BRAZIL

REGENERATIVE AND HIGH QUALITY COFFEE AGRONOMIC GUIDE

VERSION 1

JANUARY 2025

PREAMBLE

At *Nespresso*, we believe that Nature is our greatest ally in securing the future of coffee in general and especially the high-quality coffees we source for our business.

For 20 years, our sourcing program, the *Nespresso* AAA Sustainable Quality™ Program, has been the vehicle for the adoption of innovative agricultural practices. In this new chapter, the AAA Program will further promote the investment into Natural Capital. The transformative power of Nature can deliver the services that famers and society critically need: resilience, yield, quality consistency, new sources of income, carbon sequestration and biodiversity conservation.

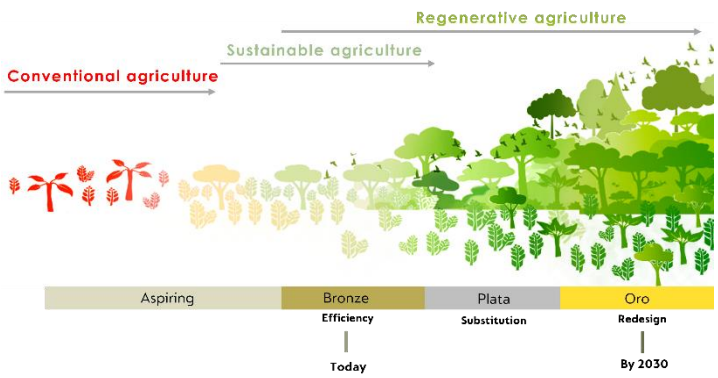
In this new chapter, Sustainable Quality will further integrate high quality coffees with healthy ecosystems, quality of life and thriving communities.

Nespresso and-the Rainforest Alliance share a common vision of regenerative agriculture building on 3 foundational principles:

- Produce in ways that actively restore and protect biodiversity in-and-around production areas;
- Reduce greenhouse gas emissions, adapt to climate change and build resilience in the farm;
- Preserve the livelihoods of the farmers now and in the long-term.

It is our conviction that these three foundational principles are the only way to guarantee a long-term sustainable supply of high-quality coffee.

The co-created Rainforest Alliance's Regenerative Coffee Scorecard helps understand where one stands in the transition: **FROM BRONZE TODAY, TO GOLD BY 2030.**



Once Gold, the farms will in turn offer many benefits to society: offering habitats or corridors for species, sequestrating carbon and replenishing watersheds. Thanks to the availability of organic matter, the soil of the farms will maintain living organisms needed for nutrients cycling.
Equally *Nespresso* and its partners will continue to enrich this document with new scientific insights towards an integrated quality concept ie cup profiles, healthy soil, heathy ecosystems and thriving communities.

We invite you to read this agronomic guide which will lays the pathway towards Gold.

BRAZIL

This document aims to guide the implementation of regenerative coffee growing in the field, with training, and support for the coffee growers, and cluster planning actions. The Agronomic Guide connects the vision of the Rainforest Alliance Regenerative Coffee Scorecard with the technical and environmental research and recommendations available in Brazil.

Regenerative agriculture is about behavioural change management, therefore relies on motivation, knowledge, and resources to ensure the transition of practices. *Nespresso* provides to the AAA farmers, the enabling conditions for_smooth change management: price premiums paid for AAA coffee, investments in infrastructures and alternative solutions, and technical assistance... To motivate behavioural change among producers and their families, field teams implement an adoption strategy through local producer networks, supported by influential local producers – opinion leaders - and encourage the exchange of experiences in their local contact networks. The innovation and creativity in the work of AAA producers, AAA agronomists, *Nespresso*, and their partners promote optimism to transform coffee production with a positive impact.

Nespresso acknowledges the contributions of its coffee partners in Brazil, including Stockler, Cooxupé, EISA, and Wolthers. It also recognises the technical lead role of IMAFLORA in compiling this document. Their experience in the field has been a fundamental input to building this agronomic guide and consolidating the work of the AAA Program.

RAINFOREST ALLIANCE ENDORSES THIS GUIDE *as a set of recommendations for the journey toward gold standard regenerative coffee production in AAA coffee farms in Colombia and is in alignment with the* Rainforest Alliance Regenerative Coffee Scorecard .

AT *NESPRESSO*, WE BELIEVE THAT NATURE IS OUR GREATEST ALLY IN SECURING THE FUTURE OF COFFEE

"Regenerative Agriculture a farming approach that emphasizes protecting and restoring natural resources (primarily soil, but also water and biodiversity) to deliver multiple benefits to farmers, environment, and society. By strengthening soil health and ecosystem services, regenerative agriculture helps make agroecosystems more productive and resilient, while also improving farmers' livelihoods. A focus on regenerative agriculture further creates important opportunities to mitigate greenhouse gas (GHG) emissions"[1].

REGENERATIVE STRATEGY FOR BRAZIL:

Under renovation or in establishing a new plot, it is an excellent opportunity to adopt regenerative practices from the beginning and build a desirable regenerative coffee plot so that when farmers renovate the coffee, some topics can be followed.

1- Improve soil conditions in aspects such as conserving and improving the soil's physical structure and promoting biological diversity by promoting several practices. For instance, leave the soil for one season with cover crops and legumes to improve the soil structure and biological diversity, use less chemical and more biological agents, and substitute traditional NPK for compost or a mix of organic and mineral fertiliser. These practices improve soil health and soil microbes. It is important to measure the soil life and structure, analysing soil compression and oxygen availability.

For analysing the soil life, we are using the BIOAS (EMBRAPA)[2] and Soil organic matter, plus some soil diagnosis in the structure and compaction that we use a penetrometer tool.

2- Choose the best space between coffee lines and the best varieties that have resilience and pest and disease resistance, not just for rust but for other critical local diseases

3-In the furrow of the plantation, farmers will adopt rock powder, compost, or biochar. Farmers will adopt more than 70% of this natural or slow-release fertiliser in the sulk. It can promote long-term fertility in the soil.

4- Design the plot layout by planting some trees as windbreakers or every 15 to 30 metres, optimising the additional trees with mechanisation, which is very important for the Brazilian reality.

[1] Pulleman et al., 2023, p. 16.
[2] EMPRAPA BIOAS (2021)

THE GUIDANCE DEFINED BELOW IS BUILT FOR AAA AGRONOMISTS AND TEAMS IN THE CLUSTER TO GUIDE FARMERS IN THE TRANSITION.

THE AGRONOMIC GUIDE BUILDS ON THREE PRINCIPLES that will be conveyed to the farmers as the Cluster Operational Plan to be deployed. These three principles require a mindset change for the producers and coffee partners working with *Nespresso*.

I. By design, the farm generates organic materials and natural biocontrol.

II. Treat the soil and then the plant.

III. Achieve production system resilience while generating profitability and livelihoods for the producers.

IT REFLECTS THE *NESPRESSO* JOURNEY TOWARD REGENERATIVE WITH ONE CHAPTER BY KEY PRACTICES' AREAS:

1. FARM DESIGN
2. SOIL HEALTH
3. PLANT NUTRITION
4. PLANT HEALTH
5. WATER MANAGEMENT
6. FARM FINANCIALS

THROUGHOUT THE DOCUMENT, WE WILL PROVIDE DIFFERENT SECTIONS FOR EACH CHAPTER. **WE IDENTIFY THREE LEVELS AS FOLLOWS**:

01 → **PERFORMANCE EXPECTATION** is primarily based on the criteria of the Rainforest Alliance Regenerative Coffee Scorecard.

02 → **IMPLEMENTATION RECOMMENDATIONS** that AAA Agronomists present to AAA Farmers.

03 → **ACTIONS** that are planned at the cluster level to facilitate the adoption and change towards regenerative practices.

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1. FARM DESIGN

1.1 REHABILITATION & RENOVATION

"Planning for renovation, and to some extent rehabilitation, provides a perfect opportunity to implement other regenerative practices that require restructuring of the production system. These practices include system diversification using well-suited intercropping and agroforestry designs as well as soil conservation practices and other measures to improve soil health."[3]

"Healthy and productive trees, that are well adapted to the local lagro-ecological conditions and farming systems, are a basic prerequisite for obtaining a good response to the adoption of any (regenerative) practice." [4]

Here, we will illustrate some terms that may be confusing in their translation and technical description.

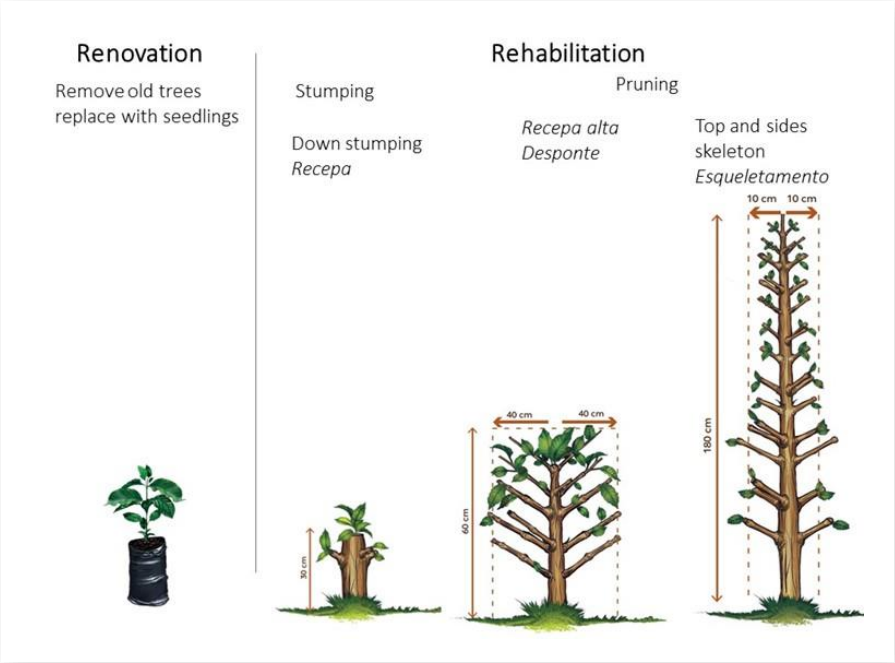


Figure 1. *Renovation and rehabilitation terms.*
Note: *Please review Annex 2 for further details on these terms in the context of the Rainforest Alliance Regenerative Coffee Scorecard.*

[3] Pulleman et al., 2023, p.50
[4] Pulleman et al., 2023, p. 48.

