



Regenerative Coffee Farming

An Economic, Agronomic
and Environmental
Analysis in Brazil

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This publication is the result of a collective effort and reinforces that collaboration among different stakeholders is essential to accelerate the transition towards more resilient, prosperous and sustainable coffee farming. GCP Brazil will continue mobilizing the sector to scale these results for the benefit of coffee farmers, their families, workers and everyone across the coffee value chain.



1. The Global Coffee Platform (GCP) is a multi-stakeholder membership association dedicated to advancing coffee sustainability, with a vision of a thriving, sustainable coffee sector for generations to come.

Executive Summary

GENERATING EVIDENCE FOR REGENERATIVE COFFEE FARMING IN BRAZIL

The transition towards more resilient coffee systems has become a priority for the sustainability of the global coffee value chain. In a context of extreme weather events and growing demand for more sustainable supply chains, regenerative coffee farming is increasingly recognized as a promising approach.

Despite growing interest in the topic, the evidence base on regenerative coffee farming is still expanding, particularly regarding the performance of different strategies on coffee farms and their economic, agronomic and environmental outcomes.

As the world's largest coffee producer and exporter, Brazil holds a strategic position in this discussion. The diversity and efficiency of the country's production systems provide a unique opportunity to understand different pathways for transitioning towards regenerative coffee farming and to generate lessons relevant not only to Brazil, but also to other coffee-producing countries.

With this purpose, the Global Coffee Platform Brazil team conducted this study as an extension of the collective work that resulted in the development of the 7 Elements for the implementation of regenerative coffee farming. Rather than seeking a single production model, GCP Brazil analyzed seven Arabica coffee farms located in South of Minas and Cerrado Mineiro, recognizing that each farmer builds their own pathway according to their production, environmental and socioeconomic conditions. The study integrated several analyses to understand how different management strategies influence the performance of production systems.

COMBINING STRATEGIES FOR COMPETITIVE AND RESILIENT PRODUCTION SYSTEMS

The study's reflections² reinforce that there is no single pathway to regenerative coffee farming. At the same time, some practices and actions are common across different journeys and play an important role in the transition. Different combinations of practices can result in competitive and resilient production systems provided that they are adapted to each farm's conditions, implemented consistently and supported by appropriate technical guidance.

From an agronomic perspective, the study showed that building soil fertility at depth represents one of the main opportunities for improvement in the field, contributing to crop resilience in the face of climate challenges, production stability and higher productivity.

Although the soils analyzed generally showed good conditions in the surface layer, physical, chemical and biological limitations below 20 cm still restrict root development and the uptake of water and nutrients. Soil sampling beyond the 0-20 cm layer is essential to gain a deeper understanding of soil conditions (diagnosis) and supports decision-making (strategy) aimed at correcting imbalances and building soil fertility at depth.



² The reflections and conclusions of this study are based on a limited sample and are not statistically representative. They should therefore not be generalized to coffee farming at regional or national level.

Soil indicators in plots under regenerative management in the surface layer (0-20 cm) and at depth (20-80 cm)	0-20cm		20-80cm	
	Overall average of the 7 farms	Reference values	Overall average of the 7 farms	Reference values
Organic matter – OM (dag/kg)	2.64	2.1 – 4.0	1.61	1.4 – 2.6
Calcium – Ca (cmolc/dm ³)	4.23	3.5 – 4.5	1.57	2.3 – 2.9
Magnesium – Mg (cmolc/dm ³)	1.18	1.3 – 1.5	0.46	0.8 – 1.0
Potassium – K (cmolc/dm ³)	0.44	0.36 – 0.50	0.22	0.23 – 0.32
Phosphorus – P (mg/dm ³)	41.21	31 – 40	8.91	20 – 26
Aluminum – Al (cmolc/dm ³)	0.30	<0.5	0.62	<0.5
Cation exchange capacity CEC (cmolc/dm ³)	9.81	10	6.86	6.5
Ca in CEC (%)	42.93	40 – 60	24.71	26 – 39
Mg in CEC (%)	12.07	15 – 20	7.33	9.7 – 13
K in CEC (%)	4.48	3 – 5	3.55	1.9 – 3.2
Base saturation (V%)	59.57	> 50	35.52	> 32
Aluminum saturation (m%)	7.07	< 20	23.45	< 20

Note:

(1) The soil indicators presented in the study (OM, Ca, Mg, K, P, Al, CEC, base saturation and aluminum saturation) represent average results from soil analyses in the canopy projection and inter-row areas across the seven farms under regenerative management.

(2) Data presented for 20-80 cm represent the average of results obtained at 20-40, 40-60 and 60-80 cm.

(3) Reference values adapted from the Modular Fertilization Program (PAM), João Carlos Peres Romero & José Peres Romero, Ed. Agronômica Ceres, 2000.

Average productivity in plots under regenerative management

45 60-kg bags/ha Overall average of the 7 farms	30 60-kg bags/ha CONAB ³
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Operating costs in plots under regenerative management

BRL 618.17 60-kg bag Overall average of the 4 mechanized farms	BRL 675.43 60-kg bag Overall average of the 3 non-mechanized farms	BRL 642.71 60-kg bag Overall average of the 7 farms	BRL 768.80 60-kg bag CONAB ⁴
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From an economic perspective, different regenerative strategies can be compatible with competitive production systems. All farms recorded productivity above the reference average and operating costs below the benchmark published by Brazil's National Supply Company (CONAB) for Minas Gerais (BRL 768.80 in March 2025).

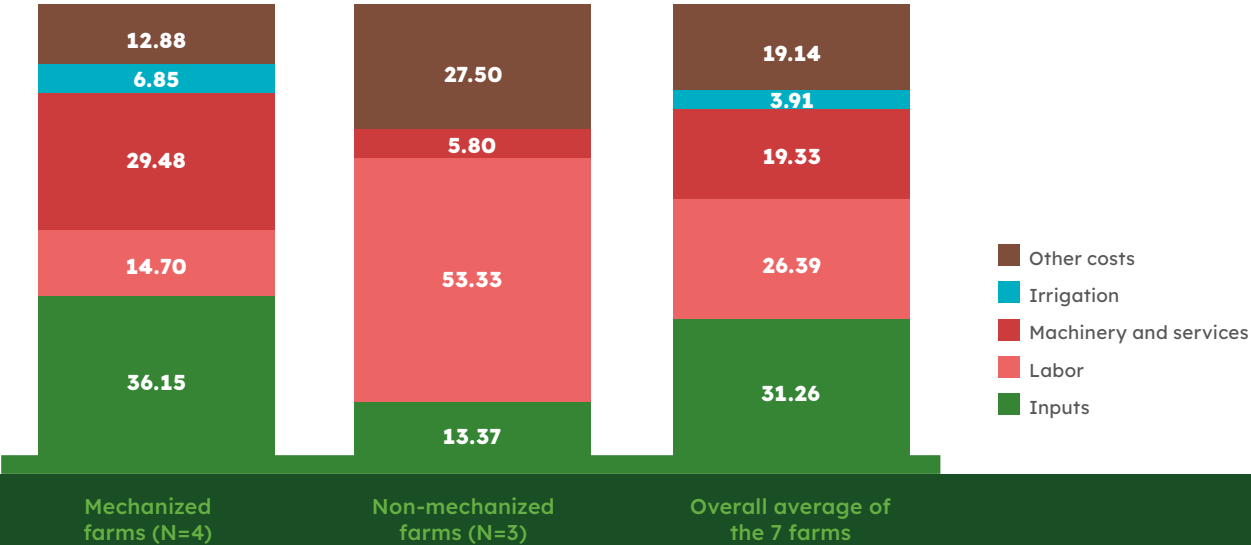
Cost structures and profitability varied according to factors such as terrain, mechanization, labor and the management strategies adopted. These results reinforce that the economic viability of the transition depends on the combination of sound agronomic practices, operational efficiency and each farm's production context.

3. National estimate for the 2025 crop year.

4. Minas Gerais state average in March 2025.



Operating cost structure in plots under regenerative management (%)



From an environmental perspective, the farms showed a favorable carbon balance, with removals exceeding estimated emissions. Concrete opportunities to reduce emissions were also identified, particularly through more efficient use of nitrogen fertilizers and improved agricultural-residue management. At the same time, the findings highlighted the importance of maintaining soil cover, conserving native vegetation and diversifying production systems.

Carbon Balance

7.63 tCO ₂ e/ha	-85.13 tCO ₂ e/ha	-77.50 tCO ₂ e/ha
Average emissions	Average removals	Average net balance

Taken together, the evidence shows that the transition to regenerative coffee farming does not depend on adopting a single technology package, but on gradually building production systems capable of integrating soil health, productive efficiency, environmental conservation and economic viability.

ESTABLISHING A METHODOLOGICAL BASIS TO GUIDE IMPLEMENTATION AND MONITORING

Beyond assessing seven farms, this study establishes an integrated methodology for analyzing coffee-system performance from different perspectives and provides an initial **evidence** base generated under **real implementation** conditions.

This evidence can support farmers, rural extension and technical-assistance services, cooperatives and traders in defining sustainability programs, strategies, investments and incentive mechanisms that are better aligned with the diverse realities of coffee production.

At the same time, the study reinforces that knowledge-building on regenerative coffee farming should be understood as a continuous process. As new farms, producing regions and production systems are incorporated, the knowledge base can be expanded, indicators refined and the impacts of the transition better understood over time.

ANALYZING REAL CASES ACROSS DIFFERENT PRODUCTION CONTEXTS

- **Seven Arabica coffee farms** located in South of Minas and Cerrado Mineiro.
- **Diverse profiles and production conditions:** from family farming to business-managed farms, flat and mountainous areas, and systems with and without mechanization and irrigation.
- **Farm selection:** farmers with experience implementing one or more regenerative coffee farming practices.
- **Standardized data-collection protocol** combining remote assessments and technical field visits.
- **Reference plots** on neighboring farms representing similar soil, climate and terrain conditions.
- **Three analytical dimensions:** economic, agronomic and environmental.



KEY EVIDENCE GENERATED BY THE STUDY

ECONOMIC COMPETITIVENESS

- **Different regenerative strategies can be economically competitive.** All farms had operating costs below the CONAB benchmark for Minas Gerais in 2025 (BRL 768.80 per 60-kg bag), ranging from BRL 488.41 to BRL 745.61 per bag.
- **Economic resilience varies according to production context and market access,** including differentiated prices and premiums. All farms were profitable under the average-price scenario, while two recorded negative margins under the low-price scenario, indicating different levels of resilience to market fluctuations.
- **There is no single cost structure for regenerative systems.** The analysis of costs by management practice shows differences between mechanized and predominantly manual systems, with harvesting representing the largest operating-cost component in both groups (32–37%). On mechanized farms, investment in soil fertilization practices (mineral fertilizers and organic nutrient sources) represented an average of 28%; in manual systems, it represented 9%, ranging from 3% to 12%. The full analysis is available in the “Economic Perspective” section of the complete study.

AGRONOMIC RESILIENCE

- **The greatest potential for improvement lies below the surface.** Corrected soils with good fertility at depth support greater root volume and deeper rooting, expanding the soil profile explored by the plant and improving the uptake of water and nutrients. This increases resilience to drought and other adverse conditions. Although the evaluated soils generally showed good conditions in the surface layer (0–20 cm), the results indicate important opportunities to build fertility in deeper layers.

- **Biological indicators obtained through BioAS complement chemical and physical analyses**, broadening soil-health diagnosis and supporting management decisions. The study shows that good chemical fertility alone does not necessarily correspond to a healthy soil with high biological activity.

Soil biological analysis results using the BioAS methodology in plots under regenerative management

Overall average of the 7 farms	FERTBIO Soil Quality Index (SQI)	Biological SQI	Chemical SQI	Nutrients		
				Cycling	Storage	Supply
Canopy projection	0.73	0.59	0.80	0.59	0.78	0.82
Inter-row	0.78	0.65	0.84	0.65	0.85	0.83
Plot (average)	0.75	0.62	0.82	0.62	0.81	0.83

CLASS	Very low	Low	Medium	High	Very high
RANGE	0 to 0.20	0.21 to 0.40	0.41 to 0.60	0.61 to 0.80	0.81 to 1.00

- **Metagenomic analyses can contribute to assessing the effects of management practices on soil microbiota when repeated in the same area over time.** Differences in soil, climate and management conditions among study areas resulted in distinct microbial communities, preventing direct attribution to the practices adopted. Although metagenomics remains relatively inaccessible in coffee farming because of its cost, it has strong potential for applied research and monitoring of regenerative systems.



ENVIRONMENTAL PERFORMANCE

- **The systems assessed showed a favorable carbon balance.** Farms averaged 7.63 tCO₂e/ha in emissions and 85.08 tCO₂e/ha in removals, resulting in an average net balance of -77.5 tCO₂e/ha.
- **Efficient nitrogen use represents the main opportunity to reduce emissions.** Synthetic nitrogen fertilizers accounted for the largest share of emissions (46%), followed by agricultural-residue management (37%), indicating opportunities to improve nitrogen-use efficiency and expand practices such as composting.
- **Conserving native vegetation strengthens farms' climate performance.** Each hectare of coffee cultivated was associated, on average, with 18 tonnes of carbon stored in adjacent native-vegetation areas, reinforcing their importance and contribution to the environmental and climate performance of the systems. This also illustrates a distinctive feature of Brazilian environmental legislation⁵, which links important conservation areas to agricultural production areas.

NOVEL CONTRIBUTIONS TO THE IMPLEMENTATION OF REGENERATIVE COFFEE FARMING IN BRAZIL

- **A concept and set of practices harmonized** across the coffee sector and organized into 7 Elements;
- **A methodology for analyzing production systems** based on economic, agronomic and environmental indicators;
- **A database for monitoring** different management strategies and local conditions over time; and
- **Evidence generated from real cases** with active farmer participation.

5. Brazilian Forest Code (Law No. 12,651/2012), including the preservation of Permanent Preservation Areas (APP) and Legal Reserves (RL).

POTENTIAL PATHWAYS AND OPPORTUNITIES FOR PROGRESS

This study establishes an initial evidence base and an integrated methodology that can support new learning cycles and the continued evolution of regenerative coffee farming in Brazil. Opportunities identified include:

- **Expand and monitor the evidence base:** new monitoring cycles on reference farms, incorporating different regions, production systems and farmer profiles, can help understand the evolution of indicators and the effectiveness of practices over time.
- **Refine the methodology and indicators:** new evidence can help validate and refine indicators, incorporate additional assessment parameters and strengthen monitoring of the 7 Elements under different production conditions.
- **Turn evidence into implementation:** the findings can inform technical assistance, training, pilot projects and sustainability programs, supporting more precise recommendations adapted to each farm's conditions while also considering the economic viability of practices.
- **Strengthen Collective Action and the climate agenda:** the evidence base can support alignment among farmers, cooperatives, companies, research and extension organizations, while helping guide investments and incentive mechanisms related to the economic, agronomic and climate benefits of regenerative coffee farming.

More than a snapshot of the farms assessed, the study offers a replicable methodology and an initial evidence base that can evolve as new knowledge is generated, supporting decisions on the implementation of regenerative coffee farming in Brazil.



Context

Extreme weather events, such as prolonged droughts, concentrated heavy rainfall, hail and temperature fluctuations, are among the main challenges reported by coffee farmers. The **Living Income** study conducted by GCP Brazil in Minas Gerais and Espírito Santo in 2023 highlighted that these events have affected productivity in different ways, directly impacting farmers' income. In a second survey conducted in 2024 with 188 farmers in Minas Gerais and Espírito Santo, 88% identified these challenges as the main causes of reduced productivity.

In response, farmers have sought strategies to make their production systems more resilient, aiming to minimize and even prevent impacts. These include practices designed to improve soil fertility and structure at depth, supporting greater root volume and deeper rooting, expanding the soil profile explored and access to water and nutrients. Such measures contribute not only to maintaining crop productivity, but also to farm profitability and the ability of farming families to remain in rural areas.

In this context, **regenerative coffee** farming has gained prominence in discussions and initiatives around the world as an approach capable of combining productivity, climate resilience and natural-resource conservation. It is based on practices that protect soil life, promote biodiversity, support water conservation, increase carbon stocks and strengthen ecosystem services. However, there is no single model for regenerative production: the same practice may be implemented in different ways and at different costs depending on terrain, soil type, climate, infrastructure and each farmer's profile.

Although interest in regenerative coffee farming has grown rapidly, recent studies⁶ on its costs and outcomes have often aggregated findings at national level or focused on a single archetypal model. Integrated evidence from real and variable production conditions remains limited. To contribute to this discussion and address this knowledge gap, GCP Brazil facilitated a collaborative process between 2024 and

6. See, for example: "Global Coffee Industry: Regenerative Coffee Investment Case"; "Can farmers close the living income gap by adopting advanced farm management practices through investing more labour time and financial resources?"; and "Benchmarking Coffee Production Climate Risk".

7. The Brazil Working Group, part of GCP Brazil's governance, comprises more than 20 coffee-sector institutions. Its recurring meetings facilitate technical discussions and contribute to proposing solutions to key challenges facing the coffee sector.



Field day in Divinolândia, Minas Gerais (February 2024), one stage in the process of harmonizing regenerative coffee farming concepts and practices.



Meeting in Campinas, São Paulo (April 2025), a stage that contributed to defining regenerative coffee farming indicators.

2025 through the Brazil Working Group⁷ involving more than 30 coffee-sector organizations as well as researchers, farmers and specialists. This work resulted in a shared concept of regenerative coffee farming and the harmonization of practices and indicators organized into the **7 Elements** (Figure 1).

Regenerative Coffee Farming – Brazil Definition

A production system in which implemented practices increase crop resilience and adaptation to the effects of climate change by promoting soil health, crop productivity, carbon stocks, water conservation and biodiversity, safeguarding ecosystem services and contributing to farmers' prosperity and social well-being.

In parallel, the Brazilian process connected with the global alignment⁸ that consolidated Regenerative Coffee Farming (RegenCoffee) as a holistic, outcome-oriented approach aimed at strengthening resilience and profitability while restoring natural resources in coffee systems.

8. The global definition, objectives, principles and expected outcomes of regenerative coffee farming are anchored in the **Coffee Sustainability Reference Code**.

As part of this effort, GCP Brazil developed this study to expand the knowledge base on the effects of regenerative coffee farming from **economic, agronomic** and **environmental** perspectives. This report therefore presents an analysis of seven farms located in South of Minas and Cerrado Mineiro regions, given that each is at a different stage in the adoption of regenerative practices.

Rather than representing a single production model, these systems provide different examples of how the transition towards more resilient and sustainable coffee farming is taking place under real field conditions.

The findings and conclusions of this study are based on a limited sample and are not statistically representative. They should therefore not be used to generalize coffee farming conditions at regional or national level.



Figure 1: 7 Elements for the Implementation of Regenerative Coffee Farming in Brazil.



Scope

The study assessed Arabica coffee production systems adopting regenerative management practices, using comparative analyses with neighboring reference areas and regional indicators where applicable. The analyses were conducted from three complementary perspectives:

Economic: assessment of operating costs associated with the management of practices such as soil cover, efficient fertilizer use, biological control and fertigation, among others.

