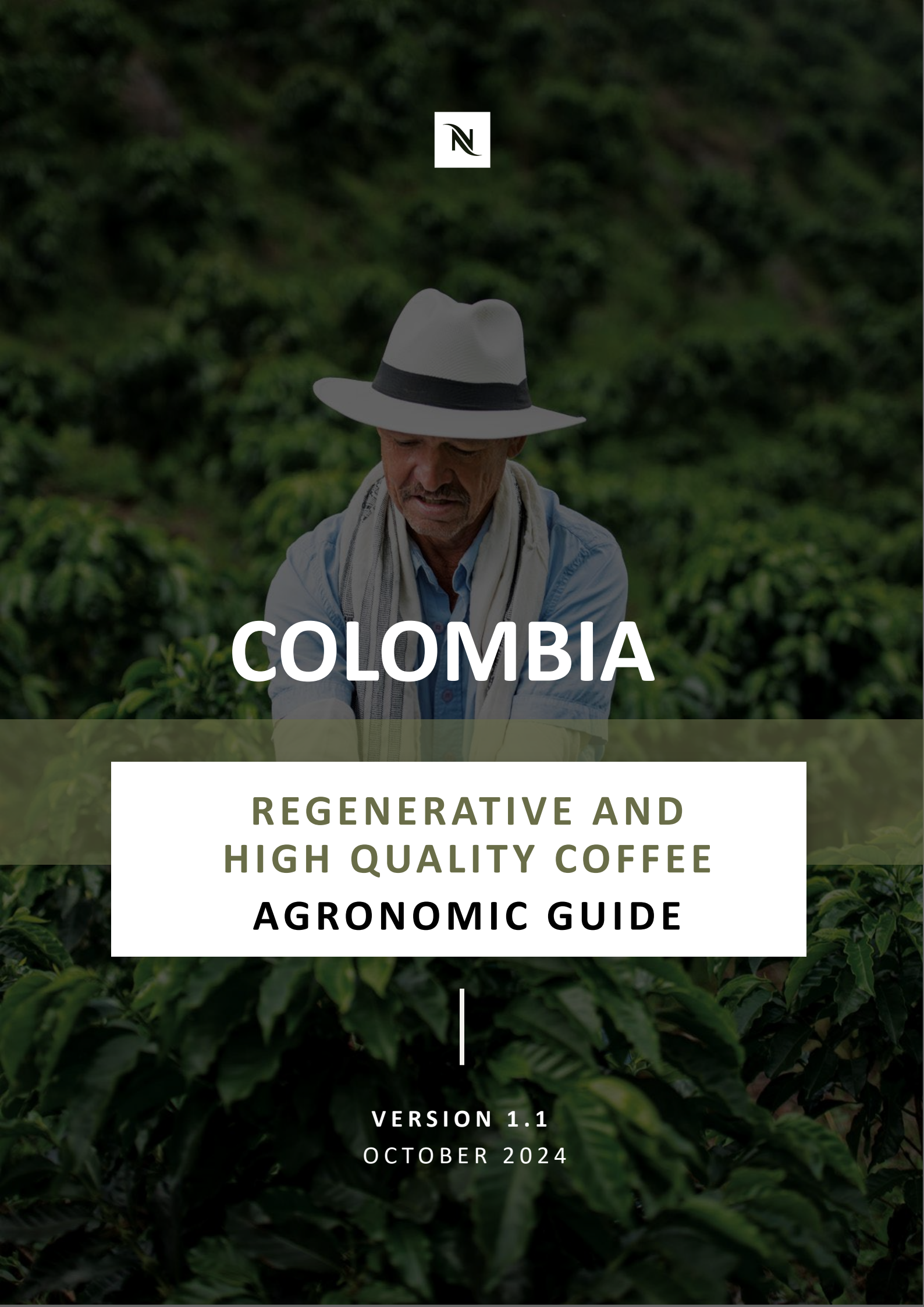


COLOMBIA

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.

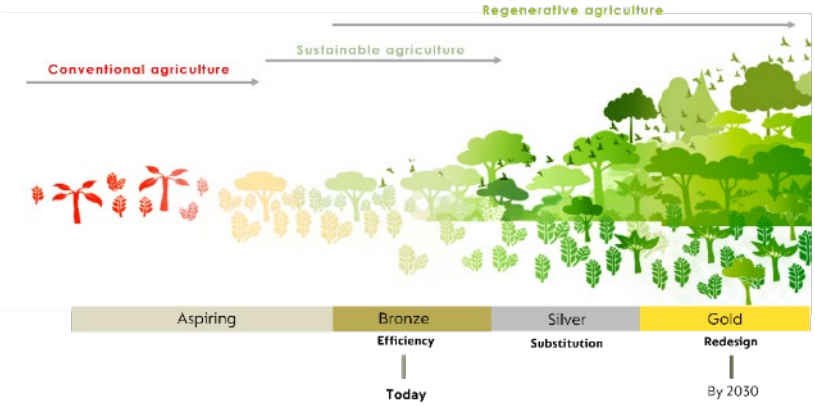
In this new chapter, Sustainable Quality will further integrate high quality coffees with healthy ecosystems, quality of life and thriving communities.

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.

COLOMBIA

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 Colombia.

The broad knowledge base developed for decades by the FNC, combined with the implementation experience of *Nespresso* and partners on the ground, give access to proven and scalable solutions to AAA producers.

Regenerative agriculture is about 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 coffee partners in Colombia, including the National Coffee Growers Federation of Colombia, Cafexport, SKN Caribecafé, Carcafé, and OFI. 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].

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

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

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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FARM

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.

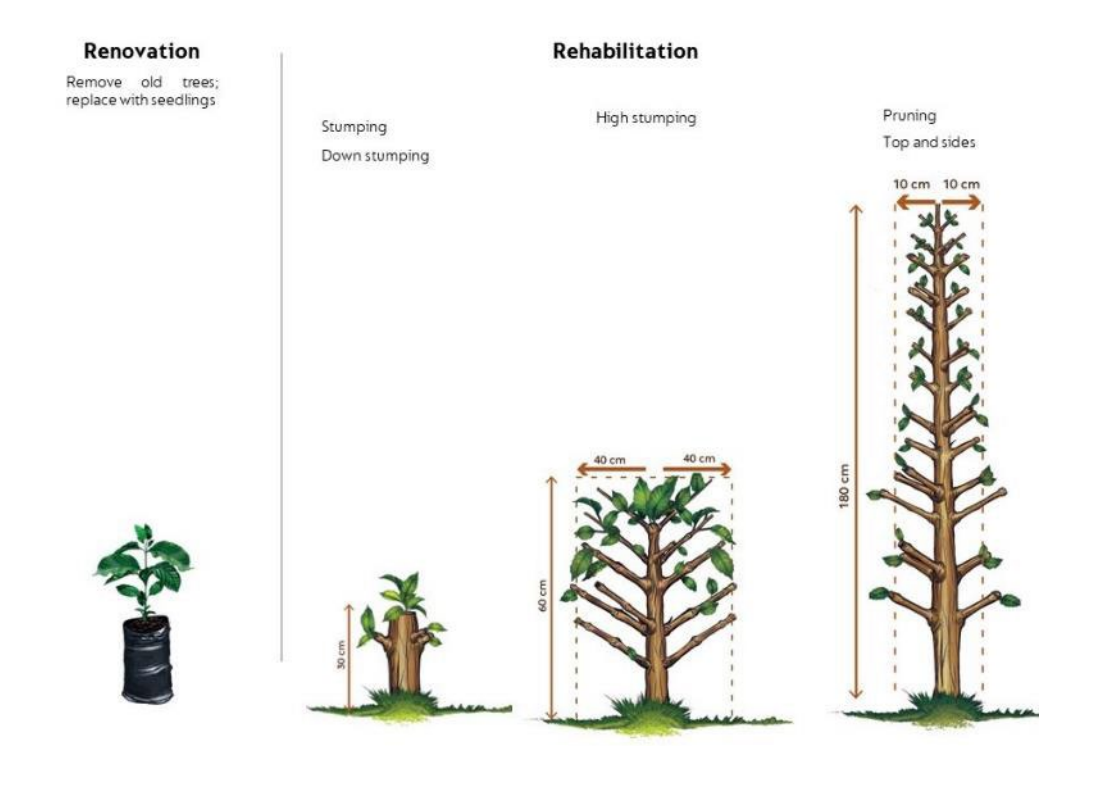


Figure 1. Renovation and rehabilitation terms

REHABILITATION:

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

"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. When coffee trees decline in productivity, one option is rehabilitating growth through various tissue pruning or interventions. This rehabilitation is carried out at the end of the coffee harvest. It is an activity that can be part of the routine agronomic management of coffee production. Colombia has different harvest patterns, including one or two harvest seasons per year. Farmers prune after the main harvest.[6] Harvest seasons differ among Colombian regions, with a distinct coffee harvest distribution by region and year.[7] (See annex 2)

b. The duration of the renewal cycle, or the time between planting and the first pruning, depends on the growth rate of coffee trees, planting density, variety, and overall management. It is expected to last between five and eight harvest seasons, before initiating the first rehabilitation phase after planting. It is crucial to understand the evolution of productivity, the optimal production under farm conditions, and the profitability of the crop to determine whether this cycle will be five, six, seven, or even eight harvest seasons. Analyses from "Mi Finca Cuenta" provide local knowledge as input to make this decision.

c. Planning the renewal cycle should allow the farm to develop areas at different productivity levels. It is essential to avoid a total rehabilitation or renewal of the entire farm area due to the negative impact on cash flow or the seasonality of the farm's peak production levels. Stabilise production, dividing the farms into plots with different ages to keep at least 80% of the trees in production and no more than 20% rehabilitated (coffee plots pruned or stumped) and/or renovated (coffee plots with newly planted seedlings). [8] [9]

[4] Pulleman et al., 2023, p. 48.
[5] Rainforest Alliance, 2022 a.
[6] Federación Nacional de Cafeteros, 2023.
[7] Federación Nacional de Cafeteros, 2023.
[8] Mestre-Mestre y Ospina-Ospina, 1994.
[9] Rendón, 2016.

d. Rehabilitation of coffee trees by stumping and pruning should be done at the end of the main harvest and the beginning of the dry season.[10]

e. Decisions about the type of rehabilitation depend on the condition of the coffee trees, the planning of the renewal cycle, and the intention to design coffee production lots to stabilise production: (i) down stumping, more unproductive time, more harvests before the following rehabilitation, five to six harvests; (ii) high stumping, two to three harvests before the following rehabilitation; (iii) pruning top and sides. One or two harvests. (Figure 1).

f. Rehabilitation can also be carried out in only some rows (all trees in the row) or on preselected trees based on productivity analysis. Adopting high stumping and pruning tops and sides contributes to cost savings and productivity. [11]

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.." [12]

"Replanting or renovation, implemented to ensure at least 50% of plot in young or middle age (≤ 8 years) trees" RA Scorecard – Gold Level.[13]

"Coffee variety is selected based on quality, productivity, and rust resistance. Use of rust-resistant varieties on >50% of plot" RA Scorecard – Gold Level. [14]

"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." [15]

[10] Federación Nacional de Cafeteros, 2013, p. 315.
[11] Plataforma de Comercio Sostenible; Solidaridad, 2020
[12] Pulleman et al., 2023, p. 48.
[13] Rainforest Alliance, 2022 a.
[14] Rainforest Alliance, (2022).
[15] Pulleman et al., 2023, p. 54.

