RAINFOREST ALLIANCE

SEPTEMBER 2024

Regenerative Tea Scorecard

A Best Practices Guide

The Rainforest Alliance is creating a more sustainable world by using social and market forces to protect nature and improve the lives of farmers and forest communities.

CONTENTS

INTRODUCTION

Agriculture is a major contributor to the twin crises of climate change and biodiversity loss. In turn, agricultural productivity suffers greatly from the impact of these crises, particularly extreme weather, increased pests, and reduced ecosystem services. This affects the tea sector as well: the factors listed above affect tea productivity and quality, as well as reducing the suitability of tea cultivation in current tea producing regions, in addition to increasing the need for external inputs to fight pests and adverse conditions [1, 2]. Unsustainable farming practices such as monoculture, excessive use of fertilizers and pesticides further exacerbate the degradation of natural resources and the need for synthetic inputs, creating a vicious cycle. Ultimately, this causes unstable yields and increased costs for farmers, affecting the livelihoods of tea farmers worldwide, particularly smallholders.

Given this context, improving agricultural practices to repair and restore tea production areas is key to ensure the long-term viability of tea farming. While sustainable agriculture aims to ensure that production does not affect natural resources and future productivity, regenerative agriculture goes beyond this. It is a system-based approach using agroecological principles, which leverages ecological interactions to ensure that ecosystem services are enhanced, natural resources are restored, and high and stable productivity is maintained. There is no agreed-upon definition of regenerative agriculture, but for the Rainforest Alliance it falls under the umbrella of climate-smart agriculture. Biodiversity is key in this approach, as it is instrumental for agroecosystem regeneration, ensures climate resilience and diversified livelihoods for producers [3].

To make this concept concrete and workable, we have developed a scorecard for regenerative agriculture in the tea sector. The scorecard is a framework to promote, measure and monitor the adoption of regenerative agriculture practices, supporting farmers and companies to track their progress and identify areas for improvement. This scorecard has been developed together with Kirin, a long-term partner of the Rainforest Alliance with extensive experience in tea. We leveraged Kirin's strong relations with estates, smallholders and value chain actors in Sri Lanka, who offered invaluable support for the development and testing of this scorecard. The scorecard is a general framework tailored to each context through specific indicators relevant for local conditions. Hence, while we developed and tested these indicators based on the context of Sri Lanka, the scorecard is flexible enough to account for other contexts, functioning as a tool for the whole tea sector. As an example, on biodiversity the scorecard accounts for both regions where tea is grown with shade trees (such as Sri Lanka mid-country) and regions where this is not possible, and keeping an area under natural vegetation is a more feasible option.

The scorecard builds on Rainforest Alliance certification, expanding on and raising the expectations for aspects related to crop resilience, natural resource use and biodiversity. For these areas, the scorecard provides desired outcomes, coupled with the specific practices and the levels at which these should be taken up at different stages of the transition. A high-level summary of the scorecard can be found in the next section, including an overview of the key areas, outcomes and practices that the scorecard covers. More information can be provided upon request on the detailed activities in the scorecard and its practical implementation.

Photo: Anna-Karin Landin

RAINFOREST ALLIANCE

REGENERATIVE TEA SCORECARD

SEPTEMBER 2024

	ACTIVITY	KEY PRACTICES	OUTCOMES
 **SOIL**	Farms implement an **Integrated Weed Management** approach	❑ Implementing an Integrated Weed Management approach ❑ Reducing herbicide use in favor of hand and mechanical removal	Restored soil quality and fertility Improved crop nutrition
	Farms manage **crop nutrition**	❑ Providing a well-balanced fertilization ❑ Promoting the use of on-farm organic material	
	Farms promote **soil health** and prevent erosion	❑ Implementing soil erosion control measures ❑ Increasing soil organic matter	
 **BIODIVERSITY**	Farms contribute to **landscape biodiversity** and natural habitats	❑ Maintaining and properly managing a variety of agroforestry and shade tree species	Increased on-farm biodiversity Improved ecosystem services
 **WATER**	Farms **conserve and protect watersheds**	❑ Maintaining or establishing riparian buffers surrounding aquatic ecosystems	Enhanced water quality and availability
	Farms **use water responsibly**	❑ Only irrigating if the yield is threatened by water shortage ❑ Preferring highly efficient irrigation systems	
 **CROP RESILIENCE**	Farms **prune** tea bushes to maintain crop health and productivity	❑ Timely pruning and tipping to optimize bush health and productivity	Improved crop health and sustainable productivity Reduced risk and impact from pesticide use
	Farms **maintain healthy and vigorous bushes** that can deliver high yields which are harvested on time	❑ Monitoring bush health and replanting as needed ❑ Ensuring good plucking practices	
	Farms choose the **right variety** and **appropriate planting density**	❑ Following official recommendations for the selection of planting material ❑ Optimizing bush spacing for tea productivity ❑ Promoting the genetic diversity of planting material	
	Farms implement **Integrated Pest Management** approach	❑ Implementing an Integrated Pest Management approach ❑ Only using pesticides as a last resort	
 **LIVELIHOODS**	Farms manage their tea farm as a business, and are compensated accordingly	❑ Ensuring that farmers keep records of their costs and revenues ❑ Ensuring that farmers earn enough to cover all living costs and moderate savings.	Resilient livelihoods for farmers Farmers compensated for their efforts towards regenerative practices

THE SCIENCE BEHIND THE SCORECARD

Tea leaves are harvested from the plant Camellia sinensis, a perennial crop native to Southeast Asia and currently cultivated in multiple tropical countries around the world. China, India, Kenya and Sri Lanka are the biggest tea producers worldwide [4]. Tea is grown in a wide variety of systems, including agroforestry or traditional cultivation landscapes such as ancient tea forests, some of which are protected as valuable agricultural heritage systems [5]. However, most of the tea worldwide is produced in large monoculture plantations with limited to no shade, intensively managed with a high and persistent use of fertilizers and, especially in Asia, of pesticides [6, 7]. These systems have been associated with soil impoverishment and a decline in productivity and quality, as well as with harmful effects for the surrounding environment and for human health [8]. On the other hand, tea farming is increasingly facing the challenges posed by climate change, especially erratic rainfall and extreme weather events, negatively impacting tea productivity and quality [9, 10, 11].

Given this context, regenerative agriculture focuses on practices aimed at reinstating the resilience of the system by restoring soil health, regenerating natural resources, conserving biodiversity and increasing crop resilience. In this perspective, regenerative agriculture practices involve and aim for a reduction in the use of external chemical inputs, particularly pesticides (including herbicides, insecticides, fungicides, acaricides, nematicides, etc.), which are key drivers of the degradation of natural resources and of biodiversity loss. Overall, the scorecard strives to maintain high yields and promote on-farm diversification, ultimately ensuring that farmers have a stable revenue. The regenerative tea scorecard focuses on five key areas: soil, biodiversity, water, crop resilience, and livelihoods.

SOIL

Soil quality is a key factor in determining tea bush productivity. Hence, regenerative practices recommended in the scorecard aim to restore soil quality and fertility and to improve crop nutrition. While the optimum soil pH for tea cultivation is between 4.5 and 5.6 [12], soil acidification is a common issue in long-term conventional tea cultivation, especially due to excessive fertilization. Inappropriate use of mineral fertilizers can also lead to nutrient leaching and groundwater contamination, and it can contribute to reduced soil fertility in the long term [13, 14]. However, ensuring that tea bushes receive the right amounts of nutrients is key for plant growth and to achieve maximum yield and quality. Nutrients need to be provided in the right amount and with appropriate frequency to meet the plant replenishment needs [15]. They should also be provided at the right time, when the tea bushes are able to absorb and utilize them, to ensure efficiency and prevent losses to the environment [16].

