COSTA RICA

REGENERATIVE AND HIGH QUALITY COFFEE AGRONOMIC GUIDE

VERSION 1.1

OCTOBER 2024

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.

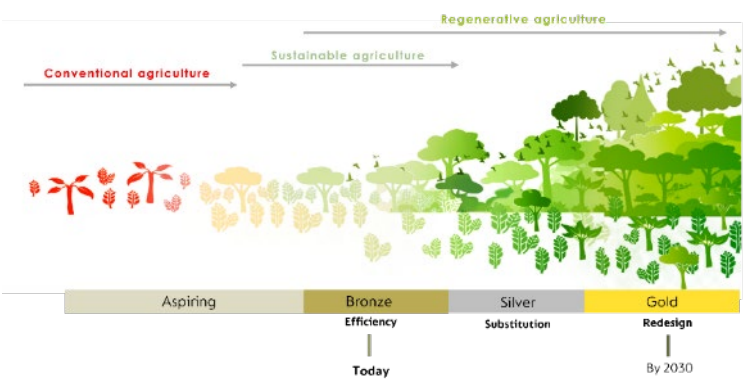
In this new chapter, Sustainable Quality will further integrate high quality coffees with healthy ecosystems, quality of life and thriving communities.

Nespresso and the rainforest alliance share a common vision of regenerative agriculture building on 3 foundational principles:

I. Produce in ways that actively restore and protect biodiversity in-and-around production areas.
II. Reduce greenhouse gas emissions, adapt to climate change and build resilience in the farm.
III. 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.

COSTA RICA

This document aims to guide the implementation of regenerative coffee growing in the field, training, support work for 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 Costa Rica.

Regenerative agriculture is about change management, therefore relies on motivation, knowledge, and resources to ensure the transition of the practices. *Nespresso* provides to the AAA farmers, the enabling conditions for a smooth change management, price premiums paid by AAA coffee, investment, infrastructure 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 guarantee optimism for transforming coffee production with a positive impact.

Nespresso acknowledges the contributions of coffee partners in Costa Rica, ECOM, and Volcafe. 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 Costa Rica; this guide 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]

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 is deployed. These three principles require a mindset change of the producers and the coffee partners *Nespresso* works with.

I. By Design, the farm generates organic materials and natural biocontrol.
II. Soil Health first before plant nutrition
III. Resilience and profitability vs. productivity

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.

[1] Pulleman et al., 2023, p. 16.

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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." [2]

"Healthy and productive trees, well adapted to the local agroecological conditions and farming systems, are a basic prerequisite for obtaining a good response to the adoption of any (regenerative) practice." [3]

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

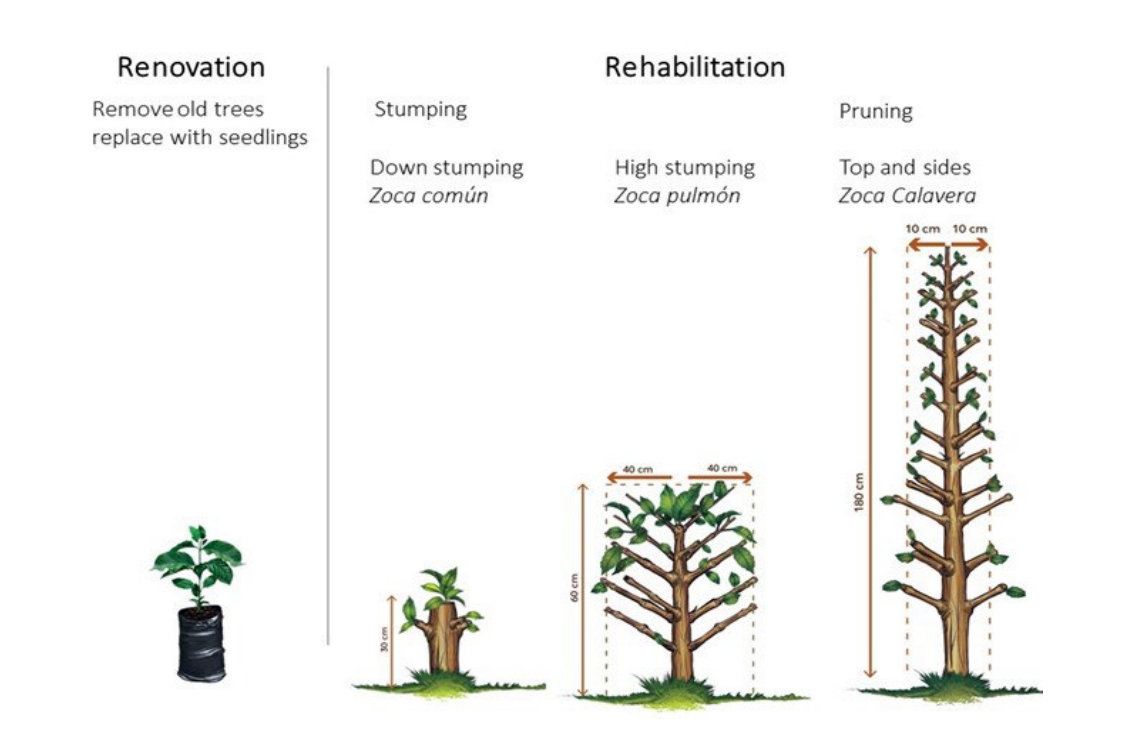


Figure 1. Renovation and rehabilitation terms.

Note: Please review Annex 2 for further details on these terms in the context of the Rainforest Alliance Regenerative Coffee Scorecard.

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

REHABILITATION:

"Rehabilitation involves pruning and stumping the coffee trees, while maintaining the current root stock." [4]

"Frequent pruning to maintain coffee tree health and productivity" RA Scorecard – Gold Level. [5]

RECOMMENDATIONS

a. The definition of coffee tree tissue rehabilitation frequency depends on the evolution of yearly productivity. When the average productivity declines, it is time to intervene in the tree tissues to promote young tissue that restores production. When coffee trees have few productive branches, stumping (down or high, See Figure 1) or pruning can restore coffee productivity.[6]

b. Rehabilitation can be done by combining types of stumping (down stumping – high stumping) and pruning. The rehabilitation system can be selective, in rows, a complete lot, or a combination of the previous options.[7]

c. The definition of rehabilitation types depends on the distance and planting arrangement, the stems or branches per site, the age of the trees, soil and climate conditions, variety, crop vigour, phytosanitary conditions, and management.[8]

[4] Pulleman et al., 2023, p. 48.
[5] Rainforest Alliance, 2022 a.
[6] Pulleman et al., 2023, p. 51.
[7] Rojas & Ramírez, 2016.
[8] Rojas & Ramírez, 2016.

RENOVATION:

"Renovation involves uprooting old trees and filling gaps with new plantings to replace the current coffee variety as well as the rootstock. This practice also makes it possible to increase planting densities or change to a different system design." [9]

"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. [10]

"Coffee variety is selected based on quality, productivity, and rust resistance. Use of rust-resistant varieties on >50% of the plot. RA Scorecard – Gold Leve.[11]

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. [12]

RECOMMENDATIONS

a. The installation of the germinator and nursery must be planned considering the age of transplantation of the plants to the field. Planting is recommended in May when the rains begin.[13]

b. Before the renovation, soil correction (pH and aluminium) is performed one month before the sowing based on soil analysis using options such as calcium carbonate, magnesium carbonate, calcium hydroxide, calcium sulphate, and agricultural gypsum.[14]

[9] Pulleman et al., 2023, p. 48.
[10] Rainforest Alliance, 2022 a.
[11] Rainforest Alliance, 2022 a.
[12] Pulleman et al., 2023, p. 54.
[13] Instituto del Café de Costa Rica, 2020.
[14] Instituto del Café de Costa Rica, 2020, p. 84

c. In areas with a high incidence of pathogenic nematodes, amendments can be combined with formulations of the biological controller *Trichodema* applied to the soil.

d. The main coffee varieties in terms of planted area in Costa Rica are Caturra (41% of the total area) and Catuai (49% of the total area), both with good productivity and quality but with the limitation of susceptibility to coffee rust. ICAFE and companies have worked on new varieties or hybrids (cultivars). Available for plantation renovations (Table 1).[15] [16] [17]

CULTIVAR	PERFORMANCE AGAINST COFFEE LEAF RUST	PERFORMANCE AGAINST NEMATODES
Catiguá MG2	Tolerant	Medium resistance
Catuaí	Susceptible	Susceptible
Caturra	Susceptible	Susceptible
Clon híbrido F1	Tolerant	Unknown
Esperanza L4 A5	Medium resistance	Medium resistance
H-8	Tolerant	Unknown
H-12	Tolerant	Unknown
Marsellesa	Resistant	Medium resistance
Obatá amarillo IAC 4739	Tolerant	Unknown
Obatá IAC 1669-20	Resistant	Unknown
Paraíso MG H419-1	Tolerant	Unknown
San Isidro 35	Tolerant	Tolerant
San Isidro 48	Tolerant	Unknown
San Isidro 49	Tolerant	Unknown
San Isidro 6	Tolerant	Unknown
Sarchimor T-5296	Tolerant, but some lines have susceptibility.	Medium resistance
Starmaya	Resistant	Unknown
Victoria 14	Tolerant	

Table 1. Improved coffee cultivars planted in Costa Rica[18] [19] [20] [21]

e. The AAA Agronomists will advise and encourage farmers to choose a suitable variety or cultivar (hybrid) based on their analysis of local variables. All varieties and cultivars listed

[15] Instituto del Café de Costa Rica, 2020.
[16] Arrieta, 2016.
[17] Starbucks, 2023.
[18] Instituto del Café de Costa Rica, 2020.
[19] World Coffee Research, 2023.
[20] Arrieta, 2016.
[21] Starbucks, 2023.

in Table 1 adhere to *Nespresso* quality profiles associated with each cluster. Given the investment required for a change in varieties, renewal process should be undertaken gradually, at 10-15% annually, for the total coffee area.

f. Nurseries can be built on the ground in planting beds (1.5 m width, 10-15 cm height, maximum 40 m length) or individual bags; the size of the bags depends on the duration of the nursery stage (15 x 20 cm, 6-10 months. 18 x 23, 12 months).[22] *Nespresso* and the clusters may contemplate encouraging renewal through centralised nursery programmes that provide planting materials to producers. These nurseries should adhere to agronomic management recommendations concerning the health and overall management of the plants.

g. Recommended density/spacing depends on technical criteria such as climate conditions, soil fertility, rejuvenation cycle duration, and agronomic practices. Different planting distances can be applied between trees and lines, with some models based on dry season prevalence over the year (Table 2).[23]

RAINING PATTERN	DISTANCE BETWEEN LINES (M)	DISTANCE BETWEEN TREES (M)
The dry season STRONGLY DEFINED	*2,00*	*1,00*
	2,20	*0,90*
	2,40	*0,80*
The dry season IS NOT DEFINED	*2,00*	*1,00*
	2,25	*0,85*
	2,50	*0,80*

Table 2. Some planting distance alternatives for coffee renewals in Costa Rica
Source: Instituto del Café de Costa Rica, 2020.