RECOMMENDATIONS

a. Renovation by uprooting the old tree and sowing new ones is done when farmers want to change the variety or the spatial arrangement or when the plot exceeds 20 years.[16]

b. Varieties: To plan rust-resistant varieties. Castillo®, Tabi and CENICAFE 1. The National Federation of Coffee Growers is the country's official supplier of certified seed.[17]

c. The installation of the germinator and nursery must be planned six to eight months before sowing, 70 to 80 days in the seedbeds, and six months in the nursery.[18]

d. Regulate the shade and maintain good soil cover to provide optimal conditions for the growth of young seedlings.

e. Before the renovation, perform soil correction six months in advance based on soil analysis, using liming, gypsum rock powder, natural phosphate, and organic compost.

f. Recommended coffee planting density/spacing: to define the spatial arrangements and sowing density to ensure viable productivity for the rehabilitated plantation, at least 5500 trees per hectare are required.[19]

g. It is suggested to plant in the rainy season after the main harvest in the region[20]. There are maps and regional recommendations showing the recommended planting months for the different Colombian coffee regions.[21]

h. The renovation and rehabilitation do not fundamentally change the production scale. The difference for smaller farms lies in the investment risk compared to their total income. Limitations in net income for families restrict their investment capacity, leading to a higher exposure to the risk of having no income. Renovation and rehabilitation for producers with less area should consider the family income projection and technical aspects.

i. Root-knot nematodes are not a limited pest in Colombia. The primary management strategy is preventive, starting from the establishment of nurseries with clean substrates and materials uncontaminated by the pathogen, either through soil or residues from affected roots. Soil with any history of nematode presence should not be used for seedbeds. Preferably, it should be exposed to the sun (Soil solarization) in a yard for two to three weeks, covered with dark plastic, and exposed to sunlight to reduce the populations of these pathogens. The organic matter used for seedbeds should decompose and be of known origin. When transplanting the seedling from the germinator to the seedbed, the application of biological control fungi such as *Paecylomices lilacinus*, *Metarhizium anisopliae*, and *Beauveria bassiana* is

[16] Federación Nacional de Cafeteros (National Federation of Coffee Growers), 2013, p. 318.
[17] Centro Nacional de Investigaciones de Café (National Centre of Coffee Investigations) y Federación Nacional de Cafeteros, 2021.
[18] Centro Nacional de Investigaciones de Café y Federación Nacional de Cafeteros, 2021, pp. 50, 51.
[19] Rendón y Bermúdez, 2017.
[20] Centro Nacional de Investigaciones de Café y Federación Nacional de Cafeteros, 2021. p. 34
[21] Federación Nacional de Cafeteros, 2023.

recommended. This can be done by immersing the seedlings in a 2.0 g/L suspension before planting or applying 50 mL/plant of this suspension at planting time. Additionally, the incorporation of mycorrhizae of 10 to 20 g of inoculum composed of soil + roots per plant is suggested.[22]

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
Update the productivity information and the coffee structure of the farms in KOLTITRACE		☑
Use "Mi Finca Cuenta" (My Farm Counts) to define the productivity and profitability roadmap and the proposal of renewal cycles.	☑	☑
Promote the adoption strategy supported by the segments proposed in "Mi Finca Cuenta" and the defined acceleration group.	☑	☑
Define and implement the renewal plan 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.	☑	

[22] Centro Nacional de Investigaciones de Café, 2023.

1.2 AGROFORESTRY

"Maintaining agroforestry cover, including a diversity of trees on the overall farm (coffee plots and/or surroundings), with at least 8 species (ideally native), manages species diversity as described in Silver level, and provides two strata of tree levels.

If agroforestry cover is not suitable per the local environmental conditions, trees may also be planted around infrastructure, borders etc." RA Scorecard – Gold Level [23]

RECOMMENDATIONS

a. Models of tree planting may vary and can follow one of the three main models recommended by the PUR in Colombia. (Figure 2).[24]

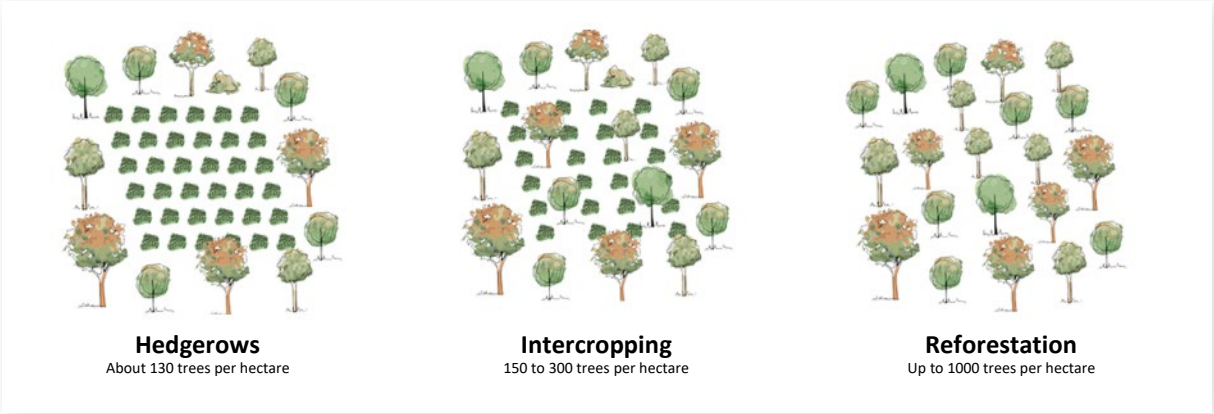


Figure 2. Different agroforestry models implemented in AAA farms – Colombia.
Source: Nespresso, PUR Projet, 2021

b. Consider the most appropriate spatial arrangement of the trees (density, canopy level) based on selected species.

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

[23] Rainforest Alliance, 2022 a.
[24] Nespresso, PUR Projet. (2021).

d. Consider factors such as the growth speed of each species, the architecture of the canopy, the type of leaves and level of shade generated, and leaf shedding seasons, among others. 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.). Native species will be planted based on the Agroforestry project implementation experience (PUR).

e. Transitory shade plays an important role during the coffee establishment, protecting the crop from high temperatures, solar radiation, and low water availability. Transitory shade trees should be cut when the permanent shade is already shading the coffee. Some transitory shade species include: *Tephrosia candida, Crotalaria juncea, Cajanus cajan, Ricinus communis.* [25]

f. These are the most common tree species planted as part of agroforestry models in Colombian clusters, also identified as the species more relevant for biodiversity conservation:[26]

COMMON NAME	SCIENTIFIC NAME
Arrayan castillo	*Myrcia sp.*
Balso blanco (*)	*Heliocarpus amiricanus*
Cajeto, pendo	*Cytharexylum subflavescens*
Caoba	*Swietenia macrophylla*
Carbonero gigante (*)	*Albizia carbonaria*
Cedro negro	*Juglans neotropica*
Cedro de altura	*Cedrela montana*
Cedro rosado (*)	*Cedrela odorata*
Chachafruto (*)	*Erythrina edulis*
Cucharo	*Myrsine guianensis*
Fresno quillitocto (*)	*Tecoma stans*
Gualanday	*Jacaranda caucana*
Guamo churimbo (*)	*Inga edulis*
Guamo macheto (*)	*Inga densiflora*
Guayacan Amarillo (*)	*Handroanthus chrysanthus*
Guayacan rosado (*)	*Tabebuia rosea*
Nacedero (*)	*Trichanthera gigantea*
Nogal cafetero	*Cordia alliodora*
Pino colombiano	*Retrophyllum rospigliosii*
Roble (*)	*Quercus humboldtii*
Vainillo	*Senna spectabilis*

Table 1. Tree species for the agroforestry projects in Colombia
( ) Espinosa, R. y López, A. M. (2019). Árboles nativos importantes para la conservación de la biodiversidad. Propagación y uso en paisajes cafeteros. Federación Nacional de Cafeteros, Cenicafé, GIZ, KFW, Minagricultura.*

g. During the renovation, implement the multi-strata agroforestry models based on diverse native trees (more than four species of trees). Consider critical criteria when selecting tree species: tree morphology, and physiology, pruning requirements, species complementarity and compatibility, capacity to fix nitrogen, support local

[25] Farfán, 2016.
[26] Espinosa y López, 2019.

biodiversity and other beneficial functional traits, multifunctionality and economic value.[27]

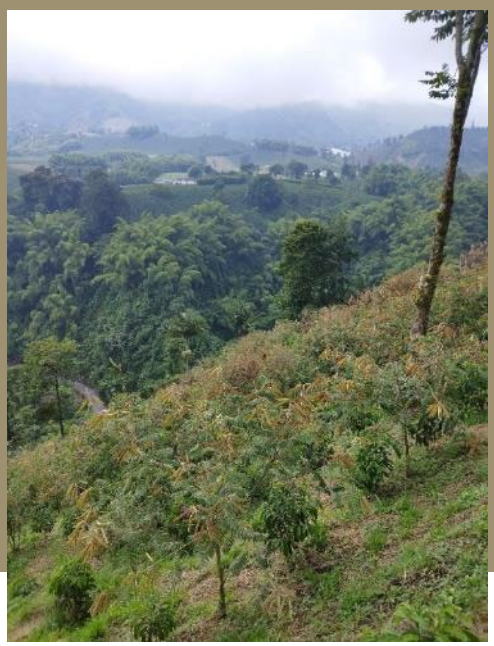
h. It is recommended to develop coffee with shade when the following conditions are present: water deficiency (150 mm rainfall accumulated in three continuous months); associated with high levels of solar radiation; steep slope (>50%); soils susceptible to erosion; soils with physical limitations, low organic matter content and low natural fertility, soils with poor drainage, low permeability, and low moisture retention.

i. The optimal shade level fluctuates between 35 and 45%. Shade levels higher than 50% limit coffee production.[28]

j. *Nespresso*, Smithsonian Migratory Bird Center, SELVA and Rizoma have worked intensively to describe the trees in three highly biodiverse regions of Colombia: Cundinamarca, Santander, and Cauca. These studies provide recommendations for coffee growers and AAA agronomists to leverage the biodiversity associated with trees in the coffee landscape as environmental services. For each species in the inventories, the studies identify threat categories, uses, environmental services, associated biodiversity, benefits for beneficial fauna, and propagation methods. [29] [30] [31]

"Pruning of companion trees ensures optimal light and microclimatic conditions for coffee growth, flowering, and fruit development. Regulating temperature and humidity in the understory is also important to control pests and diseases. Ideally, pruning should be planned according to climatic conditions and pruning calendars." [32]

"Establishing agroforestry systems requires investment and labor, 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." [33]



STEPS IN THE CLUSTER ACTION PLAN

[27] Pulleman et al., 2023. pp. 62, 63.
[28] Farfán y Jaramillo, 2009.
[29] Guzman et al., 2023.
[30] Santos et al., 2023.
[31] Velasco et al., 2023.
[32] Pulleman et al., 2023. p. 64.
[33] Pulleman et al., 2023. p. 67.