Agronomic: assessment of indicators related to the chemical, physical and biological attributes of the soil.

Environmental: estimation of greenhouse-gas (GHG) emissions and removals from the farms studied, associated with cultivation and post-harvest stages, using the Cool Farm Tool. Analyses were conducted by **Fundação Solidaridad**, enabling assessment of the carbon balance.



Participating Farms

FARM PROFILES

Seven Arabica coffee farms in South of Minas and Cerrado Mineiro were studied, representing different production profiles ranging from family farming to business-managed operations. The group includes farms of different sizes, in flat and mountainous areas, with and without mechanization and irrigation, reflecting part of the diversity of coffee-production systems in Minas Gerais. Table 1

summarizes the main characteristics of the farms studied.

Farmers were selected because they already adopted one or more regenerative coffee farming practices. On each farm, a regenerative plot was defined as the main assessment unit. Reference plots were also selected on neighboring farms with similar soil, climate and terrain characteristics. These plots do not necessarily represent conventional systems or systems opposed to regenerative management; rather, they provide a basis for comparison for part of the analyses.

Group	Region	Total & coffee-cultivated areas		Mechanization & Irrigation		Profile
7 coffee farms	6 South of Minas	3 >100 ha Total area	2 >100 ha Coffee area	3 Non-mechanized	5 Non-irrigated	4 Business-managed
			1 50-100 ha Coffee area			
		1 50-100 ha Total area	1 20-50 ha Coffee area	4 Mechanized	2 Irrigated	3 Family-managed
		2 20-50 ha Total area	3 <20 ha Coffee area			
	1 Cerrado Mineiro	1 <20 ha Total area				

Table 1: Profile of the seven farms included in the study. Source: Authors' own elaboration based on data collected from the participating farms (2025).

In addition to cultivated areas, Farms 1 and 4 included native-vegetation areas for laboratory soil analyses. From the environmental perspective, Legal Reserve and Permanent Preservation Areas across all seven farms were considered for carbon-stock estimates.

Group 1: Predominantly Mechanized Farms

Farms 1, 4, 6 and 7 comprise this group, with their plots characterized in Table 2. In general, they have higher technology levels, more developed infrastructure, mechanized operations and greater use of agricultural inputs. Two of them, Farms 4 and 6, use fertigation systems with a focus on efficient water use.

CHARACTERIZATION OF PRODUCTION SYSTEMS

The seven participating farms represent different production profiles, soil and terrain conditions, technology levels and management strategies, reflecting the diversity of contexts in which practices associated with regenerative coffee farming are being implemented in Brazil. Despite their differences, all adopt practices aligned with the 7 Elements.

To facilitate interpretation of the results, farms were organized into two groups according to the predominant type of field operation: predominantly **mechanized** farms and farms predominantly reliant on **manual labor**.



Despite these common characteristics, each system has followed its own pathway in adopting regenerative practices. Farms 1 and 4 have a well-established history of sustainability initiatives, socio-environmental certifications and practices such as permanent soil cover and bio-input use. Farm 1 has used leonardite-based organic acids for approximately 20 years and more recently introduced microorganisms into the production system. Farm 4 is distinguished by the integration of tree and shrub species such as *Inga* spp., *Senna* spp. and *Cordia verbenacea* in alleys established within the coffee area.



Farm 6 represents a more recent transition supported by specialized technical assistance, which led to changes such as integrating biological and chemical products, using cover crops and fertigation, accompanied by a substantial increase in productivity in recent years. Farm 7 represents a less complex mechanized system based on continuous use of organomineral fertilizers, coffee husks and cattle manure, combined with soil-cover maintenance and lower spraying intensity.

Overall, mechanized systems showed greater input use and a higher frequency of management operations throughout the production cycle. They combine regenerative practices with conventional production technologies, demonstrating that the two can be complementary.

Group 2: Farms Predominantly Reliant on Manual Labor

Farms 2, 3 and 5 represent production systems typical of mountainous regions, where manual or semi-mechanized operations predominate. Compared with mechanized systems, they use external inputs and agrochemicals less intensively. The plots assessed within this group are characterized in Table 3.

Farms 2 and 3 are smaller-scale family systems where the adoption of regenerative practices has intensified more recently. Key strategies include small-scale, artisanal production of biofertilizers, reduced agrochemical use, cover crops and permanent soil cover.



Farm 5 represents a well-established, larger-scale model under family management, with a long history of socio-environmental certifications and sustainability-oriented practices. Nutrient management has relied on organic compost since the 1990s, later replaced by organomineral fertilizers approximately 20 years ago. Since then, the farm has systematically monitored soil indicators to adjust management and sustain a minimum viable production level.

Taken together, systems predominantly reliant on manual labor demonstrate that regenerative practices can be adopted on farms of different scales and adapted to local conditions, resource availability and each farmer's management strategy.

The diversity of production profiles, management approaches and stages of regenerative-practice adoption among participating farms reinforces that there is no single transition model for regenerative coffee farming. Together, these systems provide a sound basis for interpreting the evidence presented below across the economic, agronomic and environmental dimensions.



FARM	1	4	6	7
Plot area	8.9 ha	20 ha	4.5 ha	2.4 ha
Planting year	2011	2002	2020	1992
Variety	Catuai Amarelo 62	Topázio	Catuai 24137	Catuai Vermelho
Spacing	3.5 x 0.7 m	3.6 x 0.6 m	3.7 x 0.6 m	3.7 x 0.6 m
Productivity	45 60-kg bags/ha	50 60-kg bags/ha	53 60-kg bags/ha	43 60-kg bags/ha
Predominant regenerative practices	- Maintenance of soil cover (spontaneous vegetation) - Use of organic nutrient sources - Application of organic acids - Use of bio-inputs	- Maintenance of soil cover (cover crops) - Use of bio-inputs - Efficient water use (irrigation) - Integration of diverse species and vegetation layers	- Maintenance of soil cover (cover crops) - Soil conservation - Efficient water use (irrigation)	- Maintenance of soil cover (spontaneous vegetation) - Use of organic nutrient sources - Use of organomineral fertilizers
Adoption period	5 years	10 years	4-5 years	20 years

Table 2: Characterization of production systems with predominantly mechanized operations. Source: Authors' own elaboration based on data collected from the participating farms (2025)

FARM	2	3	5
Plot area	0.3 ha	1.7 ha	8.5 ha
Planting year	2019	2000	1988
Variety	Catuai Amarelo 2SL	Catuai Amarelo 2SL	Catuai 144
Spacing	2.7 x 0.6 m	2.5 x 0.5 m	3.0 x 2.0 m
Productivity	53 60-kg bags/ha	34 60-kg bags/ha	37 60-kg bags/ha
Predominant regenerative practices	- Maintenance of soil cover (cover crops) - Production and use of biofertilizers - Use of biocomplexed urea	- Maintenance of soil cover (cover crops) - Production and use of biofertilizers - Use of biocomplexed urea - Management with reduced agrochemical use	- Soil conservation - Use of organic nutrient sources - Use of organomineral fertilizers
Adoption period	3-4 years	3-4 years	20 years

Table 3: Characterization of production systems predominantly reliant on manual labor. Source: Authors' own elaboration based on data collected from the participating farms (2025).

Brief Description of Practices

Soil-cover management:

Maintaining plants or plant residues on the soil surface to protect against erosion, conserve moisture and support soil life.

Use of organic nutrient sources:

Applying organic materials such as compost, manure or plant residues to supply nutrients and increase soil organic matter.

Use of bio-inputs:

Applying biologically derived products, such as microorganisms and natural extracts, to support plant nutrition, development and protection.

Production and use of biofertilizers:

Producing and applying liquid fertilizers obtained through fermentation of organic materials and microorganisms to complement plant nutrition.

Use of organomineral fertilizers:

Applying fertilizers that combine mineral nutrients and organic matter, improving fertilization efficiency and soil characteristics.

Application of organic acids:

Using organic substances that stimulate root development, improve nutrient availability and support soil biological activity.

Soil conservation:

A set of practices designed to reduce erosion, increase water infiltration and preserve soil structure and fertility.

Use of biocomplexed urea:

Using urea with additives designed to reduce nitrogen losses and improve fertilization efficiency.

Management with reduced agrochemical use:

Lower dependence on agrochemicals and synthetic fertilizers, prioritizing lower-impact alternatives.

Efficient irrigation-water use:

Planning and managing irrigation based on measurements to supply water in the right amount and at the right time, reducing waste.





Study Design & Conduct

Conducted between June and October 2025 under the coordination of GCP Brazil, the study comprised an initial remote information-collection stage followed by technical visits to the farms, during which data were validated and complemented together with farmers. The work covered economic, agronomic and environmental aspects, including greenhouse-gas emissions and removals.

During field visits, soil penetration resistance and soil moisture were measured, and soil and leaf samples were collected for laboratory analyses. Table 4 presents the

assessment protocol adopted for the study plots.

Economic analyses covered one complete production cycle corresponding to the crop harvested in 2025, including labor, input use, fuel and other operating costs for each plot. Costs were organized by management practice, allowing their share of each production system's operating-cost structure to be assessed.

For comparison, reference costs published by CONAB for the 2024/2025 crop year were used. System profitability was



Leaf sampling



Soil sampling



also assessed under different coffee-price scenarios constructed from the historical series published by the Brazilian Confederation of Agriculture and Livestock (CNA) between October 2011 and April 2024.

Environmental analyses were based on a structured questionnaire developed jointly with the technical team of Fundação Solidaridad's Coffee Program in Brazil. The information was processed by Solidaridad using Cool Farm Tool version 3.1.0 to estimate the carbon balance of the systems studied.

The methodology was structured to allow periodic updates and monitoring of indicator trends over time, contributing to continuous evidence generation on the implementation of regenerative coffee farming.

To ensure confidentiality, all data were collected with participants' consent, anonymized and stored in a secure environment in accordance with Brazil's General Data Protection Law (LGPD).

TYPE OF ANALYSIS	SAMPLING POINT	DEPTH	PURPOSE
Soil chemical analysis			
Macro- and micronutrients Sulfur (S), aluminum (Al), total carbon (C), total nitrogen (N), C/N ratio	Canopy projection and coffee inter-row	0-20 cm / 20-40 cm / 40-60 cm / 60-80 cm	Soil fertility
Soil physical analysis	Canopy projection and coffee inter-row	0-20 cm / 20-40 cm / 40-60 cm / 60-80 cm	Texture, compaction and moisture
Soil biological analysis: BioAS and metagenomics	Canopy projection and coffee inter-row	0-10 cm	Presence of beneficial and pathogenic microorganisms associated with the crop
Complete leaf tissue analysis			Macro- and micronutrient status in coffee plants

Table 4: Integrated soil and plant assessment protocol covering chemical, physical and biological attributes at different sampling depths. Source: Authors' own elaboration.

A close-up photograph of a hand holding a clump of dark, rich soil. Several red coffee cherries are visible, some still attached to green stems. The background is a blurred green field.

Evidence Generated by the Study

The results presented below represent evidence generated from the analysis of the seven participating farms and should be interpreted in light of their respective characteristics and the evolving nature of the methodology. The study was designed as an ongoing initiative for knowledge generation and refinement of regenerative coffee farming indicators. As new analyses, monitoring cycles and farms are incorporated, the evidence contained in this publication is expected to expand and deepen.

The evidence is organized into three complementary perspectives – economic, agronomic and environmental – reflecting the integrated approach adopted to understand the implementation of regenerative coffee farming under real production conditions.

More than a one-off study, this publication represents the first structured evidence base within a continuous process of collective learning and monitoring of regenerative coffee farming in Brazil.

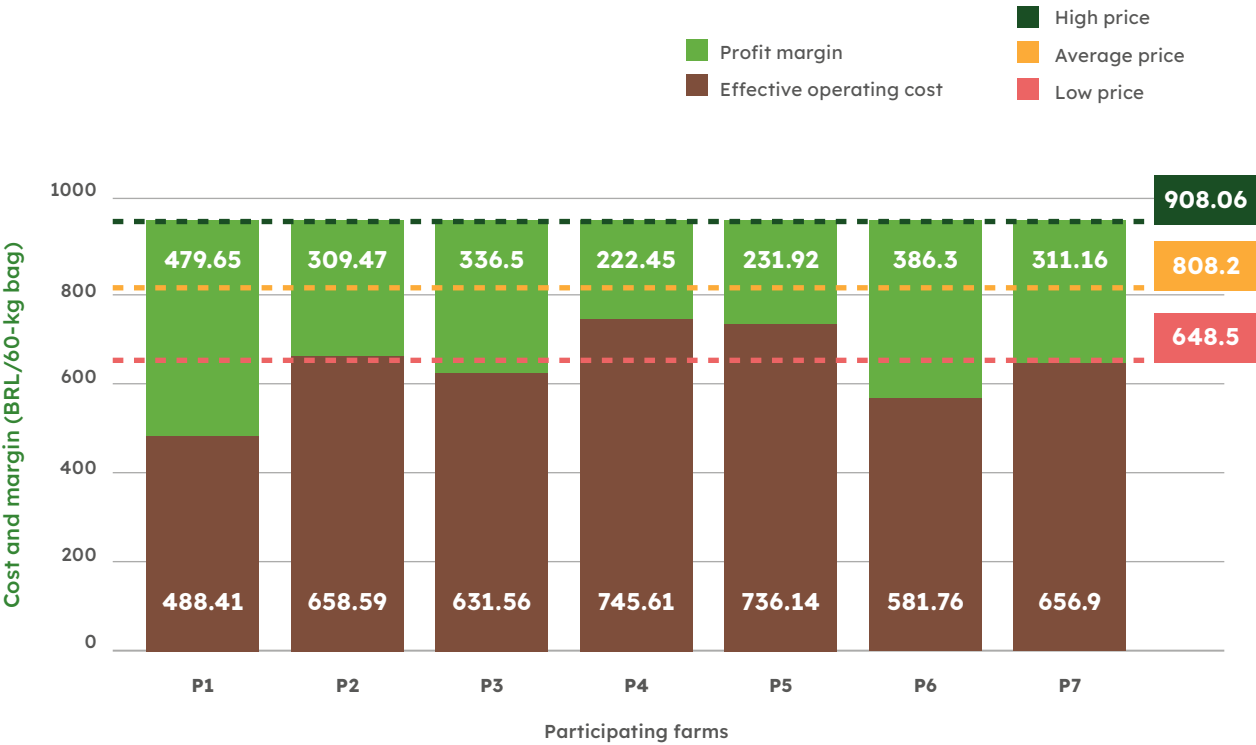
ECONOMIC PERSPECTIVE

All systems assessed recorded operating costs below the CONAB average for Minas Gerais in March 2025, indicating sound economic performance regardless of production profile.

The results also show that different management strategies can result in competitive systems when operating costs and observed productivity levels are considered together, both on mechanized farms and on farms predominantly reliant on manual labor. Effective operating costs ranged from BRL 488.41 per 60-kg bag on Farm 1 to BRL 745.61 on Farm 4, excluding interest, fees, depreciation and present value. In all cases, costs remained below the CONAB estimate of BRL 768.80 per

60-kg bag. Farm 1, in addition to having the lowest operating cost, also showed the greatest intensity and diversity of bio-input use among the farms assessed.

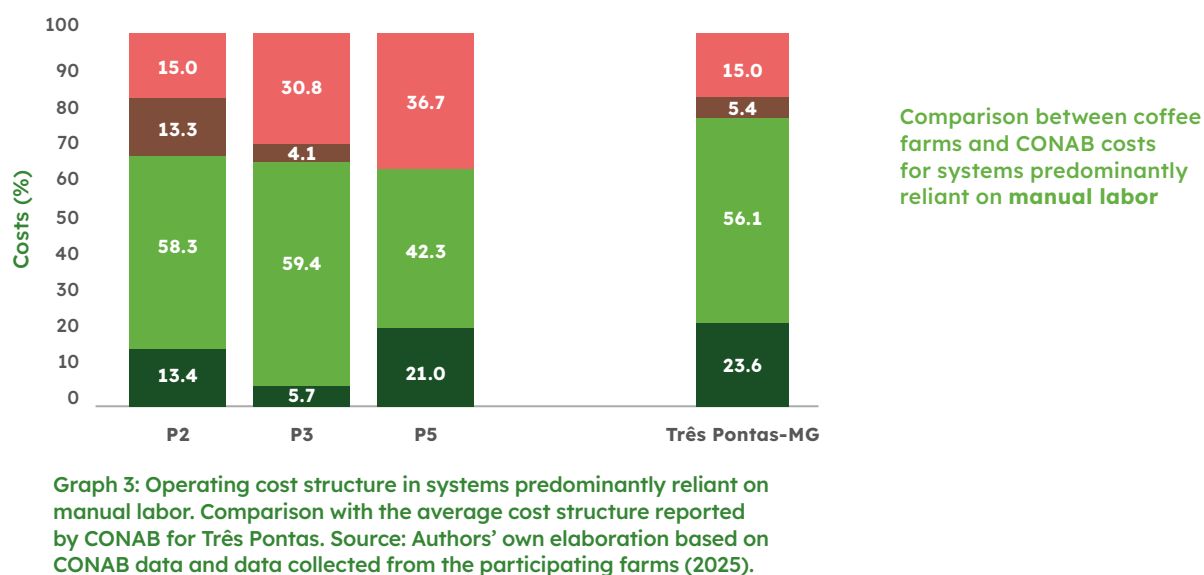
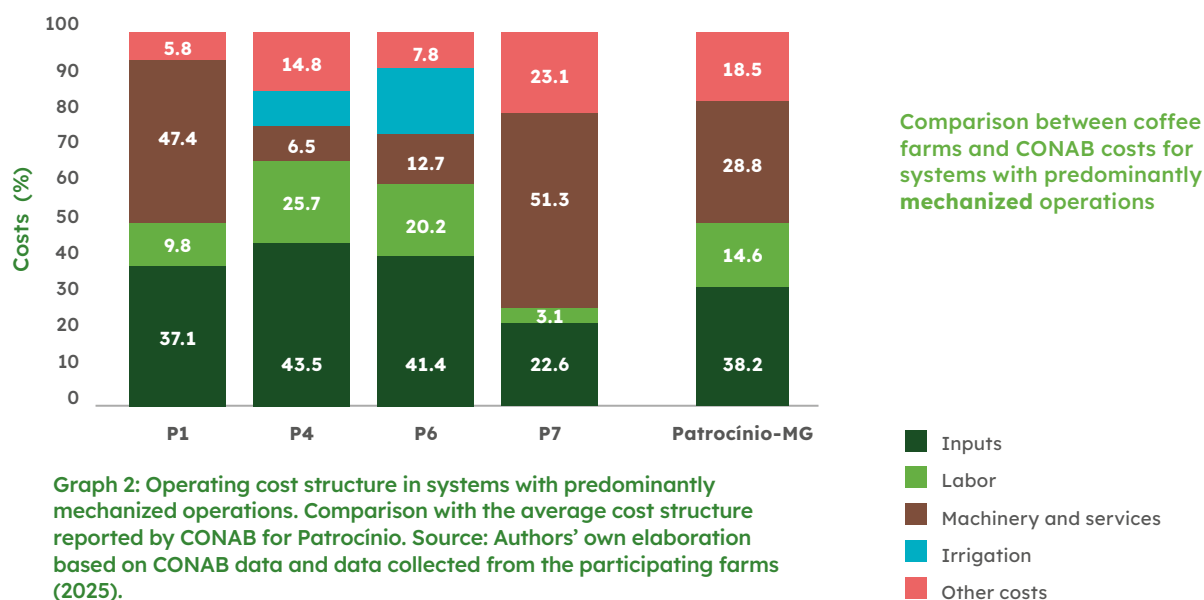
To assess profitability, three coffee-price scenarios – low, average and high – were considered based on CNA’s historical series from October 2011 to April 2024. Under the average-price scenario, all farms were profitable (Graph 1), with Farms 1 and 6 recording margins of 39.6% and 28.0%, respectively. Under the low-price scenario, Farms 4 and 5 showed greater economic vulnerability, with profitability of -15.0% and -1.3%), indicating lower capacity to absorb sharp declines in coffee prices.