Providing nutrients to soils through organic fertilizers can reduce the risks associated with mineral fertilizer use. Studies carried out in China have shown that soil degradation is less prevalent in organic tea farming, and that the use of organic manure and plant residues can mitigate soil acidification [17, 18]. Adding organic matter to the soil has also been linked to improved soil structure and reduced compaction, increased soil organic carbon and higher nutrient availability [19]. For these reasons, the scorecard supports a progressive increase in the proportion of organic fertilizer use as producers advance towards improved regenerative practices. This allows producers to reduce chemical inputs without affecting tea yields, as combining mineral and organic nutrient sources has been shown to lead to higher productivity while building up soil organic matter and minimizing nutrient runoff [20, 21, 22]. In addition, the scorecard explicitly encourages the use of organic material coming from the farm, such as cuttings from pruning of tea and other on-farm trees, reducing the risk that natural vegetation in the surrounding areas is harvested for plant residues [23].

Since tea is often grown on steep slopes in mountainous regions with high rainfall, monitoring and counteracting soil erosion is key [24]. A common good practice for erosion prevention is contour planting, which needs to be implemented at the establishment of the tea plantation. At later stages, erosion can be mitigated through soil protection and conservation measures, such as growing cover crops or applying plant residues and mulch, also linked to increased soil organic matter and carbon storage [25]. Planting shade trees further stabilizes the soil, and the crown protects the ground surface from the direct impact of raindrops [26].

In addition to preventing erosion, maintaining a soil cover helps reduce the growth of noxious weeds. These are plants that can affect tea branching and green leaf yield by competing for water and other nutrients [27]. Common noxious weed species, particularly in Sri Lanka, include Panicum repens L., Imperata cylindrica (L.) P. Beauv., and Mikania cordata (Burm. f.) B. L. Robins [28]. Herbicides are often used as the first resort to control weed growth, and there is a tendency in tea plantations to try to keep the ground clear of any vegetation other than tea, leaving the soil exposed to degradation [29]. The scorecard promotes an integrated weed management approach, where herbicides are progressively reduced, starting from the most harmful ones, and complemented with, or replaced by, less damaging control methods. These include mechanical and hand-removal of weeds, as well as promoting the growth of soft vegetation or cover crops that do not compete with tea, or maintaining a soil cover between tea bushes [30, 31].

Photo: Suvashis Mullick

BIODIVERSITY

Tea production landscapes are often considered "green deserts" without much potential for biodiversity conservation, since they are frequently based on large monoculture plantations with no trees. This model has a negative impact on multiple animal taxa: bird species are affected by the lack of vertical stratification, whereas mammals and amphibians find their habitat reduced and are often limited in their movements as the landscape sharply changes from forest to tea plantation [32]. With the expansion of tea monoculture, biodiversity is often relegated to small patches of remnant forests, a fragmentation that leads to reduced species and genetic diversity [33]. An intensive use of agrochemicals in tea is also harmful for biodiversity, as pesticides (this concept includes herbicides, insecticides, fungicides, acaricides, nematicides etc) affect the diversity of insects and other invertebrates both above and below ground, including in nearby forests and natural ecosystems [34].

The scorecard focuses on increasing on-farm biodiversity and improving ecosystem services with the use of tree cover. While tea is often considered a shade-intolerant crop, in its native environment of tropical rainforests in Southeast China it grew as an understory plant [35, 36]. In fact, there are several examples where tea is successfully cultivated under some level of shade, such as the mid-country tea production areas in Sri Lanka, or the Northeast of India [37], as trees can offer multiple benefits for tea production. They contribute to groundwater conservation and create a stable microclimate that shields tea bushes from excessive sunlight, rain, or wind [38]. Trees can also host beneficial life forms that contribute to pest control, and their presence enhances soil quality and supports below-ground microorganisms crucial for nutrient cycling [39, 40, 41]. Some tree species, especially leguminous ones, enrich the soil with nitrogen, further boosting nutrient availability [42]. Additionally, trees provide organic matter to the soil through litter and cuttings, and they can be used to produce biochar to enhance soil fertility and carbon storage [43]. Finally, trees can provide timber or fruits, contributing to income diversification and food security [44].

Including trees in tea production landscapes can boost on-farm biodiversity by increasing habitat complexity and serving as corridors connecting natural ecosystems and forest remnant [45, 46]. The scorecard promotes the inclusion of a variety of tree species to enhance biodiversity and ecosystem services, particularly pest control [47, 48], while ensuring that tree species do not host pests or diseases or compete with the tea for nutrients, water or sunlight [49]. Where local environmental conditions do not allow for shading in tea production, our recommended approach is to maintain a percentage of the farm under natural vegetation, which increases spatial heterogeneity and provides habitats for local species, ensuring beneficial ecosystem services for the nearby tea fields [50]. Ideally, on-farm tree planting combined with maintaining natural vegetation and remnant forest patches can maximize biodiversity protection, making tea plantations connectors of natural ecosystems rather than contributors to natural habitat fragmentation [51].

Photo: Sandeepan Bhattacharjee

WATER

Tea is often grown as a rainfed crop, although irrigation is increasingly being used and it can affect local water reservoirs [52]. Tea production can also have an impact on watersheds through leakage of the agrochemicals utilized for cultivation, particularly mineral fertilizers [53]. Therefore, the scorecard aims to guarantee both water quality and availability, by ensuring that water sources are protected, and that irrigation systems are efficient.

To protect watersheds, it is key to establish and maintain riparian buffers around aquatic ecosystems, which are no-application zones for pesticides and fertilizers where natural vegetation can grow. These areas prevent toxic chemicals and excessive nutrients coming from the agricultural fields from reaching the water, reducing water contamination and protecting biodiversity in aquatic ecosystems [54]. Riparian buffers themselves can also provide a habitat for several species, contributing to increased on-farm biodiversity. [55, 56].

As rainfall becomes less predictable, farmers are increasingly facing extended dry periods causing a reduction in yield or even mortality in tea bushes, especially in young tea plantations [57, 58]. In these circumstances, farmers need to provide water to the tea plants through irrigation. To ensure responsible and efficient water use, irrigation should be limited to conditions in which water shortage is threatening tea production, and it should be done through efficient systems such as drip irrigation [59]. In addition to these measures, several agricultural practices promoted for soil erosion prevention and throughout the scorecard contribute to reducing water runoff, such as contour planting, shade trees and ensuring a continuous soil cover [60, 61].

Photo: Suvashis Mullick

CROP RESILIENCE

The adoption of good agricultural practices (GAPs) is key to ensure good productivity and resilient crops, while delivering positive environmental outcomes and reducing the risk and negative impact from pesticide use. The scorecard provides a framework to improve practices related to the selection of planting material, bush health management, integrated pest management, pruning and harvesting.

Tea planting material is the primary factor determining its yield potential: no amount of optimal farming conditions, agricultural practices, or soil quality can enhance the genetic limits of a bush. Planting material typically consists of clonal cuttings produced and distributed by government-approved organizations, which are grown in nurseries and then transplanted into the field [62]. Since the genetic potential of tea clones manifests fully at maturity but declines with old age, renovating farms through replanting is economically beneficial even if older bushes still yield well [63]. Choosing the best suited varieties for the local conditions is essential. Maintaining genetic diversity within tea plots is also crucial to mitigate the risk of diseases and pest outbreaks. By including different hybrids or clones with varying susceptibilities, farmers can limit the damage from pests and diseases and ensure that at least some plants remain productive [64].