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
Implement the agroforestry program in the cluster. Viability, registration, planting, monitoring, incentives.	☑	☑
Integrating agroforestry into the coffee production system, 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 climatic supply, soils, and associated crops.		☑
Select the agroforestry model to be implemented with the producers 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 spread.		☑

1.3 CONSERVATION AREAS

"If agroforestry cover is not suitable per the local environmental conditions, trees may also be planted around infrastructure, borders etc; maintaining an area equivalent to 15% of farm area in natural vegetation" RA Scorecard – Gold Level [34]

Natural vegetation: Vegetation made up predominantly of native or locally adapted species, resembling in species composition and structure 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) [35]

RECOMMENDATIONS

a. They 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.

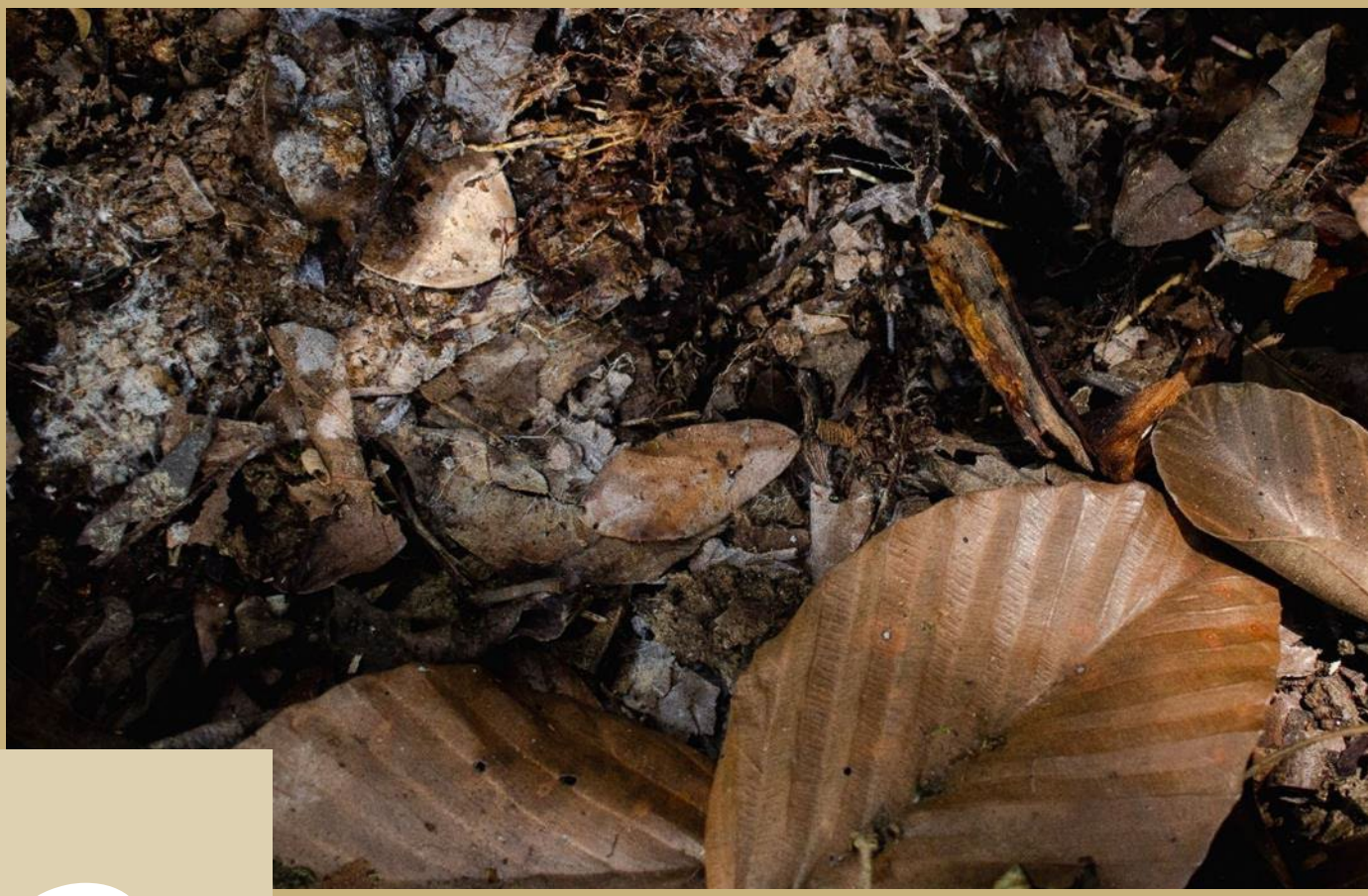
b. AAA Producers can define conservation and restoration areas on at least 15% of their farm area, in the condition that making agroforestry arrangements in their coffee crops is unfeasible.

c. Conservation areas can contribute more to biodiversity conservation if defined with the criteria of corridors or connection areas with other vegetation areas in coordination with other farmers at a landscape level.

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

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
Identify the geographical location of farms regarding areas of conservation interest, buffer zones, and biological corridors.	☑	☑
Plan conservation areas with each farm, especially when the implementation of 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.

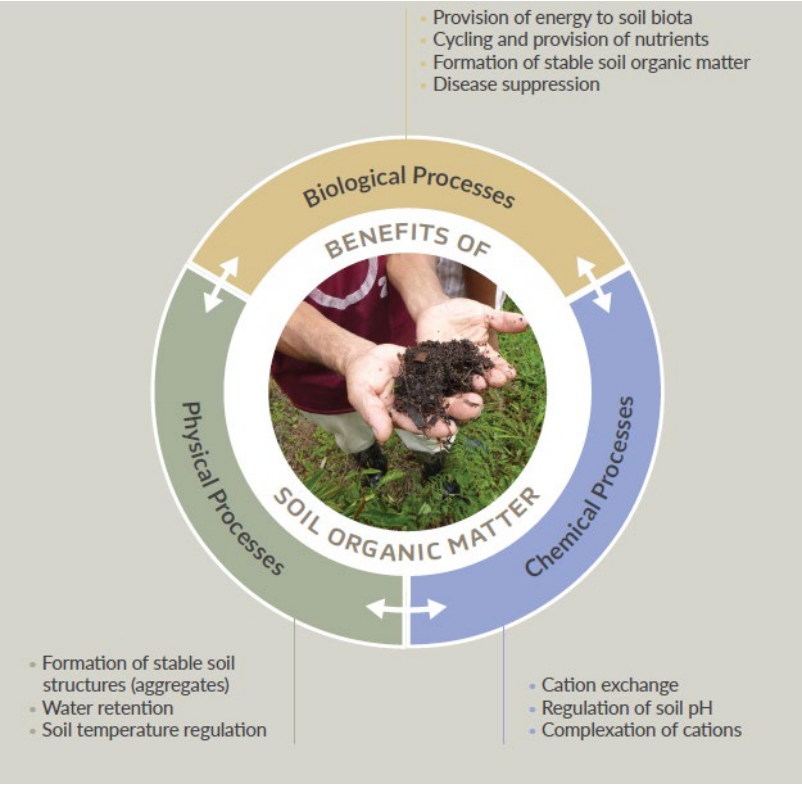


Figure 3. The benefits of soil organic matter through its effect on biological, chemical and physical processes.
Source: Pulleman, M. M., Rahn, E. y Valle, J. F. (2023). CIAT., p. 23

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 on 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 labor and initial investment. Vegetative solutions should be prioritized over the construction of physical structures whenever possible, as the latter generally involve considerable investment in labor and/or machinery." [36]

"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 [37]

RECOMMENDATIONS

[36] leman et al., 2023. p. 82
[37] Rainforest Alliance, 2022 a.

a. Pruned coffee tree branches and leaves are mulched on the soil surface. When agroforestry systems are in place, they offer a good strategy for soil conservation because they provide constant litter input and a canopy to protect the soil.[38]

b. Establish the planting of coffee trees on contour lines against the plot slope.

c. Some soil conservation practices include intercropping, sowing coffee trees in contours or strips, establishing noble covers, sowing living barriers, establishing shade, leaving plant residues that form protective covers, protecting natural drains, protecting slopes, and establishing and maintaining the ditches.[39]

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

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). The practice is most suitable in the first years after crop establishment or on farms with larger interrow distances and/or no shade (as on mechanized 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." [40]

" Maintaining at least 80% bare ground covered with mulch or cover crops (preferably flowering)" RA Scorecard – Gold Level [41]

RECOMMENDATIONS

[38] Pulleman et al., 2023. P. 85.
[39] Centro Nacional de Investigaciones de Café, s. f., p. 130.
[40] Pulleman et al., 2023, p. 85.
[41] Rainforest Alliance, 2022 a.

a. Introduce cover crops during renovation to conserve soil health and reduce herbicides in renovation areas. Cover crops benefit coffee production by improving water and nutrient availability, but they may also 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. Some leguminous cover crop species: *Crotalaria spp, Canavalia ensiformes, Arachis pointoi, Pueraria phaseolensis, Desmodium ovalifolium, Centroseman pubescens*.[42]

b. The cover crops (living mulch) must cover the space between rows but not the coffee root zone. The plants that form the living barrier are planted at a minimum distance of 1 metre. On steeper grounds, living fences should be planted with a shorter space between them.[43]

c. The shade trees' leaves on the ground form the mulch. Mulch increases water infiltration into the soil, preventing runoff and increasing water retention. Soil moisture retention allows the coffee tree to absorb water, especially during much of the dry season. [44]

2.4 INTEGRATED WEED MANAGEMENT

" Use of at most one herbicide active ingredient from the list of risk mitigation pesticides in Annex Chapter 4 of the Rainforest Alliance Standard" RA Scorecard – Gold Level – Mandatory criteria. [45]

RECOMMENDATIONS

[42] Pulleman et al., 2023. P. 81.
[43] Centro Nacional de Investigaciones de Café, s. f.
[44] Farfán, 2014. pp. 146, 159.
[45] Rainforest Alliance, 2022 a.