REHABILITATION:

"Rehabilitation involves pruning and stumping of the coffee trees, while maintaining the current root stock."[5]

"Frequent pruning to maintain coffee tree health and productivity." RA scorecard gold level[6]

"Replanting or renovation/rehabilitation, implemented to ensure at least 50% of plot in young or middle age (≤ 8 years) trees."

"Coffee variety is selected based on quality, productivity, and rust resistance. Use of rust resistant varieties on >50% of plot"
RA Scorecard – Gold Level[7]

RECOMMENDATIONS

a. Rehabilitation is adopted to keep trees young and productive. If farmers keep more than 50% of their areas well-pruned and vigorous, they can get high productivity and satisfactory profitability.

b. Continuous pruning every year after the harvest (harvest time in Brazil is from May to September). For mechanised plantations, pruning is required every two years once the plant is over seven years old. "Safra zero system" consists of pruning with the skeleton practice (*esquelatamento*) after a good harvest (more than 4.2 tons per hectare of green coffee beans).

c. When skeleton practice or another renovation practice is adopted, it is strongly recommended to plant a cover crop or a legume (soybean) between the coffee lines to promote life in the soil. This is an essential practice because when coffee trees are stumped or on a new plantation, there is more incidence of light between the coffee lines, and it is when the cover crops have an optimal development.

[5] Pulleman et al., 2023, p. 48
[6] Rainforest Alliance. 2022a.
[7] Rainforest Alliance. 2022a.

d. Different pruning techniques can increase farm productivity by up to 20%[8]. It is important to analyse the various aspects of the crop, such as plant density, variety, and age, to define the best technique to use.

Figure 2. *Coffee inter-rows with buckwheat as a cover crop. [Photo by Murilo Bettarello]*

Figure 3. *Rejuvenation area with resistance variety (Arara) and Crotalaria, a legume in inter-rows to keep soil cover and fix nitrogen. Floresta Coffee Farm [Photo by Murilo Bettarello]*

[8] Embrapa, 2020.

e. Start stumping or skeleton pruning of the trees after eight years of harvest (i.e., starting in October – should be maximum in August and September). "When coffee trees have few productive branches, stumping or skeleton pruning can restore coffee productivity." [9] Stumping is recommended in Brazil in case of frost damage or specific plant architecture. The best practice would be skeleton pruning, as it is cheaper and affects the harvest for only one year, whereas stumping leaves farmers without a harvest for two years.

f. Skeleton pruning is a practice made in mechanised areas after eight years of planting. It consists of pruning the top of the plants and lateral branches (20 cm from the main trunk) every two years. It reduces harvest cost inputs and produces a high yield in the second year.

RENOVATION:

"Renovation involves uprooting old trees and filling gaps with new plantings to replace the current coffee variety as well as and the rootstock. This practice also makes it possible to allows increasing planting densities or changing to a different system design." [10]

"Replanting or renovation, implemented to ensure at least 50% of the plot is in young or middle age (≤ 8 years) trees" RA Scorecard – Gold Level. [11]

"Coffee variety is selected based on quality, productivity, and rust resistance. Use of rust-resistant varieties on >50% of the plot" RA Scorecard – Gold Level. [12]

"The main limitations to the implementation of renovation and rehabilitation are the high upfront investments in planting materials and labour, especially in the case of renovation. A further disadvantage is that the practice leads to an initial, short-term loss of yield and income" [13]

[9] Pulleman et al., 2023.
[10] Pulleman et al., 2023, p. 48.
[11] Rainforest Alliance, 2022 a.
[12] Rainforest Alliance, 2022 a.
[13] Pulleman et al., 2023, p. 54.

a. Renovate 10% of the coffee acreage each year after harvest, just in plots over 15 years of age for Arabica and over 10 years for Robusta. 10% can be a target number and varies for the average age of coffee plots. Generally, a coffee plot with a good stand of plants can be renovated after 15 years. It is crucial in the farm plan to start the renovation after the plots achieve that age.

b. Select coffee variety based on quality, productivity, shade tolerance, disease resistance, pests and nematodes, and drought tolerance. In Table 1, there are references for the main Arabica coffee varieties in Brazil.[14] **Please note that Table 1 does not provide information on the sensory quality profile of the varieties**.

VARIETY - CULTIVAR	PEST RESISTANCE	DISEASE RESISTANCE	DROUGHT TOLERANT	TREE HEIGHT	FRUIT COLOUR	PRODUCTIVITY
Acauã	Nematode	Rust	Yes	Short	Red	High
Acauãnovo	Nematode	Rust	Yes	Short	Red	High
Arara	No	Rust	No	Short	Yellow	Very High
Asabranca	Nematode	Rust	No	Short	Red	Very High
Catucaí 785-15	Nematode	Rust	No	Short	Red	High
Catucaí Yellow 2SL	No	Rust & Phoma	No	Short	Yellow	High
Catucai 2015479	No	Rust	No	Short	Yellow	High
Graúna	No	Rust	No	Short	Red	High
IAC 125 RN	Nematode	Rust	No	Short	Red	High
IAC Catuaí SH3	No	Rust	No	Short	Red	High
IPR 100	Nematode	No	Yes	Short	Red	Very High
Paraíso MG H 419-1	Nematode	Rust	No	Short	Yellow	High

Table 1. *Main resistance cultivars from Brazil and characteristics***.**

c. It is recommended to evaluate the edaphoclimatic conditions, altitude, and the main diseases and pests of the region when choosing a coffee variety. Consult the research institute responsible for the development of the variety and the agronomist of your farm. It is important to note that the performance of the variety can vary according to local conditions, so it is essential to evaluate the previous performance of the cultivar in the region where you intend to plant it.

[14] Siqueira et al., 2022.

d. The nursery should be registered with the Minister of Agriculture and show plant certification of root analysis. Regulate shade and maintain good soil cover to provide optimal conditions for the growth of young seedlings.
   Recommended spacing:
   - For short varieties, the optimal spacing is 3.2-3.8 metres between rows and 0.5-0.7 metres between plants.
   - For tall varieties, the optimal spacing is 3.5 - 3.9 metres between rows and 0.5 - 0.7 metres between plants.

e. Farmers can substitute 50% - 100% of chemical fertiliser in the planting furrow with rock powder, compost, or biochar (see section 3.2 Organic Fertilisation).

f. When new trees are planted, it is strongly recommended that farmers plant cover crops between the coffee lines. When the plants are small, cover crops have optimal development and help protect the soils from erosion, protect the young coffee plants against strong winds and severe sunlight, and attract natural enemies; if the cover crops have a legume species, they can also supply nitrogen.

Figure 4. *Farmer applying compost in sulk of planting. Antonio Davi Farm - Franca – [Photo by Murilo Bettarello]*

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Update the productivity information and the coffee structure of the farms to match the average age of trees in different plots.		☑
Define and implement the renewal plan by considering the variety, density, arrangement, pruning, and cycle. Each farm defines the renovation plan with the assistance of the AAA Agronomist or their private agronomist. Clusters monitor the annual progress regarding the area and the number of trees renovated or rehabilitated.	☑	☑
Map the training needs in the renovation practices and coordinate these trainings between the farmers in the clusters.		☑

1.2 AGROFORESTRY

"Maintaining agroforestry cover, including a diversity of trees on the overall farm (coffee plots and/or surroundings), with at least eight species (ideally native), manages species diversity, as described in the Silver level, and provides two strata of tree levels.

If agroforestry cover is not suitable for the local environmental conditions, trees may also be planted around the infrastructure, borders, etc." RA Scorecard – Gold Level. [15]

"Maintaining an area equivalent to 15% of the farm area in natural vegetation (at least 20% in Brazil with natural vegetation). This is to be validated with GIS polygons in all countries. Please see the definition of 'natural vegetation"natural vegetation' in the definitions document." RA Scorecard – Gold Level. [16]

RECOMMENDATIONS

a. Re-introduce trees in coffee farms to maintain an area equivalent to 20% of the farm area in natural vegetation (if the farm doesn't have the 20%) and protect aquatic ecosystems through riparian buffers at least 10m wide.

b. Follow one of the three tree-planting models recommended by PUR PROJET in other countries, if needed:

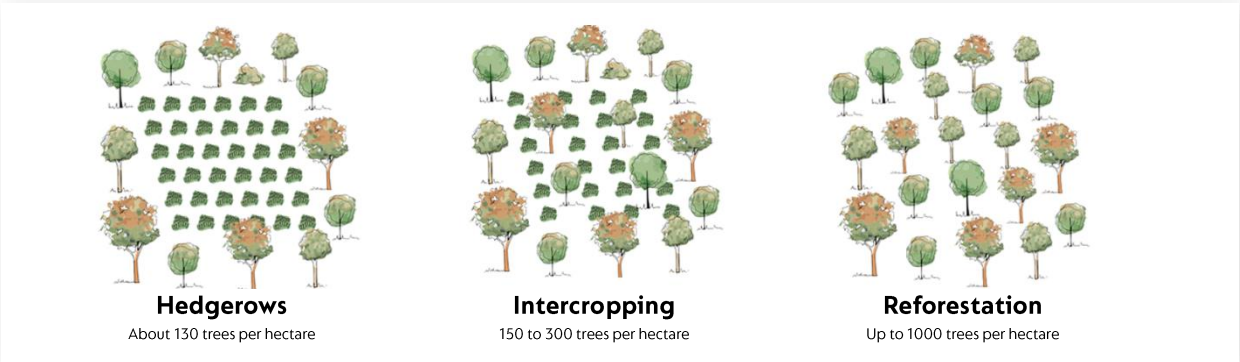


Figure 5. *Different agroforestry models implemented in AAA farms. Source: Nespresso, PUR Project, 2021*[17]

[15] Rainforest Alliance, 2022 a.
[16] Rainforest Alliance, 2022a.
[17] *Nespresso* and Pur Project, 2021.

c. In Cerrado, hedgerows and intercropping models are promoted:

- Windbreak barriers/hedgerows (Planting vegetation between the rows, along the edges of the fields, along the borders, and along contour lines)
- Afforestation/ intercropping (Planting trees inside the field with adequate density and spacing)

d. The spatial arrangement of the trees (density, canopy level) will be considered as species are selected. See Table 2.

e. Plant trees during the rainy season (October - December) when farmers plant coffee; it can be simultaneous.

f. Plant shade tree lines or wood trees (Mahogany or Cedar) in some coffee lines as windbreak barriers to protect the coffee plants from wind evapotranspiration. Shade trees can be planted along the edges or every nine or thirteen rows in mechanised areas.

g. Recommended spacing can vary from 12-36 metres between rows and five to eight metres between trees.