Graph 1: Effective operating cost and profit margin per 60-kg bag of coffee. Source: Authors’ own elaboration based on CNA data (2011–2014) and data collected from the participating farms (2025).

The operating-cost structures observed on participating farms were similar to CONAB benchmarks for production systems with comparable characteristics. Predominantly mechanized systems were closer to the profile of Patrocínio, Minas Gerais (Graph 2), while predominantly manual systems were more similar to Três

Pontas, Minas Gerais (Graph 3). Patrocínio is characterized by business management, semi-dense planting, mechanization and a high technology level; Três Pontas is characterized by family management, semi-dense planting, semi-mechanization and a high technology level.



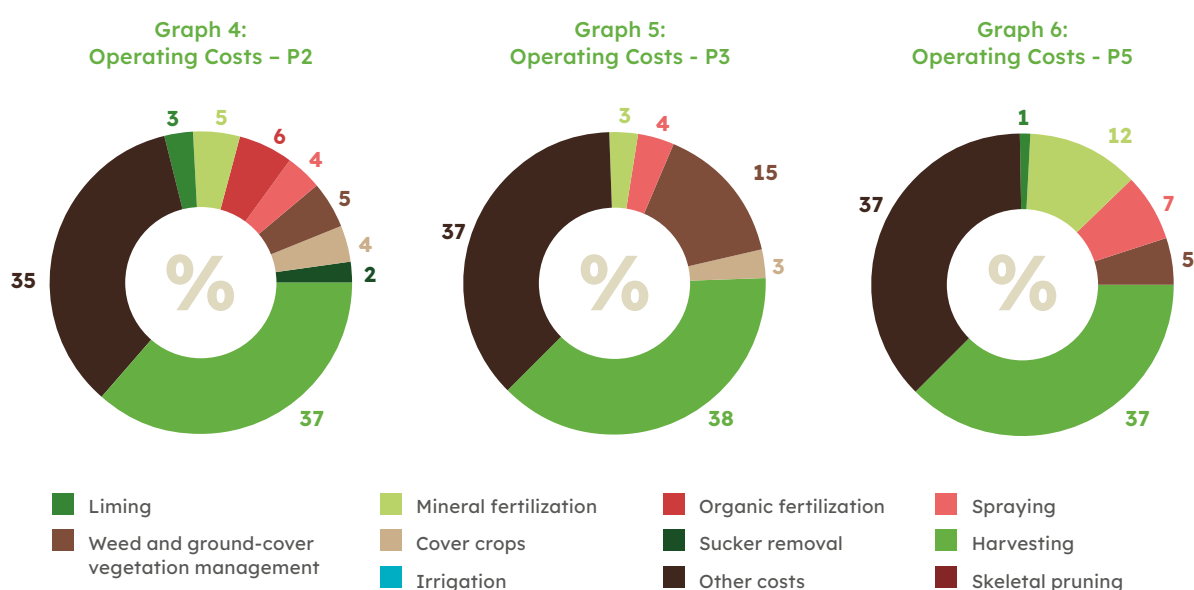
On mechanized farms, inputs accounted for a larger relative share of operating costs. Farms 1 and 7 had the highest shares of machinery and services expenses (47.4% and 51.3%, respectively), while Farms 4 and 6 had the highest shares of input costs (43.5% and 41.4%), associated with irrigation costs of 9.5% and 17.9%, respectively. By contrast, labor predominated on Farms 2, 3 and 5, representing 58.3%, 59.4% and 42.3% of operating costs, respectively, consistent with systems located in mountainous regions with lower levels of mechanization.

Analysis of operating costs by management practice shows that harvesting is the main operation, accounting on average for approximately 37% of costs in predominantly manual areas (Graphs 4, 5 and 6) and 32% in mechanized areas (Graphs 7, 8, 9 and 10). Fertilization costs differed markedly between groups. On predominantly manual farms, fertilization

represented 3–12% of operating costs, while on mechanized farms it averaged 28%, including fertigation costs on Farms 4 and 6.

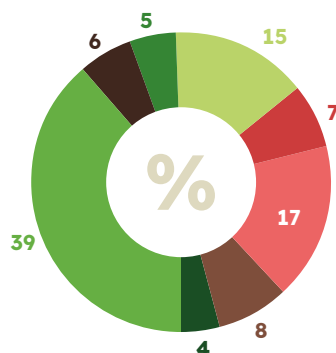
Spraying for plant nutrition and pest and disease control using biological and/or chemical products represented an average of 16% of operating costs on mechanized farms, although on Farm 7 the share was only 2%. On farms predominantly reliant on manual labor, spraying represented approximately 5% of operating costs. Liming was recorded on five farms, accounting for 1–5% of operating costs.

Weed and ground-cover vegetation management ranged from 2% to 15%, including manual or mechanized mowing, hoeing and herbicide application. Establishment and management of cover crops were observed on three farms and represented an average of 4.5% of operating costs.

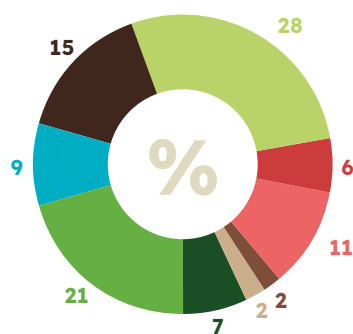


Graphs 4, 5 and 6: Operating costs by management practice in systems predominantly reliant on manual labor.
Source: Authors' own elaboration based on data collected from the participating farms (2025).

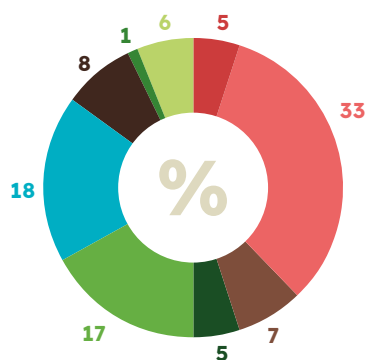
Graph 7:
Operating Costs - P1



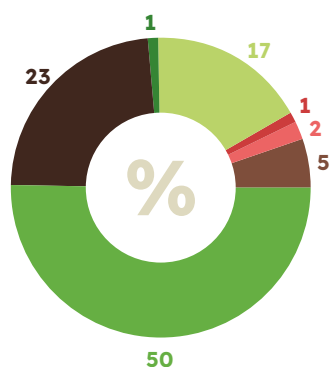
Graph 8:
Operating Costs - P4



Graph 9:
Operating Costs - P6



Graph 10:
Operating Costs - P7



- Mineral fertilization
- Cover crops
- Irrigation
- Organic fertilization
- Sucker removal
- Other costs
- Spraying
- Harvesting
- Skeletal pruning
- Liming
- Weed and ground-cover vegetation management

Graphs 7, 8, 9 and 10: Operating costs by management practice in systems with predominantly mechanized operations. Source: Authors' own elaboration based on data collected from the participating farms (2025).

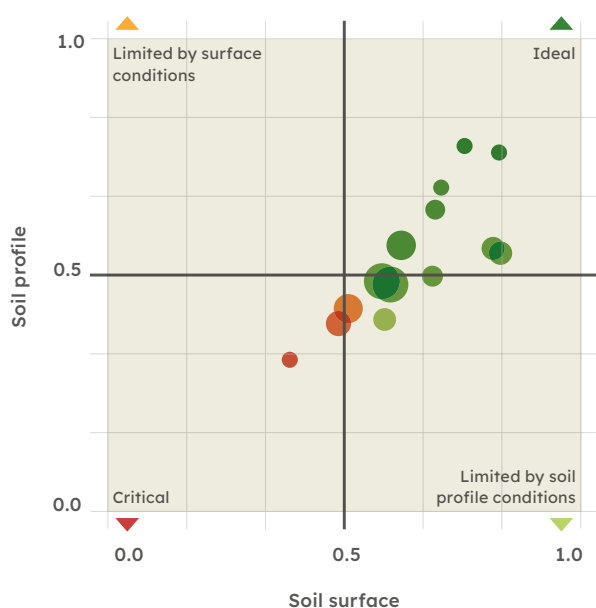


AGRONOMIC PERSPECTIVE

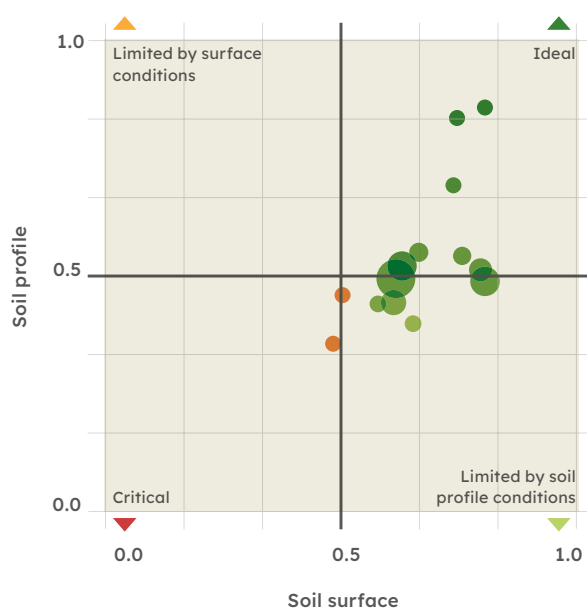
Chemical, physical and biological analyses show that the soils assessed generally had good nutritional conditions in the surface layer (0–20 cm), but important limitations to root development between 20 and 80 cm. This pattern occurred in both regenerative and reference plots, indicating that improving conditions throughout the soil profile is one of the main opportunities to increase production-system efficiency. Full laboratory results by farm are presented in the Annexes.

Graphs 11 and 12 show the distribution of regenerative and reference plots according to the average adequacy of nutrients at the surface and throughout the soil profile. In both groups, points are concentrated in the quadrant corresponding to adequate surface fertility, showing that although the 0–20 cm layer generally has good chemical conditions, nutritional limitations persist in deeper layers.

Graph 11:
Soil profile in plots under
regenerative management



Graph 12:
Soil profile in
reference plots

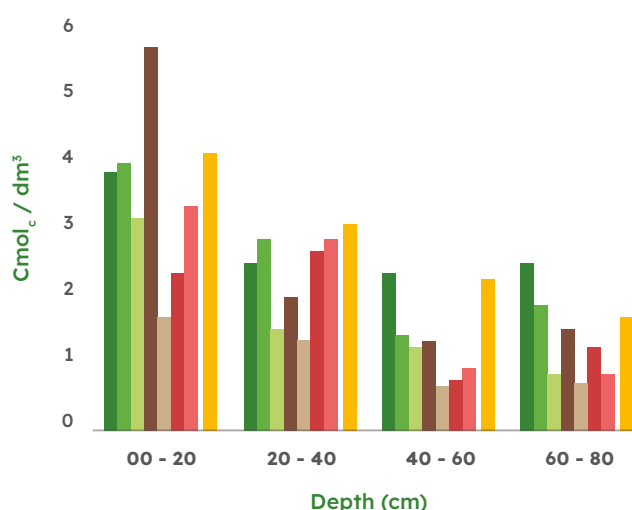


Graphs 11 and 12: Distribution of regenerative plots (left) and reference plots (right) according to nutrient adequacy in the surface layer (0–20 cm) and throughout the soil profile (20–80 cm). Source: Authors' own elaboration based on laboratory analysis results (3R Ribersolo) from the participating farms (2025).

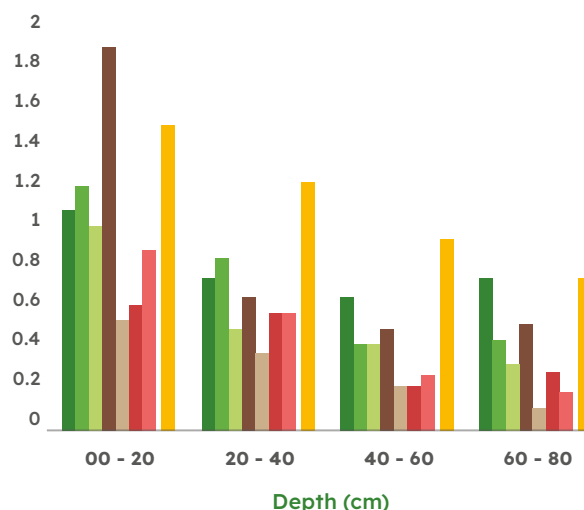
Key limiting factors included imbalances in calcium (Ca) and magnesium (Mg), particularly below 20 cm. Graphs 13 and 14 show the distribution of these nutrients in plots under regenerative management, based on samples collected within the coffee canopy projection. Farms 1, 2 and 4 showed higher adequacy levels in the surface layer, possibly associated with liming practices. However, nutrient

levels declined substantially with depth, especially magnesium, indicating the need for strategies to correct the soil profile. The balance of calcium, magnesium and potassium in cation exchange capacity (CEC), using a reference ratio of 50:15:5 (Ca:Mg:K), is important for root development, nutrient uptake, photosynthesis and fruit formation.

Graph 13:
Ca levels in plots under regenerative management – coffee canopy



Graph 14:
Mg levels in plots under regenerative management – coffee canopy



Graphs 13 and 14: Ca (left) and Mg (right) levels in plots under regenerative management. Source: Authors' own elaboration based on laboratory analysis results (3R Ribersolo) from the participating farms (2025).

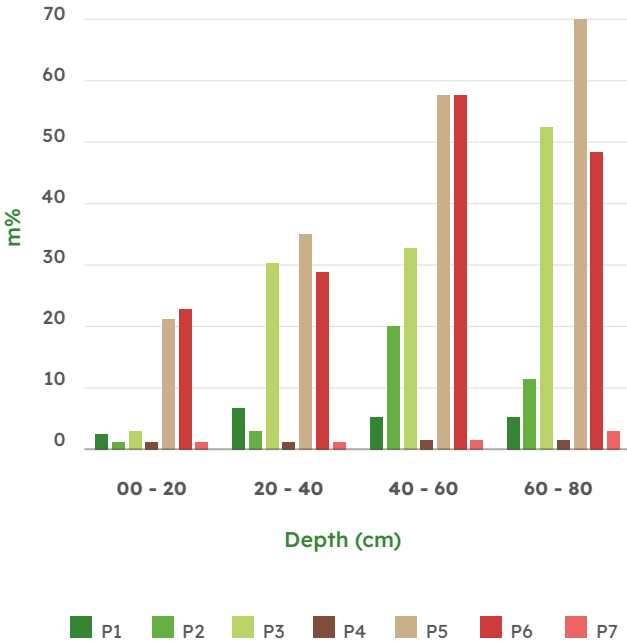
Among the micronutrients assessed, only boron (B) repeatedly showed adequate levels in regenerative and reference plots. Frequent deficiencies of manganese (Mn), zinc (Zn), copper (Cu) and iron (Fe) were observed, indicating the need for

adjustments in nutrient management. These micronutrients play essential roles in enzyme activation, hormonal regulation, photosynthesis, defense mechanisms and bean formation.

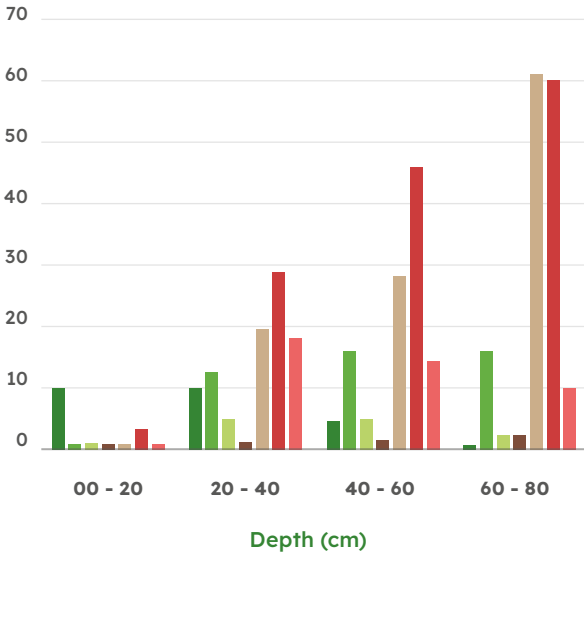
Another limiting factor was high aluminum saturation at depth. Using values below 20% as the reference, Farms 3, 5 and 6 showed the highest saturation levels, mainly below 20 cm. This condition represents

an important chemical constraint to root growth, limiting root exploration of the soil profile and reducing water and nutrient uptake.

Graph 15:
Aluminum saturation (m%) in plots under regenerative management – coffee canopy



Graph 16:
Aluminum saturation (m%) in reference plots – coffee canopy

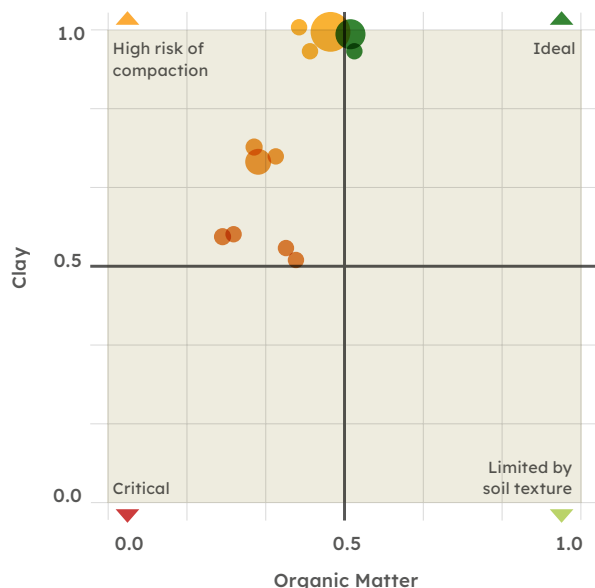


Graphs 15 and 16: Aluminum saturation (m%) in plots under regenerative management (left) and reference plots (right), within the coffee canopy projection. Source: Authors' own elaboration based on laboratory analysis results (3R Ribersolo) from the participating farms (2025).

Analysis of soil physical structure, particularly the relationship between clay and organic-matter content, indicates high susceptibility to compaction. Soils with higher clay content and low organic matter tend to face greater risk of compaction, lower structural stability and reduced water

infiltration and retention. Combined with the chemical constraints observed in the profile, these factors can limit root-system depth and compromise crop resilience during periods of water deficit. The findings therefore reinforce the importance of practices that increase soil organic matter.