STEPS IN THE CLUSTER ACTION PLAN

[22] Instituto del Café de Costa Rica, 2020.
[23] Instituto del Café de Costa Rica, 2020.

STEPS	*CLUSTER MANAGER*	***AAA AGRONOMIST***
Define and implement the renovation plan considering the variety, density, arrangement, pruning, and cycle.		☑
Adoption strategy for the defined acceleration group of AAA farmers.	☑	☑
Define and implement the renewal plan by considering the variety, density, arrangement, pruning, and the renewal cycle. Each farm defines the renovation plan with the assistance of the AAA Agronomist. Clusters monitor the annual progress regarding the area and the number of trees renovated or rehabilitated.	☑	☑
Identify alliances and coordination with the renovation and rehabilitation programmes from the government, coffee institutes, or private companies.	☑	

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."[24]

RECOMMENDATIONS

a. The agroforestry projects implemented by *Nespresso* and PUR promote three plantings: Hedgerows planted around coffee plots, intercropping with coffee shade, and plantings around coffee plots or degraded or fallen land. Trees planted in the agroforestry projects are tracked using geolocation.[25]

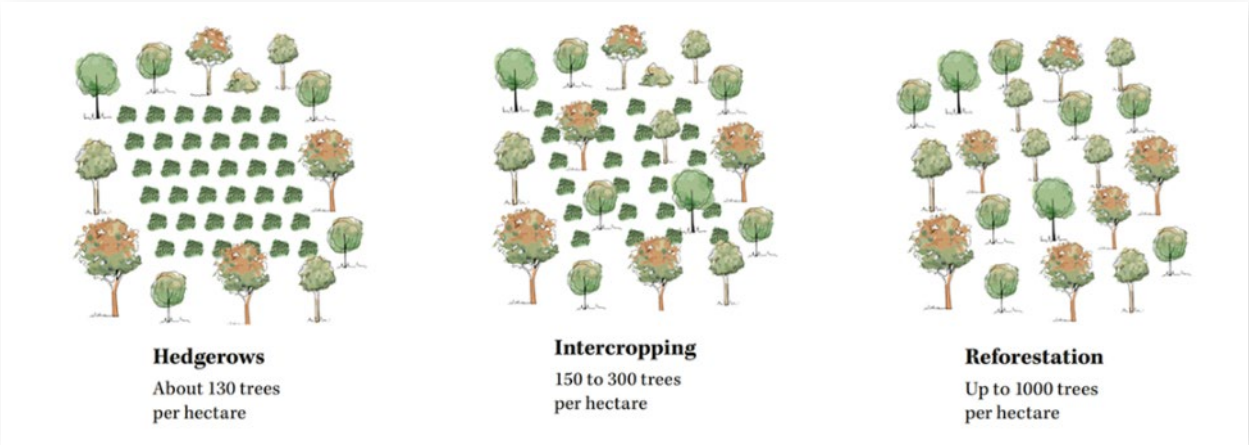


Figure 2. Different agroforestry models implemented in AAA farms.
Source: Nespresso, PUR Projet, 2021.

[24] Rainforest Alliance, 2022 a.
[25] *Nespresso*, Proyecto PUR, 2021, p. 159.

b. The choice of species is based on the on-site evaluations and according to the farmers' needs. Tree selection depends on the proven suitability for the specific site conditions and the purposes of trees in the agroforestry or forestry systems (timber production, shade, soil improvement, etc.). Most of the planted species will be native (Table 3). Based on the Agroforestry project implementation experience (PUR). Recommendations for the arrangement are proposed for each farm and are agreed upon based on the needs and expectations of the coffee growers. The models may vary according to their integration with the coffee production stage.

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

d. The planting waves occur during the rainy season, the same months indicated for coffee renovation.

e. Here, the tree species are more often planted within the PUR agroforestry models in Costa Rica clusters (Table 3).

COMMON NAME	SCIENTIFIC NAME	COMMENT
Guava	*Inga edulis*	Native (Central and South America)
Guajiniqui	*Inga spuria*	Native (Central and South America)
Poró	*Erythrina poeppigiana*	Native (Central and South America)
Colpachi	*Croton niveus*	Native (Central and South America)
Trueno	*Ligustrum lucidum*	Non-native
Sota caballo	*Zygia longifolia*	Native (Central America)
Cortez Amarillo	*Handroanthus chrysanthus*	Native (Central and South America)
Cortez Negro	*Handroanthus impetiginosus*	Native (Central and South America)

Table 3. Tree species for the agroforestry projects in Costa Rica
Source: PUR

f. During the renovation, implement the multi-strata agroforestry models based on diverse native trees (at least eight species of trees, if that number is technically feasible for the local conditions). Consider critical criteria when selecting tree species, such as tree morphology and physiology, pruning requirements, species complementarity and compatibility, capacity to fix nitrogen and other beneficial functional traits, multifunctionality, and economic value.[26]

g. CATIE research centre is a very relevant source of knowledge of the benefits, technical management of trees, coffee crops' responses to shade, and economic analysis of agroforestry systems. They have detailed information from experiments with more than 20 years of evaluation. CATIE's research indicates that the optimal shade levels

[26] Pulleman et al., 2023.

in the case of *Erythrina poeppigiana* are about 40% (45-54%) for the best levels of coffee productivity.[27] [28]

h. Shade systems with *Erythrina poeppigiana* (poró) and the combination with *Chloroleucon eurycyclum* (cashá) have shown the highest coffee productivity. Implementing Agroforestry Systems has proven effective in avoiding soil acidification, as well as in improving physical and chemical properties.[29]

i. The planting density of service shade trees, with a pruning model such as *Erythrina poeppigiana*, is between 100 and 160 shade trees per hectare. Depending on the site's luminosity and the coffee crop's planting density.

j. Some tree planting arrangements range from a minimum of 6 m x 6 m to 15 m x 15 m, in intercropping. Hedgerows recommends a distance between 6 m and 8 m for 100 to 125 trees per linear kilometre.[30]

k. The Cornell Lab has worked in Costa Rica, identifying the relationship between trees and their ecosystem services. The following species have exceptional value due to the benefits they provide to wildlife: *Inga edulis, Tabernaemontana donnell-smithii, Croton niveus, Zigia longifolia, Cordia alliodora, Montanoa guatemaliensies, Citharexylum donnell-smithii, Annova muricate, Psidium friedrichsthalianum, Ardisia compressa, Persea sp., and Astronium graveolens*. In a study, the use of some of these species by birds was analyzed (Figure 3). It is noticeable that the genus Ficus is essential for maintaining high dietary guild diversity on a farm. Even if it is not cultivated for planting, it is recommended to maintain fig trees and other trees like guarumo and ratoncillo in non-productive areas of the farm.

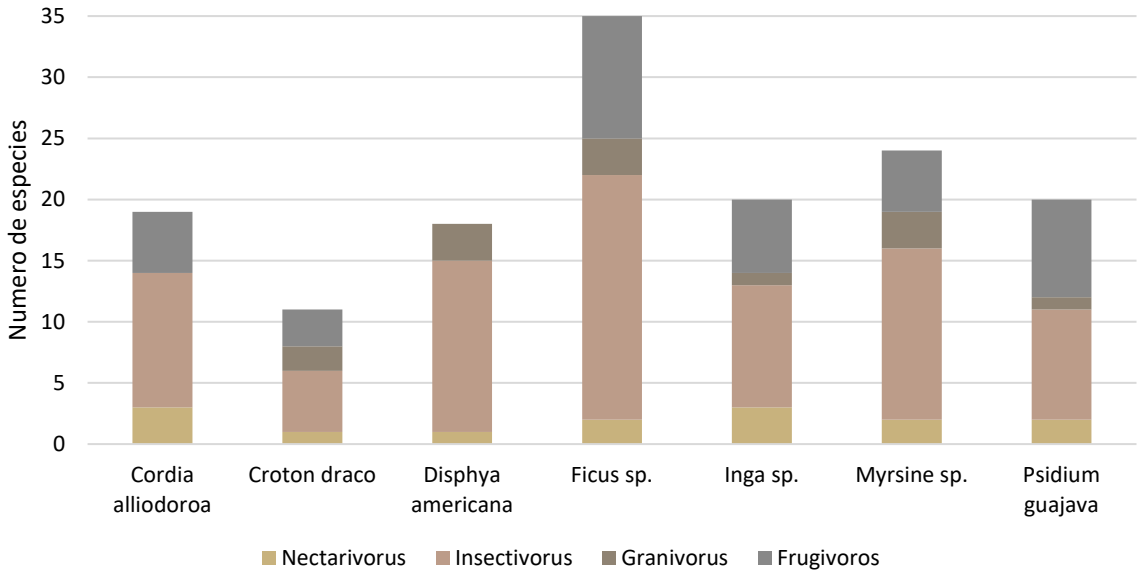


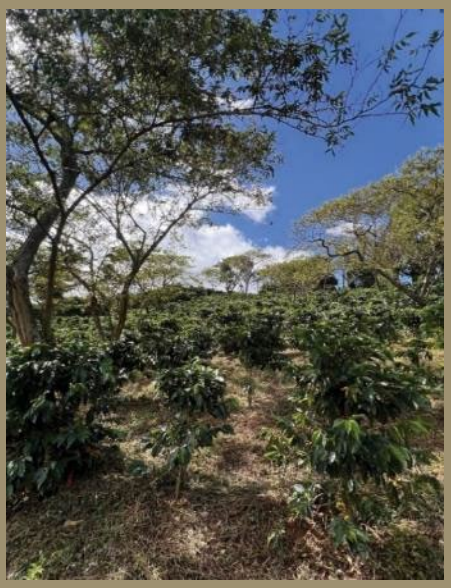
Figure 3: Number and percentage of bird species per diet in the tree genus where they were observed.[31]

[27] Muschler, 1999, p. 39.
[28] Virginio, et al., 2015.
[29] Virginio, et al., 2015.
[30] Gómez, 2022.
[31] Chaves E. N., Sandoval v., L.A, 2023.