SPECIE	SCIENTIFIC NAME	WINDBREAK	AFFORESTATION	COMMENT (NATIVE (YES)– NON-NATIVE (NO))
Acacia	*Acacia mangium*	Yes	Yes	No
African Mahogany	*Khaya ivorensis*		Yes	No
Avocado	*Persea americana*	Yes	Yes	No
Banana tree	*Musa spp.*		Yes	No
Castor hean	*Ricinus communis*		Yes	No
Casuarina	*Casuarina equisetifolia*	Yes		No
Copaíba	*Copaifera langsdorffii*	Yes	Yes	Yes
Fedegoso	*Senna macranthera*		Yes	Yes
Gliricídia	*Glericidia sepium*		Yes	No
Grevillea	*Gravillea robusta*	Yes	Yes	No
Hibiscus	*Hibiscus sp*	Yes		No
Ingazeiro	*Inga edulis, Feuillei*		Yes	Yes
Macadamia	*Macadamia integrifolia*	Yes	Yes	No
Moringa	*Moringa oleifera*		Yes	No
Papaya	*Carica papaya*		Yes	No
Urucum	*Bixa orellana*	Yes		Yes

Table 2. *Most-used tree species for the agroforestry projects in Brazil.*

h. Consider critical criteria when selecting tree species: tree morphology and physiology, pruning requirements, species complementarity and compatibility, capacity to fix

nitrogen, and other beneficial functional traits, multifunctionality, and economic value[18]. The selected species should not be considered as identified as potential hosts of pests or diseases. Other species with good local adaptation in coffee production systems can be identified in the implementation process.

i. It is recommended to select native trees be preferably and report their planting to the responsible environmental institution for future management. In Brazil, the planting of native trees for management purposes must be reported to the competent environmental agencies, such as the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA) and the State Environmental Secretariats.

j. An example of afforestation design in Cerrado:

- Trees are planted in two rows, 48 metres apart, with the following configuration:
- Avocado (*Persea americana*): 36 trees planted every 6.5 metres in the row
- Cedro rosa (*Cedrela fissilis*): six trees planted every 39 metres in the row
- Ingazeiro *(Inga edulis*): three trees planted every 78 metres in the row
- Fedegoso (*Senna macranthera*): four trees planted every 78 metres in the row
- The selection needs to be customised on each farm. In some cases, a more straightforward framework with Mahogany and Inga could work better to get scaled than a very diverse system.

k. Regulate shade: "For Arabica, a minimum of 20% shade is generally recommended but not more than 45% to avoid negative effects on productivity. The recommended shade levels for Robusta range from 10% to 30%."[19]

l. "Pruning of companion trees ensures optimal light and microclimatic conditions for coffee growth, flowering, and fruit development. Regulating temperature and humidity in the lower levels is also important to control pests and diseases. Ideally, pruning should be planned according to climatic conditions and pruning calendars."[20]

m. For mechanised systems in Brazil, a simpler system to include shade and wood trees in the inter-rows of the coffee plots is to plant them every seven to twelve rows (e.g., 7 x 3.5m inter-rows = one line of mahogany every 24.5 metres).

[18] Pulleman et al., 2023.
[19] Pulleman et al., 2023.
[20] Pulleman et al., 2023.

Figure 6. *Diverse line on trees in Tres Meninas Farm - Monte Carmelo – Brazil [Photo Murilo Bettarello]*

Figure 7. *Mahogany and Coffee every six rows - Less diverse but easy to get scale - Bella Terra Farm [Photo by Murilo Bettarello]*

"Pruning of companion trees ensures optimal light and microclimatic conditions for coffee growth, flowering, and fruit development. Regulating temperature and humidity in the lower levels is also important to control pests and diseases. Ideally, pruning should be planned according to climatic conditions and pruning calendars."[21]

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Integrate agroforestry into the coffee production system. It is a sensitive topic, so first try to understand if the farm needs to recover any environmental areas (RL or APP), then start with a windbreak, and then check if they want to make any pilot in consortia with the trees.	☑	☑
Define the plots with the producers for planting the trees according to the area on the farm where they want to plant trees.		☑
Select the agroforestry model to be implemented with the producers and define with them the management that will be made to the trees and the crop (technical knowledge, inputs, and labour)		☑
Select the best tree species according to expected benefit, local adaptation, availability, and possibility of local spread.	☑	☑

[21] Pulleman et al., 2023.

1.3 CONSERVATION AREAS

"If the agroforestry cover is not suitable perform the local environmental conditions, trees may also be planted around the infrastructure, borders, etc; maintaining an area equivalent to 15% of the farm area in with natural vegetation." RA Scorecard – Gold Level.[22]

"Natural vegetation: Vegetation made up predominantly of native or locally adapted species, resembling in where the species' composition and structure resemble the vegetation that occurs or would occur in the absence of human interference. Natural vegetation may be managed (or, in the case of restoration, established) to incorporate a minority component of exotic species if these are beneficial for regenerating the land, adapting the ecosystem to current or future climates, and/or enhancing the biodiversity. If invasive species are present, natural vegetation is managed to reduce their presence." RA Scorecard, definition.[23]

RECOMMENDATIONS

a. There are areas of natural vegetation on AAA farms: (i) tree planting in the forest systems described in Figure 2; and (ii) buffer zones, as described later in section 5.1 Water Use & Conservation, according to the area and location description.

b. AAA Producers can define conservation and restoration areas on at least 20% of their farm area if making agroforestry arrangements in their coffee crops is impossible.

[22] Rainforest Alliance, 2022a.
[23] Rainforest Alliance, 2022a.

c. The APP (Water bodies vegetation) and RL (Legal reserve vegetation) must follow the Brazilian forest code. If necessary, these areas can be reforested and enriched with trees.

   APP – (Áreas de Preservação Permanente) Permanent Preservation Areas beside water bodies, by forest code, needs to have 15 to 30 metres of native vegetation on each side of the water bodies. The length (width) depends on the size of the water body.

   RL – (Reserva Legal) Legal Reserve – By law, a Brazilian farmer needs to have 20 to 80% of their land as native vegetation. In the coffee region of Cerrado, farmers need to have 20%.

d. Conservation areas can contribute more to biodiversity conservation if they are defined with the criteria of corridors or connections with other vegetation areas, in coordination with other farmers at a landscape level.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Identify the geographical location of farms in areas of conservation interest, buffer zones, and biological corridors.		☑
Plan conservation areas with each farm and help the farmers follow the forest code.		☑
Maintain an inventory of conservation areas on AAA farms.		☑

2. SOIL HEALTH

2.1 SOIL HEALTH ANALYSIS

Soil health is a foundational principle of regenerative agriculture. Soil Health is defined as the continued capacity of the soil to function as a vital living ecosystem that sustains plants, animals and humans. Important functions are: retaining and cycling nutrients, sequestering carbon, allow infiltration, facilitating storage and filtration of water, suppressing pests and diseases, detoxifying harmful chemicals. **Soil Health** is linked to **Plant Health** and vice versa.

Each soil has a functioning capacity. The more you understand its capacity, The less you need external input. This is a virtuous cycle!

Soil health involves integrating biological, physical, and chemical conditions. While laboratories are still in early days of providing such integrated analysis to measure soil health, it is the only way to inform regenerative practices adoption for enhanced soil quality and stability, ahead and beyond fertilization optimization.

A soil health analysis can indicate if the soil is at full functioning capacity, or is degrading or is regenerating.

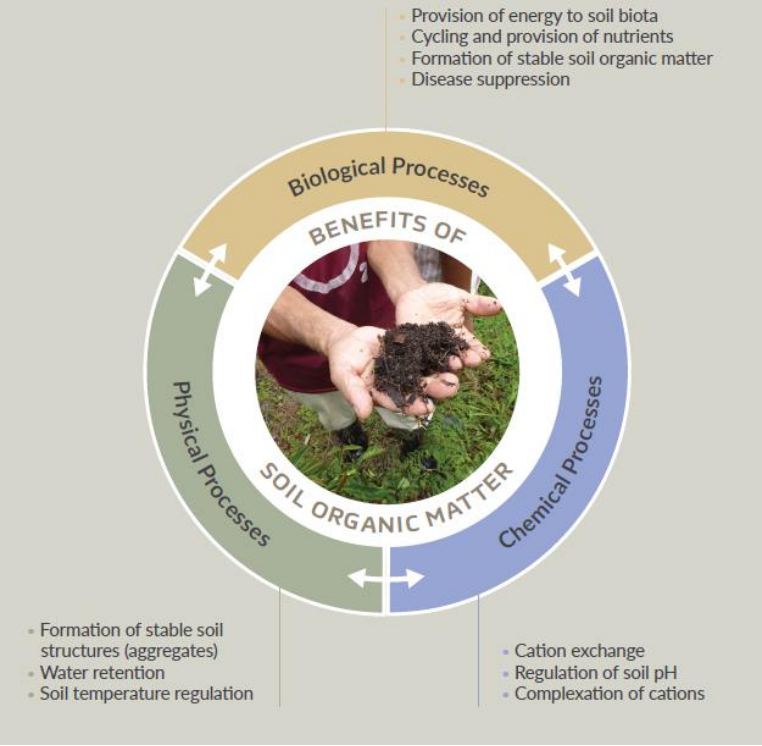


Figure 8. The benefits of soil organic matter through its effect on biological, chemical and physical processes. Source: Pulleman, M. M., Rahn, E. y Valle, J. F. (2023). CIAT., p. 23

Healthy soils are essential for high-quality and resilient agricultural production at scale.

Agricultural practices such as pesticides and fertilisation applications are unbalancing the soil biological conditions. Mechanised activities (when existing) are compacting the soil physical conditions. On the other side, practices such as tree planting, organic matter applications, cover crops, biochar applications are impacting positively the soil conditions, leading to improved water retention, reduced erosion, nutrients retention, amongst others.

Maintaining healthy soils is an investment into the farm natural capital and asset. It challenges us to shift our temporal perspective in management decisions. We are accustomed to planning activities based on the coffee crop cycle, and even fertilization is often limited to the expected results of a single year or harvest. However, this short-term horizon is insufficient to observe improvements that require more time and persistence. **Soil improvement and health must be considered over the long term**, as many changes cannot be evaluated with immediate results.

Regenerating a degraded soil takes time and optimal regenerative practices will (unfortunately) not yield productive results instantly. A new approach to fertilization should focus on enhancing the functioning capacity of the soil. Guidance on soil health analysis and recommendations on practices will continue to evolve and be made available for informed decision making.