Graph 17:
Estimated water retention in plots
under regenerative management



Graph 18:
Estimated water retention in
reference plots



Graphs 17 and 18: Distribution of plots under regenerative management (left) and reference plots (right) according to clay and organic matter content. Source: 3R Ribersolo (2025), based on laboratory results from the participating farms.

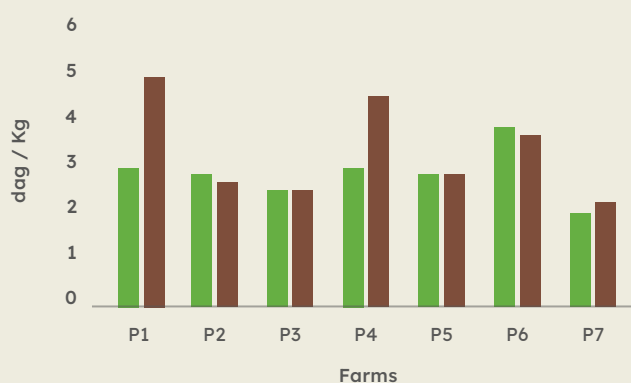
Practices such as maintaining soil cover and using organic nutrient sources were observed in the regenerative systems assessed.

On Farms 1 and 4, the effects of these practices may be reflected in higher organic-matter levels in the inter-row area than beneath the coffee canopy. Both farms maintain soil cover through managed spontaneous vegetation (Farm 1) or cover crops (Farm 4), in addition to

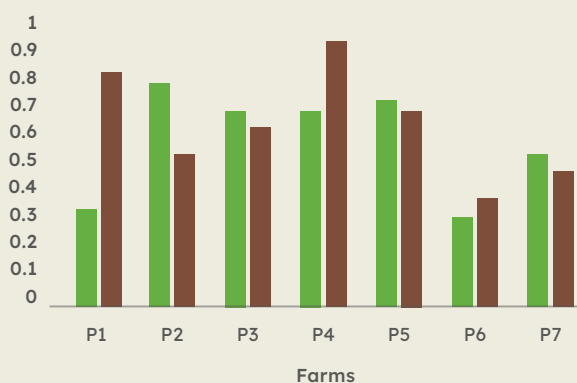
using organic nutrient sources such as manure and bio-inputs. These areas also recorded the highest Soil Biological Quality Index (Biological SQI) values were obtained using the BioAS methodology (Embrapa), indicating greater biological activity and nutrient cycling (Graph 20). Overall, BioAS analyses showed a predominance of soils classified as having medium (0.41–0.60) or high (0.61–0.80) biological activity (Graph 20).



Graph 19:
Soil organic matter content in the 0–10 cm layer – plots under regenerative management



Graph 20:
Biological Soil Quality Index (BioAS) – plots under regenerative management



■ Canopy projection ■ Inter-row

Graphs 19 and 20: Soil organic matter content (left) and Biological Soil Quality Index (right) in plots under regenerative management. Source: Authors' own elaboration based on laboratory analysis results (3R Ribersolo) from the participating farms (2025).

In the regenerative management area of Farm 6, both beneath the canopy and between rows, results indicated soils with a high Chemical Quality Index, related to nutrient storage and supply, but low biological activity and nutrient cycling (Biological Quality Index between 0.21 and 0.40). The same situation was observed beneath the coffee canopy on Farm 1 and

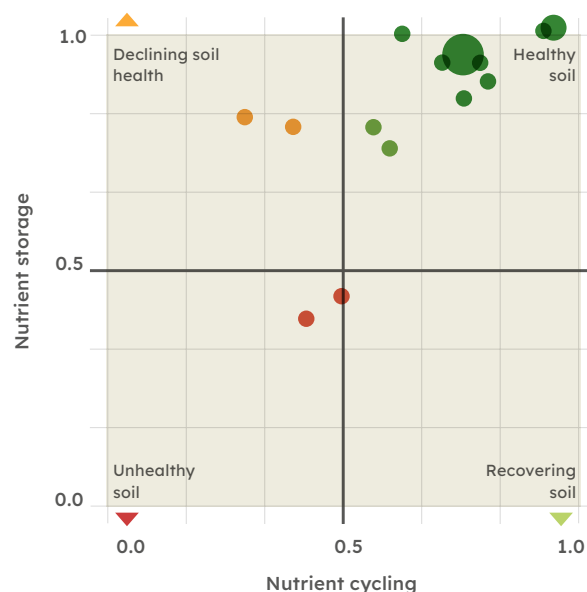
in the inter-row area on Farm 7. These findings show that biological indicators broaden soil diagnosis and contribute to more efficient planning of management strategies. Graphs 21 and 22 show the distribution of regenerative and reference plots according to the Biological SQI, with values above 0.61 considered biologically healthy soils.



Graph 21:
Biological Soil Quality Index - Biological SQI
(BioAS methodology) in plots under
regenerative management



Graph 22:
Biological Soil Quality Index - Biological SQI
(BioAS methodology) in reference plots

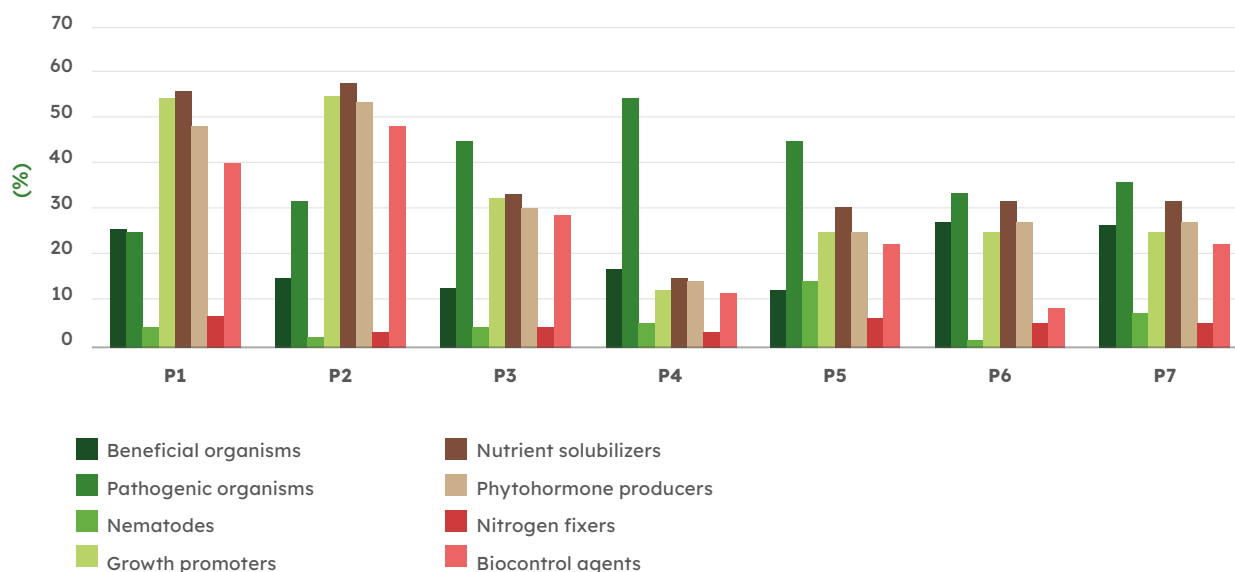


Graphs 21 and 22: Distribution of plots under regenerative management (left) and reference plots (right) according to BioAS analysis results (Embrapa). Source: 3R Ribersolo (2025), based on laboratory results from the participating farms.

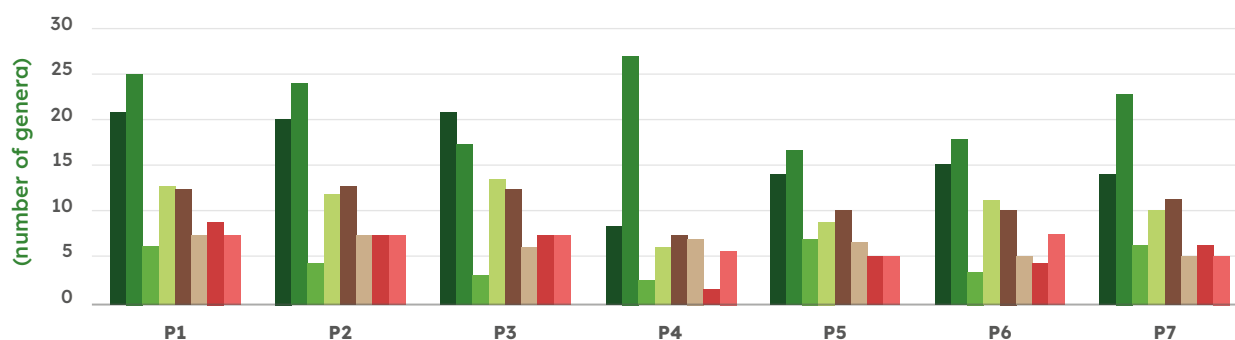
Metagenomic analyses showed differences in microbial-community composition among the systems assessed. Regenerative plots on Farms 1, 6 and 7 showed a higher relative abundance of organisms considered beneficial. On Farm 6, only *Bacillus* spp. was used for biological control. No microorganisms were applied on Farm 7, suggesting that other environmental and management factors may also influence soil-microbiota composition.

Regenerative plots on Farms 1 and 2 showed a higher relative abundance of organisms associated with nutrient solubilization, biocontrol, growth promotion and phytohormone production. By contrast, Farms 3, 4 and 5 showed a predominance of organisms classified as potentially pathogenic.

Graph 23:
Relative abundance of microorganisms and nematodes in plots under regenerative management – soil microbiota analysis (metagenomics)



Graph 24:
Diversity of microorganisms and nematodes in plots under regenerative management – metagenomic analysis



Graphs 23 and 24: Relative abundance and diversity of microorganisms and nematodes in plots under regenerative management. Source: Authors' own elaboration based on laboratory analysis results (ByMyCell) from the participating farms (2025).

Overall, a greater diversity of genera classified as pathogenic than beneficial was observed (Graph 24). However, compared with reference plots, *Trichoderma* and *Bacillus* were identified more frequently in regenerative areas. These fungi and bacteria, respectively, are commonly used in coffee farming for pest and disease protection and nutrient solubilization. Among plant-pathogenic nematodes,

Meloidogyne showed higher relative abundance in regenerative plots on Farms 2 and 7 and may represent a productivity constraint. *Pratylenchus* was more frequent in reference plots on Farms 5, 6 and 7. Other nematode genera identified, although considered pathogenic, are of lower agronomic relevance.

ENVIRONMENTAL PERSPECTIVE

The seven farms analyzed had average emissions of 7.63 tCO₂e/ha and average removals of -85.08 tCO₂e/ha, resulting in an average net balance of -77.46 tCO₂e/ha. In other words, the group showed a favorable environmental balance, with removals exceeding emissions in most cases.

Farm 3 strongly influenced the group average, reaching estimated removals of --453.00 tCO₂e/ha (Graph 5), associated with the specific characteristics of its production system, which includes approximately 200 trees per hectare distributed along borders and in alleys and currently at an early stage of growth.

NET CARBON BALANCE

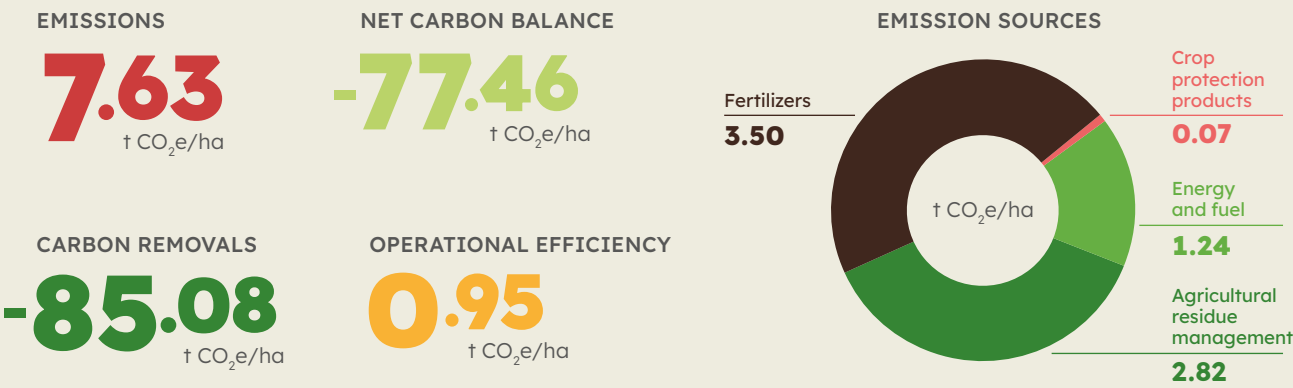


Figure 2: Summary of carbon balance results for the farms assessed. Source: Fundação Solidaridad (2025), based on analyses conducted on the participating farms using the Cool Farm Tool.



Farm	Production Scale	Emissions (tCO ₂ e/ha)	Carbon Removals (tCO ₂ e/ha)	Net Carbon Balance (tCO ₂ e/ha)	Operational Efficiency (tCO ₂ e/t of coffee cherry)
1	Large	5.33	-10.82	-5.49	0.85
2		9.60	-66.40	-56.80	0.85
3	Medium	10.00	-453.00	-443	1.00
4		9.62	-11.36	-1.74	0.95
5	Small	5.38	-36.64	-31.26	1.07
6		4.03	-7.03	-3.00	0.66
7		9.48	-10.68	-1.20	1.29
Average		7.63	-85.08	-77.46	0.95

Table 5. Emissions, carbon removals, net carbon balance and operational efficiency by farm, grouped by production scale. Source: Fundação Solidaridad (2025), based on analyses conducted on the participating farms using the Cool Farm Tool.

The analysis showed that the main sources of greenhouse-gas emissions were synthetic nitrogen fertilizers, accounting for 46% of total emissions, and agricultural-residue management, accounting for 37%, including coffee husks, leaves, pruning residues and wood produced during the coffee life cycle.

These findings are consistent with the study on Carbon Balance in Minas Gerais Coffee Farming with Good Agricultural Practices and GHG Balance promoted by the Brazilian Coffee Exporters Council⁹ (Cecafé), reinforcing the importance of nitrogen-fertilizer management and organic-residue management as priority strategies for reducing GHG emissions in coffee farming. The results highlight the importance of

more efficient and optimized nitrogen-fertilizer use and improved organic-residue management, including composting, to reduce emissions and improve nutrient use.

Maintaining soil cover represents, across all farms assessed, a practice with potential to contribute to climate-change mitigation. By supporting the capture of atmospheric carbon, it can act as a natural sink and contribute to greater production-system stability. Each management strategy, however, has its own characteristics, similarities and differences.

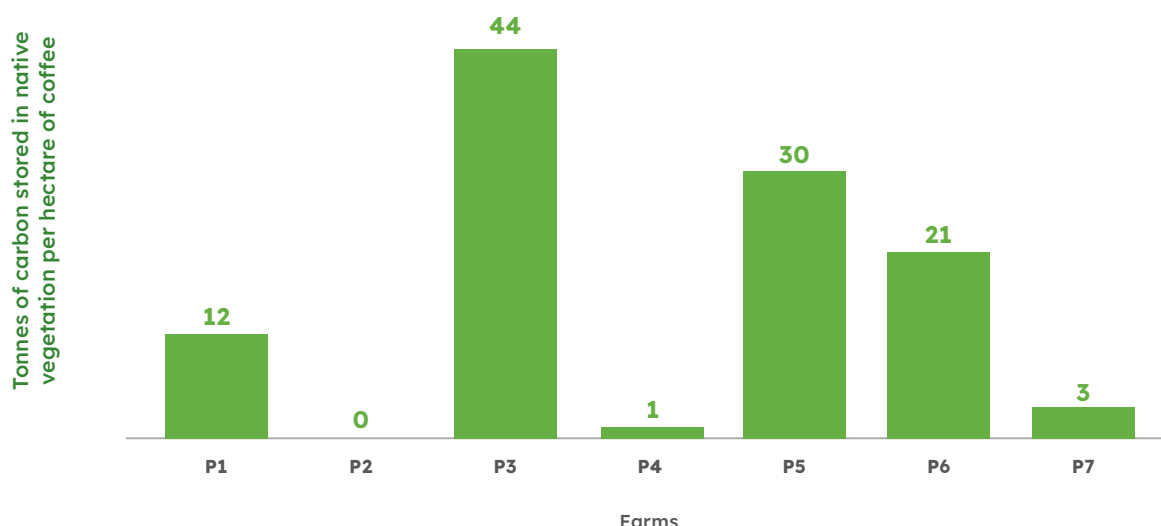
Under the methodology used by the Cool Farm Tool, it is not possible to differentiate the relative contribution of different

9. Study conducted by Cecafé with participating member exporters, in collaboration with the Educampo Project (Sebrae-MG), under the technical and scientific leadership of the Institute for Forest and Agricultural Management and Certification (Imaflora) and Professor Carlos Eduardo Cerri, Luiz de Queiroz College of Agriculture, University of São Paulo (ESALQ/USP).

types of soil cover, whether managed spontaneous vegetation, *Brachiaria* spp. or seed mixtures.

The relationship between greenhouse-gas emissions and coffee production is an important indicator of a production system's environmental performance. The average of 0.95 tCO₂e per tonne of coffee cherry indicates that emissions were below one tonne of CO₂e for each tonne of coffee produced, suggesting a relatively balanced level of efficiency between productivity and climate impact. This indicator is useful for understanding the performance of practices adopted on the farms and informing their adoption by other farmers, helping reduce emissions without compromising coffee productivity and farmer income.

To broaden understanding of impacts at landscape scale, carbon stocks in native-vegetation areas – Permanent Preservation Areas and Legal Reserves – were also estimated. Because the Cool Farm Tool assesses only the carbon balance of productive coffee areas, the carbon-stock factor from Brazil's Greenhouse Gas Emissions and Removals Estimation System (SEEG) for the Atlantic Forest in Minas Gerais (64.73 tC/ha) was used as a reference. Based on Rural Environmental Registry (CAR) information, each hectare of cultivated coffee was estimated to be associated, on average, with 18 tonnes of carbon stored in forest areas. This relationship is presented in Graph 25.



Graph 25: Carbon stock in native vegetation associated with each hectare of cultivated coffee. Note: Farm 2 does not have its Legal Reserve registered under the same Rural Environmental Registry (CAR) as the coffee production area; the Legal Reserve requirement is offset on another farm. Source: Fundação Solidaridad (2025), based on Rural Environmental Registry (CAR) data and data collected from the participating farms (2025).



Conclusions

REGENERATIVE COFFEE FARMING CAN BE IMPLEMENTED ACROSS DIFFERENT PRODUCTION CONTEXTS

The results demonstrate that regenerative coffee farming can be implemented across different production scales, socioeconomic contexts and technology levels. Both mechanized farms and predominantly manual systems adopted strategies aimed at improving soil quality, increasing functional biodiversity and strengthening production resilience.

However, practices were adopted differently on each farm, reflecting differences in terrain, labor availability, investment



capacity and historical trajectories. The evidence reinforces that the transition to regenerative coffee farming does not follow a single model, but rather an evolving pathway adapted to the characteristics of each production system.