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 based on their interference level with coffee crops are indicated below.[46]

LEVEL OF INTERFERENCE	WEED SPECIES		
NOBLE WEEDS – LOW INTERFERENCE WITH COFFEE CROPS	*Commelina elegans* *Dichondra repens* *Drymaria cordata* *Euphorbia hirta* *Euphorbia prostrata* *Hydrocotyle umbelata* *Hyptis atrorubens* *Indigofera suffruticosa*	*Oplismenus burmannii* *Oxalis acetosel* *Oxalis corniculatea* *Oxalis latifolia* *Panicum pulchelfum* *Phyllanthus niruri* *Polygonum nepalense* *Polygata paniculatae*	*Richardia scabra* *Sisyrrinchium bogotense* *Tradescantia sp.* *Tripogandra cummanensis* *Tradescantia cummanenesis* *Zornia diphylla*
MEDIUM-LOW INTERFERENCE WITH COFFEE CROPS	*Brassica alba* *Galinsoga parviflora* *Galinsoga caracasana.* *Galinsoga ciliata* *Impatiens balsamina*	*Ageratum conyzoides* *Bidens pilosa* *Cuphea racemosa* *Cuphea micrantha* *Heliopsis buphthalmoides*	*Hyptis mutabilis* *Marsypianthes chamaedrys* *Physalis nicandroides* *Scoparia dulcis* *Solanum nigrum*
POTENTIALLY HIGH INTERFERENCE WITH COFFEE CROP	*Echinochloa crus-galli* *Sorghum halepense* *Brachiaria decumbens* *Cynodon nlemfuensis* *Rottboellia exaltata*	*Cyperus rotundus* *Erigeron bonariensis* *Siegesbeckia jorullensis* *Artemisia absinthium* *Amaranthus dubius*	*Borreria alata* *Anredera cordifolia* *Thumbergia alata* *Chlorís radiata*
HIGH INTERFERENCE WITH COFFEE CROP	*Cynodon dactylon* *Paspalum paniculatum* *Digitaria sanguinalis* *D. horizontalis* *Eleusine indica* *Panicum maximum* *Panicum laxum*	*Torulinium odoratum* *Cyperus ferax* *Pseudoelephantopus spicatus* *Emilia sonchifolia* *Sida acuta* *Stachytarpheta cayennensis*	*Ipomoea spp.* *Melothria guadalupensis* *Melonthria pendula* *Momordica charantia* *Pteridium aquilinum* *Talinum paniculatum*

Table 2. Common weed species in coffee crops and their level of interference. Source: Adapted from Salazar. L. F.; Hincapie. E. (2013)

b. Selectively preserve harmless or low-interference weed species (such as those that harbour beneficial species – e.g., natural enemies of coffee pests).

c. The different methods for controlling weeds (IWM) must be used opportunely and without leaving the soil uncovered. For a successful implementation when using the manual method, avoid removing the soil; when using tools, avoid damaging the stems; carry out practices that favour coffee more than weeds (fertilisation, densities, soil cover); when using herbicides, apply them in spots where the weeds are between 10 to 15 cm high.[47]

d. Integrated Weed Management (IWM), generating live covers that protect the soil from erosion, also reduces the costs of establishing renovations and rehabilitation plots (lower

[46] Salazar and Hincapie, 2013.
[47] Centro Nacional de Investigaciones de Café y Federación Nacional de Cafeteros, 2021. p. 138.

weed control cost for labour and inputs) and minimises the application of herbicides and the use of herbicides applied with an eco-weeder (weed selector). [48]

e. The localised application of herbicides on high-interference or very aggressive weeds is intended to conserve soil, preventing its erosion and degradation, because the rational use of herbicides allows the establishment of low-interference weeds or live covers. This practice also contributes to water conservation because of the lower usage of herbicides.[49]

f. If chemical herbicides cannot be avoided, the product should be as specific as possible to reduce negative effects on non-target species and human 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 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 environmental and human health risks. Only herbicides permitted by sustainability standards should be used, and label directions must be followed precisely.[50]

g. 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. [51] See below the herbicides approved in Colombia. Only products flagged as belonging to the risk mitigation list can be used, and only one of them, as per Regenerative Coffee Scorecard Gold Level.

ACTIVE INGREDIENT	RAINFOREST ALLIANCE
2-4 D Amina	Risk mitigation
Clethodim	Not reported
Diquat	Risk mitigation
Diuron	Risk mitigation
Flumioxazin	Risk mitigation
Glufosinate Ammonium	Prohibited
Glyphosate	Risk mitigation
Haloxyfop-R Metil Ester	Not reported
Linuron	Prohibited
Metsulfuron methyl	Not reported
Oxyflourfen	Risk mitigation
Paraquat	Prohibited
Pendimetalina	Risk mitigation
Saflufenacil	Not reported

Table 3. Herbicides used in Colombia. Rainforest Alliance use status. (Updated: April 30-2024)[52][53]

STEPS IN THE CLUSTER ACTION PLAN

[48] Salazar 2021, p. 7.
[49] Salazar, 2015.
[50] Pulleman et al., 2023. p. 91.
[51] Rainforest Alliance, 2022 b. 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
[52] Rainforest Alliance: https://www.rainforest-alliance.org/wp-content/uploads/2023/07/SA-P-SD-9-V1.5-Rainforest-Alliance-Exceptional-Use-Policy.pdf
[53] ICA- Colombia. https://www.ica.gov.co/getattachment/Areas/Agricola/Servicios/Regulacion-y-Control-de-Plaguicidas-Quimicos/PUBLICACION-BD_RN-RF-4.pdf.aspx?lang=es-CO

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
Run a soil health analysis and define soil conservation and improvement practices prior to analysis focusing on plant nutrition		☑
Promote with producers the actions to protect and conserve the soil, such as slope and runoff management, terraces, drainage, and living barriers. Promoted actions should be according to the slope of the farm.		☑
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 fertilization, such as soil acidity, aging of coffee plants and shade density; (ii) balanced and efficient fertilizer 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 as well as phenological stage of the coffee plants all have a strong effect on nutrient requirements, and this should be taken into account when making fertilization plans."[54]

"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 [55]

"Soil testing must be done at the right time (at least 3-4 months after the last fertilization) and repeated regularly (every 2 to 3 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."[56]

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

RECOMMENDATIONS

a. Soil Analysis must be carried out every two years. Fertilisation based on soil analysis is fundamental for productivity and cost efficiency.[57] Samples should be taken at least three to four months after the last fertilisation. For plots with less than two hectares, it is suggested to take sub-samples at 10 spots and plots of a larger size (>2 hectares) at 15 to 20 spots.[58] Perform soil analysis (samples 0 to 20 cm deep) at the end of the harvest to support plant nutrition recommendations. Evaluating soil fertility requires chemical, physical, and biological analyses.

b. Based on soil analysis, pH and aluminium saturation results, liming could be done by sowing a high-quality product. A new application is recommended 10 to 12 months later. During the reproductive phase, the frequency is two years; this is unless a recent soil analysis is performed that suggests a new application.[59]

c. The proper pH range for coffee is 5.0 to 5.5; aluminium should be less than 1.0 cmol/kg. When the pH is higher than 5.5, the aluminium is neutralised, which leads to a problem for the growth of coffee plants.

d. Various strategies to fix acidity problems include using microorganisms (for example, mycorrhizae help plants absorb phosphorus), increasing the soil's organic matter content, controlling erosion, and applying organic fertilisers and lime. The effects of using organic matter to reduce exchangeable aluminium and increase pH have been observed with doses of over 8 tons of decomposed pulp per hectare.[60] Among these strategies, and perhaps the most effective, is soil acidity management through lime, mainly calcium carbonate ($CaCO_3$) and magnesium ($MgCO_3$).[61] Plant nutrition and soil amendments should be based on the results of soil and foliar analysis (understood as soil health analysis, i.e., including physical, chemical, and biological indications of the soil capacities).

e. Visual symptoms of nutritional deficiencies and foliar analysis can also be observed. [62] Chemical soil analysis is the primary diagnostic tool for assessing the soil's nutritional status and providing information about decisions regarding Integrated Nutrient Management.[63]

f. Alleviate local constraints that limit crop response to nutrient inputs through other regenerative practices, such as renovation, use of well-adapted varieties, adequate planting densities, agroforestry, integrated weed and pest management, and soil conservation measures.[64]

[57] Carrillo-Pachón et al.,1995.
[58] Sadegnian, 2022, p. 142
[59] Sadeghian, 2022, p. 79
[60] Salazar y Sadeghian, 2023.
[61] Sadeghian, 2022, p. 63.
[62] Sadeghian, 2022, pp. 135-136.
[63] Pulleman et al., 2023. p. 110.
[64] Pulleman et al., 2023. p. 110

g. In cases where coffee growers have not been able to conduct a soil analysis, the following applications are recommended:
    - Nitrogen: between 120 and 300 kg/ha-year,
    - Potassium (K_2O): between 0 and 300 kg/ha-year,
    - Magnesium (MgO) and Phosphorus (P_2O_5): between 0 and 60 kg/ha-year,
    - Sulphur (S): up to 50 kg/ha-year.

h. Plant nutrition plans should be determined based on the analysis of soils and adjusted according to the characteristics of the plantation, the amount of rainfall and distribution, and the price of fertilisers, among others. A database of soil-analysis results at a regional scale can help to establish management options for homogeneous areas.

i. A suitable time for applying fertilisers is when the following two premises or conditions are met: i) soil is moist in the first 5 to 10 cm; and ii) there is a high probability that the soil will maintain the moisture for at least the next two months.

j. The most efficient way to apply fertilisers is by spreading them on the coffee tree root zone.[65]

k. Crop management also affects fertilisation requirements. Regarding the shade level over the crop, it has been demonstrated that if the level exceeds the recommended shade, there is no crop response to fertilisation.[66]

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
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.	☑	☑

[65] Sadeghian, 2022, pp. 187, 190, 192
[66] Farfán y Mestre, 2004.