Pests and diseases can irreparably affect the roots, trunks, or stems of tea bushes. Some of them require heavy pruning or even immediate uprooting and replanting of entire production plots at the first signs of infection or infestation, as they are untreatable and can spread rapidly, leading to death or severe reduction in productivity. Examples from different regions include Armillaria and Poria root rot, wood rot disease, various types of canker, and tea shot-hole borer [65]. Even when they are treatable, as is the case with blister blight, pests and diseases lead to losses in the quantity or quality of tea produced [66]. Good sanitation practices, such as removing decayed branches or plants that can host pests, can help prevent their spread, but control measures are needed [67].

In monoculture tea plantations, the low crop diversity increases vulnerability to pests and diseases, which has historically led tea growers to rely heavily on chemical fertilizers and pesticides to control them and mitigate damage. However, this has led to pesticide resistance and reduced population of pests' natural enemies, making tea plantations even more vulnerable to pest outbreaks [68, 69]. Moreover, the intensive use of pesticides causes soil degradation and affects biodiversity and water resources [70]. It also poses health risks to both tea growers and consumers, which has made pesticide residues a growing concern in the tea industry and the subject of increasing regulatory scrutiny [71]. Therefore, reducing pesticide use is a key objective for sustainable tea production. The scorecard promotes the adoption of an integrated pest management approach, where producers monitor for early signs of pests and pesticides are only used once specific thresholds for certain pests have been reached, and if sanitation and other control methods have been unsuccessful [72].

One of the most important practices to maintain healthy bushes is pruning, which involves removing tea branches to maintain a convenient height, stimulate shoot growth, remove old, decayed, pest-infested and diseased branches, and ensure a high quality of tea leaves and economic viability of plantations [73]. Optimal pruning type, cycle length and timing vary strongly depending on local conditions and climate, and the adoption of pruning practices is also influenced by the presence of certain pests at specific times of the year, or by labour availability [74, 75]. In addition to pruning, the scorecard provides guidelines for good harvesting practices. In tea, harvesting is done by plucking two or three leaves and a bud at the topmost tender shoots of tea [76]. It is a key practice, ensuring that the maximum amount and highest quality of green leaves is harvested, and that they can be sold for a high price [77].

LIVELIHOODS

Smallholder farmers are responsible for 60% of global tea production, and this percentage is growing [78]. These farmers are particularly vulnerable to fluctuations and volatility in international tea prices, exposing them to financial instability. Negative trends or shocks in tea prices can impact farmers' incomes and deter them from investing in needed farm improvements, ultimately affecting the livelihoods of their families, as well as local economies at large [79]. Therefore, initiatives advancing a transition towards regenerative practices must consider the economic viability of the production model they aim to promote, as well as the financial impact of changing agricultural practices.

Studies focusing on other non-conventional tea production systems - such as organic - have shown that the reduced reliance on costly agrochemicals, improved market access and possibility to obtain a premium price can lead to increased net income and be an incentive for farmers to change agricultural practices [80, 81, 82]. Research on tea agroforestry systems in particular shows that these need fewer external inputs and have lower production costs compared to monoculture systems, and that they can ensure long-term productivity and profitability [83, 84]. Additionally, agroforestry and intercropping systems can include species providing a complementary source of income in addition to tea. As an example, farmers in India, Kenya, Sri Lanka, and Tanzania often cultivate tea alongside other crops such as pepper, fruit trees, pulses or coffee [85]. This diversification can provide financial stability in the face of adverse impacts from climate change and ensure better livelihoods for farmers. Nonetheless, transitioning to regenerative farming may initially cause a drop in yield and require some investments, for example in labour, which can discourage producers and especially smallholders [86]. Hence, collaborations among stakeholders are needed, such as supply chain actors and investors, to establish incentive mechanisms supporting farmers in the initial stages of the transition, and to ensure that farmers are rewarded in their efforts through improved access to market.

FOR MORE INFORMATION

The Rainforest Alliance is proud to share this tool with the wider tea community. We value your feedback and are happy to answer questions about the scorecard or discuss potential collaborations.

Please direct your questions to:
Elena Nera (enera@ra.org), Senior Associate, Sustainable and Resilient Agriculture
Madhuri Nanda (mnanda@ra.org), Director, South Asia

REGENERATIVE TEA DEFINITIONS

TERM	DEFINITION	REFERENCES & GUIDANCE
Agrochemicals	Commercially produced, usually synthetic, chemical compounds used in agricultural production, such as fertilizers, pesticides, growth regulators, nematicides, or soil conditioners.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance H: Integrated Pest Management
Agroforestry	The combination of trees alongside agricultural crops, potentially including other vegetation and livestock, in integrated systems that produce food, support biodiversity, create healthy soils, secure water availability and sequester carbon from the atmosphere.	Rainforest Alliance Glossary (Annex S01), version 1.3
Aquatic ecosystem	Flowing and still water bodies and other wetlands. This includes: 1. Flowing and still water bodies: All naturally occurring streams, rivers, pools, ponds, lakes, and lagoons, as well as seasonal streams that flow continuously for at least two months in most years, or flow intermittently and are at least 1 meter wide. Streams and rivers that have been altered by sedimentation, polluted runoff, bank erosion, thermal pollution, or impoundments less than 1 meter high are still considered aquatic natural ecosystems. Artificial pools, water treatment lagoons, and irrigation ponds, are not considered natural aquatic ecosystems, unless: a) these water bodies have been colonized by an endangered species; and/or b) the water body was constructed to provide fish or wildlife habitat. 2. Other wetlands: All naturally occurring wetlands, where the natural hydrological conditions result in either or both of the following conditions: a) Soils are waterlogged for most of the year; and/or b) The land is periodically or permanently inundated by shallow water, including floodplains, wet areas bordering ponds, streams, or the ocean. For the purposes of the Rainforest Alliance Sustainable Agriculture Standard [and Scorecards], the following are not considered aquatic natural ecosystems: Areas that have been made seasonally or perennially wet due to human activity (such as drainage ditches, irrigation ponds, reservoirs, effluent holding ponds, aquaculture ponds, rice paddies, or gravel pits), unless: a) these water bodies have been colonized by an endangered species; and/or b) the wetland was created by humans to provide wetland habitat.	Rainforest Alliance Glossary (Annex S01), version 1.3
Biodiversity	According to IPBES, biodiversity is "the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part. This includes variation in genetic, phenotypic, phylogenetic, and functional attributes, as well as changes in abundance and distribution over time and space within and among species, biological communities and ecosystems".	Glossary - IPBES
Climate change	Climate change refers to significant changes in global temperature, rainfall, humidity, wind patterns and other weather patterns that occur over several decades or longer. These changes in weather patterns have significant impacts on agricultural conditions, the environment and sea levels on a global level. Current climate change trends are attributed largely to human activity such as the increased levels of greenhouse gases like carbon dioxide into the atmosphere from the use of fossil fuels and changes in land use including deforestation.	Rainforest Alliance Glossary (Annex S01), version 1.3
Climate change adaptation	Adjustments to farming practices and management to reduce the negative impacts that current or expected climate change has on crops, farming systems, ecosystems, and livelihoods.	Rainforest Alliance Glossary (Annex S01), version 1.3
Climate change mitigation	Human interventions to reduce climate change by reducing the sources of greenhouse gas emissions or enhancing stocks of greenhouse gases (GHGs) in the environment.	Rainforest Alliance Glossary (Annex S01), version 1.3
Climate-smart agriculture	A combination of various sustainable methods to tackle the specific challenges from climate change of a specific farming community. It is composed of three main pillars: 1. Sustainably increasing agricultural productivity and incomes 2. Adapting and building resilience to climate change 3. Reducing and/or removing greenhouse gas emissions, where possible	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance – "What is climate-smart agriculture?" Rainforest Alliance - "Regenerative coffee scorecard"