2.2 SOIL CONSERVATION

"In addition to soil cover (...), physical structures, such as terraces, trenches, vegetative erosion barriers, or stone barriers, can help control erosion and runoff. Drainage canals and planting in furrows can allow water to infiltrate into the soil during high-rainfall events. Terracing has the additional advantage of facilitating farm operations on steep hills, but requires considerable labour and initial investment. Vegetative solutions should be prioritised over the construction of physical structures whenever possible, as the latter generally involves considerable investment in labour and/or machinery".[24]

"Monitoring soil cover and loss, implementing basic soil conservation practices according to the slope of the farm, and adjusting conservation practices as needed." RA Scorecard – Gold Level.[25]

RECOMMENDATIONS

a. For preparing the area to rejuvenate (rehabilitate) and plant new coffee plots (renovate), it is very important to adopt soil conservation practices like:
   - Dikes and small dam systems.
   - Plant cover crops or establish grasses just after tilling the soils.
   - Adopt minimum tillage practices.

b. Just sulk the rows and lines where the coffee will be planted, leave the inter-rows with natural grass, or grow the cover crops in the inter-rows.
   - Soil management before and after establishing a coffee plantation is essential. Before, adding magnesium, calcium, and phosphorus to most deep parts of the soil was crucial.[26]
   - Prefer to use slow-release fertiliser and mixture with compost and manure in the "sulk" of the coffee lines. The slow-release fertiliser, compost or organic-mineral, helps preserve soil microbiome and mitigate carbon emission.

[24] Pulleman et al. , 2023. p. 82
[25] Rainforest Alliance, 2022 a.
[26] Diaz-Chaves, 2022.

c. Measuring soil health is very important once you see the evolution of the beneficial microbes and soil food web. With the green revolution, our conventional farm system relies heavily on synthetic fertilisers or agrochemicals. These agricultural inputs are important, but using them incorrectly without considering the life of the soil can damage the soil and exterminate soil life. The regenerative practices are supposed to promote soil lives, bring back this beneficial microbiome, and promote a healthy soil food web. It is essential to measure the quality of the soil food web by analysing the soil. In Brazil, by Embrapa[27], research developed a method to analyse the soil quality index that considers chemical, physical, and enzyme content. To be healthy, the soil must have a good score in these three areas, not just for chemical areas, as most agronomists observe.

2.3 SOIL COVER

"Although cover crops can be established in existing plantations, this may prove challenging in plantations with high planting densities and shade levels (e.g., in agroforestry systems). This practice is most suitable in the first years after crop establishment or on farms with larger inter-row distances and/or no shade (as on mechanised farms and in coffee monocultures). During the first years after coffee establishment, smallholders may prefer to use intercropping (e.g., with banana, which also provides sufficient biomass residues) and thus strengthen household food and income security." [28]

"Maintaining at least 80% of bare ground covered with mulch or cover crops (preferably flowering)." RA Scorecard – Gold Level. [29]

[27] Hungria et al., 2013.
[28] Pulleman et al., 2023, p. 85.
[29] Rainforest Alliance, 2022a.

a. Leaving the soil covered with cover crops for a season is essential for improving soil structure, reducing erosion, increasing organic matter, controlling weeds, and nutrient cycling, so if farmers can leave the soil to "rest" for one crop cycle, it will benefit the coffee plot over the subsequent 15 cycles and more.

b. Pruned branches and leaves are mulched at the foot of the coffee trees. When agroforestry is implemented, "agroforestry systems offer a good strategy for soil conservation because they provide constant litter input and a canopy to protect the soil." [30]

c. Introduce cover crops during the renovation to conserve soil health and reduce herbicides in renovation areas, particularly if no agroforestry system exists. "Cover crops generally benefit coffee production by improving water and nutrient availability, but they may also compete with coffee plants for water or nutrients to some degree, resulting in yield losses. Cover crops should, therefore, be limited to the inter-row spaces. The area around the coffee plant canopy can be covered with cover crop clippings."[31]

d. In Cerrado, the recommended cover crop mix includes diverse plants. The "*Guia práctico de plantas de cobertura*" [32], includes a comprehensive reference of the benefits of the main cover species. To select the best species, consider the year's season, the agronomic topics you need to address, and the equipment available for planting. Some species are better at controlling pests, like nematodes (Crotalaria, Trigo mousico), and some are better at loosening the soil (Nabo forrageiro). Technical information can also be found in that source.

    - *Brachiaria ruziziensis*
    - Millet, *Pennisetum glaucum* (Flower presence attracts bee pollination)
    - Rattlepod Oilseed radish, *Raphanus sativus L.* (Flower presence attracts bee pollination)
    - Buckwheat, *Fagopyrum esculentum* (Flower presence attracts bee pollination)
    - Guandu anão, *Cajanus cajan (L.) Millsp* (Flower presence attracts bee pollination)
    - Mucuna-anã, *Mucuna pruriens* (Flower presence attract bee pollination)
    - Finger millet, *Eleusine coracana*
    - Crambe, *Crambe* abyssinica
    - Niger, *Guizotia abyssinica*

e. Sow the cover crop mix (14 Kg of seed/Ha) in October/November. These doses can vary from one mix of seeds to another, and it is important to follow the recommendation of the seed producer. Some mixes are more beneficial than others for specific farm challenges. One mix is better for controlling nematodes, and the other is better for

[30] Pulleman et al., 2023.
[31] Pulleman et al., 2023.
[32] Lustosa et al., 2022.

increasing organic matter in the soil, so using the right mix is very important. Follow an agronomist's recommendation to choose the best mix for each area. Treating the seeds mixed with a biological agent is also good practice control: *Trichoderma harzianum* (1mL/Kg seed) and *Bacillus amyloliquefaciens* (2 mL/Kg seed) to enable a good germination rate.

f. Mow the cover crop on every other line, in alternative rows, between December and mid-July, two to three times depending on the rain season and plant growth rate. In mid-July, the dry season ends, mow the entire area to prepare for the harvest season.

   Mowing alternative rows is very important to promote biodiversity, and natural enemies (beneficial bugs) can live in the rows of the cover crops/grass once the other rows have been mowed. It is important that some species of the cover, such as "Nabo forrageiro" or millet, have special attention. This species needs to be well managed before sowing.

The practices consist of mowing alternative rows (as shown in Figure 8 -image) every 15-20 days during the rainy season (October-March).

Figure 9. *Mow braquiaria grass in alternative rows - Floresta Coffee Farm [Photo by Murilo Bettarello]*

2.4 INTEGRATED WEED MANAGEMENT

"Use of at most one herbicide active ingredient from the list of risk mitigation pesticides in Annex S07 of the Rainforest Alliance Standard." RA Scorecard – Gold Level. Mandatory criteria[33]

RECOMMENDATIONS

a. Integrated weed management aims to alter the weed mix in the production system, favouring the presence of beneficial weeds and limiting the growth opportunities for aggressive weeds. The main weeds classified by their interference level with coffee crops are listed below.

LEVEL OF INTERFERENCE	*WEED SPECIES*		
NOBLE WEEDS: LOW INTERFERENCE WITH COFFEE CROPS	Caruru *(Amaranthus sp.)*	Beldoegra *(Portulaca oleracea)*	Picão Branco *(Galinsoga parviflora)*
MEDIUM-LOW INTERFERENCE WITH COFFEE CROPS	Braquiaria *(Braquiaria sp.)*	Pé de Galinha *(Euleusine indica)*	Apaga Fogo *(Althernatera Tenella)*
POTENTIALLY HIGH INTERFERENCE WITH COFFEE CROP	Picão Preto *(Bidens pilosa)*	Buva *(Conyza bonariensis)*	Trapoeiraba *(Commelia benghalensis)*
HIGH INTERFERENCE WITH COFFEE CROP	Capim Amargoso *(Digitaria insularis)*	Corda de viola *(Ipomea triloba)*	Grama estrela *(Cynodon nlenfuensis)*

Table 3. *Common weed species in coffee crops and their level of interference.*

[33] Rainforest Alliance, 2022a.

b. Use selective weed control measures by:
    - Removing only the aggressive weed types (such as vines, tall and broad-leaved herbs, and perennial grasses)[34] through mechanical weeding two or three times a year. Planting row; mechanised weeding; straw on cover crops on the coffee skirt; lateral brush; low toxicity herbicides (upon diagnosis).
      By mowing the cover crops or grass below the coffee skirt, we protect the soil and create mulch that makes it difficult for weeds to grow.
      For mechanised systems, we can use trenches or a specific mower that allows farmers to cut the main grass and cover the small weeds with the grass straw, like Figure 9 below.
      The mechanical mower applies the mulch produced in the coffee's inter-rows below the coffee plants. This mulch protects the soil against erosion and blocks the weed's flow for 20-40 days until this "vegetal mulch" decomposes.

Figure 10. *Floresta Farm, grass promoting natural mulching. [Photo by Murilo Bettarello]*

- Introducing cover crops (see 2.3 Soil cover): If there is a good amount of cover crops, aggressive weeds are suppressed, contributing to reduced use of herbicides.
- Using integrated weed management and promoting cover crops can reduce the use of herbicides by up to 20%[35]
- Selectively preserving harmless or beneficial species (such as those that harbour beneficial species – e.g., natural enemies of coffee pests). [36]
- Rotating active ingredients to avoid weed resistance.

c. "If the use of chemical herbicides cannot be avoided, the product applied should be as specific as possible to reduce negative effects on non-target species and human

[34] Pulleman et al., 2023.
[35] Freitas et al., 2008.
[36] Pulleman et al., 2023.

health. Spot applications of herbicides on aggressive weeds can optimise chemical use, reducing the number of applications and dosage. The rooting zone of the coffee plants (...) is the main focus area to reduce weed competition for water and nutrients. (...) Correct dosage, the use of protective clothing, and proper storage and disposal of the products and packaging materials are imperative for reducing risks to the environment and human health. Only herbicides permitted by sustainability standards should be used, and label directions must be followed precisely."[37]

d. Use at most one active ingredient from the list of risk mitigation pesticides and eliminate banned herbicides as per Rainforest Alliance Standard, Annex Chapter 4. [38] (i.e., Glufosinate-ammonium and Paraquat dichloride). Only products flagged as belonging to the risk mitigation list can be used, and only one can be used, as per the Regenerative Coffee Scorecard Gold level. Follow the practices recommended for the risk mitigation status all the time. Table 4 shows the herbicides used in coffee farms in Brazil.