"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." [32]

"Ensuring that aquatic ecosystems are surrounded by riparian buffers of natural vegetation following the RA standard width parameters. RA Scorecard – Gold Level."[33]

"Establishing agroforestry systems requires investment and labour, including specific skills and tools (e.g., to prune tall canopy trees), and it can take a long time (typically 5–20 years for fruit and timber trees) before farmers reap the economic benefits."[34]



[32] Pulleman et al., 2023, p. 64.
[33] Rainforest Alliance, 2022 a.
[34] Pulleman et al., 2023, p. 67.

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Implement the agroforestry program in the cluster.	☑	
Integrating agroforestry into the coffee production system. This is for farms that do not participate in the PUR program or choose to implement their tree-planting model.	☑	☑
Define with the producers the plots for planting the trees according to the local climate, soils, and associated crops.		☑
Select with the producers the agroforestry model to be implemented and define with them the management that will be applied to the trees and the crop (technical knowledge, inputs, and labour).		☑
Select the best tree species according to the expected benefit, local adaptation, availability, and possibility of local propagation.	☑	☑

1.3 CONSERVATION AREAS

"If agroforestry cover is not suitable for the local environmental conditions, trees may also be planted around the infrastructure, borders, etc., maintaining an area equivalent to 15% of the farm area with natural vegetation. RA Scorecard – Gold Level."[35]

"Natural vegetation: Vegetation made up predominantly of native or locally adapted species, 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 biodiversity. If invasive species are present, natural vegetation is managed to reduce their presence." (RA Scorecard, definition)[36]

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 15% of their farm area, which is not possible when making agroforestry arrangements for their coffee crops.

c. 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.

[35] Rainforest Alliance, 2022 a.
[36] Rainforest Alliance, 2022a.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	*CLUSTER MANAGER*	***AAA AGRONOMIST***
Identify the geographical location of farms regarding areas of conservation interest, buffer zones, and biological corridors.	☑	☑
Plan conservation areas with each farm, especially when implementing agroforestry models is not feasible.		☑
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.

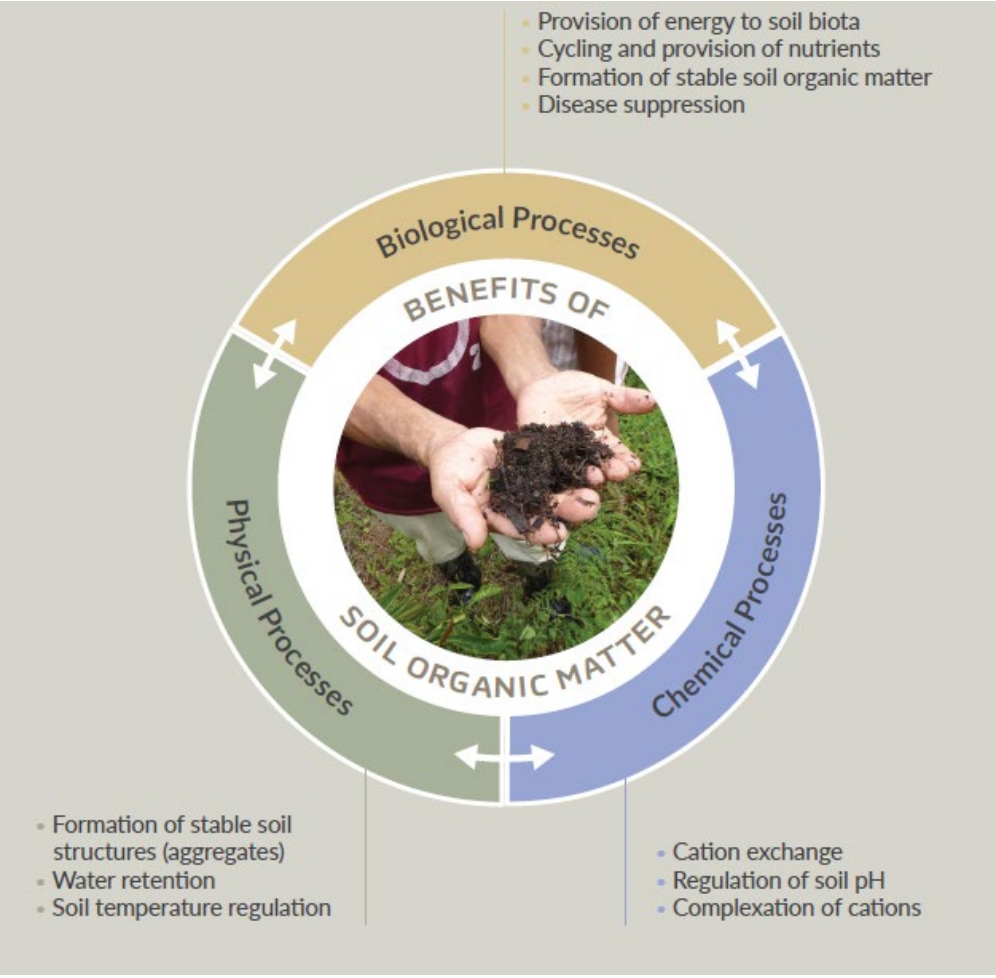


Figure 4. The benefits of soil organic matter through its effect on biological, chemical and physical processes.
Source: Pulleman, M. M., Rahn, E. y Valle, J. F. (2023). CIAT., p. 23

RECOMMENDATIONS

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 the soil during high-rainfall events. Terracing has the additional advantage of facilitating farm operations on steep hills, but it requires considerable labour and initial investment. Vegetative solutions should be prioritised over the construction of physical structures whenever possible, as the latter generally involve considerable investment in labour and/or machinery." [37]

"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." [38]

RECOMMENDATIONS

a. Identify areas of the farm susceptible to or affected by erosion.

b. Follow a soil conservation and erosion prevention program. Implement soil conservation practices based on the identification made and according to the slope of the farm.

c. Pruned coffee tree branches and leaves are mulched on the soil surface.

d. Agroforestry systems offer a good strategy for soil conservation because they provide constant litter input and a canopy to protect the soil.[39]

e. Establish the planting of coffee trees on contour lines against the plot slope.[40]

[37] Pulleman et al. , 2023. p. 82
[38] Rainforest Alliance, 2022 a.
[39] Pulleman et al., 2023, p. 85.
[40] Instituto del Café de Costa Rica, 2021.

f. Establish vegetative barriers to reduce the velocity of runoff water. Other conservation practices include terraces for planting coffee trees, hillside ditches, and runoff water diversion channels.[41]

g. Vegetative solutions should be prioritised over constructing physical structures, whenever possible, as the latter generally involve considerable labour and/or machinery investment.

h. Identify if any adjustments to the implemented conservation practices are needed and adjust accordingly. Continue monitoring soil cover and loss.

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., 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. [42]

Maintaining at least 80% of bare ground covered with mulch or cover crops (preferably flowering)."

RA Scorecard – Gold Level. [43]

[41] Instituto del Café de Costa Rica, 2021.
[42] Pulleman et al., 2023, p. 85.
[43] Rainforest Alliance, 2022a.

a. Identify what areas/plots are more feasible for introducing crops and select species.

b. The following species are suggested as live cover crops: *Vigna radiata, Crotalaria spectabilis, Avena sativa, and Ryegrass,*[44] Also *Brachiaria ruziziensis, Brachiaria Brizantha,* Rye Grass/ Mega, *Panicum Maximum/* Mombaza*, Panicum Maximum /* Massai. ECOM has evaluated the following live cover species in the field: *Vigna radiata, Crotalaria juncea, Crotalaria spectabilis*, *Brachiaria Ruzzi, Brachiaria Brizantha*, Rye Grass/Mega, Rye Grass/Tetillo, *Panicum maximum* (Mombaza), *Panicum maximum* (Massai), with management information[45] (Table 4).

SPECIE	CHARACTERISTICS	MANAGEMENT RECOMMENDATIONS
Crotalaria spectabilis	*Annual coverage* *Slow growth rate* *Fixation of 200-240 Kg Atmospheric N/year* *Mowing before flowering is recommended to extend the useful life of the coverage.* *Pollinator attractant* *Nematicide effect* *Incorporation of organic matter* *Improve the soil structure*	***Planting in lines*** *Sow 3 cm deep* *It must be covered with soil.* ***Spread*** *Maximum 6 kg of seeds/Ha* *Risk of loss of planting density because of attacks from ants and birds*
Vigna radiata	*Annual coverage* *Fixation of nitrogen* *Pollinator attractant* *Excellent establishment* *Does not compete with the crop.* *Allows you to get closer to the coffee trees without affecting them.*	***Planting*** *2 seeds/hole* *Sow 3 cm deep.* *Distance between plants of 15-20 cm* *It must be covered with soil.* ***Spread*** *Maximum 6 kg of seeds/Ha* *Risk of loss of planting density because of attacks from ants and birds*
Rye grass	*Annual grass* *Medium growth* *Does not compete with the crop* *Does not produce stolons* *Low demand for labour* *May present tolerance-resistance to the herbicides.* *Does not allow the development of other weeds*	***Planting in lines*** *Sow 3 cm deep* *It must be covered with soil* ***Spread*** *Maximum 6 kg of seeds/Ha* *Risk of loss of planting density because of attacks from ants and birds*

Table 4. Live cover species evaluated by ECOM in the SMS program [46]

[44] Instituto del Café de Costa Rica, 2020.
[45] Sustainable Management Services-ECOM, 2024.
[46] Sustainable Manement Services-ECOM 2024.

c. Introduce cover crops during the renovation to conserve soil health and reduce herbicides in the renovation areas, particularly if no agroforestry system exists. Cover crops generally benefit coffee production by improving the availability of water and nutrients. Still, they may compete with coffee plants for water or nutrients, 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.[47]

d. Maintain the mulch from shade tree leaves left on the ground (mulching)[48].