REGENERATIVE TEA DEFINITIONS

TERM	DEFINITION	REFERENCES & GUIDANCE
Conservation	Protection of a natural ecosystem against direct or indirect human conversion or degradation. Natural ecosystems may be conserved through any combination of strict preservation, restoration, or sustainable management.	Rainforest Alliance Glossary (Annex S01), version 1.3
Cover crops	According to the FAO "[…] cover crops are mainly grown for their effect on soil fertility or as livestock fodder […]. Cover crops are grown during fallow periods, between harvest and planting of commercial crops, utilizing the residual soil moisture […]. There are various crop alternatives to be used as vegetative cover, such as grains, legumes, root crops and oil crops. All of them are of great benefit to the soil; however some cover crops have certain attributes, which need to be kept in mind when planning a rotation scheme […]". Cover crops can also be grown as part of an Integrated Weed Management approach, as they can prevent the growth of noxious weeds.	Cover crop species, with a special focus on legumes - FAO Rainforest Alliance Guidance H: Integrated Pest Management Rainforest Alliance - "Regenerative coffee scorecard"
Ecosystem service	A service that is provided by an ecosystem as an intrinsic property of its functionality (e.g. pollination, nutrient cycling, nitrogen fixation, fruit and seed dispersal). The benefits (and occasionally disbenefits) that people obtain from ecosystems. These include provisioning services such as food and water; regulating services such as flood and disease control; and cultural services such as recreation and sense of place.	Glossary - IPBES
Fertilizer	Any organic or inorganic material of natural or synthetic origin (other than liming materials) that is added to a soil to supply one or more plant nutrients aiding the growth of plants. • Inorganic Fertilizer: A fertilizer material in which carbon is not an essential component of its basic chemical structure. Fertilizer in which the declared nutrients are in the form of inorganic salts obtained by extraction and/or by physical and/or chemical industrial processes. Examples are ammonium nitrate, ammonium sulfate, and potassium chloride. • Organic Fertilizer: By-product from the processing of animal or vegetable substances that contain sufficient plant nutrients to be of value as fertilizers. Examples include compost, manure, peat, and slurry.	Rainforest Alliance Glossary (Annex S01), version 1.3
Integrated Pest Management (IPM)	The careful consideration of all available pest control techniques and subsequent integration of appropriate measures that discourage the development of pest populations, as well as keep pesticides and other interventions to levels that are economically justified and reduce or minimize risks to human health and the environment. IPM emphasizes the growth of healthy crops and cattle with the least possible disruption to agroecosystems and encourages natural pest control mechanisms. The application of pesticides is based on the monitoring of disease or pest infestations.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance H: Integrated Pest Management
Integrated Weed Management (IWM)	According to the FAO "An integrated weed management approach to land management combines the use of complementary weed control methods such as grazing, herbicide application, land fallowing, and biological control. The resulting combinations provide the best possible solutions to weed problems for land managers". A good plan for weed management includes: 1. Prevent the establishment of weeds using the following interventions when applicable: • Know your major weeds, the time of their flowering and seeding • Field margin management • Clean seeds • Use of cover crops • Mulching (dead or living) • Allelopathic compounds • Timing and depth of cultivation 2. Reduce the impact of weeds on the crops through: • Plant variety choice • Spatial arrangement of crop • Mechanical or manual weeding • Intercropping • Biological control (pests that attack the weed) 3. Reduce seed return by: • Clean machinery • Water and fertilizer management • Weed seed collection and destruction • Last resort: post emergence and spot application of post-emergence herbicides	"What is Integrated Weed Management", - Food and Agriculture Organization of the United Nations (FAO) Rainforest Alliance Guidance H: Integrated Pest Management Rainforest Alliance - "Regenerative coffee scorecard"

TERM	DEFINITION	REFERENCES & GUIDANCE
Mulch	The practice of applying a layer of material to the surface of an area of soil. Mulches can be either made of materials like plastic or nets (for weed control or to exclude pests and to heat cold soils), or they can be living mulches, like flowering herbs, which help improve soil condition and increase biodiversity. Mulching can help improve soil structure, water infiltration and retention, and soil fertility.	Rainforest Alliance – "What is climate-smart agriculture?" Rainforest Alliance Guidance H: Integrated Pest Management Rainforest Alliance - "Regenerative coffee scorecard"
Native vegetation	Species, subspecies, or lower taxon occurring within its current natural range, i.e., the range it occupies without introduction or care by humans.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation
Natural ecosystem	An ecosystem that substantially resembles – in terms of species composition, structure, and ecological function – one that is or would be found in a given area in the absence of major human impacts. This includes human-managed ecosystems where much of the natural species composition, structure, and ecological function are present. Natural ecosystems include all-natural terrestrial ecosystems (including natural forests, woodlands, shrublands, savannahs, grasslands, and paramo) and all natural aquatic ecosystems. Natural ecosystems include: • Largely "pristine" natural ecosystems that have not been subject to major human impacts in recent history • Regenerated natural ecosystems that were subject to major impacts in the past (for instance by agriculture, livestock raising, tree plantations, or intensive logging) but where the main causes of impact have ceased or greatly diminished and the ecosystem has attained species composition, structure and ecological function similar to prior or other contemporary natural ecosystems; • Managed natural ecosystems (including many ecosystems that could be referred to as "semi-natural") where much of the ecosystem's composition, structure, and ecological function are present; this includes managed natural forests as well as native grasslands or rangelands that are, or have historically been, grazed by livestock • Natural ecosystems that have been partially degraded by anthropogenic or natural causes (e.g., harvesting, fire, climate change, invasive species, or others) but where the land has not been converted to another use and where much of the ecosystem's composition, structure, and ecological function remain present or are expected to regenerate naturally or by management for ecological restoration	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation
Natural enemies	Organisms which kill, decrease the reproductive potential of, or otherwise reduce the numbers of another organism. Natural enemies in agricultural production are key components of integrated pest management programs. Important natural enemies of insect and mite pests include predators, parasites, and pathogens.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance H: Integrated Pest Management
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.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation
Non-application zone	An area where no pesticides are applied. The distance in meters indicates the width of the non-application zone depends on the method by which the pesticide is applied, as follows: 1) 5 meters, if applied by mechanical, hand-assisted and targeted application methods, such as knapsack sprayers, banding, baiting, specific granule placement, soil or plant injection, seed treatments, and weed wiping. 2) 10 meters, if applied by broadcast or pressurized spray application methods, such as motorized sprayers or spray booms, air blast sprayers, or foggers (Ultra Low Volume fogging machines) depending on the equipment's technical specifications.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation

REGENERATIVE TEA DEFINITIONS

SEPTEMBER 2024

TERM	DEFINITION	REFERENCES & GUIDANCE
Pest	Any species, strain or biotype of plant (weed), animal (e.g., nematode, insect, arthropod, rodent), or pathogenic agent (microorganism, like fungus, bacteria and virus) harmful to plants or plant products.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance H: Integrated Pest Management
Pesticide	Any substance, or a mixture of substances of chemical or biological ingredients, intended for repelling, destroying or controlling any pest, and including unwanted species of plants or animals causing harm during or otherwise interfering with the production, processing, storage, transport or marketing of food, agricultural commodities. The term includes substances intended for use as a defoliant, desiccant or agent for thinning fruit or preventing the premature fall of fruit. Pesticides are also used for application on crops either before or after harvest to protect the commodity from deterioration during storage and transport.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance H: Integrated Pest Management
Plucking	Plucking is the harvesting process in tea. Pluckers collect the top most tender shoots with either two or three leaves and a bud. The highest quality (and selling price) is achieved when two leaves and a bud are harvested, whereas with three leaves the quality is decreased.	Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
Production costs	The total cost of production is the sum of labour costs, input costs, as well as any additional cost that may occur. Labor costs generally include hired labour, but can also include the costs associated with family labour. Whereas input costs typically include the costs of fertilizer, agrochemicals, water used in irrigation, energy used in processing, and transportation. Other expenses that can contribute to the total cost of production may include tools, machinery, land leases, and taxes.	"Handbook on Agricultural Cost of Production Statistics Guidelines for Data Collection, Compilation and Dissemination" - FAO Rainforest Alliance - "Regenerative coffee scorecard"
Productivity	As defined by the OECD, productivity is "... a ratio of a volume measure of output to a volume measure of input." Productivity measures how efficiently inputs—such as land, labor, fertilizers, pesticides, machinery and water—are used, compared to the value of production. Productivity takes into account the costs of these inputs. It is important to differentiate between yield and productivity, as increasing yields does not automatically lead to an increase in the farmer's income if the costs for the inputs increase more than the additional income.	Cover crop species, with a special focus on legumes - FAO Rainforest Alliance - "Regenerative coffee scorecard"
Pruning	Seasonal or annual activity to remove dead, diseased or non-productive branches, to manage pests and diseases and/or to manage crop load.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance I: Pruning
Renovation	The action of removing old trees and other plants and planting new vegetation as a replacement.	Rainforest Alliance Glossary (Annex S01), version 1.3
Riparian buffer	An area of permanent vegetation adjacent to an aquatic ecosystem where crops and livestock are not present. Aquatic ecosystems are surrounded by riparian buffers with the following riparian buffer width parameters: • 5 meters horizontal width along both sides of water courses between 1-5 meters wide. For farms < 2 ha, the width of the buffer may be reduced to 2 meters at both sides; • 8 meters horizontal width along both sides of water courses between 5-10 meters wide, and around springs, wetlands, and other water bodies; 15 meters horizontal width along both sides of rivers wider than 10 meters wide	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation
Shade coverage	Maintenance of shade coverage through the planting of shade trees and/or native vegetation serves to protect soil against erosion, fluctuations in rainfall and water availability, contribute to soil nutrients through foliage decomposition, as well as serve as a source of biodiversity. Shade coverage can be calculated through a variety of methods from photographing the canopy to more advanced technologies like satellite imagery.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation
Smallholder	According to the FAO, "smallholders are small-scale farmers, pastoralists, forest keepers, fishers who manage areas varying from less than one hectare to 10 hectares. Smallholders are characterized by family-focused motives such as favouring the stability of the farm household system, using mainly family labour for production and using part of the produce for family consumption".	Terminology portal - FAO

TERM	DEFINITION	REFERENCES & GUIDANCE
Soil conservation practices	Soil conservation practices are intended to reduce erosion, maintain fertility and crop support (i.e. nutrient cycling), and support water hydrology (i.e. drainage and drought resistance). Common practices such as non-tillage and cover cropping all aim to maintain a "good" soil profile. A good soil profile is dependent on the following qualities that can be determined via soil assessments: • Texture: different mineral/rock particles that make up the soil (clay, slit and sand) • Structure: the way the soil particles are organized. Organic matter and calcium particles help bind the different soil components together into bigger structural units called aggregates. A well-structured soil has air-filled spaces between and within the aggregates. • Richness: rich soil is determined by the presence useful chemical reserves in the soil for the crop. The presence of soil nutrients is largely dependent on soil type (mineral composition) and organic matter content.	Rainforest Alliance Guidance J: Soil Fertility and Conservation Rainforest Alliance - "Regenerative coffee scorecard"
Soil Organic Carbon (SOC)	According to the FAO "Soil organic carbon (the carbon stored in soil organic matter) is crucial to soil health, fertility and ecosystem services, including food production – making its preservation and restoration essential for sustainable development. Soils with high carbon content are likely to be more productive and better able to filter and purify water. Soil organic carbon plays a big role in climate change, presenting both a threat and an opportunity to help meet the targets of the Paris Agreement."	Global Soil Partnership webpage - FAO Rainforest Alliance - "Regenerative coffee scorecard"
Soil Organic Matter (SOM)	The amount of recylced biomass, by which nutrients are returned to the soil.	Rainforest Alliance Guidance J: Soil Fertility and Conservation
Strata	Healthy natural forests contain multiple vertical layers, or strata, that reflect the structural integrity of the forest and contribute to ecosystem functioning. The main strata include: • the forest floor (consisting of soil, leaf litter, woody debris etc.), • the understory (composed of herbaceous plants, shrubs, saplings and young trees), • the mid-story or canopy (above the understory, approximately 15-30m above the forest floor, often dense with vegetation; vines and lianas are common), and • the overstory or emergent canopy (reaching heights of 30 or more meters, scattered tall trees with canopies that stretch above the mid-level canopy).	Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation Rainforest Alliance - "Regenerative coffee scorecard"
Threshold level	The maximum level of damage (or symptoms of damage) by a pest or disease occurring on/in a plant or plant population, that can be accepted before particular measures should be taken to control the pest or disease. If the damage increases the economic losses will be superior to the costs of control.	Rainforest Alliance Glossary (Annex S01), version 1.3 Rainforest Alliance Guidance H: Integrated Pest Management

TERM	DEFINITION	REFERENCE	ADDITIONAL GUIDANCE	
Natural enemies	Organisms which kill, decrease the reproductive potential of, or otherwise reduce the numbers of another organism. Natural enemies in agricultural production are key components of integrated pest management programs. Important natural enemies of insect and mite pests include predators, parasites, and pathogens.	Rainforest Alliance Guidance H: Integrated Pest Management IPM		
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. Natural vegetation can include one or more of the following (not exclusive): • Riparian buffers • Conservation areas within the farm • Natural vegetation in agroforestry systems • Border plantings, live fences and barriers around housing and infrastructure, or in other ways • Conservation and restoration areas outside the certified farm that effectively provide for long-term protection of the subject areas (for at least 25 years) and yield additional conservation value and protection status relative to the status quo	Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation		
Non-application zone	An area where no pesticides are applied. The distance in meters indicates the width of the non-application zone depends on the method by which the pesticide is applied, as follows: 1. 5 meters, if applied by mechanical, hand-assisted and targeted application methods, such as knapsack sprayers, banding, baiting, specific granule placement, soil or plant injection, seed treatments, and weed wiping. 2. 10 meters, if applied by broadcast or pressurized spray application methods, such as motorized sprayers or spray booms, air blast sprayers, or foggers (Ultra Low Volume fogging machines) depending on the equipment's technical specifications.	Rainforest Alliance Glossary (Annex 1)		
Prohibited / Highly Hazardous Pesticides	The Rainforest Alliance list of Prohibited Pesticides (found in Annex 7) is based on the FAO/WHO Guidelines for Highly Hazardous Pesticides. These guidelines include the definition of Highly Hazardous Pesticides (HHPs) following eight criteria. The Rainforest Alliance List of Prohibited Pesticides has eight columns that refer to each of these criteria: • Main use • Acute toxicity • Carcinogenic toxicity • Mutagenic toxicity • Reproductive toxicity • International conventions • Severe effects	International Code of Conduct on Pesticide Management, Guidelines on Highly Hazardous Pesticides FAO/WHO, 2016	Rainforest Alliance Annex S7: Pesticide Management	
Pruning	Pruning refers to the selective seasonal or annual activity to remove dead, diseased, or non productive branches, to manage pests and diseases and/or to give shape and redirect growth (formation) with the aim of influencing harvest, productivity and quality, and to ease harvesting itself. Pruning can also be done for crop reproduction/renovation (cuttings, grafting) and for rejuvenation/revitalization of the crop.	Rainforest Alliance Glossary (Annex 1)	Rainforest Alliance Guidance I: Pruning	