ACTIVE INGREDIENT	CAS NUMBER	RAINFOREST ALLIANCE CATEGORY
2,4-D	1928-43-4	Risk mitigation
Diuron	330-54-1	Risk mitigation
Diquat dibromide	85-00-7	Risk mitigation
Flumioxazin	103361-09-7	Risk mitigation
Glufosinate-ammonium	77182-82-2	Prohibited
Glyphosate	38641-94-0	Risk mitigation
Paraquat dichloride	1910-42-5	Prohibited

Table 4. *Herbicides used in coffee in Brazil. Rainforest Alliance status of use (Updated: June 01,2024)*[3940]

e. Weed or cover crops as a natural host for beneficial bugs. Some weeds or cover crops can help attract and host natural enemies. These weeds can be preserved, or cover crops can be planted to attract beneficial bugs and pollinators. The main species are the ones that flower and are easily controlled by mechanical control like bush cutters. We need to avoid aggressive plants that are hard to control and can cause damage to coffee yields. Research shows that good management of weeds and cover crops can attract natural enemies like "pisilidio" (*Proacrias coffeae*) and promote up to 30% leaf miner reduction.[41]

[37] Pulleman et al., 2023.
[38] Rainforest Alliance, 2022. Annex to Chapter 4: Agricultura Documento SA-S-SD-22. https://www.rainforest-alliance.org/wp-content/uploads/2022/06/SA-S-SD-22-V1ES-Anexo-al-Capi%CC%81tulo-4-Agricultura.pdf
[39] Rainforest Alliance: https://www.rainforest-alliance.org/wp-content/uploads/2023/07/SA-P-SD-9-V1.5-Rainforest-Alliance-Exceptional-Use-Policy.pdf
[40] Ministerio da Agricultura, Pecuária e Abastecimento, 2024. https://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons
[41] Calderón-Arroyo et al., 2023.

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Run a soil health analysis and define soil conservation and improvement practices prior to analysis focusing on plant nutrition.		☑
Promote actions with producers to protect and conserve the soil, such as slope and runoff management, terraces, drainage, and living barriers. Promoted actions should be according to the farm's slope.		☑
Implement soil conservation actions, such as integrated weed management, cover planting and cover crops.		☑
Eliminate the use of prohibited herbicides.		☑

3. PLANT NUTRITION

3.1 SOIL ANALYSIS

"Key components of Integrated Nutrient Management (INM) include: (i) addressing constraints that limit crop response to fertilisation, such as soil acidity, ageing of coffee plants, and shade density; (ii) balanced and efficient fertiliser use based on the 4R concept (right source, right rate, right time, and right place); and (iii) management of organic resources to improve soil health and stimulate biological nutrient cycling. In line with the principles of circular agriculture, INM seeks to recycle nutrients from residue and waste streams generated on and around the farm. AgroecologicalAgro-ecological conditions (such as soil type, topography, and climate), production practices, and the age as well as and phenological stage of the coffee plants all have a strong effect on nutrient requirements, and this which should be taken into account when making fertilisation plans."[42]

"Conducting a soil assessment and analysis including, if relevant:, Erosion -prone areas and slope; Soil structure; Soil depth and soil horizons; Densification of compaction areas; Soil moisture and water level in the soil; Drainage conditions; Identification of areas with visual symptoms of nutrient deficiencies; Soil organic matter"" RA Scorecard – Gold Level.[43]

"Soil testing must be done at the right time (at least 3-4three to four months after the last fertilisation) and repeated regularly (every 2two to 3three years). The use of proper sampling protocols is also critical for ensuring that results are representative of the specific plot or farm; large, heterogeneous farms require multiple tests." [44]

[42] Pulleman et al., 2023. pp. 107-108
[43] Rainforest Alliance, 2022 a.
[44] Pulleman et al., 2023. p.113

a. Soil analysis (samples 0 to 20 cm and 20 to 40 cm deep) should be performed every ear to assess nutrient needs. It is also recommended that leaf analysis be run to calibrate the nutrient application during the rainy season. Evaluating soil fertility requires chemical, physical and, biological analyses.

b. All practice recommendations must be based on soil and leaf analysis and accompanied by specialised professionals to support and help interpret the analysis and check the science behind the recommendations.

c. Soil correction must be performed one year before the renovation based on soil analysis using lime, gypsum rock powder, natural phosphorus, and organic compost.

d. Perform soil bioanalysis to understand the life of the soil and how it is evolving. If the soil life is low, farmers can apply more beneficial microorganisms and increase compost use[45] to improve the BIOAS levels of the soil.

Figure 11. *Soil with a good life under coffee trees. Fazenda Floresta [Photo by Murilo Bettarello]*

[45] Embrapa, 2021.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Identify the soil's chemical, physical, and biological composition with soil analysis.		☑
Identify constraints to fertilisation response. Consider soil acidity correction, crop age, shade level, soil compaction, or degradation.		☑
Consider solutions based on improving soil organic matter levels and apply a diversity of microorganisms.		☑
Propose fertilisation plans considering the agro-ecological conditions of the crop, crop management practices, and soil analysis results.		☑

3.2 LOW CARBON & EFFICIENT FERTILISATION

In the analysis of CO_2 equivalent emissions on AAA farms in Brazil, using the Cool Farm Tool methodology, it was identified that 78% of the GHG footprint at the farm level is related to the production and use of fertilizers. As a course of action to reduce this footprint, efforts will focus on three principles.

(I) A healthy soil is a fertile soil. Working on improving soil first will improve the entire ecosystem which ultimately benefit coffee production.

(II) Nitrogen source is key (Nitrate, ammonium and/or urea) as each one has a different reaction and GHG emission factor. [46]

(III) Nitrogen is the main source of GHG emission but Nitrogen must be analysed in relation to production.

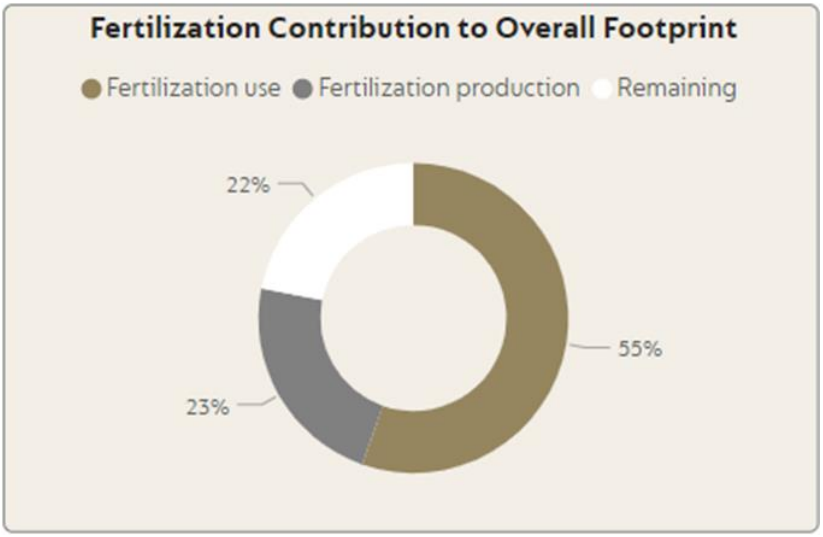


Figure 4. *Fertilization contribution to overall GHG Footprint - Brazil*
Source: Nespresso, 2023/2024 cycle.

There are several sources of nitrogen fertilisers with different percentages of nitrogen contribution. Table 4 details some fertilisers that provide nitrogen with their various chemical forms.[47] The most significant differences between nitrogen fertilisers are related to nitrogen volatilisation and leaching processes. Nitrogen losses through volatilisation are more significant in urea than in ammonium nitrate; The opposite occurs with leaching.[48] It is vital to understand the potential emissions of NO_2, considering the potential effect of equivalence in terms of CO_2. Fertilisers based on N-Ureic must be avoided.

[46] YARA International, 2011.
[47] YARA, 2023, p. 4.
[48] Sadeghian, y González-Osorio, 2002.

NITROGEN SOURCE	NUTRIENT CONTENT (%)			
	N-Total	N-Ureic $CO(NH_2)_2$	N-ammonium NH_4	N-Nitrate NO_3
Urea	46	46		
Ammonium sulphate	21		21	
Ammonium nitrate	33.5		16.9	16.9
MAP (Mono-ammonium phosphate)	10-11		10-11	
DAP (Diammonium phosphate)	16-21		16-21	
Calcium nitrate	15.5		1.1	14.4
YaraBela Nitromag	21		10.5	10.5
Nitrax-S	28		17.5	10.5
YaraVera Amidas	40	35	5	

Table 1. *Nutrient content – commonly used fertilisers.*

RECOMMENDATIONS

a. Fertiliser applications should be divided into the phenological phases of higher nutritional demand as in the table below (Table 5), always according to the analyzes of soil and leaves the interpretation. For regenerative practices, farmers should prefer local sources of nutrients and organic and low-solubility sources of nutrients, such as NPK.

PHENOLOGICAL PHASES OF HIGHER DEMAND	APPLICATIONS
Previous Induction of floral	Lime
After flowering	1st, fertilisation with Nitrogen and Potassium
Beginning of fruit formation	2nd fertilisation with Nitrogen, Phosphorus (if needed), and Potassium
Fruit expansion	3rd fertilisation with Nitrogen and Potassium
Filling of the fruits	4th fertilisation with Nitrogen and Potassium
	Compost can be gradually added to substitute chemical NPK for organic and local fertiliser - start substituting ~30% and increase over the years.

Table 5. *Fertilisation higher demand in a crop year - Brazil*

b. Good practices substitute at least 30% of the conventional NPK for other sources like compost, organo-mineral or slow-release fertiliser. **Table 6 lists the organic matter sources recommended as part of the coffee fertilization recommendations.**

NAME	TYPE
Organomineral	Different formulas with NPK are mixed with organic matter to stabilize the NPK in the formula.
Chicken manure	Residue from chicken farming.
Cattle manure	Residue from cattle farming.
Treated **coffee wastewater**	Compost liquid from washed coffee.
Compost	Organic matter is composted in different ways
Organic residue from local industry	This is derived from the local industry and has been well-analyzed with no contaminants.
Coffee Husk	Coffee husk from the coffee farm.
Wood chips	Wood chips from local sources.
Composted coffee pulp	Composted coffee pulped.

