, the project developer is a start-up company without a commercial track record, resulting in challenges to meeting typical loan requirements.
- The growth cycle of macauba trees (around five to six years from planting until the start of commercial harvesting) significantly delays project cash flows, resulting in a need for long grace periods that are not consistent with lenders' preferences and availabilities.
- Letters of intent had been secured from two interested purchasers of some of the project output, mostly the oil. Converting these letters into legally binding purchase agreements would be extremely challenging, however, given that this would require agreements on a specific future delivery date in five to six years as well as on delivery quality price and other conditions.
- The consulted banks require 125 percent of collateral for a given loan amount. Such a level would be challenging because:
    - The key asset of the project, the macauba palm trees, does not qualify as collateral, according to the criteria of the consulted financial institutions.
    - Pasture land will be rented from smallholder farmers; hence, land ownership would not be a feasible form of collateral.
- Current low oil prices negatively impact the potential to commercialize macauba oil as biofuel. This eliminated the option to potentially secure airlines—which are under pressure to offset their emissions—as off-takers of the macauba oil, which would then have been a potential source for purchase agreement-based collateral.

24 IDB "Development of a Macauba-based silvopastoral system and value chain (BR-T1333 and BR-Q0019)". Proposal for submission to the FIP sub-committee. http://pubdocs.worldbank.org/en/535621531831072433/1966-PFIPBR501A-Brazil-Project-Document.pdf.

25 IDB, "FIP Competitive Set-Aside: Request to Update Financing for Endorsed Project Concept 'Macauba—Plant Oil with Impact'."

- There is limited carbon credit[26] potential. Ex-ante payment might be possible, but at a considerable price discount, thereby rendering the discounted value of an Emission Reductions Purchase Agreement[27] commercially unattractive as collateral at this stage.

Given the project risk and the reluctance of local partners to engage in loan financing, it was not possible for the project to secure a loan. Instead, an innovative financial structure had to be designed.

SOLUTION

FIP funding typically offers blended finance, including grants and concessional loans to de-risk investments and bridge the "first mover" or "pioneer" gap. In this case, the loan could not go through because the MIF/IDB Lab was unable to find a partner on the ground to channel the loan to end beneficiaries. The MIF/IDB Lab team conducted a detailed analysis, deeming the project well-suited for an equity investment. The MIF/IDB Lab decided to offer the US$3 million investment as equity shares to INOCAS. This solution meant the MIF/IDB Lab could directly assume the risk of the project, without needing to have a third-party financial entity to partner with. This was the first time that a FIP investment was channeled as equity shares[28] of the private company executing the project. This showed an innovative approach, as other FIP investments are channeled through loans. In 2016, the US$3 million of non-grant funding endorsed by the FIP PSSA for this project was changed from a loan to equity, as an extraordinary solution.

The MIF/IDB Lab's total direct equity investment should cover capital costs and operational expenses that INOCAS will incur during its start-up and growth stage, and sustain operations until it begins to generate a profit, expected in year seven, with 2028 as the estimated exit year.

The US$3 million that MIF/IDB lab invested in the project will be used to:

- Establish and manage 2,000 hectares of macauba agroforestry systems.
- Establish a training center and pilot oil mill to collect and process fruit from existing trees.
- Execute a small collection of fruits from existing trees.

Althelia Climate Fund, which is a Conservation International-backed impact fund that finances sustainable land use projects and enterprise-based natural resource conservation, was selected as the investment adviser to the MIF/IDB Lab for this operation. In 2016, the MIF/IDB Lab, Althelia and INOCAS agreed on a term sheet to structure collaboration and investment.

The expectation of this equity investment is that successful project implementation will create the necessary awareness and track record affirming the commercial potential and viability of macauba, thereby reducing the risk of these types of agroforestry projects. In addition to developing a macauba-based value chain, the project is expected to result in the willingness of other financial actors to provide financing and invest in this type of project in the future.