“(...) I have always kept costs within what I can realistically afford (...), not ‘buying it because it is needed’ (...) I know it is needed, and I will assess whether it is viable for me to access it.”

Statement by one of the farmers participating in the study during discussions of the results.

SOIL HEALTH IS THE FOUNDATION OF THE REGENERATIVE TRANSITION

The analyses showed that the main opportunity for improving the systems assessed lies in building soil health at depth. Although most farms had good fertility in the surface layer (0–20 cm), important limitations were identified between 20 and 80 cm, related to acidity, aluminum saturation and imbalances among calcium, magnesium and potassium. These factors constrain root development, water access and crop resilience to extreme weather events.

The findings also demonstrated the importance of deeper soil analyses, moving beyond the traditional 0–20 cm layer to 20–40 cm, 40–60 cm and, where appropriate, down to 80 cm, as well as integrating chemical, physical and biological attributes to inform decision-making. Practices such as the use of organic composts and organomineral fertilizers, manure, coffee husks and maintenance of soil cover showed potential to increase organic matter, improve soil structure and support carbon accumulation, reinforcing the principles of Elements 1, 2 and 3 related to soil fertility, organic matter and physical soil conservation.



“I have to bring this soil to life; it has to be transformed. Then I started adding microorganisms. It was no longer only about the plant, but about the system (...) why? So that the system is occupied by living microorganisms and brings more and more benefits.”

Statement by one of the farmers participating in the study during discussions of the results.

Although the protocol adopted in this study may involve additional costs, particularly for smallholders, applying it through farmer groups or sustainability programs represents a viable alternative for monitoring indicators, tracking system evolution and supporting implementation of regenerative coffee farming.

ADVANCED DIAGNOSTIC TOOLS IMPROVE THE QUALITY OF DECISION- MAKING

Biological analyses showed that good chemical-fertility levels alone do not guarantee biologically active and functional soils. In some cases, areas with adequate nutrient supply showed low biological activity, indicating lower efficiency in nutrient cycling and availability. This reinforces the importance of integrating chemical, physical and biological indicators in soil diagnosis and monitoring.

Likewise, metagenomic analysis showed potential to support more precise management strategies by identifying beneficial and pathogenic organisms, informing bio-input use and cover-crop species selection, and contributing to integrated pest and disease management. However, the technology remains relatively inaccessible because of its cost and complexity and is still recent in coffee

farming. Even so, it has strong potential for monitoring regenerative systems. When repeated in the same area over time, metagenomic analyses can further contribute to assessing the effects of management practices on soil microbiota.

“(...) we can monitor it and build a really good piece of work around this. We can measure it (...) and eventually adopt it as a strategy for the farm as a whole.”

Statement by one of the farmers participating in the study during discussions of the results.

INTEGRATING REGENERATIVE PRACTICES ENHANCES ENVIRONMENTAL BENEFITS

Environmental results indicated that the systems assessed have potential to contribute positively to the carbon balance when different regenerative practices are adopted in an integrated manner. Maintaining soil cover, using organic



nutrient sources, managing bio-inputs and, especially, intentionally integrating tree species into production systems showed potential to increase carbon sequestration and strengthen biodiversity.

The farm that integrated tree species into its production system showed a substantial increase in carbon sequestration, illustrating the potential of more biodiverse systems to enhance the environmental benefits of coffee farming. Likewise, conserving Permanent Preservation Areas and Legal Reserves proved strategic for maintaining important carbon stocks and expanding ecosystem services at landscape level. This evidence strengthens the principles of Element 5, related to environmental conservation and ecosystem services.

“When we started moving in this direction, one of our workers, who was born on the farm, said: before we used to remove the weeds; now we fertilize them.

I don’t understand what is happening. And that shows how difficult it is (...). It is a major paradigm shift, even for our workers to understand what we were doing.”

Statement by one of the farmers participating in the study during discussions of the results.

“(…) we have been struggling with drought and the climate (...); if you want a different result, you have to do something different.”

Statement by one of the farmers participating in the study during discussions of the results.



THE TRANSITION DEPENDS ON AN ENABLING ENVIRONMENT AND CONTINUOUS EVIDENCE GENERATION

Beyond agronomic and environmental aspects, the study showed that factors such as specialized technical assistance, farmer-to-farmer exchange, training and Collective Action play a decisive role in the adoption of regenerative practices.

Regardless of farm size or technology level, decision-making was strongly associated with technical support, indicator monitoring and the use of historical cost and productivity information.

“I went looking for technical advice (...), someone with experience (...) and then, in 2022, we were able to innovate the project.”

Statement by one of the farmers participating in the study during discussions of the results.

From an economic perspective, the systems assessed had operating costs below national benchmarks, demonstrating that regenerative practices can be compatible with competitive production systems when supported by appropriate

technical planning. The results also show that different production models – from family farming to highly mechanized business-managed farms – can incorporate regenerative practices without necessarily increasing operating costs.

“With the difficulty of finding workers, what did I do? I improved the houses and brought residents into them. Today the housing area is full (...) simply because I improved the housing.”

Statement by one of the farmers participating in the study during discussions of the results.

More than identifying specific practices, this study demonstrates that the transition to regenerative coffee farming depends on combining technical knowledge, continuous monitoring, collaboration among different stakeholders and evidence generation. Together, these factors strengthen Element 7 and create the basis for scaling implementation of the 7 Elements, guiding future updates of this study and consolidating a continuous process of collective learning towards increasingly resilient, competitive and sustainable coffee farming.



Next Steps

This study represents a continuous process of evidence generation to support the implementation of regenerative coffee farming in Brazil. Beyond characterizing seven farms, it establishes an integrated assessment methodology, an initial indicator base and a group of reference farms that can guide future research, technical assistance, monitoring and Collective Action.

CONSOLIDATE A NETWORK OF REFERENCE FARMS

Participating farms can be followed through new research cycles, allowing changes in economic, agronomic and environmental indicators to be observed over time. This monitoring can also inform technical discussions within the Brazil Working Group and support continuous improvement of the 7 Elements.

CONTINUOUSLY IMPROVE THE METHODOLOGY AND INDICATORS

The methodology developed in this study establishes a basis for monitoring implementation and can be continuously refined. New evidence will help validate and refine indicators, incorporate additional assessment parameters and strengthen the ability to monitor the evolution of the 7 Elements across different production systems.

TURN EVIDENCE INTO TECHNICAL ASSISTANCE AND IMPLEMENTATION

The evidence generated can support technical-assistance programs, training, pilot projects and dissemination initiatives with cooperatives, companies and their own sustainability programs.

The detailed assessment of costs associated with different regenerative practices provides a reference for evaluating management alternatives

in light of their economic viability, while agronomic analyses deepen understanding of interactions among soil, plants and microbiota. This can contribute to more precise technical recommendations adapted to each farm's conditions and reduce uncertainty related to practice adoption.

mechanisms and increase recognition of the benefits generated by regenerative practices. Brazilian environmental legislation, which requires the preservation of Permanent Preservation Areas and Legal Reserves, provides a distinctive framework that links production and conservation in a viable model.

STRENGTHEN SECTOR-WIDE COLLECTIVE ACTION

Scaling regenerative coffee farming depends on coordination among farmers, cooperatives, companies, research organizations, extension services and other sector partners. The study's findings can support sector alignment, the development of shared agendas and Collective Action aimed at consolidating the 7 Elements.

STRENGTHEN THE CLIMATE AGENDA OF BRAZILIAN COFFEE FARMING

The environmental findings reinforce the potential of Brazilian coffee farming to contribute strategically to climate-change mitigation. Monitoring cycles covering emissions, carbon removals and other environmental indicators can help guide investment, strengthen incentive

EXPAND KNOWLEDGE GENERATION

New study cycles can incorporate other regions, production systems and farmer profiles, broadening the representativeness of the evidence base built by the Global Coffee Platform in Brazil. This expansion will support a better understanding of the effectiveness of different practices under real production conditions and expand their application in sustainability programs, technical assistance and Collective Action. The study and its methodology may also serve as a reference for similar studies in other coffee-producing countries.

The study's greatest legacy lies not only in the results presented, but also in the creation of an integrated methodology that can be replicated, updated and expanded, and in the establishment of a national indicator base and a continuous evidence-generation process to inform decisions related to the implementation of regenerative coffee farming in Brazil – all designed to evolve as new evidence is generated.





Annexes



Annex I: Soil analyses in the surface layer (0–20 cm) within the coffee canopy projection in plots under regenerative management. Source: 3R Ribersolo.

Farm	P1		P2		P3		P4		P5		P6		P7	
Depth	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20
pH (CaCl ₂)	4.9	4.9	4.7	5.1	5.3	4.8	5.6	5.2	5.1	4.2	4.4	4.1	5.7	5.8
OM	30	26	28	26	24	24	31	31	27	18	39	34	20	18
P (Res)	129	111	54	36	15	11	315	160	27	16	33	15	14	3
K	0.57	0.43	0.97	1.18	0.93	0.49	0.38	0.32	0.5	0.3	0.41	0.47	0.33	0.24
Ca	4.9	3.8	3.5	3.9	4.3	3.1	6.6	5.4	6.3	1.6	4.3	2.4	4.6	3.5
Mg	1.3	1.1	1.1	1.2	1.4	1	2.4	1.9	1.6	0.5	1.1	0.6	1.1	0.9
H + Al	5.5	4.7	5.5	3.4	3.3	4	2.8	3.4	2.9	5.2	8	10.4	1.3	1.4
Al	0.11	0.14	0.19	0.06	0.05	0.2	0.09	0.08	0.07	0.67	0.46	1.02	0.06	0.05
S	0	46	0	11	0	11	0	46	0	13	0	68	0	4
SB	6.77	5.33	5.57	6.28	6.63	4.59	9.38	7.62	8.4	2.4	5.81	3.47	6.03	4.64
CEC	12.3	10	11.1	9.7	9.9	8.6	12.2	11	11.3	7.6	13.8	13.9	7.3	6
V%	55	53	50	65	67	53	77	69	74	32	42	25	83	77
m%	2	3	3	1	1	4	1	1	1	22	7	23	1	1
B	0	1.24	0	2.29	0	0.56	0	1.11	0	0.68	0	1.27	0	0.23
Cu	0	6.4	0	1.2	0	1.1	0	9.8	0	1.5	0	2.2	0	0.9
Fe	0	53	0	53	0	33	0	32	0	41	0	98	0	14
Mn	0	4.5	0	9	0	2.7	0	4	0	3.9	0	4.3	0	4.1
Zn	0	3.7	0	13	0	0.8	0	7.3	0	0.7	0	2.4	0	1.8
C/N	0	5.11	0	6.54	0	10	0	8.03	0	4.81	0	6.51	0	4.74
Ctotal	0	15	0	15	0	14	0	18	0	10	0	20	0	10
Ntot	0	2933	0	2295	0	1400	0	2241	0	2080	0	3070	0	2111
Ca%	40	38	32	40	43	36	54	49	56	21	31	17	63	58
Mg%	11	11	10	12	14	12	20	17	14	7	8	4	15	15
K%	4.63	4.3	8.7	12.2	9.4	5.7	3.11	2.91	4.42	3.95	2.97	3.38	4.52	4
Total sand	306	303	519	523	365	341	170	158	458	487	257	242	587	602
Coarse sand	232	217	358	364	154	143	98	81	313	337	195	182	385	400
Fine sand	74	86	161	159	211	198	72	77	145	150	62	60	202	202
Clay	585	551	322	304	462	454	658	637	447	412	649	679	351	356
Silt	109	146	159	173	173	205	172	205	95	101	94	79	62	42
Classification	Clay	Clay	Sandy clay loam	Sandy clay loam	Clay	Clay	Very clayey	Very clayey	Clay	Sandy clay	Very clayey	Very clayey	Sandy clay	Sandy clay

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex II: Soil analyses in the surface layer (0–20 cm) within the coffee canopy projection in reference plots. Source: 3R Ribersolo.

Farm	P1		P2		P3		P4		P5		P6		P7	
Depth	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20
pH (CaCl ₂)	4.2	4.4	5.8	5.1	4.5	4.7	5.8	5	5.3	4.9	4.8	4.6	5.2	5.4
OM	27	31	25	20	41	38	38	29	33	19	33	30	27	29
P (Res)	65	108	28	6	59	46	113	68	19	7	43	8	8	7
K	0.66	0.75	0.89	0.83	0.49	0.55	0.34	0.19	0.9	0.64	0.44	0.25	0.31	0.29
Ca	5.6	4	5.5	3.1	3.4	4.1	8.7	5.2	6.7	3.2	4.9	3.8	4.1	3.7
Mg	2.5	1.5	1.5	0.9	1.2	1.7	2.4	1.6	2.3	1.3	1.1	0.7	1.3	1.1
H + Al	8.8	8.4	2.1	2.8	9.8	7.5	2.2	3.3	2.2	2.6	6.1	5.8	3.1	2.6
Al	0.03	0.7	0.03	0.07	0.41	0.13	0.1	0.05	0.05	0.05	0.18	0.22	0.04	0.03
S	0	44	0	5	0	15	0	11	0	6	0	14	0	10
SB	8.76	6.25	7.89	4.83	5.09	6.35	11.44	6.99	9.9	5.14	6.44	4.75	5.71	5.09
CEC	17.6	14.7	10	7.6	14.9	13.9	13.6	10.3	12.1	7.7	12.5	10.6	8.8	7.7
V%	50	43	79	64	34	46	84	68	82	67	52	45	65	66
m%	0	10	0	1	7	2	1	1	1	1	3	4	1	1
B	0	1.27	0	0.33	0	1.63	0	0.99	0	0.42	0	1.5	0	0.7
Cu	0	3.4	0	0.7	0	2.5	0	10	0	0.9	0	2.9	0	1
Fe	0	72	0	36	0	88	0	40	0	38	0	105	0	40
Mn	0	27.9	0	3.9	0	5.2	0	3.5	0	4.6	0	4.4	0	3.2
Zn	0	2.2	0	1.4	0	15.9	0	8.7	0	1.2	0	1.2	0	3.4
C/N	0	6.74	0	6.42	0	7.33	0	7.55	0	6.56	0	5.83	0	8.36
Ctotal	0	18	0	12	0	22	0	17	0	11	0	17	0	17
Ntot	0	2669	0	1867	0	3002	0	2252	0	1678	0	2916	0	2034
Ca%	32	27	55	41	23	29	64	50	55	42	39	36	47	48
Mg%	14	10	15	12	8	12	18	16	19	17	9	7	15	14
K%	3.75	5.1	8.9	10.9	3.3	4	2.5	1.84	7.44	8.31	3.52	2.36	3.52	3.77
Total sand	242	322	494	466	240	247	98	80	404	415	304	310	263	318
Coarse sand	168	228	315	305	114	132	48	42	256	258	226	232	102	173
Fine sand	74	94	179	161	126	115	50	38	148	157	78	78	161	145
Clay	499	496	362	358	620	610	754	774	326	314	615	624	630	581
Silt	259	182	144	176	140	143	148	146	270	271	81	66	107	101
Classification	Clay	Clay	Sandy clay	Sandy clay	Very clayey	Very clayey	Very clayey	Very clayey	Sandy clay loam	Sandy clay loam	Very clayey	Very clayey	Very clayey	Clay

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex III: Soil analyses in the surface layer (0–20 cm) in the inter-row area of plots under regenerative management. Source: 3R Ribersolo.

Farm	P1		P2		P3		P4		P5		P6		P7	
Depth	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20
pH (CaCl ₂)	6.2	6.2	5.8	5.9	4.6	4.5	5.7	6	5.2	4.4	4.7	4.7	5.6	5.2
OM	50	36	26	28	24	22	46	32	27	18	38	39	22	18
P (Res)	161	85	30	28	14	9	193	73	47	12	18	14	14	4
K	0.39	0.42	1.17	1.1	0.23	0.15	0.6	0.44	0.4	0.14	0.48	0.32	0.2	0.16
Ca	11.6	9.3	6.2	6.1	3	2.7	9.6	6.5	5.6	1.8	4.7	5	5.6	4.1
Mg	2.5	2.5	1.4	1.6	0.7	0.5	2.8	1.9	1.4	0.5	1.3	1.3	1.2	1
H + Al	1.6	1.3	1.6	1.5	4.7	5.2	1.9	1.8	3.4	6.4	5	5.5	1.3	1.4
Al	0.04	0.05	0.04	0.03	0.31	0.51	0.1	0.09	0.07	0.93	0.09	0.08	0.07	0.05
S	0	12	0	5	0	11	0	8	0	9	0	8	0	4
SB	14.49	12.22	8.77	8.8	3.93	3.35	13	8.84	7.4	2.44	6.48	6.62	7	5.26
CEC	16.1	13.5	10.4	10.3	8.6	8.6	14.9	10.6	10.8	8.8	11.5	12.1	8.3	6.7
V%	90	91	84	85	46	39	87	83	69	28	56	55	84	79
m%	0	0	0	0	7	13	1	1	1	28	1	1	1	1
B	0	0.45	0	0.3	0	0.35	0	0.68	0	0.86	0	0.67	0	0.3
Cu	0	6	0	0.8	0	1	0	8	0	2.1	0	3.4	0	0.9
Fe	0	27	0	30	0	43	0	22	0	77	0	94	0	17
Mn	0	10.8	0	4.1	0	3.6	0	4.9	0	4.2	0	2.5	0	3.5
Zn	0	8.1	0	4.7	0	2.2	0	7.4	0	1	0	3	0	3.1
C/N	0	5.39	0	7.9	0	9.07	0	7.97	0	4.43	0	6.62	0	5.26
Ctotal	0	21	0	16	0	13	0	19	0	10	0	23	0	10
Ntot	0	3897	0	2025	0	1433	0	2384	0	2258	0	3476	0	1902
Ca%	72	69	60	59	35	31	64	61	52	20	41	41	67	61
Mg%	16	19	13	16	8	6	19	18	13	6	11	11	14	15
K%	2.42	3.11	11.3	10.7	2.7	1.7	4.03	4.15	3.7	1.59	4.17	2.64	2.41	2.39
Total sand	271	290	497	519	348	344	180	160	475	480	239	242	590	567
Coarse sand	197	212	308	355	154	149	104	86	334	335	179	190	391	372
Fine sand	74	78	189	164	194	195	76	74	141	145	60	52	199	195
Clay	547	540	348	320	457	437	604	646	429	430	673	689	354	355
Silt	182	170	155	161	195	219	216	194	96	90	88	69	56	78
Classification	Clay	Clay	Sandy clay	Sandy clay loam	Clay	Clay	Very clayey	Very clayey	Sandy clay	Sandy clay	Very clayey	Very clayey	Sandy clay	Sandy clay

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex IV: Soil analysis results in the surface layer (0–20 cm) in the inter-row area of reference plots.
Source: 3R Ribersolo.