Table 6. *Fertilisers list with organic sources in Brazil*
Note: Fertilizers that have organic matter have low solubility and lower carbon emission.

c. Use nitrogen-fixing bacteria and biological inputs for acidity control. Usually, a coffee farm with productivity of less than 2.5 tons of green coffee/per hectare will need 300 Kg of nitrogen per year. The combined use of bacteria, cover crops, legumes, and organic fertiliser allows for substituting 10-30% of nitrogen in the application.

d. Use compost in liquid form (compost extract, compost tea bokashi), infused in water that contains beneficial microorganisms from the farm, nutrients, and humic acids to improve the microbial relationship of the soil, nitrogen fixation, and decomposition of organic matter and crop nutrition.

e. Farmers can use biological inputs instead of chemicals for nematode control. Use biological nematicides that allow the plant to absorb nutrients better. The following microorganisms can be used to promote root resistance and also reduce nematodes in a regenerative farm. We recommend applying these microorganisms two or three times a year; based on the soil health analysis, the application can be made in the leaves of soils. For soils, the best time is in the rainy season, from October to January.
    - *Bacillus subtilis*
    - *Bacillus amilolichefaciens*
    - *Bacillus aryabhatai* (Also add drought resistance)

- *Tricoderma* beneficial fungus.
- *Beuveria basiana* (Used to control coffee berry borer).
- *Metharizium* (Use to control insects)
- *Bacillus megaterium* (Use in the soil to increase nutrient efficiency in roots)

f. Prioritise organic fertilisers, especially those composed of raw materials from the farm itself or fertilisers that have the characteristic of slow nutrient release.

g. Several additional factors, including the coffee tree's age, the selection of well-adapted varieties, appropriate planting densities, the implementation of agroforestry practices, integrated weed and pest management, and soil conservation measures, can all influence the effectiveness of fertilisation recommendations. Effective crop management should address any potential limitations that may hinder the crop's response to fertilisation, thereby optimising the utilisation of fertiliser inputs. [49]

h. Based on the soil analysis, leaf analysis results and following the 4R concept, efficient levels of synthetic fertiliser should be applied to the productivity level. "The 4R concept focuses on optimising fertiliser use efficiency and effectiveness by applying the "right source of nutrients, at the right rate, at the right time, and in the right place".[50]

i. A recommendation for a source with better nitrogen efficiency, like nitrate ammonium or 20-00-20, with urea protection or slow-release fertiliser (organo-mineral or protective N), reduces nitrogen volatilisation. Farmers should also try to apply in different rounds per the following approach: at least four 300 kg/hectare applications in October, November, January, and February.

   It is crucial to base this on soil analysis, a primary decision factor for plant nutrition. On average, a plot with a yield expectation of 2.4 to 3 tons per hectare will supply the plants with at least these macronutrients.

   - N (Nitrogen)- 270-330 kg per hectare
   - P (Phosphorus) - 60-100 kg per hectare
   - K (Potassium) - 200-280 kg per hectare
   - C (Calcium) - 200-300 kg per hectare
   - Mg (Magnesium) - 80-180 kg per hectare.

j. Add micro-nutrients such as Zinc, Boron, Manganese, and Iron to stimulate plant resistance. It is always based on soil and leaf analysis.

k. Ensure that the crop and leaves have balanced macro and micro-nutrient levels.[51]

[49] Pulleman et al., 2023.
[50] Pulleman et al., 2023.
[51] Malavolta et al., 1993.

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Recommend fertilisation sources with the best nitrogen use efficiency (NUE) and proper planning of dosage, timing, and place of application.		☑
Define interventions to promote and encourage adopting efficient nitrogen fertiliser use based on the previous recommendations.	☑	☑

3.3 ORGANIC FERTILISATION

"The availability of organic residues determines to what the extent that organic inputs can substitute for or complement mineral fertilisers. Coffee farms generally do not generate sufficient organic residues to fully satisfy the plant nutrient demand. Synchronization of Synchronising nutrient availability with crop demand can also pose challenges when using organic inputs are used. Therefore, combined use of combining mineral and organic fertilisers is the recommended option. The establishment of local capacity to produce quality organic inputs from local waste streams on larger coffee farms or in smallholder coffee communities should also be encouraged."[52]

"Applying organic fertiliser, or composted organic matter, on at least 75% of the farm, when possible, using organic material coming from the own farm" RA Scorecard – Gold Level. [53]

Photo by Diego Branquião

RECOMMENDATIONS

a. Recycling organic matter is crucial for maintaining or restoring soil organic matter content. Soil organic matter positively impacts chemical, physical, and biological soil properties and processes. It influences nutrient retention and cycling, cation exchange capacity, and buffering soil acidity in chemical processes. In physical processes, organic matter improves soil structure, regulates soil temperature, and enhances water retention and purification. Organic matter is also the primary energy source for soil biota, affecting nutrient cycling, fertilizer efficiency, and plant disease regulation. [54]

b. Other regenerative practices should be implemented to increase soil fertility (see 1.2 Agroforestry, and 2.3 Soil Cover). Agroforestry enhances soil life and nutrient cycling. [55]

[52] Pulleman et al., 2023, p. 121.
[53] Rainforest Alliance, 2022a.
[54] Pulleman et al., 2023, p. 23
[55] Pulleman et al., 2023.

Mulching and cover cropping also enhance nutrient cycling, especially when living roots are present, as with cover cropping, and when N-fixing crops are used. [56]

Based on the results of the soil analysis:

c. Add composted pulp when available at scale. Compost coffee husk with a local organic fertiliser (i.e., manure) and add bokashi and slow-release fertiliser. This can be done on the farm. Another option is to farm and use compost tea, like the soil food web system.[57]

d. Apply two to eight tons per hectare as a substitute for chemical NPK fertiliser (Nitrogen, Phosphorus, and Potassium, the three primary nutrients that plants need to grow).

e. A good compost should have balanced and stable organic matter and the right mix of nutrients. It is well-balanced with NPK and micro-minerals. Good compost usually has a good mix of organic matter sources, and this organic matter is stable in the final product.

f. A suitable compost needs to have a C/N relation between 20-30/1. It allows the compost to be stable and nutrients to be released quickly. Also, farmers can add different types of nutrients like sulfur, rock powder, magnesium (Dunit), and other types of organic matter besides coffee husk. A good balance of coffee and animal manure is two for one part of coffee husk. [58]

g. Add organic/organo-mineral fertilisers & biofertilisers such as biochar coffee processing residues, cattle manure, stonemeal amendment (incorporating rocks and/or minerals to the soil), and soil bioactivation with beneficial microbes.

h. Beneficial microorganisms can help decompose minerals and make nutrients from organic matter, compost, or mineral rock available to plants. The main microorganisms used in Brazil can be isolated species or communities of beneficial microorganisms.
Isolated species can be bought from commercial companies or even be multiplied on the farm in an “in-house” system. Some examples of isolated species:
    - *Tricoderma* spp. A fungus that promotes root development and prevents phytopathogenic fungus like *Fusarium*.
    - *Bacillus subtilis* promotes the root system and protects it from nematodes.
    - *Bacillus araybathai*. It promotes the root system, helps regulate root osmosis, and improves drought tolerance.
    - *Azospirilum* – Fixes nitrogen and regulates root hormones.

    Examples of communities of microorganisms:
    - Beneficial microorganisms made on farm.
    - Bokashi
    - Soil food web compost tea.[59]

[56] Pulleman et al., 2023.
[57] Soil Food Web School, 2024.
[58] De Souza et al., 1998.
[59] Leaf & Limb, 2024.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Promote the application of compost according to the availability of organic matter on the farm. Prioritise using this and other available sources of organic matter on the farm.		☑
Identify the availability of sources of organic matter in commercial products within the local context.	☑	
Apply biological products such as compost tea or bokashi to improve the roots' absorption of nutrients and promote better solubilisation of the rocks.		☑

4. PLANT HEALTH

4.1 INTEGRATED PEST MANAGEMENT (IPM)

"Reducing the use of pesticides (2two or less fewer ingredients from the risk mitigation list), and eliminating the use of synthetic chemical nematicides on the farm" RA Scorecard – Gold Level – Mandatory criteria.[60]

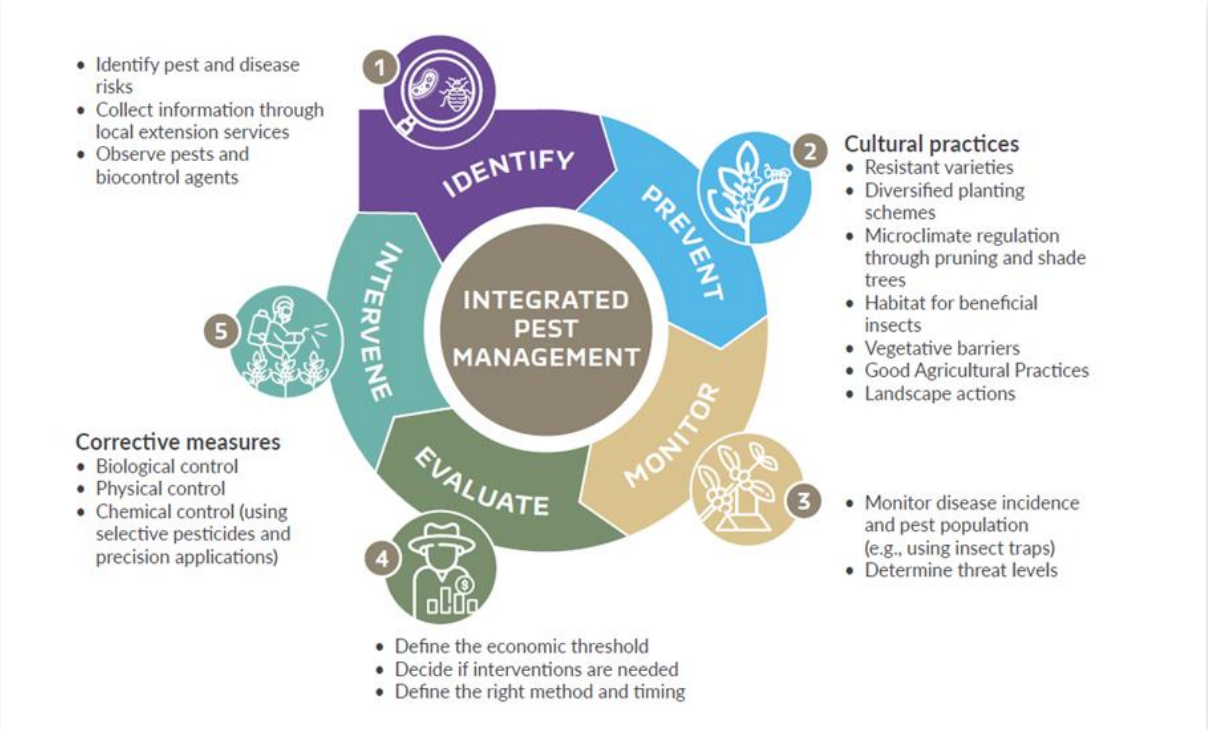


Figure 11. *Key components of an integrated pest management approach*
Source: Pulleman et al.,2023, p. 97.