At the same time, and for the financial structuring of the equity component of the project to be successful, INOCAS had to find an external co-financing contribution of over US$1 million. There were several failed attempts to find seed capital from European and US-based impact investors. Investments did not go through for a number of reasons: The project was still at too early a stage, investment funds were not interested in the land use sector, or their geographic focus was elsewhere. Finding external partners to provide such co-financing contribution from impact

26 Carbon credit refers to a certificate or permit representing the right to emit one tonne of carbon dioxide equivalent (tCO_2e), which can be traded in the market.

27 An Emissions Reduction Purchase Agreement (ERPA) is a legal contract between entities that buy and sell carbon credits.

28 The equity funds invested in this project were entrusted to the MIF/IDB Lab by the FIP for use in this project.

investment funds and other potential investors proved very challenging for INOCAS.

Finally, INOCAS turned to local Brazilian investors interested in the success of the macauba project and in partnering with it. It was able to accept investment commitments from the following local partners: Viveiro Nativo, Perfil Agricola and Reinaldo Melo. The first investor is the main nursery partnering with INOCAS, Viveiro Nativo. It is a seedling production company working on the recovery of the Cerrado Biome, with an annual production capacity of 500,000 native tree seedlings and 2 million seedlings of coffee, eucalyptus, mahogany, and cedar. Viveiro Nativo made an in-kind investment commitment by providing macauba seedlings. The second local investor is Perfil Agrícola, a company specializing in the distribution of agricultural inputs and technical assistance. Having worked with farmers in the region for a very long time, Perfil Agrícola also adds to the project's know-how in building long-lasting partnerships in the agricultural sector. The third local investor is a local private actor, Reinaldo Melo, who has extensive experience in organic crop production in Minas Gerais. He has developed special expertise in palm cultivation and recently developed a pesticide based on natural ingredients. Mr. Melo made an in-kind investment commitment in the form of pesticides. All together, local investors made investment commitments of over US$1million. The MIF/IDB Lab expects to exit this investment by year 10 (in 2028). It plans to sell its shares to other interested investors or execute an exit option negotiated with INOCAS.

Photo: INOCAS

KEY DELIVERY CHALLENGE TWO: PROJECT DESIGN

During the project design phase, the seed germination rate expected was unrealistically high. The germination data came from local agricultural research entities, which achieved these rates in laboratories. Such high rates proved to be unrealistic when project implementation started and germination was done at the local nursery in less controlled conditions. When the local nursery, Viveiro Nativo, started producing macauba seedlings in natural environment conditions, the germination rate was less than half the rate considered at project design. The project design did not take into account that there could be low germination rates in the nursery during the period of adaptation of the technology for scale production.

Compounding this problem, there was an issue with timing of planting during the first year of project implementation. The macauba planting season lasts only four months (October through February), representing a limited window of opportunity to plant saplings. By the time the project became effective in

October 2018, there was not enough time to produce the necessary saplings to start planting. As it takes 12 months for macauba seeds to produce saplings, INOCAS had to wait until the next year to produce and plant them.

In addition, as the macauba trees were being planted, farmers faced losses of about 10 percent from pests they did not anticipate. Ants were a particular nuisance in areas with macauba saplings.

SOLUTION

INOCAS partnered with two local research institutions, Instituto Agronômico de Campinas (IAC) and the Universidade Federal de Viçosa (UFV), to tackle the germination challenge. Through this partnership and following technical guidance from the local nursery, the research institutions developed a germination protocol for macauba seeds. Following this protocol, INOCAS applied different seed treatments and was able to increase the success rate significantly. Other measures taken by INOCAS included increasing the number of germinated seeds to compensate for the losses, buying seedlings from other nurseries, and starting its own germination laboratory.

INOCAS provided technical assistance to small farmers engaged in macauba farming. Through the project, INOCAS already trained 26 farmers on agroforestry and silvopastoral systems, and expects to train a total of 120 farmers by the end of the project implementation. Other technical assistance provided through INOCAS include supporting farmers to become eligible for government financing programmes from entities such as CONAB,[29] providing support to improve soil quality and to control pests that translate into plant losses.

29 CONAB (Companhia Nacional de Abastecimento) is Brazil's national agricultural statistics agency. CONAB supports the commercialization of non-wood forest products with the payment of a direct subsidy, guaranteeing a minimum price for native products. The macauba is one of these seventeen identified products.