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)[49]

RECOMMENDATIONS

a. Integrated weed management (IWM) aims to alter the production system's weed mix, favouring beneficial weeds and limiting the growth opportunities for aggressive weeds. The main weeds classified by their interference with coffee crops in Costa Rica are listed below (Table 5).[50] [51]

[47] Pulleman et al., 2023, p. 81.
[48] Farfán, 2014, pp. 146, 159.
[49] Rainforest Alliance, 2022a.
[50] Virginio et al., 2022 a.
[51] Virginio et al., 2022 b.

LEVEL OF INTERFERENCE	WEED SPECIES		
Noble weeds: **GOOD COVER**	*Arachis pintoi* *Borreria laevis* *Borreria sp.* *Commelina difusa* *Commelina elegans* *Commelina erecta* *Commelina virginica* *Desmodium canum* *Desmodium sp.* *Dichondra repens*	*Drymaria cordata* *Drymaria villosa* *Euphorbia hirta* *Euphorbia prostrata* *Hydrocotyle bowlesioides* *Hydrocotyle mexicana* *Hydrocotyle umbellata* *Hyptis atrorubens* *Indigofera spicata* *Jaegeria hirta*	*Mucuna urens* *Oplismenus burmannii* *Oxalis acetosella* *Oxalis corniculata* *Oxalis latifolia* *Oxalis sp.* *Phyllanthus niruri* *Phyllanthus sp.* *Richardia scabra*
Medium: **REGULAR COVER**	*Ageratum conyzoides* *Amaranthus hybridus* *Amaranthus viridis* *Arachis hypogaea* *Argemone mexicana* *Asclepias sp.*	*Bidens pilosa* *Cajanus cajan* *Canavalia ensiformis* *Centrosema pubescens* *Chamaesyce hirta* *Chenopodium album*	*Conyza apurensis* *Conyza bonariensis* *Impatiens walleriana* *Indigofera suffruticosa* *Llum pinnatum*
COMPETING SPECIES	*Amaranthus spinosus* *Blechum pyramidatum* *Borreria alata* *Eichornia crassipes* *Emilia fosbergii* *Equisetum arvense* *Euphorbia heterophylla* *Galinsoga ciliata*	*Galinsoga parviflora* *Glicina max* *Hyptis capitata* *Impatiens balsamina* *Ipomea batatas* *Ipomea nil* *Ipomea quamoclit* *Lantana camara*	*Ludwigia sp.* *Mikania micrantha* *Mimosa púdica* *Momordica charantia* *Plantago major* *Pseudelephantopus spicatus* *Rumex crispus*
VERY COMPETING SPECIES	*Andropogon bicornis* *Cynodon dactylon* *Cyperus rotundus* *Digitaria sanguinalis*	*Eleusine indica* *Phytolacca icosandra* *Polygonum nepalense* *Portulaca oleracea*	*Pteridium aquilinum* *Ricinus communis* *Rottboellia cochinchinensis* *Rumex obtusifolius*

Table 5. Common weed species in coffee crops and their level of interference.
Source: Adapted from Virginio et al., 2021 a.

b. In recently planted coffee plantations, the critical period of weed competition with the coffee crop is the first 12 to 18 months after sowing. Weed control should aim to keep the fertilisation strip clean and promote adequate coverage in the inter-row to avoid soil erosion.[52]

c. Identify the most competing weeds within the coffee plots.

d. Follow an IWM plan to reduce the population of competing weeds, prioritising mechanical control and herbicide spot applications.

e. Define and follow a herbicide application reduction plan with specific targets over time. Promote the use of eco-weeder (*selector de arvenses*) for focalised control and lower doses of herbicide.

f. Use at most one active ingredient from the RA Risk mitigation list pesticides and eliminate banned herbicides as per RA Annex Chapter 4 – Farming[53]. Table 6 shows the herbicides approved in Costa Rica. Only products flagged as belonging to the risk mitigation list can

[52] Instituto del Café de Costa Rica, 2020.
[53] Rainforest Alliance, 2022 b.

be used, and only one of them, as per Rainforest Alliance Regenerative Coffee Scorecard Gold Level.

g. Eliminate the use of herbicides included in the Exceptional Use Policy from RA Annex chapter 4.

ACTIVE INGREDIENT	CAS Number	Main use	RAINFOREST ALLIANCE CATEGORY
Calcium carbonate	471-34-1	Fungicide	Whithout restrictions
Metallic copper	7440-50-8	Fungicide	Whithout restrictions
Difenoconazole	119446-68-3	Fungicide	Whithout restrictions
Hexaconazole	79983-71-4	Fungicide	Whithout restrictions
Pencycuron	66063-05-6	Fungicide	Whithout restrictions
Propineb	12071-83-9	Fungicide	Whithout restrictions
TCMTB (benzothiazole)	21564-17-0	Fungicide	Whithout restrictions
Tebuconazole	107534-96-3	Fungicide	Whithout restrictions
Validamycin	37248-47-8	Fungicide	Whithout restrictions
Copper dibasic sulfate	8011-63-0	Fungicide	Whithout restrictions
Copper tribasic sulfate	1333-22-8	Fungicide	Whithout restrictions
Tolclofos-methyl	57018-04-9	Fungicide	Whithout restrictions
Hydramethylnon	67485-29-4	Insecticide	Whithout restrictions
Metaldehyde	108-62-3	Insecticide	Whithout restrictions
Copper oxide	1317-39-1	Fungicide	Risk mitigation
Ferbam	14484-64-1	Fungicide	Risk mitigation
Copper oxide	1317-38-0	Fungicide	Risk mitigation
Copper hydroxide	20427-59-2	Fungicide	Risk mitigation
Pyraclostrobin	175013-18-0	Fungicide	Risk mitigation
Copper oxychloride	1332-40-7	Fungicide	Risk mitigation
Trifloxystrobin	141517-21-7	Fungicide	Risk mitigation
Novaluron	116714-46-6	Insecticide, Acaricide	Risk mitigation
Lambda-cyhalothrin	91465-08-6	Insecticide, Acaricide	Risk mitigation
Malathion	121-75-5	Insecticide, Acaricide	Risk mitigation
Pyrethrins	8003-34-7	Insecticide, Acaricide	Risk mitigation
Diazinon	333-41-5	Insecticide, Acaricide	Risk mitigation
Deltamethrin	52918-63-5	Insecticide, Acaricide	Risk mitigation

Benfuracarb	82560-54-1	Insecticide, Acaricide	Risk mitigation
Alpha-cypermethrin	52315-07-8	Insecticide, Acaricide	Risk mitigation
Benomyl	17804-35-2	Fungicide	Prohibited
Carbendazim	10605-21-7	Fungicide	Prohibited
Cyproconazole	94361-06-5	Fungicide	Prohibited
Epoxiconazole	133855-98-8	Fungicide	Prohibited
Propiconazole	60207-90-1	Fungicide	Prohibited
Triadimenol	55219-65-3	Fungicide	Prohibited
Phorate	298-02-2	Insecticide, Acaricide	Prohibited
Imidacloprid	138261-41-3	Insecticide, Acaricide	Prohibited
Fenamiphos	22224-92-6	Nematicide, Insecticide, Acaricide	Prohibited
Oxamyl	23135-22-0	Nematicide, Insecticide, Acaricide	Prohibited
Terbufos	13071-79-9	Nematicide, Insecticide, Acaricide	Prohibited

Table 6. Herbicides used in coffee in Costa Rica. *(Updated: April 30-2024)*[54]

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

STEPS IN THE CLUSTER ACTION PLAN

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.		☑
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. Agroecological conditions (such as soil type, topography, and climate), production practices, and the age and phenological stage of the coffee plants all have a strong effect on nutrient requirements, which should be taken into account when making fertilisation plans.[55]

"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.[56]

"Soil testing must be done at the right time (at least three to four months after the last fertilisation) and repeated regularly (every two to three 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."[57]

[55] Pulleman et al., 2023. pp. 107-108
[56] Rainforest Alliance, 2022 a.
[57] Pulleman et al., 2023. p.113

RECOMMENDATIONS

a. Soil analysis should be understood as soil health analysis, i.e., including physical, chemical, and biological indications of the soil's condition. Evaluating soil fertility requires chemical, physical and biological analyses.

b. Conduct (at least every two years) a soil assessment for a representative sample of the coffee area.

c. Based on the soil assessment, identify soil management measures and relevant actions to maintain the best-growing conditions and enhance productivity.

d. . Visual symptoms of nutritional deficiencies and foliar analysis can also be observed.[58] Chemical soil analysis is the primary diagnostic tool for assessing the soil's nutritional status and supporting crop nutrition decisions.[59]

e. Design and follow a fertilisation plan based on the soil assessment results, soil management measures identified, and any additional recommendations from an expert.

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 the fertilisation response. Consider soil acidity correction, crop age, shade level, compaction, or degradation.		☑
Consider solutions based on improving soil organic matter levels and the diversity of microorganisms among the alternatives to mitigate soil acidity.		☑
Propose fertilisation plans considering the agroecological conditions of the crop, crop management practices, and soil analysis results.		☑

[58] Sadeghian & Gonzáles–Osorio, 2022, p. 135-136.
[59] Pulleman et al., 2023, pp. 110.

3.2 LOW CARBON & EFFICIENT FERTILISATION

In the analysis of CO_2 equivalent emissions on AAA farms in Costa Rica, using the Cool Farm Tool methodology, it was identified that 58% 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. [60]

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

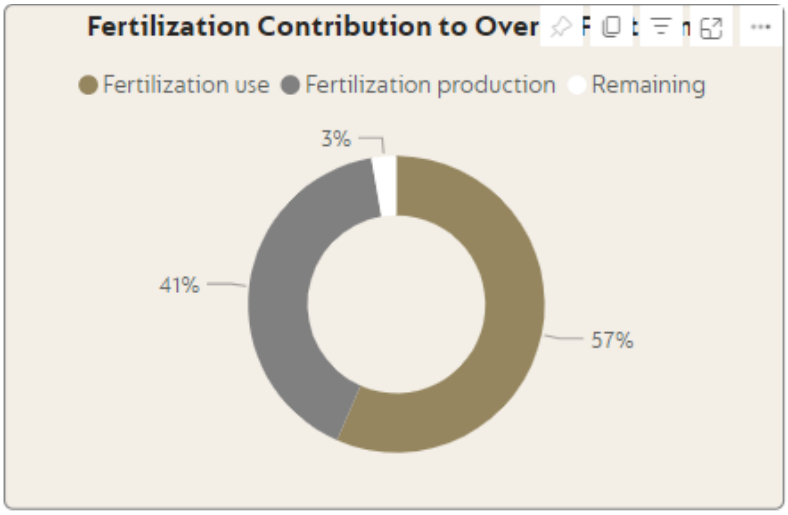


Figure 5. Fertilization contribuition to overall GHG Footprint – Costa Rica.
Source: Nespresso, 2023/2024 cyle

There are several sources of nitrogen fertilisers with different percentages of nitrogen contribution. Table 7 details some fertilisers that provide nitrogen in various chemical forms.[61] With respect to nitrogen losses related to fertiliser sources, the most significant differences are related to volatilisation and leaching processes. Nitrogen losses through volatilisation are more significant in urea than in ammonium nitrate; The opposite occurs with leaching.[62] Understanding the potential emissions of nitrogen dioxide (NO_2) is critical, considering the potential effect of equivalence in terms of CO_2. Fertilisers based on N-Ureic must be avoided.