REGENERATIVE COFFEE DEFINITIONS

TERM	DEFINITION	REFERENCE	ADDITIONAL GUIDANCE	
Regenerative agriculture	For the Rainforest Alliance, "regenerative agriculture" comprises a broad set of principles and practices under the umbrella of climate-smart agriculture. Taking an agroecology and integrated system management approach, regenerative agriculture aims to increase biodiversity, enhance ecosystem services, and increase agroecosystem resilience thus leading to resilient livelihoods.	Raising the Bar—Regenerative Agriculture for More Resilient Agro-Ecosystems Position Paper		
Renovation	Renovation of coffee describes the complete uprooting of old unproductive trees and replanting with new high-yielding, disease and or climate tolerant varieties. Complete renovation might be necessary where pests or diseases have irreversibly affected trees, better-adapted varieties are availed, and yields warrant the renovation. Plantations that comprise of trees older than 40-50 years should perform a staggered renovation by replacing a percentage of the oldest and least productive trees every season.	Rainforest Alliance Glossary (Annex 1)	Rainforest Alliance Guidance I: Pruning	
Revenue	Revenue is calculated as the production volume multipled by the average price received for the crop.	"Handbook on Agricultural cost of Production Statistics: Guidelines for Data Collection, Compilation, and Dissemination"- FAO		
Riparian buffer	An area of permanent vegetation adjacent to an aquatic ecosystem where crops and livestock are not present. Aquatic ecosystems are surrounded by riparian buffers with the following riparian buffer width parameters: • 5 meters horizontal width along both sides of water courses between 1-5 meters wide. For farms < 2 ha, the width of the buffer may be reduced to 2 meters at both sides; • 8 meters horizontal width along both sides of water courses between 5-10 meters wide, and around springs, wetlands, and other water bodies; 15 meters horizontal width along both sides of rivers wider than 10 meters wide	Rainforest Alliance Glossary (Annex 1)	Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation	
Rust resistant varieties	Coffee leaf rust CLR (Hemileia vastatix) is a fungal disease that attacks older coffee leaves. Farmers can prevent coffee leaf rust by planting resistant varieties (please consult your local agronomic extension officer or research institute to choose the correct one). The resistance may be naturally occurring, or it may be the result of breeding programs designed to enhance the plant's ability to resist the specific disease(s). It is important to consider that rust-resistant varieties may exhibit some disease symptoms or damage under heavy pest or pathogen pressure."	Rainforest Alliance Guidance H: Integrated Pest Management	"Resistance terminology"- Enza Zaden, & "Disease Resistance"- International Seed Federation	
Shade coverage	Maintenance of shade coverage through the planting of shade trees and/or native vegetation serves to protect soil against erosion, fluctuations in rainfall and water availability, contribute to soil nutrients through foliage decomposition, as well as serve as a source of biodiversity. Shade coverage can be calculated through a variety of methods from photographing the canopy to more advanced technologies like satellite imagery. Because shade cover is difficult to estimate, we recommend using the following categorization system to assess shade cover: (Contextualization to local conditions needed) 1. 0-10% shade: sparse shade; needs improvements to increase shade cover 2. 10-25% shade: low-intermediate shade level; need to increase shade (for example, for coffee and cocoa, the minimum shade threshold is 40%) 3. 25-35% shade: intermediate-high shade level 4. 35-45% shade: high shade level 5. >45% shade: excessive shade level; suggest to selectively thin by harvesting commercial trees	Rainforest Alliance Glossary (Annex 1)	Rainforest Alliance Guidance J: Soil Fertility and Conservation Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation	

TERM	DEFINITION	REFERENCE	ADDITIONAL GUIDANCE	FOOTNOTE
Soil conservation practices	Soil conservation practices are intended to reduce erosion, maintain fertility and crop support (i.e. nutrient cycling), and support water hydrology (i.e. drainage and drought resistance). Common practices such as non-tillage and cover cropping all aim to maintain a "good" soil profile. A good soil profile is dependent on the following qualities that can be determined via soil assessments: • Texture: different mineral/rock particles that make up the soil (clay, slit and sand) • Structure: the way the soil particles are organized. Organic matter and calcium particles help bind the different soil components together into bigger structural units called aggregates. A well-structured soil has air-filled spaces between and within the aggregates. • Richness: rich soil is determined by the presence useful chemical reserves in the soil for the crop. The presence of soil nutrients is largely dependent on soil type (mineral composition) and organic matter content.	Rainforest Alliance Guidance J: Soil Fertility and Conservation		
Soil Organic Carbon (SOC)	According to the FAO "Soil organic carbon (the carbon stored in soil organic matter) is crucial to soil health, fertility and ecosystem services, including food production – making its preservation and restoration essential for sustainable development. Soils with high carbon content are likely to be more productive and better able to filter and purify water. Soil organic carbon plays a big role in climate change, presenting both a threat and an opportunity to help meet the targets of the Paris Agreement."	"Soil Ogranic Carbon"- FAO		
Soil Organic Matter (SOM)	The amount of recylced biomass, by which nutrients are returned to the soil.	Rainforest Alliance Guidance J: Soil Fertility and Conservation		
Spot application	When agrochemicals are used applications are made only on the impacted plants and areas	Rainforest Alliance Guidance H: Integrated Pest Management		
Strata	Healthy natural forests contain multiple vertical layers, or strata, that reflect the structural integrity of the forest and contribute to ecosystem functioning. The main strata include: • the forest floor (consisting of soil, leaf litter, woody debris etc.), • the understory (composed of herbaceous plants, shrubs, saplings and young trees), • the mid-story or canopy (above the understory, approximately 15-30m above the forest floor, often dense with vegetation; vines and lianas are common), and • the overstory or emergent canopy (reaching heights of 30 or more meters, scattered tall trees with canopies that stretch above the mid-level canopy).	Rainforest Alliance Guidance M: Natural Ecosystems and Vegetation		
Water Quality (Wastewater) Parameters	The Rainforest Alliance parameters for wastewater discharge into aquatic ecosystems are: • Biochemical Oxygen Demand (BOD5) < 750 mg/l • Total suspended solids < 50 mg/l • Grease and oils < 50 mg/l • pH Between 5.5 and 9.0 The Rainforest Alliance wastewater parameters for irrigation are: • Intestinal nematodes (arithmetic mean No. of eggs per liter) <1 • Faecal coliforms (geometric mean No. per 100 ml) ≤ 1000"	Rainforest Alliance Glossary (Annex 1)		

ENDNOTES

1 Jayasinghe, S. L., & Kumar, L. (2020). Climate change may imperil tea production in the four major tea producers according to climate prediction models. Agronomy, 10(10), 1536.

2 Ahmed, S., Griffin, T., Cash, S. B., Han, W. Y., Matyas, C., Long, C., Orians, C. M., Stepp, J. R., Robbat, A., & Xue, D. (2018). Global climate change, ecological stress, and tea production. Stress physiology of tea in the face of climate change, 1-23.