3.2 LOW CARBON & EFFICIENT FERTILISATION

In the analysis of CO2 equivalent emissions on AAA farms in Colombia, 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. [67]

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

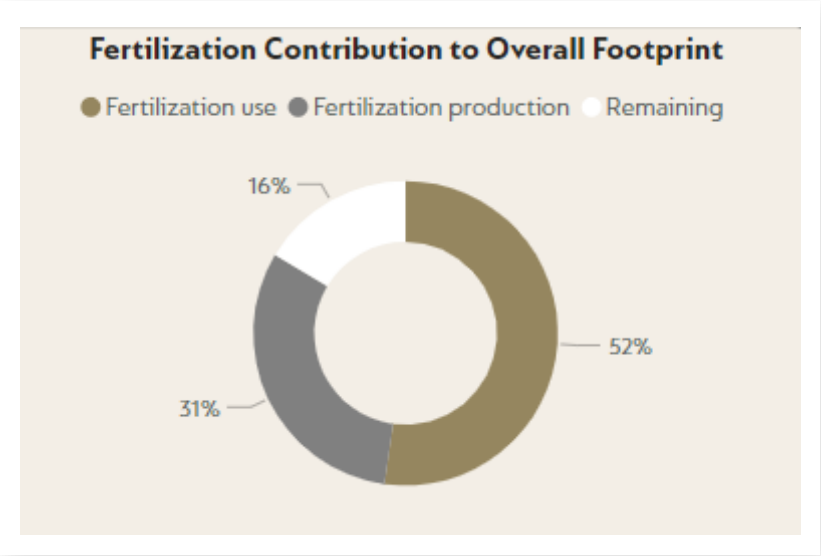


Figure 4. Fertilization contribution to overall GHG Footprint – Colombia.
Source: Nespresso, 2023/2024 cyle.

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.[68] 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.[69] 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.

[67] YARA International, 2011.
[68] YARA, 2023, p. 4.
[69] 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 4. Nutrient content – commonly used and YARA fertilisers

RECOMMENDATIONS

a. Following the 4R concept, apply efficient levels of synthetic fertiliser 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 place. [70] – The source of nutrients will be complemented with organic fertilisation (see 3.3 section)

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 to the demand of the coffee crop based on extraction curves and nitrogen demand in the different stages of the coffee tree and field diagnoses.

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

e. Split the applications and use appropriate tools for precision agriculture to adjust the dose of nitrogen to the crop's requirements.

f. Treatment of crop residues and organic fertilisers efficiently reduces nitrogen emissions from the transformation process.[71]

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
*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 incentivise the adoption of efficient nitrogen fertiliser use based on the previous recommendations.	☑	☑

[71] YARA, 2023, p. 4.

3.3 ORGANIC FERTILISATION

"The availability of organic residues determines to what extent organic inputs can substitute for or complement mineral fertilizers. Coffee farms generally do not generate sufficient organic residues to fully satisfy plant nutrient demand. Synchronization of nutrient availability with crop demand can also pose challenges when organic inputs are used. Therefore, combined use of mineral and organic fertilizers 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" [72]

" Applying organic fertilizer, 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 [73]

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. [74]
b. Fertilisation with chemical fertilisers can be partially or wholly replaced by organic fertilisation without affecting production if the appropriate sources and required quantities are supplied. It is possible to maintain productivity levels by using 75% of the recommended chemical fertilisation based on soil analysis, combined with 1500 to 1700

[72] Pulleman et al., 2023, p. 65.
[73] Rainforest Alliance, 2022 a.
[74] Pulleman et al., 2023, p. 23

kilograms per hectare per year of decomposed pulp (60%-65% moisture). These quantities can be obtained with a production close to 2,875 kg of dried parchment coffee (dpc) per hectare per year. [75] This level of productivity is notably high, considering the conditions of farms in Colombia. Only 2% of farms in the clusters surpass 2800 kg of dried parchment coffee per hectare per year. The average productivity on AAA farms is 1152 kg of dried parchment coffee per hectare per year, with an estimated 650 kilograms of decomposed pulp per year. In conclusion, the availability of composted coffee pulp poses a limitation for substituting mineral fertilisation. *Nespresso* recommends utilising the total available coffee pulp and, to the extent that availability and productivity allow, replacing it with organic matter based on soil analysis recommendations. However, there is no defined minimum application for a percentage of organic matter or farm area.

c. Despite not being a linear relationship, Table 5 shows an approximation of the possibility of substituting mineral fertilisation based on the availability of organic material on the farms from the coffee process itself. This condition would evolve by first improving productivity levels.

Table 5. Approximation of the average availability of organic matter from composted coffee pulp according to the average conditions of the clusters

CLUSTER	YIELD (KG DPC- HA-YEAR)	KG COMPOSTED PULP	PERCENTAGE OF SUBSTITUTION OF MINERAL FERTILISATION
Reference (Cenicafe)	*2875*	*1600*	*25%*
Huila	1688	939	15%
Santander	1485	826	13%
Caldas-Antioquia	1351	752	12%
Nariño	967	538	8%
Cauca	950	529	8%
Cundinamarca	770	429	7%

Source: Productivity analysis based on information from "Mi Finca Cuenta" for farms in the different clusters, year 2022.

d. Essential factors to consider include the high doses required, the availability of the fertiliser, and, therefore, the higher costs incurred for the product and those related to its transportation and application.

e. AAA Producers utilise all available organic matter on the farm through composting coffee pulp. They prioritise its use and combine it as part of the fertilisation recommendation. The primary source of organic matter in coffee farms is composted coffee pulp since 44% of the total coffee harvested is fresh pulp. [76]

[75] Salazar y Sadeghian, 2023).
[76] Sociedad Colombiana de la Ciencia del Suelos y Centro Nacional de Investigaciones de Café, 2009.

f. Managing cover crops and mulching is a significant source of biomass and organic matter in the soil.

g. As a source of organic matter and other nutrients, the management of green manures, such as Tephrosia or Crotalaria, can be implemented. Also, these species and others with similar characteristics could be used as transitory shade during plot establishment. [77]

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
Promote the application of composting 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 organic matter sources in commercial products within the local context.	☑	☑

[77] Jiménez, et al., 2005.

4. PLANT HEALTH

4.1 INTEGRATED PEST MANAGEMENT (IPM)

" Reducing the use of pesticides (2 or less ingredients from the risk mitigation list), and eliminating the use of synthetic chemical nematicides in farm" RA Scorecard – Gold Level – Mandatory criteria [78]

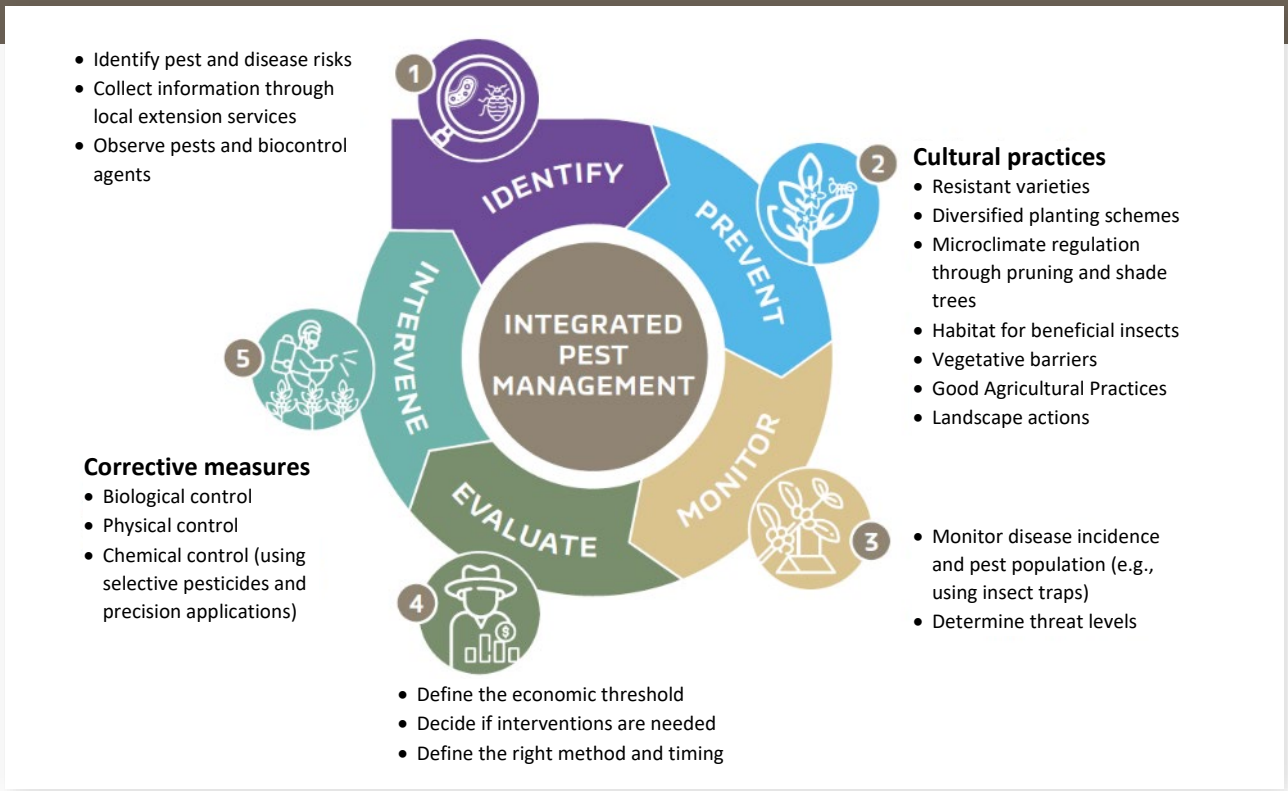


Figure 54. Key components of an integrated pest management approach.
Source: Pulleman, M. M., Rahn, E. y Valle, J. F. (2023). CIAT., p. 97

The primary disease of economic importance is coffee rust. It can reduce production in susceptible varieties by 23-50%. In Colombia, planting varieties with genetic resistance to this disease is promoted. More than 80% of the coffee area in the clusters is planted with resistant varieties.

The coffee berry borer (CBB) is the primary pest with respect to spreading and causing economic damage. CENICAFE has investigated Integrated Pest Management solutions in the Colombian context. The main recommendations within this approach are listed below.

[78] Rainforest Alliance, 2022 a .

a. Monitor disease incidence and pest population and evaluate if interventions are needed. CBB monitoring is started 90 days after flowering, at which time the fruits begin to be drilled by the borer. Field tracks are made monthly to define the attack level and ensure that it does not exceed 5% damage in the field.

b. 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, it includes aspects 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; (v) borer management in coffee processing, hopper, pulp pit and drying of high-infested coffee.[79] [80]

c. Introduce specific biocontrol agents on the farm, such as wasps of African origin as a biocontrol for the coffee berry borer or the *Beauveria bassiana* fungus, which are more effective and available in various commercial formulations. (check CABI BioProtection Portal).

d. Use natural enemies as a biological control: "Preserve and enhance the native populations of natural enemies of the CBB in coffee farms: birds, lizards, ants, lady beetles, mites, predatory and parasitic wasps, and beneficial microorganisms can help control coffee pests and diseases. It requires protecting 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.".[81] CENICAFE has also identified different species of native insects attacking the borer, such as *Monanus sp, Crematogaster sp, Solenopsis sp, Wasmannia sp, Brachymyrmex sp.* The presence of natural enemies is associated with coffee plantations that have greater biological diversity and hosts for these natural enemies. [82]

e. **Use chemical pesticide applications only when** threshold levels of pests and diseases are reached, and only use the minimum necessary.