[60] YARA International, 2011.
[61] YARA, 2023, p. 4.
[62] Sadeghian & Gonzáles-Osorio, 2022.

N 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 (Monoammonium 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 7. Nitrogen content of common fertiliser sources and Yara brands.

RECOMMENDATIONS

a. Following the 4R concept, efficient levels of synthetic fertiliser should be applied for productivity. 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.[63] – The source of nutrients will be complemented with organic fertilisation (see section 3.3)

b. When applying nitrogen fertilisers to crops, it is essential to consider where the nitrogen used will end up. The quantities to be applied must also consider the immediate fixation in the soil's organic matter, the soil cation exchange complex, and the losses due to denitrification, volatilisation, or leaching.

c. Use efficient nitrogen sources that are readily available to the plant. The application of nitrates (= nitrogenous fertilisers with less than 50% NO_3-N) is more efficient than other nitrogen sources due to low losses of ammonia volatilisation and faster assimilation by the plant.

d. Adjust the nitrogen rate during the growing season growth to the actual demand of the crop based on extraction curves and nitrogen demand in the different stages of the coffee tree and field diagnoses.

[63] Pulleman et al., 2023, p. 114.

e. Split applications and use tools for precision agriculture to adjust the nitrogen dose to the crop's requirements. In Costa Rica, it is recommended that fertilisation be divided into three parts: (i) 124 days after flowering, complete formula; (ii) 180 days after flowering, complete formula; (iii) 260 days after flowering (nitrogen, calcium, and magnesium).

f. For Acidity (Soil pH) and Aluminium correction, the recommendation is to apply calcium carbonate, magnesium carbonate, calcium hydroxide, calcium sulphate, and agricultural gypsum of adequate purity and granulometry. Maintain a separation of at least 30 days between applying the addition and then applying the fertiliser. Use 500 to 2000 kg per hectare, depending on the soil analysis result and lime quality[64].

STEPS IN THE CLUSTER ACTION PLAN

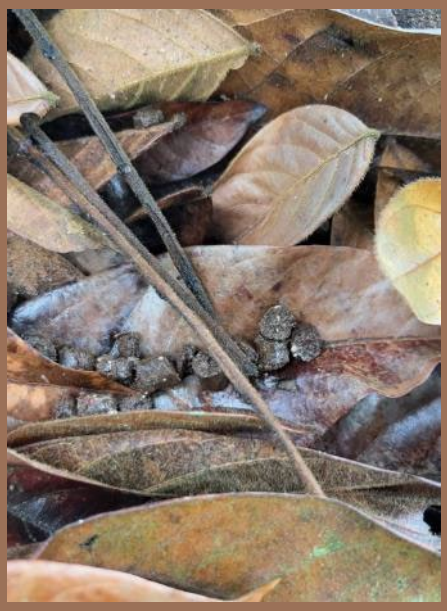
STEPS	*CLUSTER MANAGER*	*AAA AGRONOMIST*
Recommend fertilisation sources with the best nitrogen use efficiency (NUE) and proper planning of dosage, timing, and place of application.		☑
Define interventions to promote and encourage adopting efficient nitrogen fertiliser use based on the previous recommendations.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

[64] Instituto del Café de Costa Rica, 2020.

3.3 ORGANIC FERTILISATION

"The availability of organic residues determines to what extent organic inputs can substitute for or complement mineral fertilisers. Coffee farms generally do not generate sufficient organic residues to fully satisfy plant nutrient demand. Synchronising nutrient availability with crop demand can also pose challenges when using organic inputs. Therefore, combining mineral and organic fertiliser 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."[65]

"Apply organic fertiliser, or composted organic matter, on at least 75% of the farm, when possible, using organic material coming from the same farm." RA Scorecard – Gold Level [66]



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. [67]

b. Cover crop management and mulching are significant sources of biomass and organic matter in the soil.

c. Fertilisation with chemical fertilisers can be partially or wholly replaced by organic fertilisation without affecting production if the appropriate sources and required quantities

[65] Pulleman et al., 2023, p. 121.
[66] Rainforest Alliance, 2022a.
[67] Pulleman et al., 2023, p. 23

are supplied. Furthermore, organic fertilisers can favour the soil's physical, chemical, and biological properties.

d. Create a farm fertilisation plan, including the application of organic fertiliser/matter combined with chemical fertilisers. As part of the Agronomic Plan in Costa Rica, the third fertiliser application could be replaced with FERTIPELLET, an organic mineral fertiliser manufactured by ECOM, or with other sources of organic fertilisers produced by Volcafe, available to coffee growers in the clusters. FERTIPELLET combines chicken manure and organic nitrogen, potassium, calcium, and magnesium sources. Dose 250-600 kg/ha. Do not apply Fertipellet 30 days before or post-contact herbicide application. The recommendations, including using FERTIPELLET as part of the fertilisation recommendation, are projected to cover 75% of the coffee area of the clusters.

e. In Costa Rica, coffee is processed in central mills. Coffee pulp is transformed into compost under aerobic conditions. It is a centralised process that controls the composting process quality (aeration, humidity, and temperature). The compost must have a final moisture level between 25%-60%. This stabilised compost can be distributed back to coffee growers and applied to crops.[68] Add composted pulp when available at scale (Volcafe has developed a project to build small-scale compost facilities on targeted farms to allow farmers to create their organic matter). Apply 1 kg of compost (pulp, ash) per tree (50 bags/ha)

f. Farmers apply BIOL made from coffee honey as part of the organic fertilisation complement. BIOL results from the aerobic fermentation of different organic and mineral materials, which microorganisms transform. In addition to the mineral component, BIOLES may contain plant hormones to stimulate growth. It can also elicit the plant's response to pest and disease attacks. It is also reported that BIOLES can contribute to unifying maturation.[69]

g. ECOM and Volcafe produce BIOLES at an industrial level with standardised quality and commercial grade. These products are included in the management recommendations for coffee growers. Made from coffee honey and minerals, it is rich in microorganisms. This formula is recommended as a source of micronutrients, solubilisation of nutrients in the soil, maturation uniformity, and recovery of trees in case of poisoning for herbicides. Doses 2 gallons/ha, twice a year in April/May and October.

[68] Hafner et al., 2018.
[69] COMSA, 2020.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Promote composting according to the availability of organic matter on the farm. *Prioritise using this and other available sources of organic matter on the farm. Integrate the organic sources into the coffee fertilisation plan.*		☑
Identify the availability of other sources of organic matter in commercial products within the local context.	☑	☑

4. PLANT HEALTH

4.1 INTEGRATED PEST MANAGEMENT (IPM)

Reducing the use of pesticides (two or fewer ingredients from the risk mitigation list) and eliminating the use of synthetic chemical nematicides on the farm.
RA Scorecard – Gold Level (Mandatory criteria)[70]

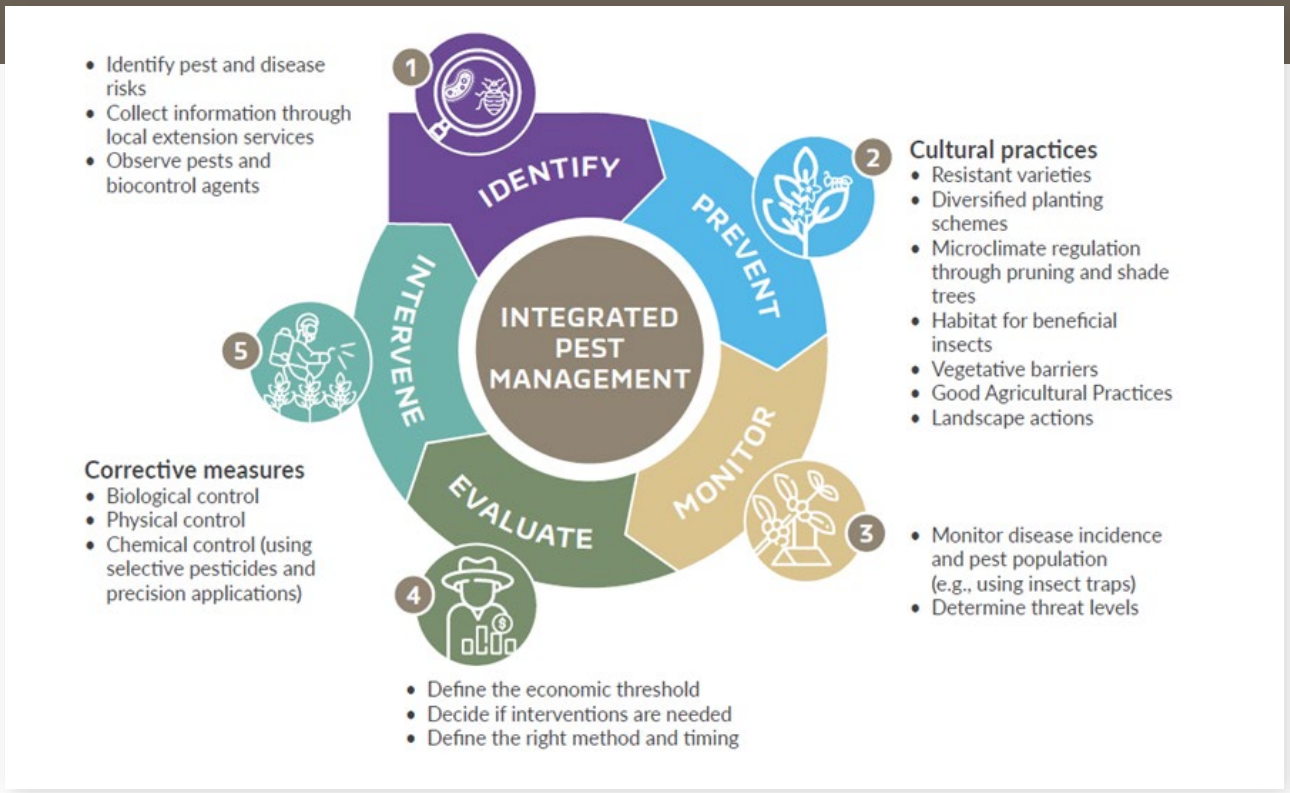


Figure 6. Key components of an integrated pest management approach.
Source: Pulleman, M. M., Rahn, E. y Valle, J. F. (2023). CIAT., p. 97

RECOMMENDATIONS

For all phytosanitary problems:

a. Follow the IPM principles and create IPM plans at cluster and farm levels.

b. Use agrochemical application only when cultural and physical methods have been exhausted and threshold levels of pests and diseases have been reached.