KEY DELIVERY CHALLENGE THREE: STAKEHOLDER ENGAGEMENT

Previous programs run by the government and other organizations enticed farmers with the idea of selling biofuels. For example, in the early 2000s, the Brazilian government and Petrobras supported the cultivation of castor beans[30] and jatropha to produce biodiesel. None of these initiatives succeeded in the long term, however, for various reasons, including lack of capital and investments in production technologies. These previous failed attempts to produce biofuel oil caused skepticism among local farmers.

The macauba tree, being native to the region, was previously seen as a nuisance plant, as it was not productive. No one extracted oil from the nut for commercial processing. Most farmers in Minas Gerais are dedicated to cattle and have been for generations. Many farmers, especially older, have a conservative approach to farming and raising cattle, and are wary of taking risks.

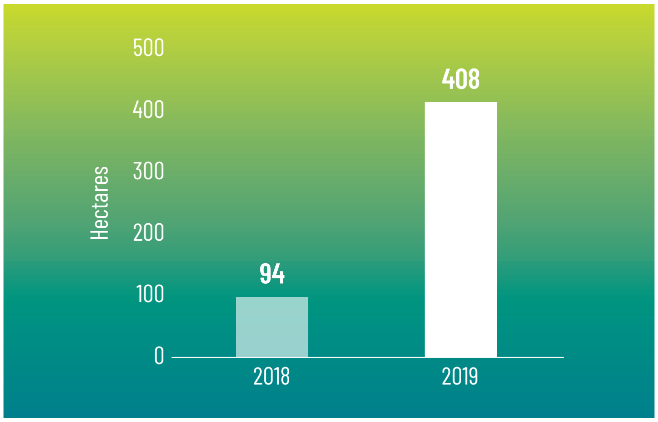
A significant drawback for farmers was that during the first three years, Macauba trees could not be grown on the same land with cattle, which would eat the tender stems of young trees. Having to reallocate cattle to other pastures was perceived as an inconvenience for farmers, who did not see much benefit in growing the macauba trees. This lack of buy-in seriously jeopardized overall project success.

SOLUTION

INOCAS realized early on that to get a critical mass of people supporting change, they needed to find champions, or farmers that could inspire other farmers by successfully growing macauba trees. INOCAS did extensive outreach to farmers through visits and participation in community meetings to present the macauba farming project. The INOCAS team traveled a total of 90,000 kilometers on dirt

30 Carlos Augusto Colombo, Luiz Henrique Chorfi Berton, Brenda Gabriela Diaz, and Roseli Aparecida Ferrari, 2018, "Macauba: a promising tropical palm for the production of vegetable oil," *Oilseeds and Fats, Crops and Lipids* 25: 1, https://doi.org/10.1051/ocl/2017038.

Figure 3.
AREA PLANTED WITH MACAUBA TREES (HECTARES) AS A RESULT OF THE PROJECT



Source: INOCAS

roads to present the project to smallholders and published a YouTube video garnering over 100,000 views. Team members also appeared on local television to talk about the project. INOCAS presented data to small farmers, some of whom were community representatives or leaders, on how the project will be profitable in a few years, which convinced them that the program made sense economically.

Some farmers became early adopters, experimenting with the macauba trees on their farms. The adoption grew year after year, as more farmers joined. The farmers who first joined, were followed in many cases by their neighbors, who soon also saw the benefits of cultivating macauba. Eventually, a critical mass of farmers emerged, who inspired others to join too.

By March 2020, INOCAS planted 502 hectares of macauba trees on 26 farms. Twenty-three are smallholder farms, and three are large rural producers. The average size of smallholder farms is 58 hectares and that of large rural properties is 867 hectares. The total average size of project farms is 155 hectares. Figure 3 shows hectares planted annually with macauba trees in 2018 and 2019.

Farmers interested in planting macauba trees managed to find a way for their cattle and macauba trees to grow on separate lots during the first three years. Some farmers moved their cattle to neighboring land, and planted young macauba trees mixed with seasonal crops, such as pineapples, beans, sweet potatoes, cassava, pumpkin, rice, corn, watermelon, and peanuts.