3 Rainforest Alliance, 2020. Raising the Bar—Regenerative Agriculture for More Resilient Agro-Ecosystems.

4 FAOSTAT, 2022

5 FAO, 2022. International tea market: Market situation, prospects and emerging issues.

6 Le, V. S., Lesueur, D., Herrmann, L., Hudek, L., Quyen, L. N., & Brau, L. (2021). Sustainable tea production through agroecological management practices in Vietnam: a review. Environmental Sustainability, 4(4), 589-604

7 Chowdhury, A., Samrat, A., & Devy, M. S. (2021). Can tea support biodiversity with a few "nudges" in management: Evidence from tea growing landscapes around the world. Global Ecology and Conservation, 31, e01801

8 Le, V. S., Lesueur, D., Herrmann, L., Hudek, L., Quyen, L. N., & Brau, L. (2021). Sustainable tea production through agroecological management practices in Vietnam: a review. Environmental Sustainability, 4(4), 589-604

9 Han, W., Li, X., Yan, P., Zhang, L., & Ahammed, G. J. (2018). Tea cultivation under changing climatic conditions (pp. 455-472). Burleigh Dodds Science Publishing Limited

10 Jayasinghe, S. L., & Kumar, L. (2020). Climate change may imperil tea production in the four major tea producers according to climate prediction models. Agronomy, 10(10), 1536.

11 Ahmed, S., Griffin, T., Cash, S. B., Han, W. Y., Matyas, C., Long, C., Orians, C. M., Stepp, J. R., Robbat, A., & Xue, D. (2018). Global climate change, ecological stress, and tea production. Stress physiology of tea in the face of climate change, 1-23.

12 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.

13 Yan, P., Wu, L., Wang, D., Fu, J., Shen, C., Li, X., Zhang, L., Zhang, L., Fan, L., & Wenyan, H. (2020). Soil acidification in Chinese tea plantations. Science of the Total Environment, 715, 136963.

14 Le, V. S., Lesueur, D., Herrmann, L., Hudek, L., Quyen, L. N., & Brau, L. (2021). Sustainable tea production through agroecological management practices in Vietnam: a review. Environmental Sustainability, 4(4), 589-604

15 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.

16 Mukhopadhyay, M., & Mondal, T. K. (2017). Cultivation, improvement, and environmental impacts of tea. In Oxford research encyclopedia of environmental science.

17 Yan, P., Wu, L., Wang, D., Fu, J., Shen, C., Li, X., Zhang, L., Zhang, L., Fan, L., & Wenyan, H. (2020). Soil acidification in Chinese tea plantations. Science of the Total Environment, 715, 136963.

18 Li, S., Li, H., Yang, C., Wang, Y., Xue, H., & Niu, Y. (2016). Rates of soil acidification in tea plantations and possible causes. Agriculture, Ecosystems & Environment, 233, 60-66.

19 Cu, N. X., & Thu, T. T. T. (2014). Effects of tea-pruned mulches and microbial products on the accumulation of organic matter and micro biota in soils grown tea in Phu Ho, Phu Tho province, Vietnam.

20 Lin, X. J., Huang, D. F., Li, W. H., Wang, L. M., Wang, F., Fan, P., & Qiu, X. X. (2012). Effect of fertilization regime on tea yield, nutrient accumulation and soil fertility. Chinese Journal of Eco-Agriculture, 20(2), 151-157.

21 Huang, D., Wang, Y., Chen, X., Wu, J., Wang, H., Tan, R., ... & Mao, Y. (2022). Application of tea-specific fertilizer combined with organic fertilizer improves aroma of green tea. Horticulturae, 8(10), 950.

22 Xie, S., Yang, F., Feng, H., Yu, Z., Wei, X., Liu, C., & Wei, C. (2022). Potential to reduce chemical fertilizer application in tea plantations at various spatial scales. International Journal of Environmental Research and Public Health, 19(9), 5243.

23 Chowdhury, A., Samrat, A., & Devy, M. S. (2021). Can tea support biodiversity with a few "nudges" in management: Evidence from tea growing landscapes around the world. Global Ecology and Conservation, 31, e01801

24 Le, V. S., Lesueur, D., Herrmann, L., Hudek, L., Quyen, L. N., & Brau, L. (2021). Sustainable tea production through agroecological management practices in Vietnam: a review. Environmental Sustainability, 4(4), 589-604

25 Sahoo, D. C., Madhu, M. G., Bosu, S. S., & Khola, O. P. S. (2016). Farming methods impact on soil and water conservation efficiency under tea [Camellia sinensis (L.)] plantation in Nilgiris of South India. International soil and water conservation research, 4(3), 195-198.

26 Wijeratne, T. L. (2018). Assessing and reducing the environmental impact of tea cultivation (pp. 473-483). Burleigh Dodds Science Publishing Limited.

27 Chauhan, G., Kumar, S., Rana, S. S., & Manuja, S. (2022). Weed management indices as affected by different weed control treatments in tea [Camellia sinensis (L.) Kuntze]. Himachal Journal of Agricultural Research, 48(01), 104-106.

28 Singh, R. D., Sud, R. K., & Pal, P. K. (2014). Integrated weed management in plantation crops. Recent advances in weed management, 255-280.

29 Peiris, H. M. P. (2016). Diversity and behaviour of the naturally regenerated vegetation in commercial tea soils under herbicide free integrated weed management. Procedia food science, 6, 314-317

30 Singh, R. D., Sud, R. K., & Pal, P. K. (2014). Integrated weed management in plantation crops. Recent advances in weed management, 255-280.

31 Peiris, H. M. P., Gunarathne, A. D. N., & Lee, K. H. (2016). Eco-control for Sustainable Agriculture Management in Commercial Tea Industry. 2016 International Conference on Climate Change and Sustainable Innovation.

32 Chowdhury, A., Samrat, A., & Devy, M. S. (2021). Can tea support biodiversity with a few "nudges" in management: Evidence from tea growing landscapes around the world. Global Ecology and Conservation, 31, e01801

33 González, A. V., Gómez‐Silva, V., Ramírez, M. J., & Fontúrbel, F. E. (2020). Meta‐analysis of the differential effects of habitat fragmentation and degradation on plant genetic diversity. Conservation Biology, 34(3), 711-720.

34 Chowdhury, A., Samrat, A., & Devy, M. S. (2021). Can tea support biodiversity with a few "nudges" in management: Evidence from tea growing landscapes around the world. Global Ecology and Conservation, 31, e01801

35 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.

36 Mukhopadhyay, M., & Mondal, T. K. (2017). Cultivation, improvement, and environmental impacts of tea. In Oxford research encyclopedia of environmental science.

37 Bajaj, R. (2021). Indian Tea Landscapes. International Council on Monuments and Sites 11, rue du Séminaire de Conflans 94220 Charenton-le-Pont France, 232.

38 Udawatta, R. P., & Gantzer, C. J. (2022). Soil and water ecosystem services of agroforestry. Journal of Soil and Water Conservation, 77(1), 5A-11A.

39 Pumariño, L., Sileshi, G. W., Gripenberg, S., Kaartinen, R., Barrios, E., Muchane, M. N., ... & Jonsson, M. (2015). Effects of agroforestry on pest, disease and weed control: A meta-analysis. Basic and Applied Ecology, 16(7), 573-582.

40 Mortimer, P. E., Gui, H., Xu, J., Zhang, C., Barrios, E., & Hyde, K. D. (2015). Alder trees enhance crop productivity and soil microbial biomass in tea plantations. Applied Soil Ecology, 96, 25-32.

41 Zhang, G., Chu, X., Zhu, H., Zou, D., Li, L., & Du, L. (2021). The response of soil nutrients and microbial community structures in long-term tea plantations and diverse agroforestry intercropping systems. Sustainability, 13(14), 7799.

42 Lebrazi, S., & Fikri-Benbrahim, K. (2022). Potential of tree legumes in agroforestry systems and soil conservation. In Advances in Legumes for Sustainable Intensification (pp. 461-482). Academic Press.

43 Shrestha, B. M., Chang, S. X., Bork, E. W., & Carlyle, C. N. (2018). Enrichment planting and soil amendments enhance carbon sequestration and reduce greenhouse gas emissions in agroforestry systems: a review. Forests, 9(6), 369.