[70] Rainforest Alliance, 2022a .

c. Use agrochemicals with the lowest possible toxicity and highest selectiveness.

d. Apply agrochemicals only to the impacted coffee areas/plants.

e. 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, Farming*.[71]

COFFEE BERRY BORER

f. Cultural control is the most crucial component of integrated CBB management. Cultural control consists of manipulating the environment to make it less favourable to pest insect populations. In the case of the borer, cultural control includes actions such as:
   (i) the age of the crop and the planting distance to allow a good harvest;
   (ii) timely renovation and rehabilitation of coffee plantations and avoiding the spread of the borer when doing these tasks;
   (iii) integrated weed management to promote the presence of beneficial fauna and natural control;
   (iv) good control of the coffee picking during harvest and at the end of the season to reduce the borer population in the coffee plantation.[72] [73]

g. Insecticides are applied in conditions of infestation in the field above 4%; the economic threshold is 2% infestation; no control measures are needed below this level.[74] Considering the dispersion of the CBB in the lot, affected areas must be identified, and localised control must be carried out.

COFFEE LEAF RUST

h. The main recommendation is to renovate the plantations with tolerant varieties/hybrids.

i. Adequate disease control is favoured by implementing the following recommendations:
   (i) establish appropriate planting distances for the coffee variety and region;
   (ii) prune exhausted or diseased plants. Pruning stimulates the growth of productive plant tissue and eliminates part of the inoculum and damaged and/or dead tissue due to rust;
   (iii) integral management of weeds to avoid excessive humidity;
   (iv) regulate shade trees, keeping around 40% of shade;
   (v) carry out good fertilisation at the appropriate times and following the soil analysis results;
   (vi) for the chemical control of coffee rust, it is necessary for the producer to monitor the state of the disease in the coffee plantation before deciding on the type of control to be applied (protective or curative). If the monitoring of rust incidence in

[71] Rainforest Alliance, 2022 b.
[72] Benavides et al., 2013.
[73] Constantino, 2023.
[74] Instituto del Café de Costa Rica, 2021.

the coffee plantation is less than 10%, protective fungicides (cupric) should be used, but if the level of infection is higher than 10%, systemic fungicides (curative) should be used. Conduct rust sampling at opportune times of the year to define action strategies. Biological fungicides could be considered with the IPM (i.e., Best Ultra/Roya Out)

AMERICAN LEAF SPOT (OJO DE GALLO).

j. The management recommendations for rust IPM contribute to and control this disease. These include pruning, shade management, host weed management, adequate nutrition, plant spacing, and soil moisture management. In the case of chemical control, applications of contact fungicides such as the Bordeaux mixture or copper oxychloride can be considered for their good results in controlling the pathogen.

ANTHRACNOSE

k. Control with copper-based fungicides and biological control from *Bacillus subtilis*.

l. The symbiotic relationship between birds and bees, crucial for providing pollination benefits, has been definitively established in Costa Rica. The impact of these pollinators on coffee yield is noteworthy. Research findings suggest that the combined contribution of birds and bees to pollination could account for approximately 24.7% of the overall coffee yield. Furthermore, birds and bees act as natural enemies of the Coffee Berry Borer in the field.[75]

m. For nematodes, control treatments are directed to the substrates of the seedbeds with biological products, especially the use of decomposed organic matter. To eliminate the use of synthetic chemical nematicides in farms.

n. The active ingredients are registered in Costa Rica and following RA Standard 2020 and its requirements. (Table 8). Safety conditions in the application, re-entry times to the lot, and safety periods before harvest must be respected.

o. CABI BioProtection Portal includes biocontrol products available with registration for use in coffee plantations in Costa Rica (Table 9).[76]

[75] Martínez-Salinas, et al., 2022.
[76] Portal de Bioprotección CABI, 2024.

GROUP	ACTIVE INGREDIE	CAS NUMBER	RAINFOREST ALLIANCE CATEGORY
Fungicide	Azoxystrobin	131860-33-8	Risk mitigation
Fungicide	Etridiazole + Thiophanate-methyl	2593-1z5-9 + 23564-05-8	Risk mitigation
Fungicide	Ferbam	14484-64-1	Risk mitigation
Fungicide	Copper hydroxide	20427-59-2	Risk mitigation
Fungicide	Thiophanate-methy	23564-05-8	Risk mitigation
Fungicide	Copper oxychloride	1332-40-7	Risk mitigation
Fungicide	Copper oxide (ous)	1317-39-1	Risk mitigation
Fungicide	PCNB (Quintozene)	82-68-8	Risk mitigation
Fungicide	Copper sulphate (pentahydrate)	7758-99-8	Risk mitigation
Insecticide	Carbaryl	63-25-2	Risk mitigation
Insecticide	Cypermethrin, alpha	52315-07-8	Risk mitigation
Insecticide	Cypermethrin, beta	65731-84-2	Risk mitigation
Insecticide	Deltamethrin	52918-63-5	Risk mitigation
Insecticide	Diazinon	333-41-5	Risk mitigation
Insecticide	Dimethoate	60-51-5	Risk mitigation
Insecticide	Fluopyram	658066-35-4	Risk mitigation
Insecticide	Malathion	121-75-5	Risk mitigation
Insecticide	Novalurón	116714-46-6	Risk mitigation
Insecticide	Propargite	2312-35-8	Risk mitigation
Fungicide	Sulfato Dibasico de Cobre	8011-63-0	Without restriction
Fungicide	Basic Copper sulphate	1333-22-8	Without restriction
Fungicide	Tebuconazole + Trifloxystrobin	107534-96-3 141517-21-7.	Without restrictions
Fungicide	Streptomycin sulphate + oxytetracycline hydrochloride Basic Copper sulphate	3810-74-0 2058-46-0 1333-22-8	Without restrictions
Fungicide	Calcium carbonate	471-34-1	Without restrictions
Fungicide	Copper	7440-50-8	Without restrictions
Fungicide	Copper Oleate	1120-44-1	Without restrictions
Fungicide	Difenoconazole	119446-68-3	Without restrictions
Fungicide	Hexaconazole	79983-71-4	Without restrictions
Fungicide	Pencycuron	66063-05-6	Without restrictions
Fungicide	Propineb	12071-83-9	Without restrictions
Fungicide	TCMTB (benzothiazole)	21564-17-0	Without restrictions

Table 8. Active ingredients are registered in Costa Rica and following RA Standard 2020 and its requirements. (Updated: April 30-2024)[77]

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

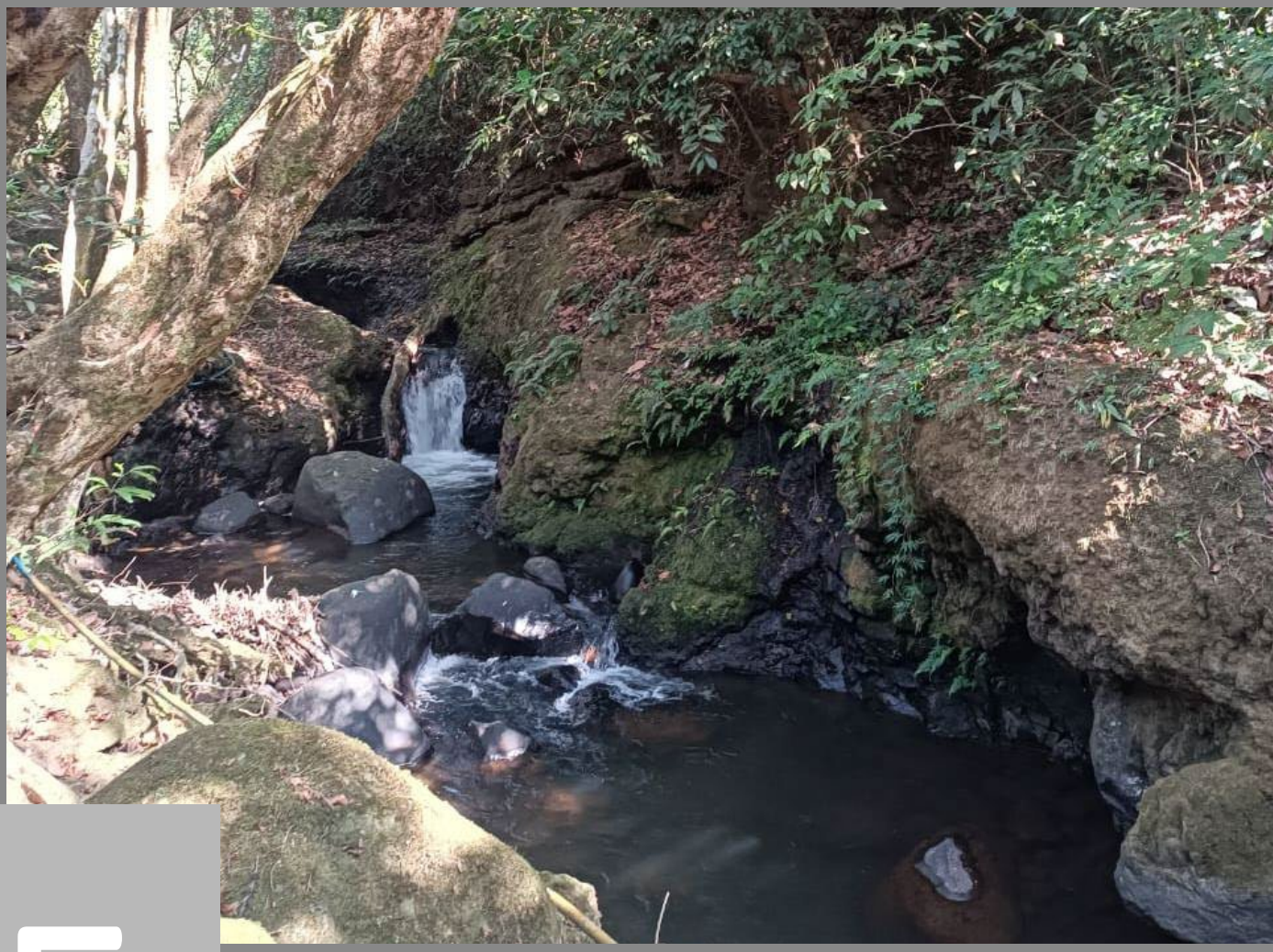
BIOCONTROL PRODUCT	TYPE	ACTIVE INGREDIENT	PEST TARGET
Larvanem	Macrobial	*Heterorhabditis bacteriophora*	Coffee Berry Borer
Atrayente para Broca 98 VP	Semiochemical	Pheromone	Coffee Berry Borer
Trichogramma System	Macrobial	*Trichogramma sp.*	Coffee Berry Borer
Timorex gold 22.3 EC	Natural substance	Tea tree extract	Coffee leaf rust
Biocto 6 84.68 SL	Natural substance	Citrus seed extract	Coffee leaf rust