[79] Benavides et al., 2013.
[80] Constantino, 2023.
[81] Pulleman et al., 2023, p. 98.
[82] Vera-Montoya et al., 2007.

f. The threshold level for CBB for field infestation levels is above 2% of coffee fruits infected and more than 50% of the borers entering the coffee fruit in position B or adult borers in the penetration channel with the possibility of being reached by contact insecticides. Safety conditions in the application, re-entry times to the lot, and safety periods before harvest must be respected. [83]

g. Use pesticides with the lowest possible toxicity and highest selectivity. Apply pesticides only to the impacted coffee areas/plants.

h. Use only the correct dosage and precision applications (2 or fewer ingredients from the RA risk mitigation list). The following directions for usage, as described on the label, are in the Rainforest Alliance Annex Chapter 4, Agriculture.[84]

i. Nematodes are not considered a limited or widely distributed pest in Colombia. There are treatments for the substrates of the seedbeds with biological products, especially the use of decomposed organic matter. In nematodes' severe attacks, nematicides can be applied after other IPM actions were considered, only under specific circumstances. The goal is to eliminate the use of synthetic chemical nematicides in farms.

j. Pesticides approved by Rainforest Alliance (see Table 6 below).

USE	ACTIVE INGREDIENT	RAINFOREST ALLIANCE
Fungicide	Azoxystrobin	Risk mitigation
Fungicide	Benomyl	Prohibited
Fungicide	Boscalid	Not reported
Fungicide	Carbendazim	Prohibited
Fungicide	Chlorothalonil	Prohibited
Fungicide	Cyproconazole	Prohibited. *With exception until 2024*
Fungicide	Epoxiconazole	Prohibited
Fungicide	Flutriafol	Not reported
Fungicide	Hexaconazole	Not 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	Not reported
Fungicide	Thiamethoxam	Prohibited
Fungicide	Thiophanate Methyl	Risk mitigation

[83] Federación Nacional de Cafeteros, 2017.
[84] Rainforest Alliance, 2022 a.

Fungicide	Thiabendazole	Risk mitigation
Fungicide	Triadimefon	Not reported
Fungicide	Trifloxystrobin	Risk mitigation
Insecticide	Abamectin	Prohibited – 2025
Insecticide	Acetamiprid	Prohibited
Insecticide	Alphacypermethrin	Risk mitigation
Insecticide	Carbaryl	Risk mitigation
Insecticide	Chlorantraniliprole	Not reported *Not allowed as a mixture with Thiamethoxam*
Insecticide	Chlorpyrifos	Prohibited
Insecticide	Cypermethrin	Risk mitigation
Insecticide	Cyantraniliprole	Not reported
Insecticide	Bifentrin	Risk mitigation
Insecticide	Diamethoate	Risk mitigation
Insecticide	Fenitrothion	Risk mitigation
Insecticide	Fentoato	Not reported
Insecticide	Fipronil	Prohibited
Insecticide	Imidacloprid	Prohibited
Insecticide	Lambda cyhalothrin	Risk mitigation
Insecticide	Lufenuron	Risk mitigation
Insecticide	Sodium octaborate	Prohibited – 2025
Insecticide	Matahion	Risk mitigation
Insecticide	Thiamethoxam	Prohibited – 2024 Not allowed as a mixture

Table 6. Fungicides and Insecticides used in Colombia. Rainforest Alliance status of use (Updated: April 30-2024)[85] [86]

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

[86] ICA Colombia. https://www.ica.gov.co/getattachment/Areas/Agricola/Servicios/Regulacion-y-Control-de-Plaguicidas-Quimicos/PUBLICACION-BD_RN-RF-4.pdf.aspx?lang=es-CO

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
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. (such as products from the CABI Bioprotection Portal).		☑
Apply chemical pesticides only as a last resort and at spot applications. Use chemical pesticides according to the lists of prohibited products and restricted use. The only permitted products are those belonging to the risk mitigation risk at Silver and Gold Levels.		☑
Eliminate the use of prohibited pesticides and fungicides		☑

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 [87]

Ensuring that aquatic ecosystems are surrounded by riparian buffers of natural vegetation following the RA standard width parameters. RA Scorecard – Gold Level [88]

For washed Arabica coffee processing in Colombia, water is used for pulping, transporting, and washing. Farms' wet mills can be classified according to the level of water consumption into:

1. Conventional mill with an average water consumption close to 40 litres/ kg of dpc.
2. Model in transition to ecological with an average consumption of about 10 litres/kg of dpc.
3. Ecological processing facilities with consumption lower than 10 litres/kg of dpc.
4. Ecological processing, ECOMILL without discharges with water recirculation until incorporated into the treatment systems. Less than 3 litres/ kg of dpc.

By 2020, around 25% of the mills in Colombia had already implemented the ecological process, and 60% were categorised as in transition to ecological.[89]

RECOMMENDATIONS

a. To address water consumption and pollution in coffee processing, it is advised that Ecological Coffee Processing and the Use of By-products be implemented. This technology has the following characteristics: [90]
    - Movement of coffee from the hopper to the pulper by gravity, without water. (Non-use of water)

[87] Rainforest Alliance, 2022 a.
[88] Rainforest Alliance, 2022 a.
[89] Rodríguez-Valencia et al., 2022.
[90] Rodríguez et al., 2015, p. 7.

- Wash coffee with a water consumption using the tub tank (*Tanque tina*), potentially lowering the water consumption from 25 to 4.1 litres/kg dpc. [91] This technology is the most accessible due to investment and ease of operation for coffee producers with less area or production. *Nespresso* promotes it within the investment in projects in the clusters. (Significant reduction in water consumption).
- Mechanical Washing. Using ECOMILL®, with this technology, it is possible to reach minimum water consumption in the process (<1 litre/kg dpc) using equipment that mechanically washes the mucilage degraded in the process with natural fermentation. It is the recommended solution for farms with higher production due to the requirement for investment in equipment and operating costs. (Significant reduction in water consumption).
- The transportation of the pulp is carried out without water, i.e., endless screw (Non-use of water).
- The pulp is transformed into a compost pit (Non-use of water)
- Pollution control is carried out using by-products.
  All of the above practices have an additive effect in reducing water consumption in coffee processing to minimum levels.

b. Farmers maintain a riparian buffer of natural vegetation adjacent to aquatic ecosystems per the Rainforest Alliance 2020 Sustainable Agriculture Standard. Aquatic ecosystems are surrounded by riparian buffers with the following riparian buffer width parameters: 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 on both sides; 8 metres horizontal width along both sides of water courses between 5-10 metres wide, and around springs, wetlands, and other water bodies; 15 metres horizontal width along both sides of rivers wider than 10 metres wide. It is a specific condition for the Regenerative Coffee Scorecard- Gold Level. [92]

c. Farmers should ensure they do not bury or burn waste. Farmers have a basic waste management plan to ensure hygiene and overall farm management. Practices such as recycling should be encouraged. Integrated waste management activities must be according to the types and amounts of waste generated. It includes all solid and liquid wastes (coffee pulp, pulp waters, and leachates for farms with wet processing or composting areas).

[91] Zambrano – Franco et al., 2011.
[92] Rainforest Alliance, 2023.

5.2 WATER TREATMENT

Coffee farms produce water contamination from domestic consumption and wastewater from coffee processing.[93]

RECOMMENDATIONS

a. Septic systems are the most efficient and utilised method for treating domestic wastewater.[94]

b. CENICAFE Designed modular anaerobic treatment systems (MATS) are used to decontaminate the wastewater generated by coffee washing. This system adapts according to the production of each farm.[95]The overall water consumption must be checked before installing a modular system to treat coffee processing water to avoid irrational or unnecessary use. This system is much more efficient when the processing system is ecological. [96]

c. As an alternative to MATS systems, the wastewater treatment solution uses green filters with zero discharges, combining biological treatment through plant beds, evaporation, and recirculation to the treatment system. It is estimated that a 1-hectare farm could treat its wastewater in an area of 16 square metres of green filter.[97] [98]

[93] Rodríguez et al., 2018, *p. 7*
[94] Rodríguez-Valencia et al., 2002, p. 33.
[95] Zambrano-Franco, et al., 2006, p. 5.
[96] Zambrano-Franco et al., 2006, p. 24.
[97] Rodríguez-Valencia et al., 2023.
[98] Federación Nacional de Cafeteros, 2020.

STEPS IN THE CLUSTER ACTION PLAN

STEPS	CLUSTER MANAGER	AAA AGRONOMISTS
Promote and encourage the adoption of technology to reduce water consumption for coffee processing and other home uses.	☑	☑
Define with producers actions for the rational use of water, considering the maintenance of water distribution networks and reducing consumption in the home.	☑	☑
Adjust coffee processing to reduce water consumption below 10 L/kg dpc		☑
Promote and encourage the processing of pulp, mucilage, and leakage as organic fertiliser.	☑	☑
Implement wastewater treatment solutions such as MATS or green filters with zero discharge, according to the capacity and conditions of each farm.	☑	☑
Identify and conserve in each farm the riparian buffer zones 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 labor conditions, health and safety*
- *Diversifying production and sources of income."* [99]

"Monitoring costs of production and calculating revenue from 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 [100]

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

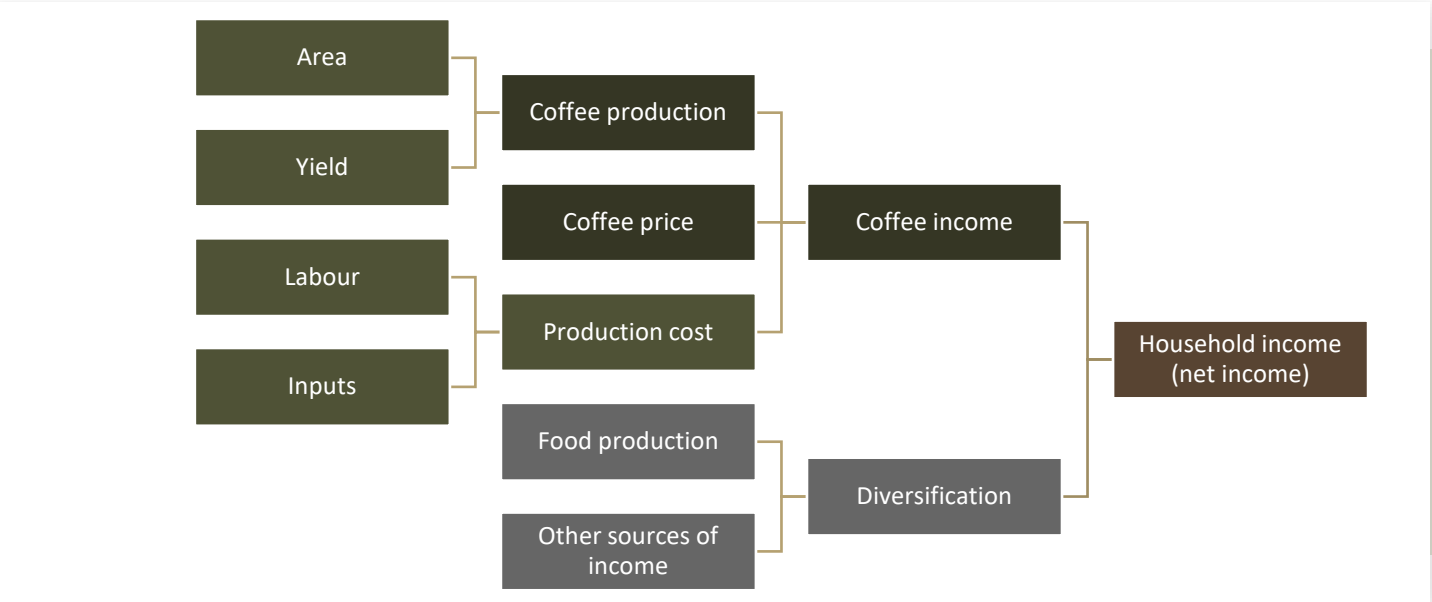


Figure 65. Household income drivers.