44 Bermúdez, S., Voora, V., Larrea, C., & Luna, E. (2024). Global Market Report: Tea prices and sustainability

45 Pumariño, L., Sileshi, G. W., Gripenberg, S., Kaartinen, R., Barrios, E., Muchane, M. N., ... & Jonsson, M. (2015). Effects of agroforestry on pest, disease and weed control: A meta-analysis. Basic and Applied Ecology, 16(7), 573-582.

46 Jose, S. (2012). Agroforestry for conserving and enhancing biodiversity. Agroforestry systems, 85, 1-8.

47 Mukhopadhyay, M., & Mondal, T. K. (2017). Cultivation, improvement, and environmental impacts of tea. In Oxford research encyclopedia of environmental science.

48 Jose, S. (2012). Agroforestry for conserving and enhancing biodiversity. Agroforestry systems, 85, 1-8.

49 Altieri, M. A., & Nicholls, C. I. (2004). Effects of agroforestry systems on the ecology and management of insect pest populations. Ecological engineering for pest management: advances in habitat manipulation for arthropods. CSIRO, Collingwood, 143-155.

50 Chowdhury, A., Samrat, A., & Devy, M. S. (2021). Can tea support biodiversity with a few "nudges" in management: Evidence from tea growing landscapes around the world. Global Ecology and Conservation, 31, e01801.
51 Jose, S. (2012). Agroforestry for conserving and enhancing biodiversity. Agroforestry systems, 85, 1-8.
52 Hong, N. B., & Yabe, M. (2017). Improvement in irrigation water use efficiency: a strategy for climate change adaptation and sustainable development of Vietnamese tea production. Environment, Development and Sustainability, 19, 1247-1263.
53 Nagumo, T., Yosoi, T., & Aridomi, A. (2012). Impact of agricultural land use on N and P concentration in forest-dominated tea-cultivating watersheds. Soil science and plant nutrition, 58(1), 121-134.
54 Willemen, L., Crossman, N. D., Newsom, D., Hughell, D., Hunink, J. E., & Milder, J. C. (2019). Aggregate effects on ecosystem services from certification of tea farming in the Upper Tana River basin, Kenya. Ecosystem services, 38, 100962.
55
56 Luke, S. H., Slade, E. M., Gray, C. L., Annammala, K. V., Drewer, J., Williamson, J., ... & Struebig, M. J. (2019). Riparian buffers in tropical agriculture: Scientific support, effectiveness and directions for policy. Journal of Applied Ecology, 56(1), 85-92.
57 Hong, N. B., & Yabe, M. (2017). Improvement in irrigation water use efficiency: a strategy for climate change adaptation and sustainable development of Vietnamese tea production. Environment, Development and Sustainability, 19, 1247-1263.
58 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
59 Hong, N. B., & Yabe, M. (2017). Improvement in irrigation water use efficiency: a strategy for climate change adaptation and sustainable development of Vietnamese tea production. Environment, Development and Sustainability, 19, 1247-1263.
60 Sahoo, D. C., Madhu, M. G., Bosu, S. S., & Khola, O. P. S. (2016). Farming methods impact on soil and water conservation efficiency under tea [Camellia sinensis (L.)] plantation in Nilgiris of South India. International soil and water conservation research, 4(3), 195-198
61 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
62 Mukhopadhyay, M., & Mondal, T. K. (2017). Cultivation, improvement, and environmental impacts of tea. In Oxford research encyclopedia of environmental science.
63 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
64 Tea Research Foundation of Kenya, 2022. "Tea growers handbook", 5th edition. ISBN 9966-9886-5-3
65 Tea Research Foundation of Kenya, 2022. "Tea growers handbook", 5th edition. ISBN 9966-9886-5-3
66 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
67 Mamun, M. S. A., Ahmed, M., & Paul, S. K. (2014, December). Integrated approaches in tea pest management for sustainable tea production. In Proceedings of the Workshop on Tea Production Technology Updated (Vol. 24, pp. 18-32). Dhaka: 24 December 2014, organized by Bangladesh Tea Research Institute, Srimangal, Moulvibazar and Krishi Gobeshona Foundation, BARC campus.
68 Hazarika, L. K., Bhuyan, M., & Hazarika, B. N. (2009). Insect pests of tea and their management. Annual review of entomology, 54, 267-284.
69 Muraleedharan, N., & Roy, S. (2016). Arthropod pests and natural enemy communities in tea ecosystems of India. Economic and Ecological Significance of Arthropods in Diversified Ecosystems: Sustaining Regulatory Mechanisms, 361-392.
70 Le, V. S., Lesueur, D., Herrmann, L., Hudek, L., Quyen, L. N., & Brau, L. (2021). Sustainable tea production through agroecological management practices in Vietnam: a review. Environmental Sustainability, 4(4), 589-604
71 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
72 Mukhopadhyay, M., & Mondal, T. K. (2017). Cultivation, improvement, and environmental impacts of tea. In Oxford research encyclopedia of environmental science.
73 Yilmaz, G., Kandemir, N., & Kinalioglu, K. (2004). Effects of different pruning intervals on fresh shoot yield and some quality properties of Tea (Camellia sinensis (L.) O. Kuntze) in Turkey. Pak J Biol Sci, 7(7), 1208-1212.
74 Samansiri, B. A. D., Rajasinghe, J. C. K., & Mahindapala, K. G. J. P. (2011). Agronomic profile of the corporate sector tea plantations in Sri Lanka. Tea Research Institute of Sri Lanka.
75 Mukhopadhyay, M., & Mondal, T. K. (2017). Cultivation, improvement, and environmental impacts of tea. In Oxford research encyclopedia of environmental science.
76 Hajiboland, R. (2017). Environmental and nutritional requirements for tea cultivation. Folia horticulturae, 29(2), 199-220.
77 Bermúdez, S., Voora, V., Larrea, C., & Luna, E. (2024). Global Market Report: Tea prices and sustainability.
78 Bermúdez, S., Voora, V., Larrea, C., & Luna, E. (2024). Global Market Report: Tea prices and sustainability.
79 Food and Agriculture Organization of the United Nations. (2011). The state of food insecurity in the world: How does international price volatility affect domestic economies and food security?
80 Doanh, N. K., Thuong, N. T. T., & Heo, Y. (2018). Impact of conversion to organic tea cultivation on household income in the mountainous areas of Northern Vietnam. Sustainability, 10(12), 4475.
81 Bui, H. T. M., & Nguyen, H. T. T. (2021). Factors influencing farmers' decision to convert to organic tea cultivation in the mountainous areas of northern Vietnam. Organic Agriculture, 11, 51-61.
82 Qiao, Y., Halberg, N., Vaheesan, S., & Scott, S. (2016). Assessing the social and economic benefits of organic and fair trade tea production for small-scale farmers in Asia: a comparative case study of China and Sri Lanka. Renewable Agriculture and Food Systems, 31(3), 246-257.
83 Tian, Y., Cao, F., & Wang, G. (2013). Soil microbiological properties and enzyme activity in Ginkgo–tea agroforestry compared with monoculture. Agroforestry systems, 87, 1201-1210.
84 Chowdhury, A., Samrat, A., & Devy, M. S. (2021). Can tea support biodiversity with a few "nudges" in management: Evidence from tea growing landscapes around the world. Global Ecology and Conservation, 31, e01801
85 Bermúdez, S., Voora, V., Larrea, C., & Luna, E. (2024). Global Market Report: Tea prices and sustainability.
86 Le, V. S., Lesueur, D., Herrmann, L., Hudek, L., Quyen, L. N., & Brau, L. (2021). Sustainable tea production through agroecological management practices in Vietnam: a review. Environmental Sustainability, 4(4), 589-604