RECOMMENDATIONS

a. Implement preventive measures consisting of cultural practices ranging from resistant varieties, diversified planting schemes, microclimate regulation, and habitat provision to support natural enemies of pests and diseases. Cultural measures also include Good Agricultural Practices that reduce the risk of pest or disease proliferation, such as removal and appropriate composting of infected plant organs.[61]

[60] Rainforest Alliance, 2022a .
[61] Calderón-Arroyo et al., 2023.

b. Pests and diseases can cause severe damage and decrease productivity by up to 80%. Farmers must understand the main pests and diseases that affect the farm and promote the best-integrated management of these pests[62].

c. Monitor disease incidence and pest population and evaluate if interventions are needed.

d. Use biological control:
   - Introduce specific biocontrol agents, such as microbial inoculants or releasing beneficial insects (e.g., fungi and bacteria). These can be bought or produced 'on the farm':
     - Spinosina (Biological enzyme from Saccharopolyspora spinosa) – used for leaf miner control
     - *Bacilus subtilis* – Rust control
     - *Bacilus thurginiensis* – Leaf miner control
     - *Beuveria bassiana* – Berry borer control
     - *Tricoderma* spp – Fungus and nematode control
     - *Bacillus Arabathay* – Drought resistance
   - To apply available biopesticides, check the CABI BioProtection Portal.[63]
   - Preserve and enhance native populations of natural enemies in coffee farms: birds, lizards, ants, lady beetles, mites, predatory and parasitoid wasps, and beneficial microorganisms can help control coffee pests and diseases. It requires protecting the natural habitats on farms or enhancing the habitat quality of the coffee production system. These measures strongly complement other regenerative practices, such as agroforestry, intercropping, cover cropping, and integrated weed management. Selective conservation of noble weeds, intercropping, and cover crops can be helpful when the species provide resources for beneficial insects. Shade trees can also favour the abundance of natural control agents.[64]

e. Use physical control measures. Different traps – mechanical, light, pheromone, or alcohol – may be used for this purpose.[65] A coffee study in Brazil shows that coffee traps used at 20-30 traps per hectare can keep the infestation level of coffee berry borer (CBB) under control and reduce more than 57% of the number of beans affected by CBB. [66]

f. It is also used to cover crops, such as intercropping and cover crops, beyond increasing soil organic matter and microbiome. The cover crops help increase the number of natural enemies. Studies show that Phytophagous mites from the *Tetranychidae* family were less abundant when coffee was intercropped with *C. juncea*. Their predators, Phytoseiidae mites, were more abundant on coffee intercropped with *C. juncea* and *C. juncea* plus *F. esculentum*.[67]

[62] Mesquita et al., 2016.
[63] CABI,2022.
[64] Pulleman et al., 2023.
[65] Pulleman et al., 2023.
[66] Lesmes et al., 2014.
[67] Da Consolação et al., 2021.

g. Apply chemical control only as a last resort and keep usage to a minimum. Use only the correct dosage and precision applications of selective pesticides (two or fewer ingredients from the RA risk mitigation list) following directions for usage, as described on the label, in line with Rainforest Alliance Standard Annex, Chapter 4. – See Chapter 4 for - Risk mitigation and prohibited pesticides in Annex Chapter 4. [68]

USE	ACTIVE INGREDIENT	RAINFOREST ALLIANCE STATUS
Fungicide	Azoxystrobin	Risk mitigation
Fungicide	Benomyl	Prohibited
Fungicide	Boscalid	No reported
Fungicide	Carbendazim	Prohibited
Fungicide	Cyproconazole	Prohibited. *With exception until 2024*
Fungicide	Flutriafol	No reported
Fungicide	Hexaconazole	No reported
Fungicide	Copper hydroxide	Risk mitigation
Fungicide	Mancozeb	Prohibited. *With exception until 2024*
Fungicide	Copper oxychloride	Risk mitigation
Fungicide	Pyraclostrobin	Risk mitigation
Fungicide	Copper sulphate	Risk mitigation
Fungicide	Tebuconazole	No reported
Fungicide	Thiophanate Methyl	Risk mitigation
Fungicide	Thiabendazole	Risk mitigation.
Fungicide	Triadimefon	No reported
Fungicide	Trifloxystrobin	Risk mitigation
Insecticide	Abamectin	Prohibited-2025
Insecticide	Alphacypermethrin	Risk mitigation
Insecticide	Carbaryl	Risk mitigation
Insecticide	Chlorantraniliprole	No reported. *Not allowed as a mixture with Thiamethoxam*
Insecticide	Chlorpyrifos	Prohibited
Insecticide	Cypermethrin	Risk mitigation
Insecticide	Cyantraniliprole	No reported
Insecticide	Fenitrothion	Risk mitigation
Insecticide	Fentoato	No reported
Insecticide	Fipronil	Prohibited
Insecticide	Lambda -cyhalothrin	Risk mitigation
Insecticide	Lufenuron	Risk mitigation
Insecticide	Sodium octaborate	Prohibited-2025
Insecticide	Thiamethoxam	Prohibited -2024. Not allowed as a mixture

Table 7. Fungicides and Insecticides used in Brazil and Rainforest Alliance use status. (Updated: June 01,2024)[69] [70]

[68] Rainforest Alliance,2022b. Annex to Chapter 4: Agricultura Documento SA-S-SD-22. https://www.rainforest-alliance.org/wp-content/uploads/2022/06/SA-S-SD-22-V1ES-Anexo-al-Capi%CC%81tulo-4-Agricultura.pdf

[69] Rainforest Alliance: https://www.rainforest-alliance.org/wp-content/uploads/2023/07/SA-P-SD-9-V1.5-Rainforest-Alliance-Exceptional-Use-Policy.pdf

[70] Ministerio da Agricultura, Pecuária e Abastecimento, 2024. https://agrofit.agricultura.gov.br/agrofit_cons/principal_agrofit_cons

h. Control leaf miner. Usually, a farmer will apply around three to four rounds of insecticide during drought months. Recent studies showing promising results matching a *Metharizium spp* and Spinosina suggest that farmers can substitute chemicals for biological control in one or two instances out of the three to four rounds typically needed.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Promote the implementation of Integrated Pest and Disease Management. Create IPM plans at the cluster and farm levels.	☑	☑
Favour cultural and biological control practices over synthetic chemical control.		☑
Implement biofactory and biological control on the farms.		☑
Eliminate the use of prohibited pesticides and fungicides		☑

5. WATER

5.1 WATER USE & CONSERVATION

"Reduction of total water usage during processing (per unit of product) and have better efficient use of the significantly reducing irrigation from off-farm water sources.." RA Scorecard – Gold Level. [71]

"Ensuring that aquatic ecosystems are surrounded by riparian buffers of natural vegetation following the RA standard width parameters. RA Scorecard – Gold Level." [72]

RECOMMENDATIONS

a. Implement cultural measures for water-efficient coffee cultivation, such as planting drought-tolerant varieties, maintaining soil cover, and increasing soil organic matter.[73]

b. Use structural measures, such as digging trenches or pits or harvesting rainwater using reservoirs or collection basins where needed.

c. 'Cultivate' and hold water on the farm, like the Barraginha project Embrapa 1998[74] .Farmers can adjust their soils and land to hold water for their use and improve it for others. The small dams (Barraginhas) distributed over the farmland to hold water and decrease the speed of runoff water can improve water availability and increase the volume of water bodies.

d. Further 'cultivate' water on the farms. Farmers should keep the riparian vegetation with well-established trees (Permanent protection areas – APP) at more than 15 metres wide along the water bodies and springs.

[71] Rainforest Alliance, 2022 a.
[72] Rainforest Alliance, 2022a.
[73] Pulleman et al., 2023.
[74] Embrapa, 1998.

e. Install and use a smart irrigation system (SIS) to promote efficient water use when irrigating. The SIS should have a tensiometer and sensors to measure soil moisture and analyse local rainfall to help farmers determine the right amount of water to use in irrigation.

Figure 12. *Two types of smart irrigation systems: 1- Simpler bottle system development by Embrapa, and 2- Digital system development by startup Pitaya. Floresta Farm – [Photo by Murilo Bettarello]*

f. Plan irrigation needs and timing based on the phenological stage of the coffee crop, climatic conditions, and soil type and depth. Consider the need for irrigation to ensure the synchronisation of flowering.[75]

g. Use clean water to avoid spreading plant pathogens or pests like nematodes. Test water quality to assess the risk of salinisation and contamination (i.e., conductivity, hardness, heavy metals, etc.). [76]

h. Perform maintenance and periodic irrigation system checks to ensure no leaks or obstructions. [77]

i. Keep records of the amount of water used and compare it to the amount of coffee produced to assess water-use efficiency.

[75] Pulleman et al., 2023.
[76] Pulleman et al., 2023.
[77] Pulleman et al., 2023.

j. Farmers should adopt optimal irrigation techniques according to their reality, such as smart irrigation equipment and soil sensors. They should keep a rainfall record, as irrigation is critical to retain soil moisture at optimal levels[78].

As in Figure 13, farmers should adopt the optimal level and best soil moisture to allow the best soil capability to hold water. Using sensors is very important. According to field trials, the optimal levels are between 0.1 and 0.3 atm.