OUTCOMES AND LESSONS LEARNED

Photo: INOCAS

OUTCOMES

As of March 2020, although the project was behind schedule in terms of results delivered, it had achieved the following results:

- 133,944 macauba trees planted
- 502 hectares planted with macauba trees
- 26 farmers trained on agroforestry and silvopastoral systems, including with macauba
- 207,000 tons of macauba fruit collected

INOCAS is planning to scale up operations beyond the FIP intervention. The goal is to expand beyond the 2,000 hectares starting in year six, and to expand by 1,000 hectares per year after year six with its own cash flow. INOCAS also intends to raise additional finance to build its own macauba processing factory, which will require a US$4 million investment. In the long term, the objective is to become a large-scale supplier of an environmentally friendly substitute to palm oil for the Brazilian market.

LESSONS LEARNED

The macauba project encountered some unexpected delivery challenges during implementation. Yet it overcame these by making adaptive changes. The project has now established the world's first sustainable macauba-based silvopastoral agroforestry value chain through the capitalization of INOCAS, together with local investors. For the first time, the FIP channeled an investment through a multilateral development bank—the MIF/IDB Lab in this case—by taking equity shares in a private sector project. This experience and the challenges surmounted offer lessons for developing similar agricultural supply chains in other countries.

Blended finance can reduce investment risk: The project presented significant risks, as the company is a start-up involved in a new business, with a little-known product that has not been attempted in the past. Blended finance is a successful mechanism to de-risk the investment and enable uptake of a new sustainable agri-business. This project showcases a unique blended finance structure: the use of MIF/IDB Lab reimbursable and non-reimbursable grants; equity share investments from the FIP, channeled through the MIF/IDB Lab; and a counterpart contribution through equity shares investments from local partners with an interest in the development of the macauba value chain. While the project has not yet reached a mature stage of implementation, blended finance is proving to be a successful resource to jump-start the first macauba value chain intended for mass commercialization and to de-risk future investments.

Working with the private sector may require flexible financial instruments and innovative solutions: Working with the private sector represents a unique opportunity to foster wider participation but also to ensure the longer-term viability of the supply chain. It is important to find flexible financial instruments that are best suited for the private sector. In this project, the MIF/IDB Lab took a bold step forward, coming up with an innovative solution and taking an equity share of a start-up company.

Local co-investors can increase project visibility and enhance capacity: Finding local co-investors was a key success factor for the project. These co-investors are also project partners, who have a stake in the overall project success. Their engagement and efforts to move the project results forward is especially useful, giving the project larger visibility in the region and enabling coordinated capacity to scale-up operations. Partnering with local universities to develop a germination protocol to improve the overall success rate from seeds to saplings is key to replication in the region.

Importance of working hand in hand with local partners: Project implementation needs to be well suited to the local reality. In the first three years of the macauba project, this approach was essential in persuading farmers to grow the macauba tree with other crops. This is especially important in this context, as most participating farmers are small-scale and therefore need to perceive short-term benefits until the macauba trees start producing fruits. Also, the macauba offers a complementary income for coffee harvesters in the region.

Importance of adaptability during program implementation: Adaptability and flexibility during program implementation are key to tackling unexpected obstacles and enhancing the chances of overall project success. INOCAS showed leadership and resourcefulness when faced with unforeseen challenges, such as a lack of engagement from stakeholders, unrealistic germination rate at project design and a dearth of investors. The MIF/IDB Lab did the same when restructuring the financial agreement and converting the FIP investment from a loan to equity share.

ANNEX 1: LIST OF INTERVIEWEES

NAME	POSITION	ORGANIZATION
Johannes Zimpel	CEO and shareholder	INOCAS
João Mattos	Board member	INOCAS
Marco Curatella	Board member	INOCAS
Geraldo França	President of the Board and Shareholder	INOCAS Owner of Viveiro Nativo
Malte Höpfner	Project developer	INOCAS
Felipe Cresciulo	Senior Investment Officer	IDB Lab
Gregory Watson	Lead Specialist Natural Capital Lab and former macauba project Task Team Leader	IDB Lab
Dieter Wittkowski	Lead Investment Officer	IDB Lab
Eduardo Roxo		Belterra
Roberto Barros	President of Conselho Municipal de Desenvolvimento Rural Sustentavel (CMDRS) and farmer	
Cleuton Daniel	Farmer	
Paulo Henrique		APAC, Associação de Proteção e Assistência aos Condenados
Daniel Silva		APAC, Associação de Proteção e Assistência aos Condenados