Table 9. Biocontrol products available with registration for use in coffee plantations in Costa Rica[78]

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMIST
Promote the implementation of Integrated Pest and Disease Management.	☑	☑
Use plant protection products according to the lists of prohibited products and restricted use. Chemical pesticides should be applied only as last resort and in spot applications. Favour the application of biological products or other low-toxicity products (such as products from the CABI BioProtection Portal).		☑
Eliminate the use of prohibited pesticides and fungicides		☑

[78] Portal de Bioprotección CABI, 2024.



5. WATER

5.1 WATER USE & CONSERVATION

"Reducing total water usage during processing (per unit of product) and significantly reducing irrigation from off-farm water sources RA Scorecard – Gold Level." [79]

"Ensuring that aquatic ecosystems are surrounded by riparian buffers of natural vegetation following the RA standard width parameters. RA Scorecard – Gold Level."[80]

RECOMMENDATIONS

a. Famers maintain existing riparian buffers of natural vegetation adjacent to aquatic ecosystems. Aquatic ecosystems are surrounded by riparian buffers with the following riparian buffer width parameters:
   (i) 5 metres horizontal width along both sides of water courses between 1-5 metres wide. For farms < 2 ha, the width of the buffer may be reduced to 2 metres along both sides;
   (ii) 8 metres horizontal width along both sides of water courses between 5-10 metres wide, and around springs, wetlands, and other water bodies.
   (iii) 15 metres horizontal width along both sides of rivers wider than 10 metres.[81]

b. In Costa Rica, coffee is processed in central mills; the economy of scale of water and the technology used allows for attaining less than 5 litres of water/kilo of dry parchment coffee (dpc).

[79] Rainforest Alliance, 2022 a.
[80] Rainforest Alliance, 2022a.
[81] Rainforest Alliance, 2022 a.

5.2 WATER TREATMENT

Coffee farms produce water contamination from domestic consumption.

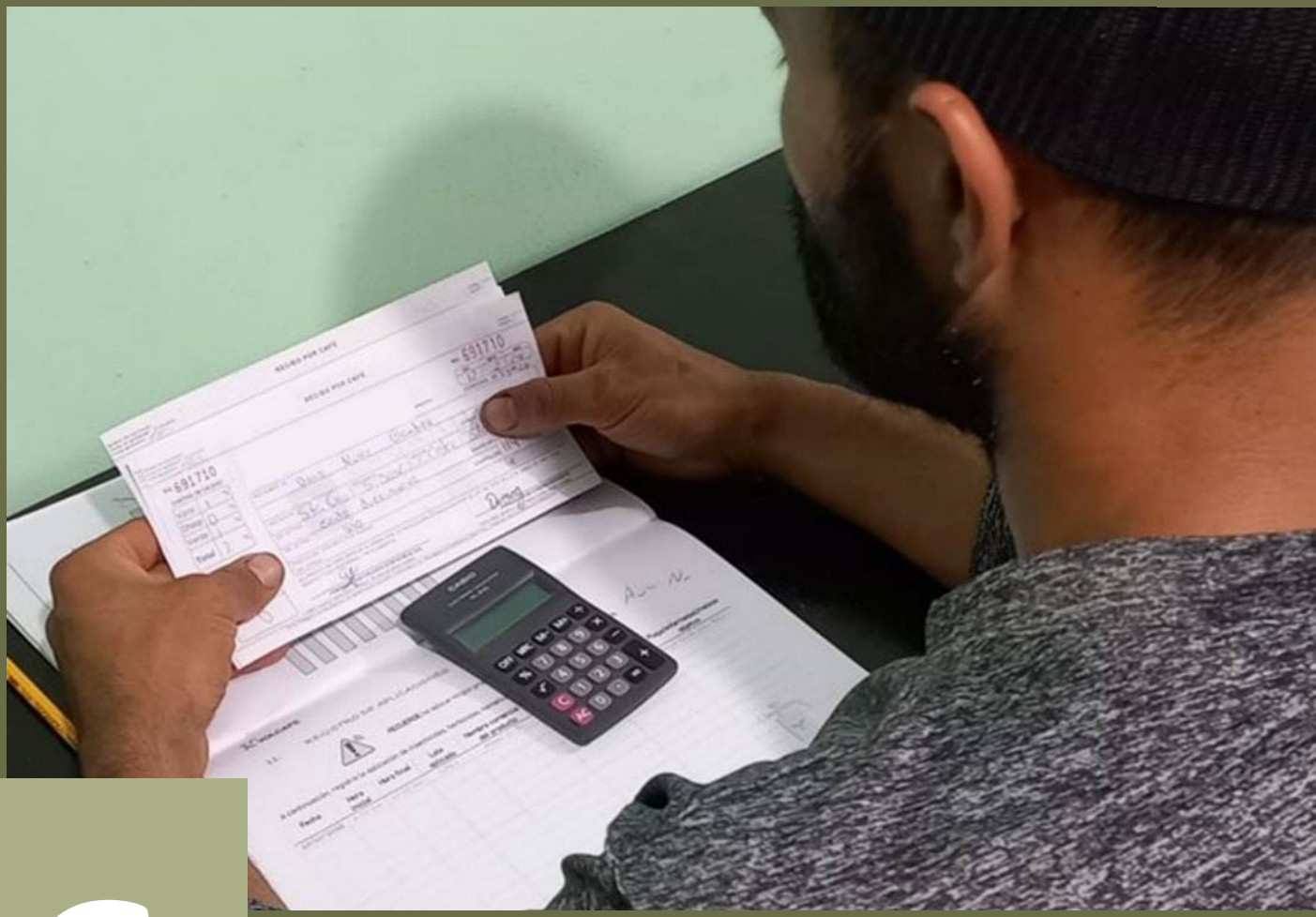
RECOMMENDATIONS

a. Domestic wastewater should be treated in septic tank systems.

b. According to national legislation (Executive Decree No. 26042-S-MINAE), wastewater discharge into all water resources without prior treatment is prohibited. The processing plants guarantee the treatment of wastewater as a condition for operating.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	*CLUSTER MANAGER*	***AAA AGRONOMIST***
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.		☑
Keep water consumption for coffee processing below 10 liters/kg dpc.	☑	
Promote and encourage the processing of pulp as an organic fertiliser.	☑	
Identify and conserve the riparian buffer zones in each farm following the criteria of the Rainforest Alliance Regenerative Coffee Scorecard (Gold level).		☑



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."* [82]

"Monitoring costs of production 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. [83]

The main income drivers of family income are annual coffee production, sales price, and other family income (Figure 7). All variables contribute, but when considering small producers' limited land, productivity changes increase the risk of having low household income (net income).

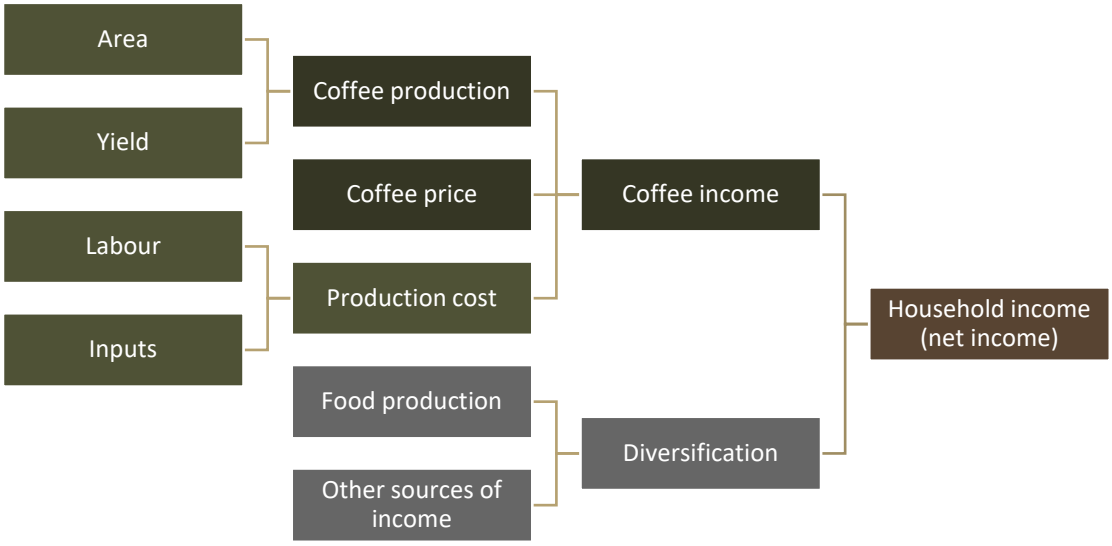


Figure 7. Household income drivers.

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

From the producers' perspective, it is a decision game that considers:

- Current income risks
- Risks to your future income
- Availability of resources for investment.
- Uncertainty about expected outcomes.
- Time for change
- Incentives
- Benefits and cost savings
- Effect on the adaptation and resilience of farms.