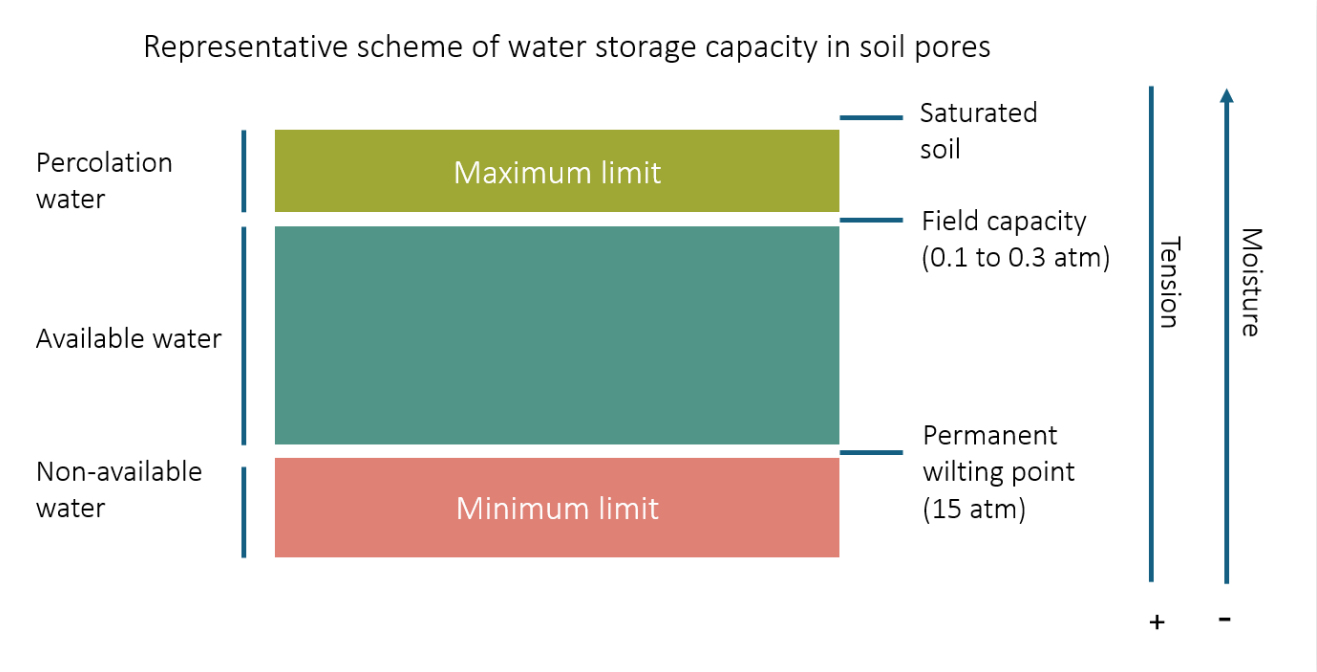


Figure 13. *Water moisture in the soils keeps the best levels for plant growth. Source: Vinivius and Texeira, 2013.* [79]

[78] Vinivius and Texeira, 2013.
[79] Vinivius and Texeira, 2013.

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Promote and incentivise technology adoption to reduce water consumption for coffee processing and other home uses.	☑	
Define actions with the producers for the rational use of water, considering the maintenance of water distribution networks and the reduction of consumption in the home.		☑
When farmers use efficient irrigation systems, such as the Smart Irrigation System,		☑
Implement wastewater treatment according to the capacity and conditions of each farm.		☑
Identify and conserve the riparian buffer zones in each farm following the criteria of the Rainforest Alliance Regenerative Coffee Scorecard (Gold level)		☑

5.2 WATER TREATMENT

For the farmers that wash coffee and use a wet process in the post-harvest process, it is important to have:

a. A recycling system where they can reuse the water from washing the coffee cherries.

b. Monitor the water consumption; best-performing farms can use less than one litre of water per kg of coffee parchment washed.

c. The farms should have a sewage tank to treat the sewage of farmhouses.

6. FARM FINANCIALS

6.1 FARM FINANCIALS

"Regenerative agriculture seeks to improve coffee farmers' livelihoods by achieving these objectives:

- ***Improving productivity and income.***
- ***Strengthening food security.***
- ***Ensuring good labour conditions, health, and safety.***
- ***Diversifying production and sources of income."*** [80]

"Monitoring costs of production costs and calculating revenue from the sale of coffee", "-Creating farm management or business plans", "When appropriate, diversifying income streams, and adjusting business practices as necessary. RA Scorecard – Bronze, Silver & Gold. [81]

In Table 8, we see some impacts of adopting the agronomic guide on income, resilience, and potential risks. As described in Figure 5, the same technology can yield different outcomes depending on the initial conditions of the production model.

	HIGHER INCOME	RESILIENCE EFFECT	RISKS AND UNCERTAINTIES FOR FARMERS
Farm Design: Renovation and rehabilitation	In the medium and long term, once the new plots can increase the yield	Yes, once the new plots have resistance varieties, cover crops, organic fertilisers, and windbreaks,	It is very costly to establish new coffee plants, so farmers need to take care of the cash flow once the rejuvenation of a coffee plot has at least three years of payback.
Farm Design: Agroforestry	No	Yes, shade can promote drought resistance	Shade can decrease yield.
Soil health and organic matter management	Yes, better soil promotes better yields	Yes, better soil makes plants more vigorous and more resistant.	Farmers need financial mechanisms to incentivise the investment of increasing organic matter on the soil.
Plan nutrition	Yes, a nursing plant produces a better yield	Yes, a nourishing plant is more resilient.	Technical assistance and soil analysis are fundamental to having good plant nutrition.
Plant health: Integrate Pest Management	Yes, farmers can save money on ag agro-inputs	Not direct	Technical assistance is very important essential to ensure good and valuable IPM control.
Water management	Lower irrigation and energy cost	Better water management can promote better use of irrigation and better plants.	

Table 8. *Expected impacts of adopting the agronomic guide on the economy of AAA farmers.*

[80] Pulleman et al., 2023, pp. 34-35
[81] Rainforest Alliance, 2022 a.

RECOMMENDATIONS

a. Reduce production costs by adopting regenerative practices such as soil conservation, integrated nutrient management (using organic material from the farm), natural weed and pest control, and efficient water management.

b. Monitor production costs and calculate revenue from coffee sales.

c. Create a farm business plan, including renovation, machine investments, infrastructure, and training.

d. Farmers should also diversify their crops and balance their income from other crops. Diversify income streams through agroforestry and generate revenue from selling wood, like mahogany, teak, or cedar, or consider planting fruit trees, such as avocados, which combine with coffee trees.

e. Farmers should also have good financial and cash flow management once they establish a coffee plot and medium- and long-term payback.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Schedule farmers' training and field days to share positive experiences in the gold-level farms (most advanced farms)	☑	☑
Promote technical debate between farmers and agronomists from the clusters to share experiences on decreasing the use of chemicals and not using the agrochemicals on the mitigation list.	☑	☑
Promote training in using bio inputs and quality control of such inputs.		☑

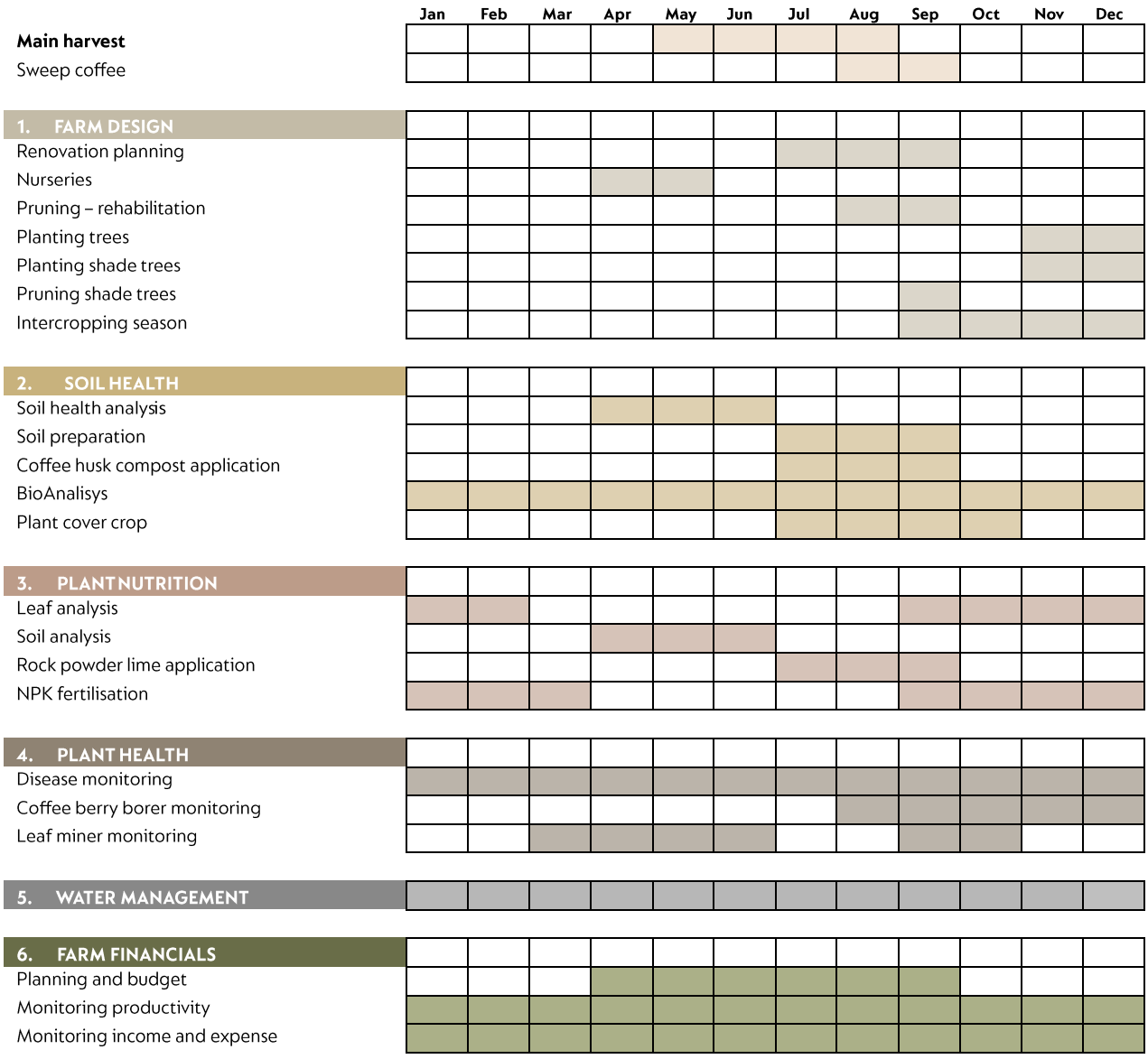
ANNEXES

ANNEX 1

AGRONOMIC REGENERATIVE GUIDE - BRAZIL

Calendar for the main activities in the different clusters, based on weather and harvest distribution.

Coffee Year Calendar for Brazil Custers



ANNEX 2

LOCALISATION OF IMPLEMENTATION CRITERIA FOR THE REGENERATIVE COFFEE SCORECARD OF RAINFOREST ALLIANCE

These criteria have been reviewed by the Rainforest Alliance, based on the recommendations and arguments of this agronomic guide.

	LEVEL	SCORECARD CRITERION
CROP RESILIENCY **FARMS IMPLEMENT GOOD AGRONOMIC PRACTICES INCLUDING:**	Gold	Replanting or renovation, implemented to ensure at least 50% of plot in young or middle age (≤ 8 years) trees
LOCALISATION FOR BRAZIL	As illustrated in Figure 1, there are local definitions to understand the different interventions that help keep coffee trees young, thereby promoting better productivity and quality. All these interventions, whether through tissue management (pruning) or replacing trees with new trees are equivalent to the concepts of "Replanting and Renovation" in the Rainforest Alliance Regenerative Coffee Scorecard.	

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