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

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

- Risks to current income.
- 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 adaptability 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 effective use of inputs, the resilience of the farm, and the ecosystem services. On the other hand, it depends on the level of productivity and income. As the following graph describes, 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 in resilience and ecosystem services, but ultimately with decreased profitability. [101]

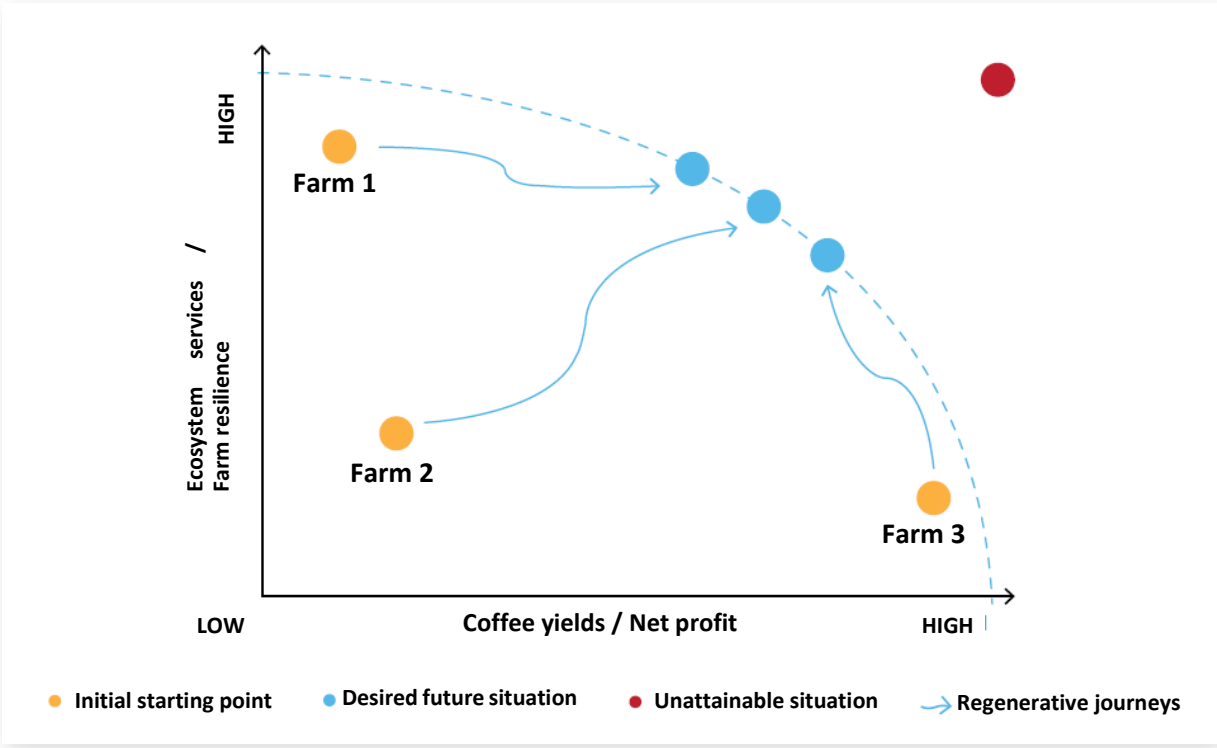


Figure 76. Possible trajectories for coffee farms that seek to improve the balance between two objectives: productivity and sustainability. The blue dotted curve shows the so-called "productivity-sustainability frontier". The red dot represents a situation that growers cannot attain because maximising 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.

[101] Pulleman et al., 2023.

Source: Pulleman, M. M., Rahn, E. y Valle, J. F. (2023). CIAT., p. 46

In Table 7, we foresee some impacts of adopting the agronomic package on income, resilience, and potential risks. As described in Figure 7, the same technology can yield different outcomes depending on the initial conditions of the production model.

Table 7. Expected impacts of adopting the agronomic package on the economy of AAA families.

	HIGHER-INCOME	RESILIENCE EFFECT	RISKS AND UNCERTAINTIES FOR FARMERS
FARM DESIGN: Renovation and rehabilitation	+++	+++	Lower productivity in the short term. Plot handling cost during the unproductive stage.
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 of the effect.
Soil health and organic matter management	++ | - -	+++	In practice, costs can be considerable in the short term, especially if there is a substitution for organic inputs and greater demand for labour.
Nutrition plan	+++	+	Capital demand in the short term is mainly input for soil acidity correction and better fertilisation sources and doses.
HEALTH PLAN: Integrated Pest Management	+++	++	Integrated Pest Management may require 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 wastewater treatment system technology.

RECOMMENDATIONS

a. The AAA Agronomist teams in the clusters plan intervention actions with coffee growers considering the available information. Farm for area ranges, production, and performance projections. “Mi Finca Cuenta” will be used as input for analysis and trends. Above all, as a team, they understand the economic and productive dynamics of the cluster's different production systems or archetypes.

b. The “Mi Finca Cuenta Program allows monitoring production, income, production costs, and net income with a sample of producers with an informational record. It is possible to

have a better quality of analysis and to propose recommendations for archetypes of producers with similar conditions. AAA Ambassadors advise farmers based on the consolidated data and analysis of farms reporting with the “Mi Finca Cuenta Program”. (Dashboard Colombia 2017-2022).

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

d. Reduce production costs by adopting regenerative practices, such as soil conservation, integrated nutrient management, Integrated weed management, and integrated pest management.

e. Coffee producers begin basic information management by recording production information and income from coffee sales as a preparation for the detailed records for the “Mi Finca Cuenta”.

f. Diversify income sources through agroforestry and intercropping.

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

STEPS IN THE CLUSTER ACTION PLAN

STEPS	*CLUSTER MANAGER*	*AAA AGRONOMISTS*
Define expected sustainable productivity level – feasible for segments.	☑	☑
Promote record keeping of coffee production, costs, sales, and other income.	☑	☑
Promote and encourage income diversification projects. Monitor the contribution of other diversification activities to families' net income within “Mi Finca Cuenta”.		☑

ANNEXES

ANNEX 1

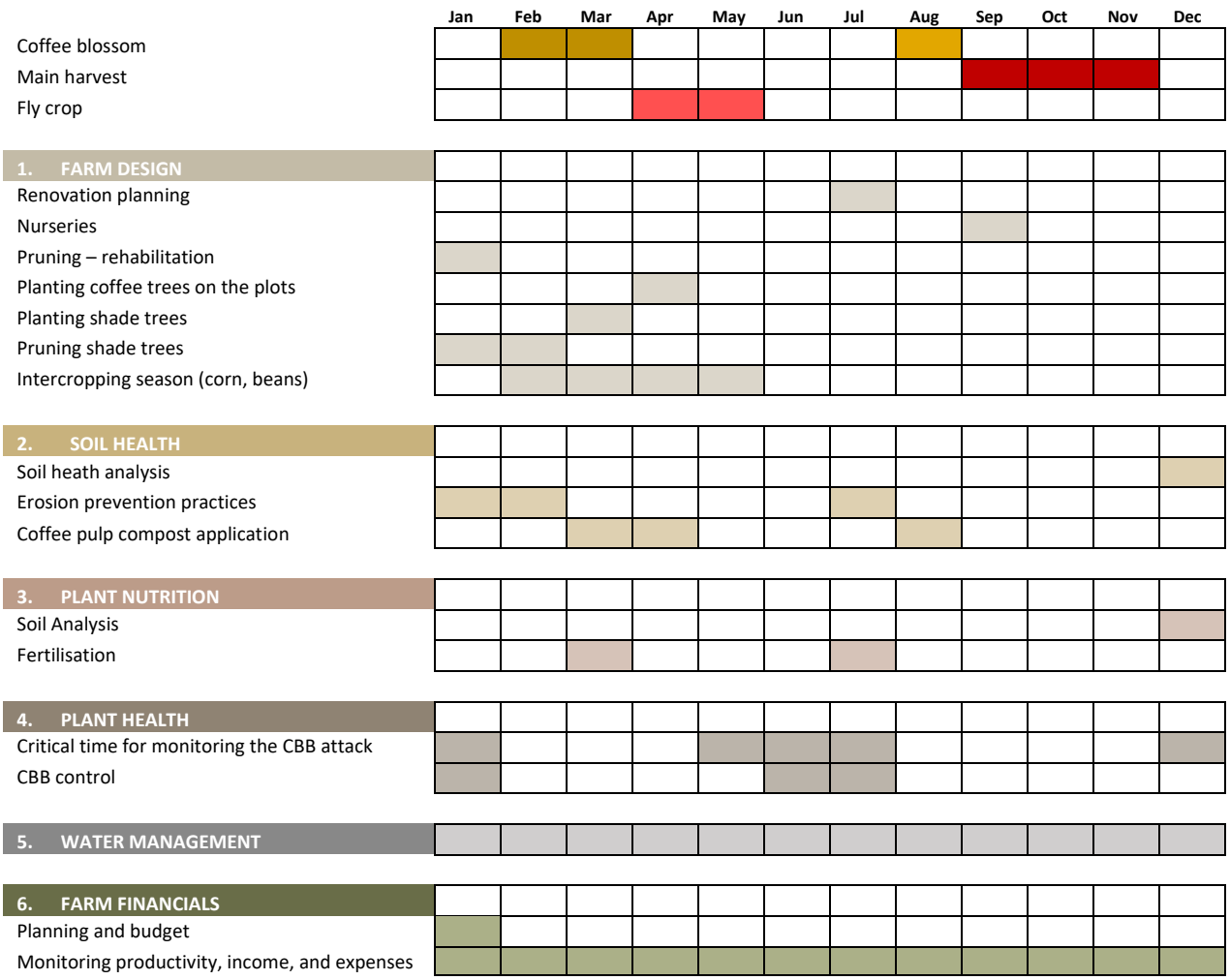
AGRONOMIC REGENERATIVE GUIDE – COLOMBIA

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

Reference: Mapa de cosecha cafetera. https://federaciondecafeteros.org/wp/cosecha-cafetera/
Reference: Av Tecnico 465. Épocas recomendadas para la siembra de café en Colombia. 2016