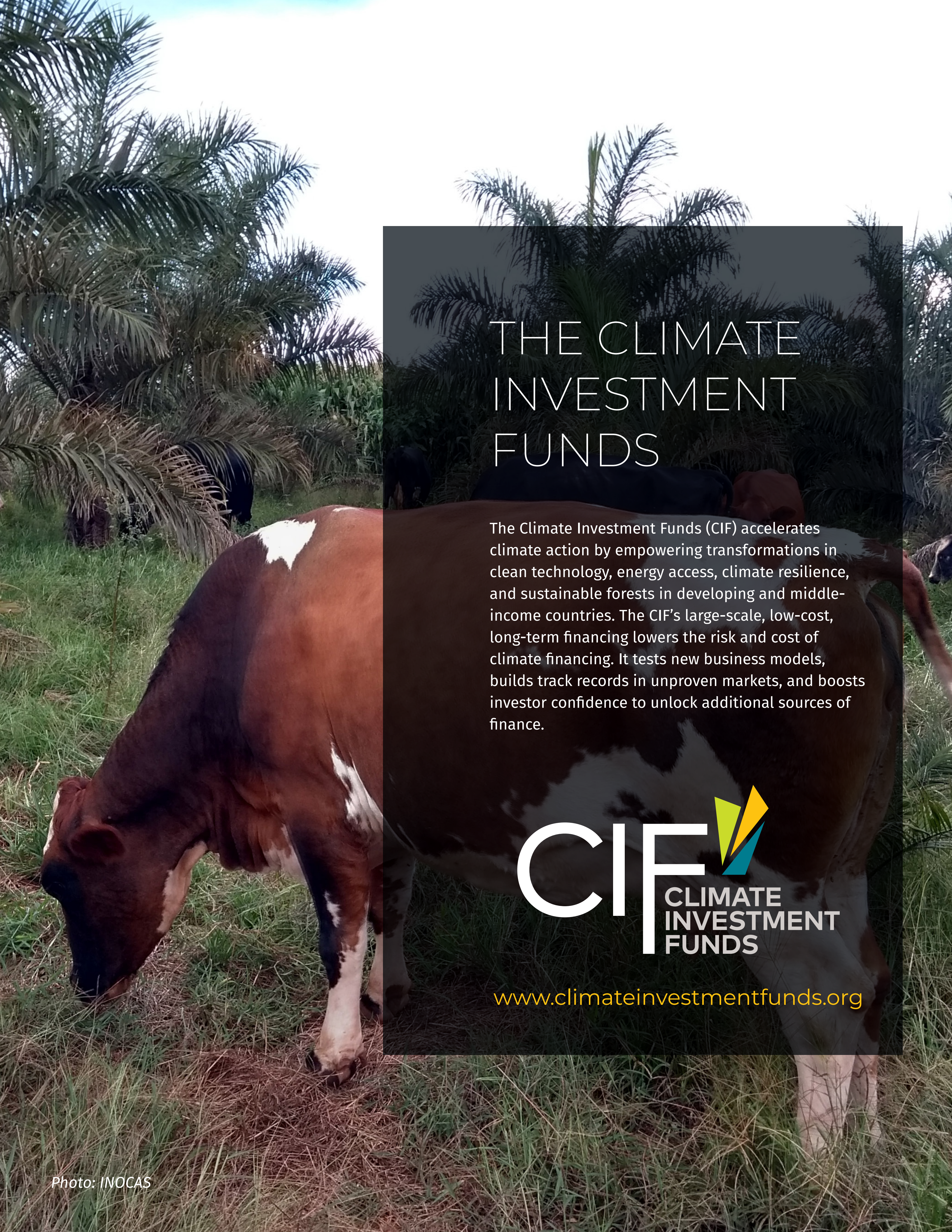


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Photo: INOCAS

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