Actions to implement regenerative coffee farming can contribute to improving the family income. Adopting regenerative agriculture is a transition process that depends on the availability of labour, inputs, and capital and the capacity of farmers to face the risks.

Each producer and their farm begin the journey at a different time. On one hand, it depends on the condition of input use, the resilience of the farm, and the ecosystem services. On the other hand, the level of productivity and income. Figure 8 shows the possible trajectories for coffee farms. The blue dotted curve shows the so-called "productivity-sustainability frontier". The red dot represents a situation that growers cannot attain because maximising coffee yields or profit (shown on the horizontal axis) is inconsistent with maximising ecosystem services and resilience (shown on the vertical axis). However, depending on the starting point, farms might still have room for improvement for either one or both objectives without necessarily incurring a trade-off until they reach the frontier. Farm 1 and 2 conditions will be changed to improve their income, based on better use of resources, in some cases improving the ecosystem services they receive. In the case of Farm 3, it could gain resilience and ecosystem services, but ultimately, with decreased profitability. [84]

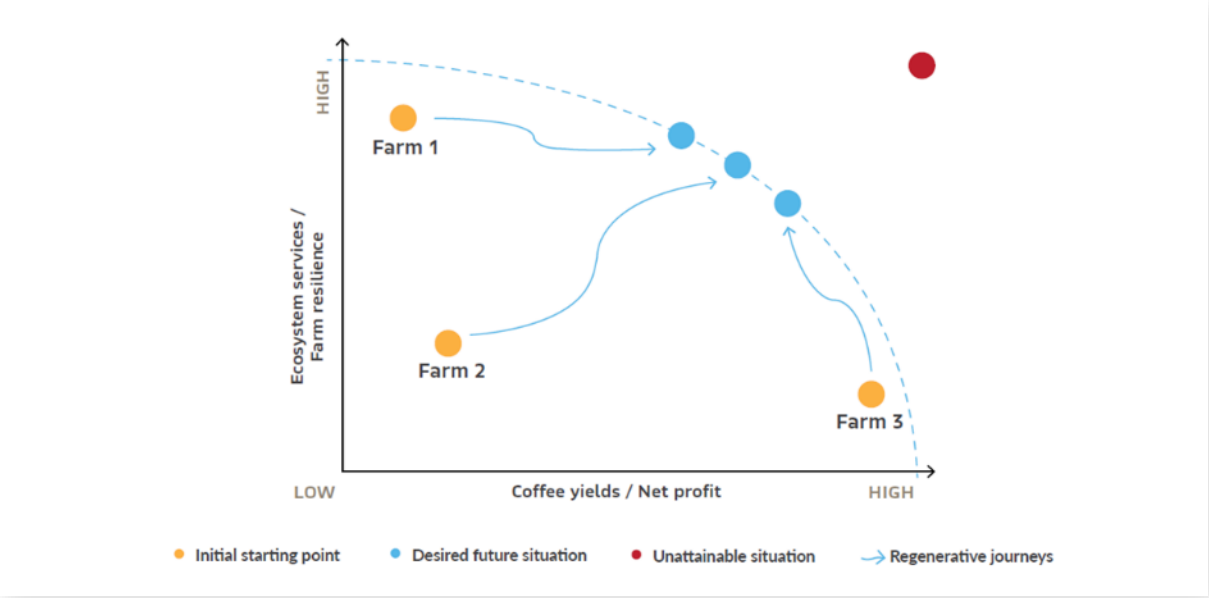


Figure 8. Possible trajectories for coffee farms that seek to improve the balance between two objectives: productivity and sustainability. *Source: Pulleman et al., 2023, p. 46.*

[84] Pulleman et al., 2023.

In Table 10, we foresee some impacts of adopting the agronomic guide on income, resilience, and potential risks. As described in Figure 8, the same technology can yield different outcomes depending on the initial conditions of the production model.

	BETTER INCOME	RESILIENCE EFFECT	RISKS AND UNCERTAINTIES FOR FARMERS
FARM DESIGN Renovation and rehabilitation	+++	+++	Lower productivity in the short-term, improvement stage of the renovation
FARM DESIGN Agroforestry	++	+++	The level of shade on some farms can reduce productivity. The Design of the agroforestry arrangement and the level of shade are determining factors in this effect.
SOIL HEALTH AND ORGANIC MATTER MANAGEMENT	++ | - -	+++	Implementation costs can be considerable in the short term, especially if organic inputs are substituted and labour demand is greater.
NUTRITION PLAN	+++	+	Capital demand in the short term mainly in inputs for soil acidity correction and better fertilisation sources and doses.
HEALTH PLAN	+++	++	Integrated Pest Management may demand higher costs when compared to conventional pest control using chemical pesticides. Adopting an IPM requires a transition plan that protects current production and income levels. In the medium term, the results in quality and income can be positive if viable and efficient natural control alternatives are available.
WATER MANAGEMENT	+	+++	Investment in the wastewater treatment system for domestic wastewater.

Table 10. Expected impacts of adopting the agronomic guide on the economy of AAA families.

RECOMMENDATIONS

a. From 2024, *Nespresso* will start a monitoring plan for technical-economic performance indicators of coffee production in different archetypes of farms. This information will be a reference to monitor the economic efficiency of changes in adopting the agronomic plan and the basis for projections in farm management plans.

b. Plan renovations and rehabilitation to stabilise production and mitigate the risk of decreased yield.

c. Reduce production costs by adopting regenerative practices such as soil conservation, integrated nutrient management, natural weed, and pest control.

d. Producers can begin information management by recording their production and income from coffee sales.

e. Diversify income sources through agroforestry and intercropping.

f. Promote income saving by promoting food production for family consumption.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	*CLUSTER MANAGER*	*AAA AGRONOMIST*
Define expected sustainable productivity levels and propose farm management plans.	☑	☑
Promote record-keeping of coffee production, costs, sales, and other income.	☑	☑
Promote and encourage income diversification projects.	☑	☑

ANNEXES

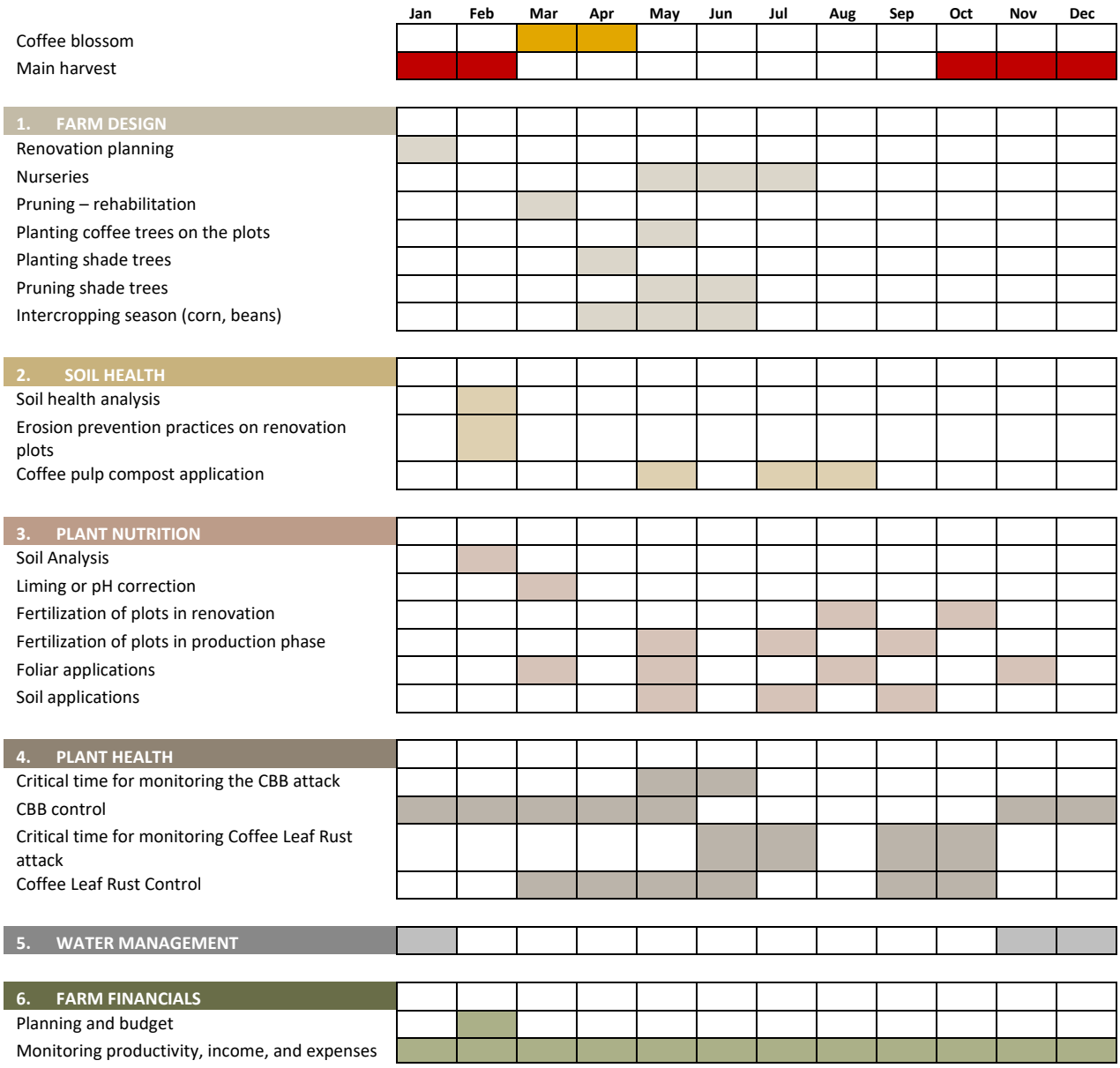
ANNEX 1

AGRONOMIC REGENERATIVE GUIDE

Calendar for the main activities in Costa Rica

Reference: Instituto del Café de Costa Rica (ICAFE). (2021). Guía de Buenas Prácticas Agrícolas para el cultivo del café. Costa Rica:
ICAFE – Ministerio de Agricultura, Ganadería de Costa Rica, BID. Retrieved from www.icafe.cr/wp-content/uploads/cicafe/documents/GuiaBPAsICAFEbaja.pdf

COSTA RICA



Source: Instituto de Café de Costa Rica, 2021.

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 COSTA RICA	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. In the local context, the term "renovation" is used broadly to refer to new plantings and various types of pruning. All these interventions, whether through tissue management 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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