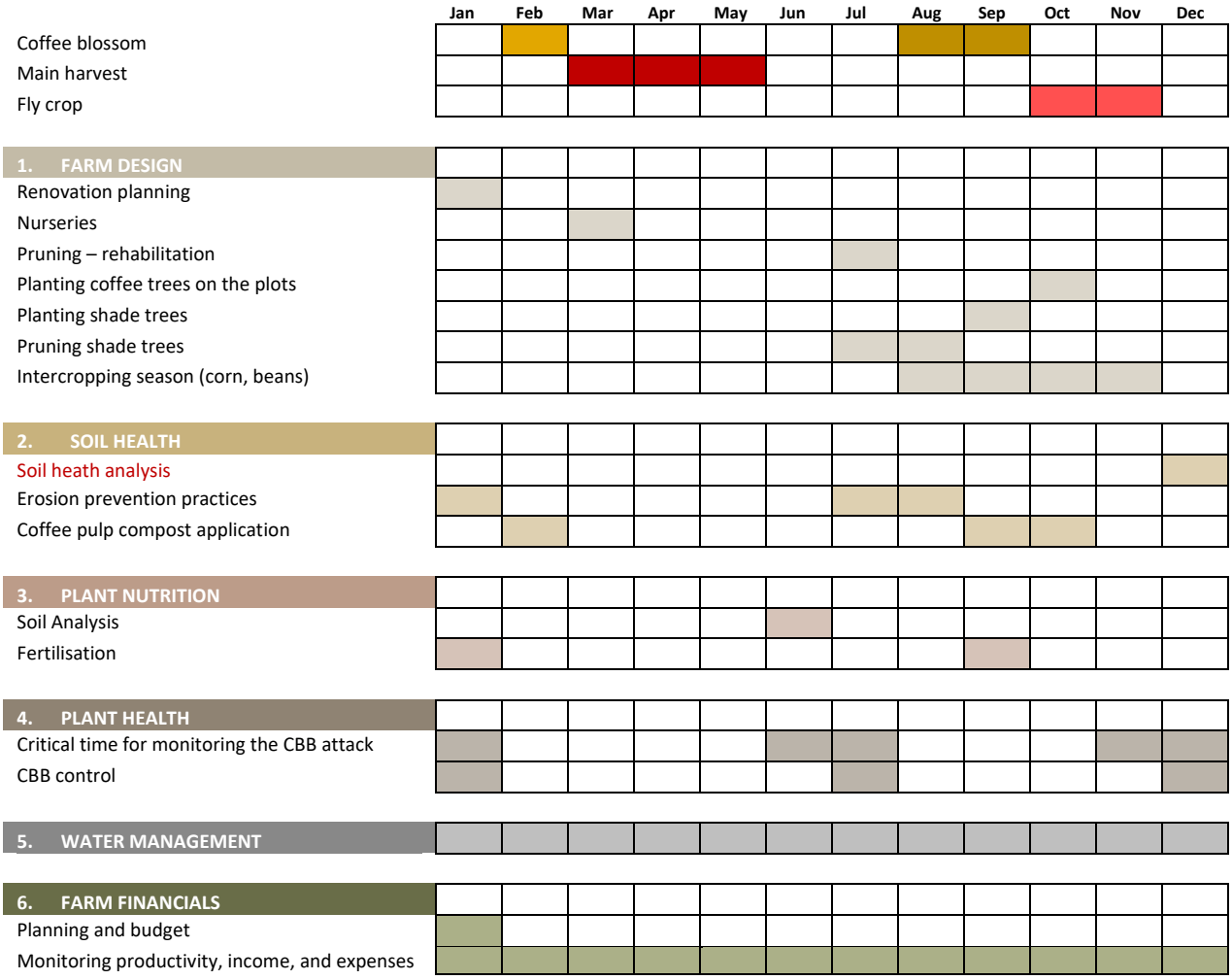
1. MAIN COFFEE HARVEST IN THE SECOND SEMESTER AND FLY CROP IN THE FIRST SEMESTER

Clusters/regions
Caldas-Antioquia
Huila (South)



2. MAIN COFFEE HARVEST IN THE FIRST SEMESTER AND FLY CROP IN THE SECOND SEMESTER

Clusters/regions
Cundinamarca
Huila (Centre – North)
Cauca (East)



3. ONE MAIN HARVEST PER YEAR IN THE SECOND SEMESTER

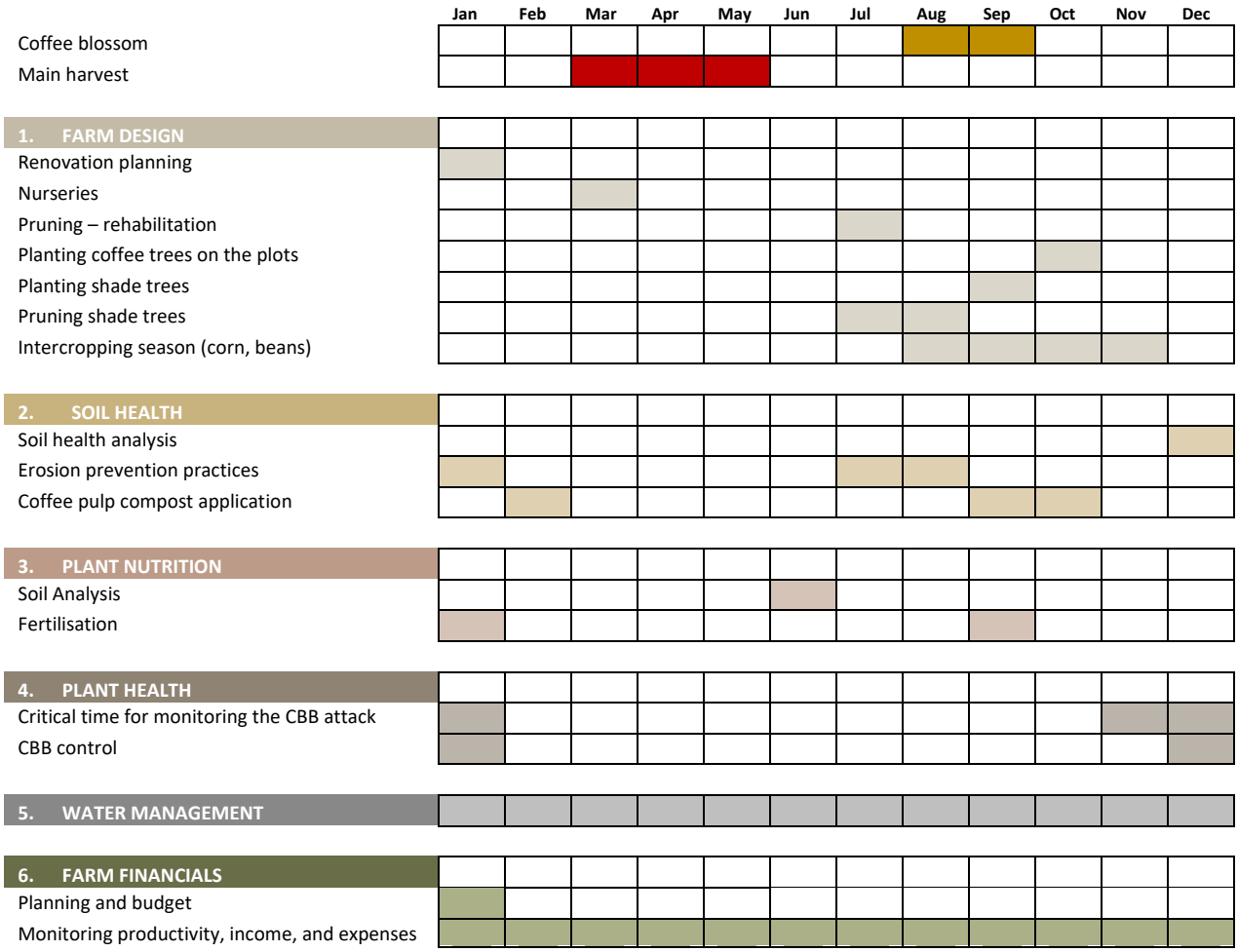
Clusters/regions

Santander

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Coffee blossom												
Main harvest												
1. FARM DESIGN												
Renovation planning												
Nurseries												
Pruning – rehabilitation												
Planting coffee trees on the plots												
Planting shade trees												
Pruning shade trees												
Intercropping season (corn, beans)												
2. SOIL HEALTH												
Soil Health analysis												
Erosion prevention practices												
Coffee pulp compost application												
3. PLANT NUTRITION												
Soil Analysis												
Fertilisation												
4. PLANT HEALTH												
Critical time for monitoring the CBB attack												
CBB control												
5. WATER MANAGEMENT												
6. FARM FINANCIALS												
Planning and budget												
Monitoring productivity, income, and expenses												

4. ONE MAIN HARVEST PER YEAR IN THE FIRST SEMESTER

Nariño
Cauca



Sources. Jaramillo, 2016; Federación Nacional de Cafeteros, 2023.

Sources. Jaramillo, 2016; Federación Nacional de Cafeteros, 2023.

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
SOIL **FARMS PROMOTE SOIL HEALTH BY:**	Gold	Applying organic fertiliser, or composted organic matter, on at least 75% of the farm, when possible, using organic material coming from the own farm.
LOCALISATION FOR COLOMBIA	*Nespresso* recommends utilising the total available coffee pulp and, to the extent that availability and productivity allow, replacing it with organic matter based on soil analysis recommendations. However, there is no defined minimum application for a percentage of organic matter or farm area. This condition would evolve by first improving productivity levels. AAA Producers utilise all available organic matter on the farm through composting coffee pulp. They prioritise its use and combine it as part of the fertilisation recommendation. The primary source of organic matter in coffee farms is fresh coffee pulp (since 44% of the total coffee harvested is fresh pulp). Managing cover crops and mulching is a significant source of biomass and organic matter in the soil. As a source of organic matter and other nutrients, the management of green manures, such as Tephrosia or Crotalaria, can be implemented. Also, these species and others with similar characteristics could be used as transitory shade during plot establishment.	

	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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