Farm	P1		P2		P3		P4		P5		P6		P7	
Depth	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20	00-10	00-20
pH (CaCl ₂)	5.6	5.3	5.2	4.5	5.4	5.1	6.5	5.5	4.8	4.7	4.9	4.5	4.4	4.7
OM	29	24	26	22	56	41	38	31	32	21	35	34	29	29
P (Res)	44	14	9	5	22	23	81	46	4	8	15	12	9	6
K	0.32	0.46	0.54	0.33	0.4	0.32	0.27	0.2	0.29	0.15	0.31	0.25	0.28	0.2
Ca	10.4	4.3	3.1	2.1	7.6	5.2	10.5	6.2	6.4	4.1	4.3	4.3	3.7	3.4
Mg	2.2	1.9	1.1	0.7	3.1	2.1	2.5	1.9	1.8	1.1	1.4	1.3	1	0.8
H + Al	2.6	2.6	2.9	4.7	3.3	5	1.4	1.9	2.5	2.9	4.2	6.1	4	4
Al	0.04	0.01	0.08	0.34	0.06	0.05	0.09	0.05	0.04	0.07	0.05	0.23	0.07	0.06
S	0	8	0	10	0	7	0	4	0	9	0	15	0	13
SB	12.92	6.66	4.74	3.13	11.1	7.62	13.27	8.3	8.49	5.35	6.01	5.85	4.98	4.4
CEC	15.5	9.3	7.6	7.8	14.4	12.6	14.7	10.2	11	8.3	10.2	12	9	8.4
V%	83	72	62	40	77	60	90	81	77	64	59	49	55	52
m%	0	0	2	10	1	1	1	1	0	1	1	4	1	1
B	0	0.28	0	0.34	0	0.35	0	0.79	0	0.3	0	0.55	0	0.48
Cu	0	3.3	0	0.8	0	6.6	0	8.7	0	1.5	0	2.7	0	1.3
Fe	0	35	0	54	0	68	0	19	0	58	0	109	0	46
Mn	0	28.2	0	3.9	0	3.6	0	2.2	0	8.6	0	2.6	0	3.1
Zn	0	2.5	0	0.5	0	12.2	0	7.4	0	2.4	0	0.9	0	3.2
C/N	0	6.89	0	7.64	0	7.69	0	8.1	0	5.54	0	6.42	0	10.59
Ctotal	0	14	0	13	0	24	0	18	0	12	0	20	0	17
Ntot	0	2031	0	1701	0	3121	0	2223	0	2165	0	3113	0	1605
Ca%	67	46	41	27	53	41	71	61	58	49	42	36	41	40
Mg%	14	20	14	9	22	17	17	19	16	13	14	11	11	10
K%	2.06	4.95	7.1	4.2	2.8	2.5	1.84	1.96	2.64	1.81	3.04	2.08	3.11	2.38
Total sand	263	237	505	512	234	241	116	95	414	459	307	328	245	234
Coarse sand	164	228	312	347	131	135	51	42	269	305	232	252	100	103
Fine sand	99	9	193	165	103	106	65	53	145	154	75	76	145	131
Clay	492	408	331	349	560	602	614	649	328	294	624	610	641	667
Silt	245	355	164	139	206	157	270	256	258	247	69	62	114	99
Classification	Clay	Clay	Sandy clay loam	Sandy clay	Clay	Very clayey	Very clayey	Very clayey	Sandy clay loam	Sandy clay loam	Clay	Very clayey	Very clayey	Very clayey

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex V: Soil analysis results at depth (20–80 cm) within the coffee canopy projection in plots under regenerative management. Source: 3R Ribersolo.

Farm	P1			P2			P3			P4			P5			P6			P7		
Depth	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80
pH (CaCl ₂)	4.7	4.9	4.8	4.8	4.5	4.4	4.5	4.4	4.3	5.3	5.2	4.9	4.3	3.9	4.1	4.3	3.7	4	5.6	4.7	5.4
OM	23	18	17	21	16	15	15	13	12	20	15	14	16	14	14	25	19	16	14	11	9
P (Res)	49	38	23	20	6	6	4	3	2	5	2	1	7	6	7	12	5	5	8	5	4
K	0.33	0.3	0.27	0.71	0.53	0.58	0.25	0.11	0.1	0.18	0.16	0.2	0.24	0.15	0.11	0.37	0.29	0.29	0.31	0.26	0.22
Ca	2.5	2.3	2.4	2.9	1.4	1.7	1.3	1.2	0.7	2	1.3	1.3	1.2	0.7	0.5	1.8	0.8	1	2	1	0.6
Mg	0.7	0.6	0.7	0.8	0.4	0.4	0.4	0.4	0.3	0.6	0.5	0.5	0.3	0.2	0.1	0.5	0.2	0.3	0.5	0.3	0.2
H + Al	5.5	4.2	4.7	4.5	4.2	4.5	4.2	4.5	4.7	3.3	2.6	2.2	5.5	7.2	7.2	8.8	9.8	7.5	1.5	1.4	1.3
Al	0.25	0.21	0.22	0.14	0.58	0.35	0.85	0.83	1.23	0.07	0.07	0.02	0.92	1.42	1.7	1.01	1.71	1.41	0.04	0.04	0.04
S	46	60	73	21	76	139	30	31	43	131	185	186	24	49	68	78	127	101	3	10	26
SB	3.53	3.2	3.37	4.41	2.33	2.68	1.95	1.71	1.1	2.78	1.96	2	1.74	1.05	0.71	2.67	1.29	1.59	2.81	1.56	1.02
CEC	9	7.4	8.1	8.9	6.5	7.2	6.2	6.2	5.8	6.1	4.6	4.2	7.2	8.3	7.9	11.5	11.1	9.1	4.3	3	2.3
V%	39	43	42	50	36	37	31	28	19	46	43	48	24	13	9	23	12	17	65	52	44
m%	7	6	6	3	20	12	30	33	53	2	3	1	35	57	71	27	57	47	1	3	4
B	0.93	0.75	0.9	1.61	1.28	1.1	0.38	0.28	0.3	0.87	0.88	0.9	0.89	1	1.02	1.59	1.52	1.34	0.2	0.2	0.16
Cu	2.8	2	2.2	0.8	0.5	0.4	0.5	0.3	0.3	1.2	0.8	1	1.2	0.8	0.7	1.3	0.7	0.6	0.7	0.4	0.3
Fe	36	29	30	44	23	18	21	15	15	14	10	10	44	32	29	62	31	14	18	8	7
Mn	3.8	2	2	4.7	2.9	3.1	1.6	0.8	0.8	0.4	0.3	1.7	4.9	2.8	3.2	1.4	0.7	0.4	3	1	0.8
Zn	2	1.5	1.5	10.5	9.5	6.6	0.2	0	0.1	0.9	0.4	0.3	0.5	0.4	0.3	0.7	0.2	0.1	1	0.3	0.1
C/N	5.58	5.47	5.29	5.93	7.26	8.7	8.41	8.34	8.94	12.93	12.73	14.29	6.08	5.32	7.34	6.98	6.95	6.97	5.1	6.78	6.8
Ctotal	13	10	10	12	9	9	9	8	7	12	9	8	9	8	8	15	11	9	8	6	5
Ntot	2330	1827	1891	2025	1239	1034	1070	959	783	928	707	560	3387	1504	1090	2150	1582	1292	1570	885	735
Ca%	28	31	30	33	22	24	21	19	12	33	28	31	17	8	6	16	7	11	47	33	26
Mg%	8	8	9	9	6	6	6	6	5	10	11	12	4	2	1	4	2	3	12	10	9
K%	3.67	4.05	3.33	8	8.2	8.1	4	1.8	1.7	2.95	3.48	4.76	3.33	1.81	1.39	3.22	2.61	3.19	7.21	8.67	9.57
Total sand	280	261	250	479	435	417	326	310	317	133	125	130	447	412	428	216	197	207	509	484	616
Coarse sand	204	198	181	315	283	285	139	135	136	73	64	66	302	295	300	157	144	147	314	299	418
Fine sand	76	63	69	164	152	132	187	175	181	60	61	64	145	117	128	59	53	60	195	185	198
Clay	579	577	600	345	372	418	468	480	515	716	799	756	442	504	475	703	742	742	371	412	429
Silt	141	162	150	176	193	165	206	210	168	151	76	114	111	84	97	81	61	51	120	104	0
Classification	Clay	Clay	Clay	Sandy clay	Sandy clay loam	Clay	Clay	Clay	Clay	Very clayey	Very clayey	Very clayey	Clay	Clay	Clay	Very clayey	Very clayey	Very clayey	Sandy clay	Sandy clay	Sandy clay

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex VI: Soil analysis results at depth (20–80 cm) within the coffee canopy projection in reference plots.
Source: 3R Ribersolo.

Farm	P1			P2			P3			P4			P5			P6			P7		
Depth	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80
pH (CaCl ₂)	4.2	4.6	4.7	4.5	4.6	4.6	4.6	4.6	4.7	5.2	4.8	5	4.4	4.2	4.2	4.2	3.9	4	4.1	4.4	4.8
OM	22	23	20	17	13	12	37	33	29	18	14	13	10	8	6	28	24	21	21	18	14
P (Res)	32	11	12	5	2	2	24	24	28	4	1	1	5	5	15	4	7	6	5	4	4
K	0.76	0.63	0.63	0.55	0.41	0.33	0.38	0.4	0.35	0.16	0.12	0.1	0.47	0.39	0.22	0.24	0.13	0.08	0.31	0.19	0.12
Ca	4.1	4	3.2	1.4	1.1	0.9	3	2.6	2.9	2.3	1.4	1.1	1.4	0.8	0.4	1.8	1.5	1.1	0.8	0.6	0.3
Mg	1.4	1.4	1.3	0.5	0.4	0.4	1.3	1.1	1.3	0.6	0.4	0.4	0.8	0.7	0.3	0.3	0.3	0.2	0.3	0.2	0.1
H + Al	9.3	5	4.7	4.5	3.1	3.3	6.4	6.8	5.5	3.1	2.8	2.6	3.1	2.6	3.3	9.8	10.4	12.8	4.2	3.4	2.6
Al	0.72	0.34	0.03	0.37	0.37	0.3	0.26	0.26	0.16	0.05	0.06	0.05	0.62	0.75	1.41	0.94	1.56	2.03	0.29	0.17	0.06
S	55	58	35	15	28	39	29	44	50	41	93	81	13	12	14	55	77	80	50	44	31
SB	6.26	6.03	5.13	2.45	1.91	1.63	4.68	4.1	4.55	3.06	1.92	1.6	2.67	1.89	0.92	2.34	1.93	1.38	1.41	0.99	0.52
CEC	15.6	11	9.8	7	5	4.9	11.1	10.9	10.1	6.2	4.7	4.2	5.8	4.5	4.2	12.1	12.3	14.2	5.6	4.4	3.1
V%	40	55	52	35	38	33	42	38	45	49	41	38	46	42	22	19	16	10	25	23	17
m%	10	5	1	13	16	16	5	6	3	2	3	3	19	28	61	29	45	60	17	15	10
B	1.21	0.89	0.8	0.35	0.32	0.29	1.37	1.24	1.5	0.91	1.04	1.24	0.25	0.29	0.3	1.36	1.24	1.1	1.08	1.03	0.74
Cu	2.6	1.7	1.6	0.6	0.4	1.3	1.3	1.1	1.3	1.3	0.8	0.6	0.5	0.4	0.3	1.8	1.4	1	0.7	0.5	0.3
Fe	53	26	38	31	17	13	52	53	51	15	11	7	22	8	12	66	45	30	26	16	7
Mn	38	21.2	18.3	1.9	0.9	z1	2.7	2.1	2.6	0.4	0.3	0.1	2.7	0.8	1.3	1.4	1.1	0.8	0.9	0.5	0.3
Zn	1.5	1	1.4	1.2	0.3	0.1	10.3	8.8	8.9	0.7	0.4	0.2	0.3	0.1	0.2	0.4	0.2	0.1	0.6	0.2	0.1
C/N	7.72	9.15	9.02	7.72	8.16	8.09	10.29	9.6	8.48	9.79	11.68	10.68	5.52	6.5	8.62	8.33	8.5	8.65	7.55	7.54	8.02
Ctotal	13	13	12	10	8	7	22	19	17	10	8	8	6	5	3	16	14	12	12	10	8
Ntot	1684	1420	1331	1296	980	865	2137	1979	2004	1021	685	749	1087	769	449	1164	1647	1388	1589	1326	998
Ca%	26	36	33	20	22	18	27	24	29	37	30	26	24	18	10	15	12	8	14	14	10
Mg%	9	13	13	7	8	8	12	10	13	10	9	10	14	16	7	2	2	1	5	5	3
K%	4.87	5.73	6.43	7.9	8.2	6.7	3.4	3.7	3.5	2.58	2.55	2.38	8.1	8.67	5.24	1.98	1.06	0.56	5.54	4.32	3.87
Total sand	310	219	193	467	416	388	217	214	219	65	57	55	388	422	399	286	286	277	242	223	226
Coarse sand	215	148	126	307	274	247	117	109	111	35	35	28	279	298	270	210	213	205	89	94	89
Fine sand	95	71	67	160	142	141	100	105	108	30	22	27	109	124	129	76	73	72	153	129	137
Clay	493	462	471	411	432	461	614	665	647	823	799	802	332	282	204	641	668	670	643	647	686
Silt	197	319	336	122	152	151	169	121	134	112	144	143	280	296	397	73	46	53	115	130	88
Classification	Clay	Clay	Clay	Sandy clay	Clay	Clay	Very clayey	Very clayey	Very clayey	Very clayey	Very clayey	Very clayey	Sandy clay loam	Sandy clay loam	Sandy clay loam	Very clayey	Very clayey	Very clayey	Very clayey	Very clayey	Very clayey

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex VII: Soil analysis results at depth (20–80 cm) in the inter-row area of plots under regenerative management. Source: 3R Ribersolo.

Farm	P1			P2			P3			P4			P5			P6			P7		
Depth	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80
pH (CaCl ₂)	5.5	5.3	5.5	4.7	4.4	4.9	4.2	4.2	4.2	5.5	5.5	5.2	4.3	4	4.2	3.8	4	4.1	5.8	5.3	5.8
OM	18	18	21	20	15	13	17	13	12	20	14	12	21	17	14	26	20	17	15	12	10
P (Res)	15	22	36	8	3	3	4	2	2	5	1	2	11	6	2	6	6	5	5	6	5
K	0.31	0.2	0.17	0.47	0.26	0.39	0.08	0.05	0.05	0.17	0.14	0.16	0.15	0.06	0.05	0.18	0.12	0.08	0.14	0.12	0.06
Ca	4	3.8	4.3	2.3	1.3	2.1	0.8	0.4	0.4	2.5	1.3	1	1.2	0.9	0.9	2.3	0.9	0.5	2.3	1.3	0.9
Mg	1.2	1.2	1.3	0.7	0.4	0.6	0.2	0.1	0.1	0.7	0.4	0.3	0.3	0.2	0.2	0.6	0.4	0.2	0.6	0.4	0.3
H + Al	2.8	2.2	2.5	4.7	3.8	3.1	5.8	5.5	5.2	3.3	2.6	2.2	6.4	6.8	9.1	7.2	8.8	7.5	1.5	1.3	1.3
Al	0.02	0.02	0.03	0.17	0.55	0.13	1.51	1.46	1.53	0.05	0.02	0.04	0.97	1.28	1.27	0.55	1	1.3	0.04	0.03	0.03
S	18	47	89	15	65	90	13	23	24	51	127	110	19	44	47	22	31	45	4	17	21
SB	5.51	5.2	5.77	3.47	1.96	3.09	1.08	0.55	0.55	3.37	1.84	1.46	1.65	1.16	1.15	3.08	1.42	0.78	3.04	1.82	1.26
CEC	8.3	7.4	8.3	8.2	5.8	6.2	6.9	6.1	5.8	6.7	4.4	3.7	8.1	8	10.3	10.3	10.2	8.3	4.5	3.1	2.6
V%	66	70	70	42	34	50	16	9	9	50	42	39	20	15	11	30	14	9	68	59	48
m%	0	0	1	5	22	4	58	73	74	1	1	3	37	52	52	15	41	63	1	2	2
B	0.41	0.35	0.32	0.37	0.35	0.34	0.33	0.32	0.26	0.84	0.52	0.48	0.76	0.62	0.54	0.92	0.72	0.76	0.24	0.16	0.11
Cu	1.8	1.8	1.3	0.9	0.5	0.3	0.5	0.3	0.2	3.4	1	0.6	1.5	0.9	0.7	1.2	0.9	0.7	0.8	0.5	0.5
Fe	20	20	14	42	24	14	32	18	12	17	11	7	61	32	25	49	27	18	16	10	7
Mn	2.1	2.9	2.5	3.5	1.8	2.4	2	1.1	0.6	0.6	0.3	0.2	4.8	2.7	1.8	0.6	0.3	0.2	1.8	1.2	1.2
Zn	1.4	2.1	2.1	11.2	6.7	5.9	1	0.2	0	1.9	0.4	0.1	0.6	0.2	0.1	0.4	0.1	0.1	1.5	0.6	0.4
C/N	6.69	5.89	7.06	6.96	7.48	8.38	9.25	9.32	7.99	10.99	11.49	13.33	6	6.29	6.33	7.09	8.3	7.96	5.89	6.35	7.6
Ctotal	10	10	12	12	9	8	10	8	7	12	8	7	12	10	8	15	12	10	9	7	6
Ntot	1495	1699	1699	1724	1203	955	1081	852	876	1092	696	525	1999	1589	1264	2115	1446	1257	1527	1102	789
Ca%	48	51	52	28	22	34	12	7	7	37	30	27	15	11	9	22	9	6	51	42	35
Mg%	14	16	16	9	7	10	3	2	2	10	9	8	4	3	2	6	4	2	13	13	12
K%	3.73	2.7	2.05	5.7	4.5	6.3	1.2	0.8	0.9	2.54	3.18	4.32	1.85	0.75	0.49	1.75	1.18	0.96	3.11	3.87	2.31
Total sand	285	244	261	481	415	411	326	304	311	149	120	130	441	375	397	225	200	220	321	182	516
Coarse sand	203	177	190	320	257	261	136	122	138	86	68	72	299	234	243	173	145	165	223	83	334
Fine sand	82	67	71	161	158	150	190	182	173	63	52	58	142	141	154	52	55	55	98	99	182
Clay	602	608	606	333	425	403	464	469	485	733	759	769	440	520	499	722	750	723	347	419	432
Silt	113	148	133	186	160	186	210	227	204	118	121	101	119	105	104	53	50	57	332	399	52
Classification	Very clayey	Very clayey	Very clayey	Sandy clay loam	Clay	Clay	Clay	Clay	Clay	Very clayey	Very clayey	Very clayey	Clay	Clay	Clay	Very clayey	Very clayey	Very clayey	Sandy clay loam	Sandy clay	Sandy clay

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex VIII: Soil analysis results at depth (20–80 cm) in the inter-row area of reference plots. Source: 3R Ribersolo.

Farm	P1			P2			P3			P4			P5			P6			P7		
Depth	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80	20 - 40	40 - 60	60 - 80
pH (CaCl ₂)	4.9	4.8	5	4.1	4.2	4.3	4.5	4.6	4.7	4.4	4.4	4.4	4.8	4.8	4.5	4	3.8	3.9	4.4	4.3	4.2
OM	15	12	12	16	13	12	27	22	18	18	14	13	14	10	9	27	24	21	25	19	14
P (Res)	3	1	0	3	2	2	7	4	4	4	1	1	10	5	5	5	6	6	5	6	5
K	0.42	0.35	0.31	0.2	0.13	0.16	0.13	0.08	0.05	0.17	0.1	0.07	0.09	0.05	0.05	0.11	0.07	0.03	0.2	0.14	0.11
Ca	2.3	2.3	2.6	0.6	0.3	0.5	1.7	1.5	1.3	2.2	1.2	0.9	2.6	1.5	1.6	1	0.8	0.5	1.2	0.5	0.4
Mg	1.3	1.5	2	0.2	0.1	0.2	0.7	0.7	0.6	0.8	0.4	0.4	0.9	0.7	0.6	0.3	0.2	0.1	0.3	0.2	0.1
H + Al	3.4	3.1	3.1	6.1	4.7	4.5	5.8	5.2	4	2.5	2.5	2.8	2.6	2.4	3.3	12.8	12.8	12.8	5.5	3.8	2.9
Al	0.1	0.13	0.05	1.11	1.11	0.75	0.36	0.32	0.18	0.05	0.04	0.03	0.18	0.33	0.97	2.32	2.23	1.84	0.34	0.26	0.12
S	11	11	17	16	31	38	18	37	52	18	60	78	7	13	19	32	35	49	48	74	74
SB	4.02	4.15	4.91	1	0.53	0.86	2.53	2.28	1.95	3.17	1.7	1.37	3.59	2.25	2.25	1.41	1.07	0.63	1.7	0.84	0.61
CEC	7.4	7.3	8	7.1	5.2	5.4	8.3	7.5	6	5.7	4.2	4.2	6.2	4.7	5.6	14.2	13.9	13.4	7.2	4.6	3.5
V%	54	57	61	14	10	16	30	30	33	56	40	33	58	48	40	10	8	5	24	18	17
m%	2	3	1	53	68	47	12	12	8	2	2	2	5	13	30	62	68	74	17	24	16
B	0.22	0.24	0.1	0.23	0.22	0.2	0.35	0.3	0.24	0.77	0.94	0.79	0.22	0.13	0.15	0.78	0.56	0.51	0.47	0.35	0.34
Cu	2.6	1.8	0.8	0.5	0.3	0.2	1.3	0.7	0.5	1.2	0.7	0.7	0.7	0.5	0.4	1.5	1.5	1.2	1	0.6	0.5
Fe	33	26	10	37	16	10	44	23	18	12	9	7	37	16	19	76	65	38	42	23	14
Mn	22.4	13.6	5.1	1.7	0.7	0.5	1.7	1	0.8	0.7	0.4	0.4	4	2.3	2.3	0.9	0.8	0.6	1.6	0.8	0.4
Zn	1.5	1.1	0.5	0.2	0	0	4.9	3.2	1.7	0.6	0.1	0.2	0.9	0.5	0.5	0.3	0.2	0.2	1.1	0.2	0.1
C/N	7.35	7.58	20.53	8.61	8.7	7.49	9.24	9.6	7.87	10.57	11.73	13.68	5.21	5.92	4.6	7.23	8.12	8.15	9.46	6.47	6.45
Ctotal	9	7	7	9	8	7	16	13	10	10	8	8	8	6	5	16	14	12	15	11	8
Ntot	1224	924	341	1045	920	934	1731	1354	1271	946	682	585	1535	1013	1087	2212	1725	1473	1585	1701	1241
Ca%	31	32	33	8	6	9	20	20	22	39	29	21	42	32	29	7	6	4	17	11	11
Mg%	18	21	25	3	2	4	8	9	10	14	10	10	15	15	11	2	1	1	4	4	3
K%	5.68	4.79	3.88	2.8	2.5	3	1.6	1.1	0.8	2.98	2.38	1.67	1.45	1.06	0.89	0.77	0.5	0.22	2.78	3.04	3.14
Total sand	309	237	195	456	413	400	226	216	210	59	60	66	401	360	303	274	305	269	248	285	250
Coarse sand	214	157	130	289	258	259	120	113	97	32	33	37	270	231	204	200	228	186	107	132	123
Fine sand	95	80	65	167	155	141	106	103	113	27	27	29	131	129	99	74	77	83	141	153	127
Clay	457	526	548	386	439	466	620	593	609	812	875	877	328	351	327	663	658	669	668	632	666
Silt	234	237	257	158	148	134	154	191	181	129	65	57	271	289	370	63	37	62	84	83	84
Classification	Clay	Clay	Clay	Sandy clay loam	Clay	Clay	Very clayey	Clay	Very clayey	Very clayey	Very clayey	Very clayey	Sandy clay loam	Sandy clay loam	Sandy clay loam	Very clayey	Very clayey	Very clayey	Very clayey	Very clayey	Very clayey

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex IX: Soil analysis results at depth (0–80 cm) in native vegetation areas on Farms 1 and 4.
Source: 3R Ribersolo.

Farm	P1					P2				
Depth	00 - 10	00 - 20	20 - 40	40 - 60	60 - 80	00 - 10	00 - 20	20 - 40	40 - 60	60 - 80
pH (CaCl ₂)	5.7	5.4	5.2	4.7	4.6	4.9	4.6	4.8	4.7	5
OM	44	35	23	21	16	75	43	23	19	19
P (Res)	11	6	2	1	1	16	5	1	1	1
K	0.62	0.51	0.67	0.42	0.29	0.58	0.26	0.16	0.08	0.07
Ca	5.4	4.2	2	1.1	0.9	6	2	0.5	0.1	0.1
Mg	3.2	2.7	1.9	1	0.9	1.6	0.5	0.2	0.1	0.1
H + Al	2	2.8	2.9	3.8	4.2	6.8	5.5	3.8	2.8	2.5
Al	0.09	0.05	0.06	0.13	0.2	0.15	0.19	0.2	0.1	0.04
S	0	6	6	9	9	0	5	5	14	6
SB	9.22	7.41	4.57	2.52	2.09	8.18	2.76	0.86	0.28	0.27
CEC	11.2	10.2	7.5	6.3	6.3	15	8.3	4.7	3.1	2.8
V%	82	73	61	40	33	55	33	18	9	10
m%	1	1	1	5	9	2	6	19	26	13
B	0	0.27	0.15	0.13	0.11	0	0.33	0.14	0.04	0
Cu	0	1.9	1.7	1.1	0.9	0	2	1.7	1.6	1.5
Fe	0	28	17	12	11	0	184	53	30	23
Mn	0	74.1	34.8	18.2	13.2	0	3.5	0.9	0.5	0
Zn	0	6	1.6	0.8	0.7	0	1.3	0.3	0.2	0.1
C/N	0	6.61	6.98	7.66	6.89	0	11.1	10.5	12.04	12.69
Ctotal	0	20	13	12	9	0	25	13	11	11
Ntot	0	3026	1863	1567	1306	0	2252	1238	914	867
Ca%	48	41	27	17	14	40	24	11	3	4
Mg%	29	26	25	16	14	11	6	4	3	4
K%	5.54	5	8.93	6.67	4.6	3.87	3.13	3.4	2.58	2.5
Total sand	299	266	248	214	215	161	152	127	141	125
Coarse sand	187	160	140	125	117	104	98	81	91	78
Fine sand	112	106	108	89	98	57	54	46	50	47
Clay	442	448	509	523	574	598	719	734	749	763
Silt	259	286	243	263	211	241	129	139	110	112
Classification	Clay	Clay	Clay	Clay	Clay	Clay	Very clayey	Very clayey	Very clayey	Very clayey

Units: pH measured in CaCl₂. Organic Matter (OM) expressed in g/dm³. Resin-P, sulfate-S (SO₄-S), B, Cu, Fe, Mn and Zn expressed in mg/dm³. K, Ca, Mg, H+Al, Al, Sum of Bases (SB), and Cation Exchange Capacity (CEC) expressed in cmolc/dm³. Cu, Fe, Mn, and Zn extracted using the DTPA method.



Annex X: Leaf tissue analysis results in plots under regenerative management.
Source: 3R Ribersolo.

Farm	P1	P2	P3	P4	P5	P6	P7
N	28.77	27.65	26.67	31.08	31.99	30.1	32.06
P	1.3	1.25	1.35	0.95	1.27	1.16	1.19
K	25.48	14.66	12.15	19.07	19.38	17.67	21.65
Ca	8.15	16.02	14.99	16.71	11.46	8.02	10.48
Mg	1.83	3.06	4.54	3.71	3.79	2.84	2.4
S	1.82	1.72	1.65	1.81	1.88	1.78	1.86
B	35.7	52.02	61.73	52.97	67.3	36.2	52.49
Cu	11.9	14.9	13.5	25.9	6.7	21.9	9.6
Fe	119	71	61	123	195	194	153
Mn	91.3	176.8	138.1	72.5	146.6	143.1	58.9
Zn	6.2	8.2	7.5	9.9	7.3	6.3	7.7
Mo	0.5	x	x	5.1	x	x	x

Units: N, P, K, Ca, Mg, and S expressed in g/kg; B, Cu, Fe, Mn, Zn, and Mo expressed in mg/kg.

Annex XI: Leaf tissue analysis results in reference plots. Source: 3R Ribersolo.

Farm	P1	P2	P3	P4	P5	P6	P7
N	31.71	26.74	26.74	30.1	33.81	28.42	30.24
P	1.18	1.45	1.17	1.06	1.25	1.02	1.15
K	25.48	17.58	15.68	16.08	18.7	11.25	19.12
Ca	10.46	14.27	13.24	12.89	10.67	8.2	9.32
Mg	2.74	3.8	4.9	2.79	3.95	2.99	2.48
S	1.99	1.99	1.63	2.05	2.02	1.66	1.69
B	36.3	58.6	91.3	105.05	55.04	31	37.2
Cu	26.6	16.3	10.8	32.9	8.3	80.8	9.3
Fe	95	122	86	156	210	158	129
Mn	363.3	123.1	60.3	155.1	125	107.5	140.7
Zn	13	7.2	9.5	60	7	5.2	13.2
Mo	0.8	x	x	4.7	x	x	x

Units: N, P, K, Ca, Mg, and S expressed in g/kg; B, Cu, Fe, Mn, Zn, and Mo expressed in mg/kg.



Annex XII: Soil biological analysis results (BioAS) – Coffee canopy projection, plots under regenerative management. Source: 3R Ribersolo.

Farm	P1	P2	P3	P4	P5	P6	P7
FERTBIO SQI	0.65	0.87	0.73	0.74	0.81	0.65	0.65
Biological SQI	0.35	0.8	0.69	0.69	0.72	0.31	0.54
Chemical SQI	0.8	0.91	0.74	0.77	0.85	0.83	0.71
Nutrient cycling	0.35	0.8	0.69	0.69	0.72	0.31	0.54
Nutrient storage	0.73	0.97	0.69	0.67	0.82	0.9	0.65
Nutrient supply	0.87	0.84	0.79	0.87	0.88	0.75	0.77
Arylsulfatase	12	83	176	96	54	22	17
Beta-glucosidase	60	65	36	105	108	37	75
SOM	30	28	24	31	27	39	20
Clay	59	32	46	66	45	65	35

Units: Arylsulfatase activity ($\mu\text{g p-nitrophenol/g/h}$); B-glucosidase activity ($\mu\text{g p-nitrophenol/g/h}$); SOM, soil organic matter content (g/dm^3).

Annex XIII: Soil biological analysis results (BioAS) – Coffee canopy projection, reference plots. Source: 3R Ribersolo.

Farm	P1	P2	P3	P4	P5	P6	P7
FERTBIO SQI	0.65	0.85	0.84	0.74	0.93	0.66	0.5
Biological SQI	0.39	0.8	0.74	0.56	0.95	0.29	0.42
Chemical SQI	0.77	0.88	0.89	0.83	0.93	0.84	0.54
Nutrient cycling	0.39	0.8	0.74	0.56	0.95	0.29	0.42
Nutrient storage	0.79	0.88	0.95	0.79	0.99	0.81	0.4
Nutrient supply	0.75	0.87	0.84	0.87	0.86	0.87	0.67
Arylsulfatase	15	131	170	64	85	10	44
Beta-glucosidase	59	61	71	114	137	45	48
SOM	27	25	41	38	33	33	27
Clay	50	36	62	75	33	62	63

Units: Arylsulfatase activity ($\mu\text{g p-nitrophenol/g/h}$); B-glucosidase activity ($\mu\text{g p-nitrophenol/g/h}$); SOM, soil organic matter content (g/dm^3).



Annex XIV: Soil biological analysis results (BioAS) – Inter-row, plots under regenerative management. Source: 3R Ribersolo.

Farm	P1	P2	P3	P4	P5	P6	P7
FERTBIO SQI	0.91	0.77	0.69	0.93	0.8	0.66	0.67
Biological SQI	0.86	0.54	0.65	0.94	0.69	0.38	0.46
Chemical SQI	0.93	0.89	0.71	0.92	0.86	0.8	0.78
Nutrient cycling	0.86	0.54	0.65	0.94	0.69	0.38	0.46
Nutrient storage	0.99	0.92	0.64	0.97	0.85	0.77	0.78
Nutrient supply	0.87	0.85	0.77	0.87	0.87	0.83	0.77
Arylsulfatase	154	36	169	156	55	37	21
Beta-glucosidase	113	50	25	177	89	47	49
SOM	50	26	24	46	27	38	22
Clay	55	35	46	60	43	67	35

Units: Arylsulfatase activity ($\mu\text{g p-nitrophenol/g/h}$); B-glucosidase activity ($\mu\text{g p-nitrophenol/g/h}$); SOM, soil organic matter content (g/dm^3).

Annex XV: Soil biological analysis results (BioAS) – Inter-row, reference plots. Source: 3R Ribersolo.

Farm	P1	P2	P3	P4	P5	P6	P7
FERTBIO SQI	0.82	0.79	0.82	0.81	0.85	0.71	0.51
Biological SQI	0.75	0.78	0.62	0.72	0.93	0.59	0.5
Chemical SQI	0.86	0.8	0.93	0.86	0.81	0.77	0.52
Nutrient cycling	0.75	0.78	0.62	0.72	0.93	0.59	0.5
Nutrient storage	0.85	0.92	0.98	0.93	0.99	0.75	0.44
Nutrient supply	0.87	0.68	0.87	0.78	0.63	0.79	0.59
Arylsulfatase	180	146	119	96	113	32	54
Beta-glucosidase	58	54	33	103	99	129	70
SOM	29	26	56	38	32	35	29
Clay	49	33	56	6	33	57	64

Units: Arylsulfatase activity ($\mu\text{g p-nitrophenol/g/h}$); B-glucosidase activity ($\mu\text{g p-nitrophenol/g/h}$); SOM, soil organic matter content (g/dm^3).



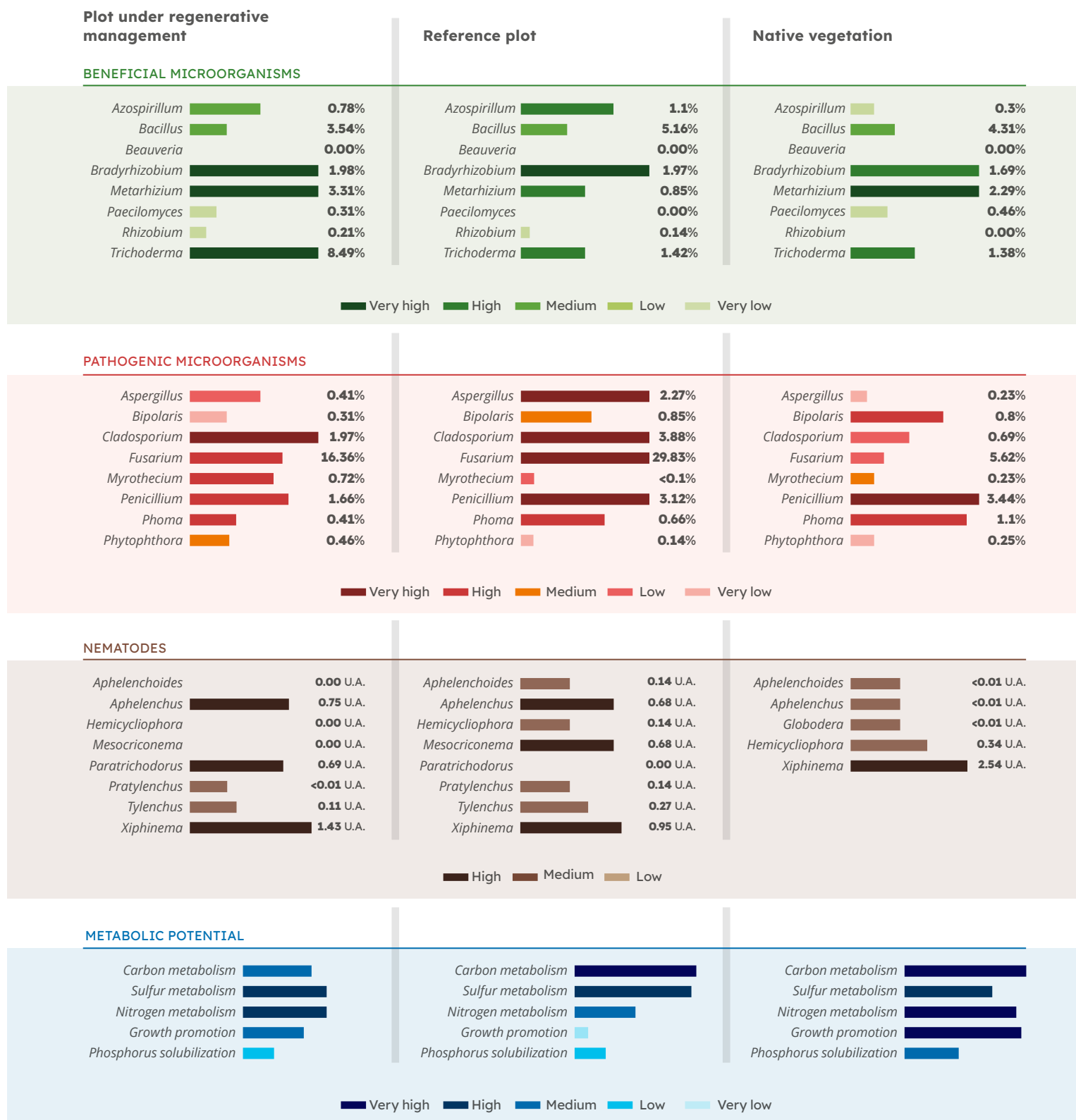
Annex XVI: Soil biological analysis results (BioAS) – Native vegetation area.
Source: 3R Ribersolo.

Farm	P1	P4
FERTBIO SQI	0.78	0.84
Biological SQI	0.66	0.71
Chemical SQI	0.84	0.91
Nutrient cycling	0.66	0.71
Nutrient storage	0.98	0.98
Nutrient supply	0.71	0.83
Arylsulfatase	69	155
Beta-glucosidase	62	60
SOM	44	75
Clay	44	60

Units: Arylsulfatase activity (μg p-nitrophenol/g/h); B-glucosidase activity (μg p-nitrophenol/g/h); SOM, soil organic matter content (g/dm^3).



Annex XVII: Soil microbiota analysis results (metagenomics) – Farm 1.
Source: ByMyCell.



Relative levels of microorganism occurrence presented as a heat map.

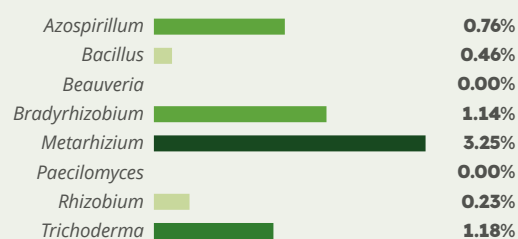
Annex XVIII: Soil microbiota analysis results (metagenomics) – Farm 2.
Source: ByMyCell.

Plot under regenerative management

BENEFICIAL MICROORGANISMS

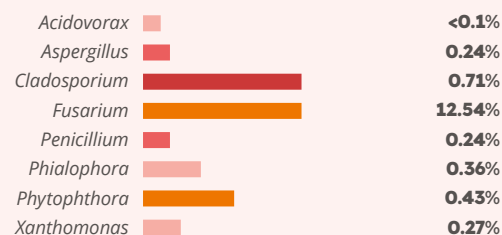


Reference plot



Very high High Medium Low Very low

PATHOGENIC MICROORGANISMS



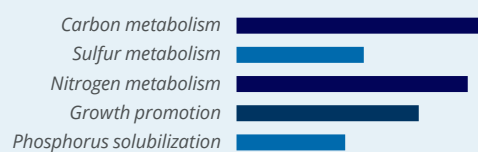
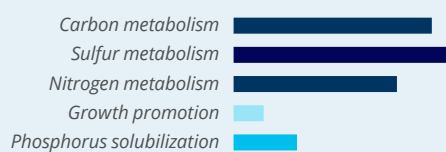
Very high High Medium Low Very low

NEMATODES



High Medium Low

METABOLIC POTENTIAL



Very high High Medium Low Very low

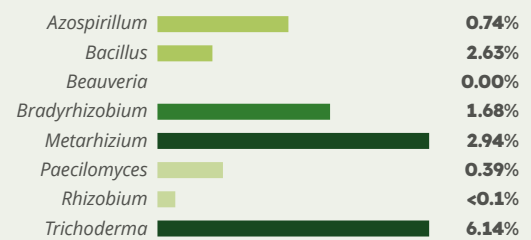
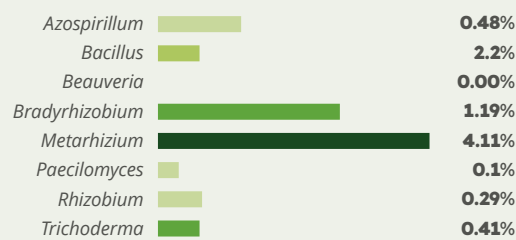
Relative levels of microorganism occurrence presented as a heat map.

Annex XIX: Soil microbiota analysis results (metagenomics) – Farm 3.
Source: ByMyCell.

Plot under regenerative management

Reference plot

BENEFICIAL MICROORGANISMS



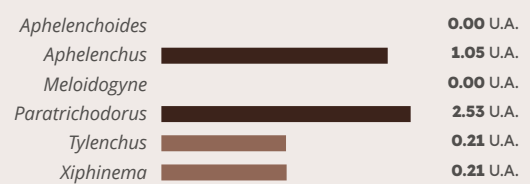
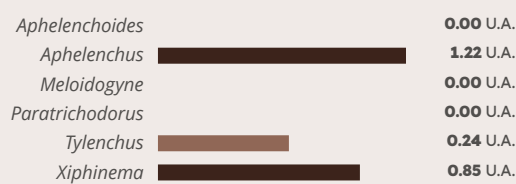
Very high High Medium Low Very low

PATHOGENIC MICROORGANISMS



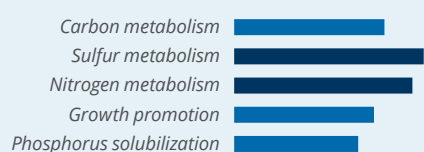
Very high High Medium Low Very low

NEMATODES



High Medium Low

METABOLIC POTENTIAL



Very high High Medium Low Very low

Relative levels of microorganism occurrence presented as a heat map.

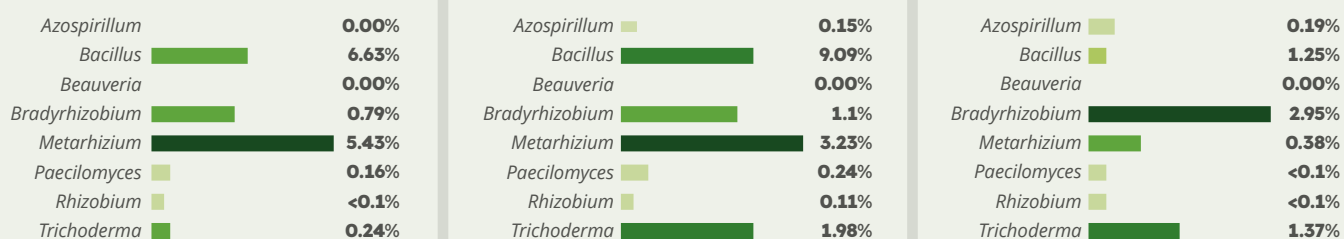
Annex XX: Soil microbiota analysis results (metagenomics) – Farm 4.
Source: ByMyCell.

Plot under regenerative management

Reference plot

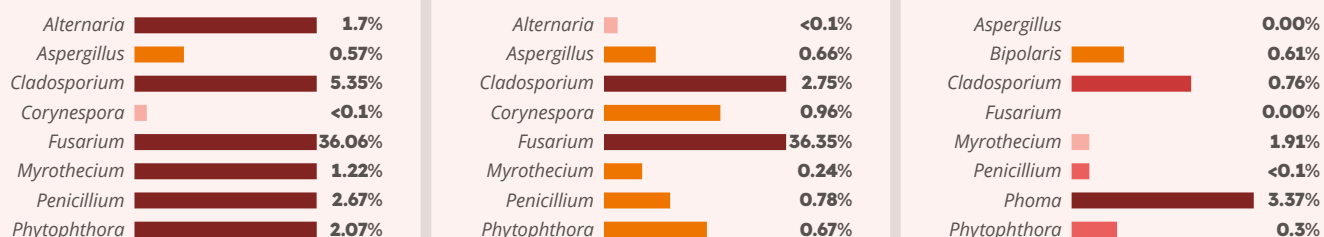
Native vegetation

BENEFICIAL MICROORGANISMS



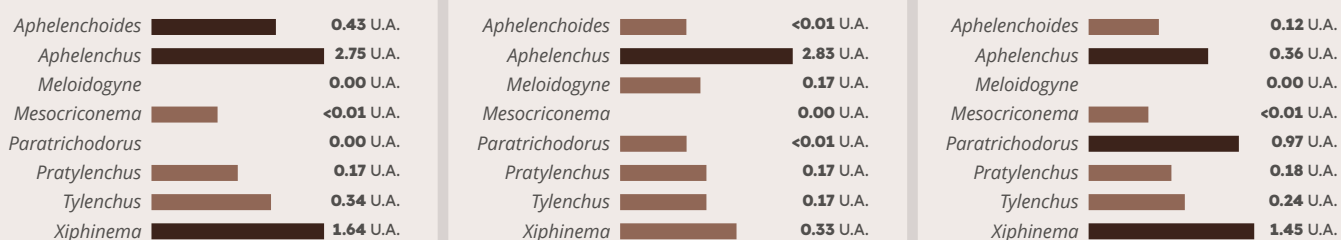
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PATHOGENIC MICROORGANISMS



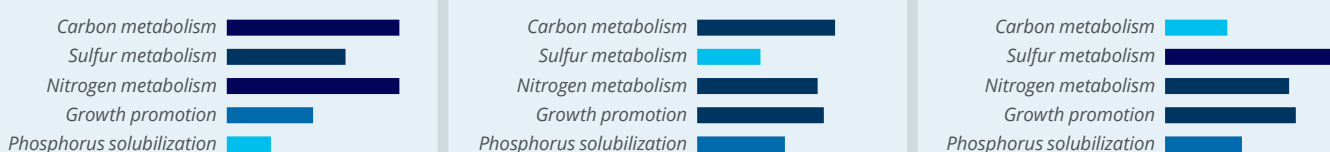
Very high High Medium Low Very low

NEMATODES



High Medium Low

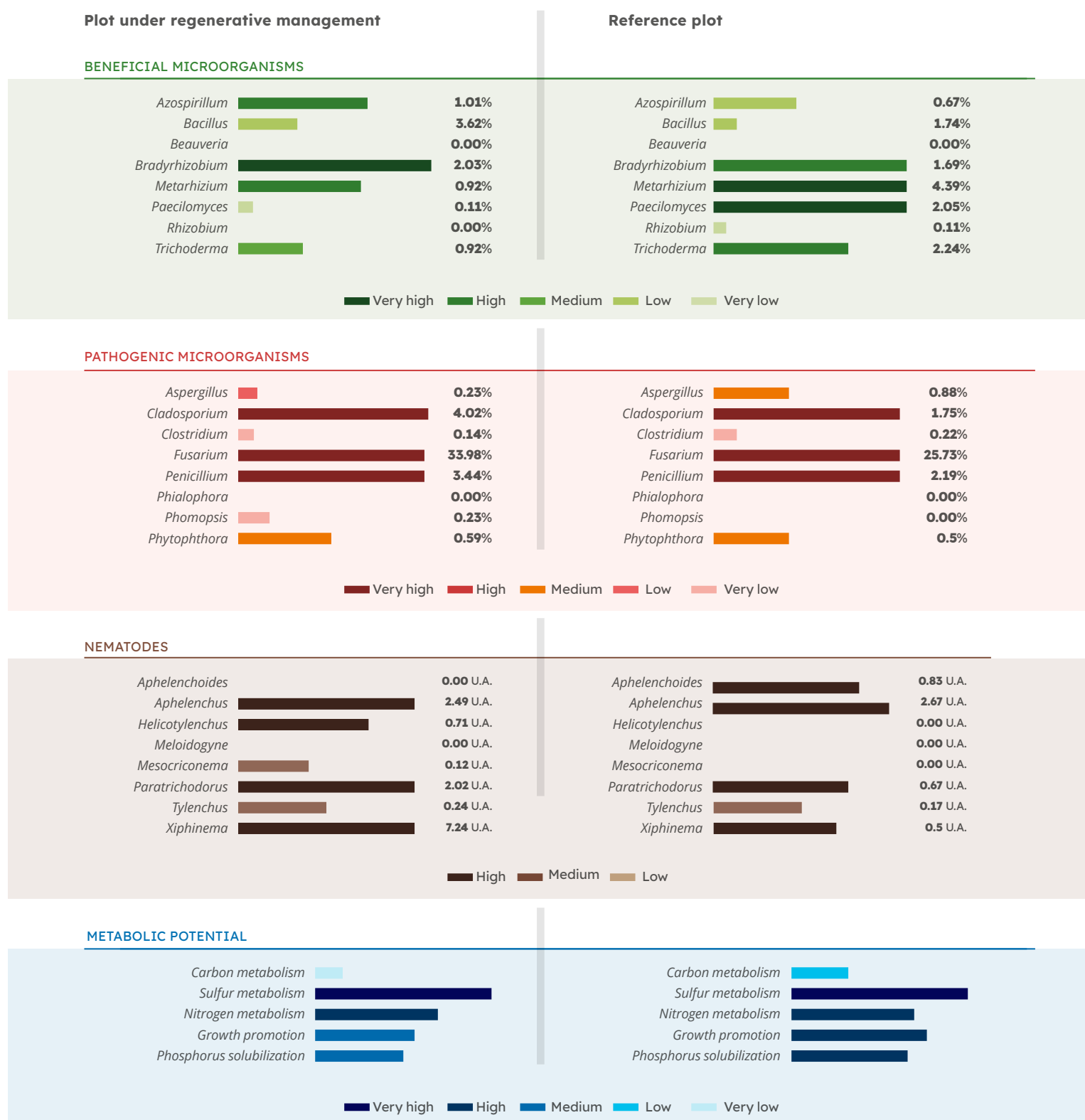
METABOLIC POTENTIAL



Very high High Medium Low Very low

Relative levels of microorganism occurrence presented as a heat map.

Annex XXI: Soil microbiota analysis results (metagenomics) – Farm 5.
Source: ByMyCell.

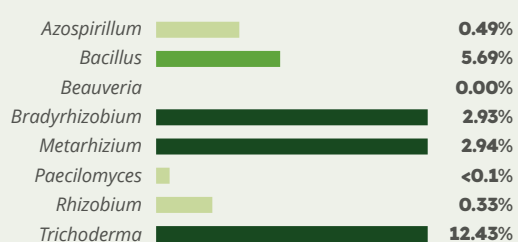


Relative levels of microorganism occurrence presented as a heat map.

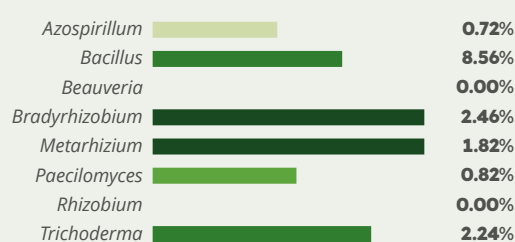
Annex XXII: Soil microbiota analysis results (metagenomics) – Farm 6.
Source: ByMyCell.

Plot under regenerative management

BENEFICIAL MICROORGANISMS

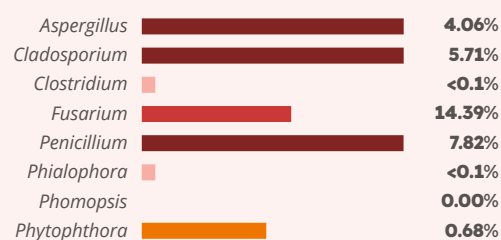
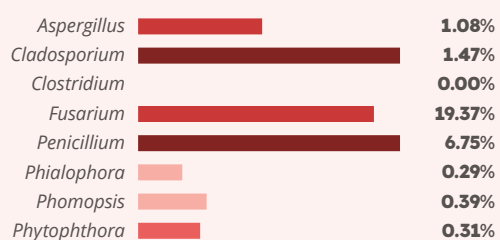


Reference plot



Very high High Medium Low Very low

PATHOGENIC MICROORGANISMS



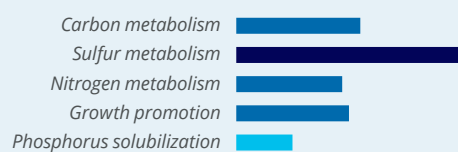
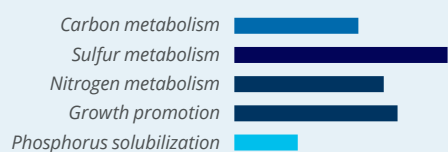
Very high High Medium Low Very low

NEMATODES



High Medium Low

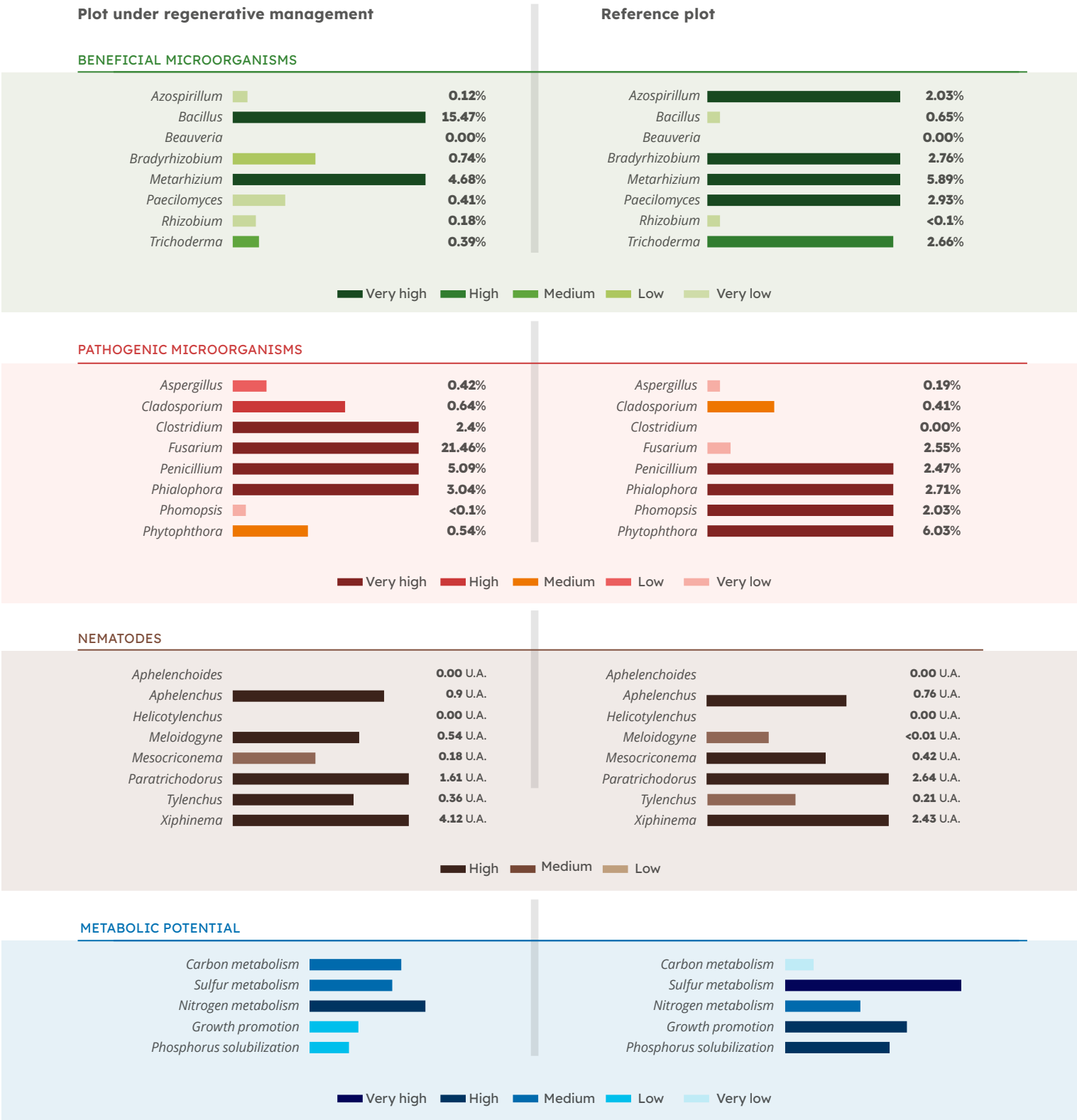
METABOLIC POTENTIAL



Very high High Medium Low Very low

Relative levels of microorganism occurrence presented as a heat map.

Annex XXIII: Soil microbiota analysis results (metagenomics) – Farm 7.
Source: ByMyCell.



Relative levels of microorganism occurrence presented as a heat map.



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