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AGROFORESTRY – RESILIENT LAND USE THROUGH MORE HOLISTIC PRODUCTION SYSTEMS

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.

Introduction

Balancing the multiple—often competing—land-use needs of increasing global food demand, environmental protection, biodiversity conservation, and tackling the climate emergency, presents one of the most significant challenges of this century. Evidence shows that intensive and unsustainable agricultural practices, such as monocropping, can be detrimental to the health and functioning of the natural ecosystem. In systems where animals, crops, and trees are perceived as competing, rather than complementing one another, conversion to monocrop agriculture continues to be one of the leading causes of deforestation and land degradation. For subsistence farmers, the reliance on farming a single commodity can increase their financial vulnerability due to both price fluctuations, and costs incurred by ensuring high productivity. In particular, female-led households tend to be more vulnerable to land degradation and natural disasters, as their lower access to resources means women have a higher dependency on natural resources.

Agroforestry is perhaps as old as agriculture itself; it has been practiced for many centuries in different ways all over the world. It enables the optimal management of nature's ecosystem functions, redesigning conventional extensive agriculture, while maximizing land-use efficiency and protecting forests. Agroforestry is the deliberate inclusion of trees in cropping systems in a defined spatial arrangement and temporal order[1]. The Food and Agriculture Organization of the United Nations defines agroforestry as a "collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. It is a dynamic, ecologically based, natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels."[2]

There is no single type of agroforestry system; they vary across contexts in their design, management, and purpose. Smaller-scale and subsistence agroforestry systems are usually more complex, resembling natural forests in terms of diversity of tree species and canopy structure. Larger-scale agroforestry systems tend to follow a plantation-style design and are usually more simplified, with one main crop in association with one or two additional species. They can also vary in management, ranging from low-input organic systems to highly intensified, often semi-mechanized systems. All agroforestry systems have more than one output—like food, fodder, building materials, woodfuel—and overall, its ecology and economics will be more complex than those of monocultures[3].

Depending on their type, design, scale, and context, agroforestry systems can contribute to achieving at least nine of the 17 Sustainable Development Goals. Agroforestry systems are considered a natural climate solution[4], alongside reforestation, forest protection, and diverse agricultural management practices, thus particularly supporting climate action (SDG 13). Due to their contribution to protecting and conserving biodiversity, agroforestry systems also support life on land (SDG 15). Products and services flowing from the integration of trees within farming systems can contribute to food security (SDG 2), farmers' livelihoods and wellbeing (SDGs 1 and 3), gender equality (SDG 5), and responsible consumption and production (SDG 12)[5].

Rainforest Alliance's Position on Agroforestry

As an organization, we assert that agroforestry systems provide a holistic approach to addressing the challenges of simultaneously increasing global food demand, environmental protection, biodiversity conservation and tackling the climate emergency, by **increasing resilience of agricultural systems** to climate-change impacts**, conserving biodiversity** and by **enabling more equitable livelihoods**. Developing agroforestry solutions requires knowledge-intensive strategies and multifunctional approaches tailored to local conditions.

INCREASING REGENERATIVE PRODUCTIVITY AND RESILIENCE OF AGRICULTURE TO CLIMATE CHANGE

We believe agroforestry—deployed in context—can be applied at different scales, from large production areas to smallholder contexts, and can offer the opportunity to transition to a system that maintains high productivity but is based on ecological intensification[6]. Agriculture that uses extensive monocultures and external inputs may be perceived as high yielding, but it depletes natural resources such as soil and forests, and is environmentally unsustainable. Ecological intensification—using environmentally friendly inputs and ecological knowledge to enhance crop production and supporting ecosystem services—is a knowledge-intensive process, requiring optimal management of nature's ecological functions and biodiversity to improve agricultural system performance and efficiency, and farmers' livelihoods[7].

Agroforestry systems are often more productive in the long term as they increase the longevity of the cropping system through improved ecosystem health and resilience. They help to address a combination of challenges like heat stress on trees, nutrient availability, soil structure, and increased exposure to extreme climate events (droughts, heavy rains, etc.). On the other hand, in sun-grown systems, crops such as cocoa, coffee, and tea, usually obtain their highest yields with high rates of fertilizers and other inputs. However, yields tend to decline sharply after about 10 years[8].

Two key productivity factors in agroforestry systems are soil health, and natural regulation of pests, diseases, and weeds.

For soil health, adding organic matter (for example, from pruning agroforestry trees and crops)and including nitrogen-fixing trees improves the chemical, physical and biological characteristics of soil. Adding organic matter improves the activity of soil microbes, which make nutrients available to plants[9]. Trees within agroforestry systems prevent nutrient losses in deeper soil layers by improving soil structure through their root systems, preventing compaction, and improving soil aeration and water infiltration.

The selection of plant species and their spatial arrangement is important to reduce the spread of pests and disease. For instance, trees within agroforestry systems affect wind transport of disease propagules and insect host location. On infertile soils, crops' susceptibility to pests and diseases is strongly affected by the availability of plant nutrients, but are positively influenced by the improved soil health found in agroforestry systems. In general, agroforestry systems allow the development of an equilibrium between pests/diseases and their natural enemies, which is an important component of biological and integrated pest control[10].

Overall, agroforestry systems are a key contributor to regenerative agriculture[11].

Furthermore, agroforestry is key in ensuring long-term resilience to climate change, while significantly contributing to its mitigation. There is no one-size-fits-all model for addressing climate change. However, because agroforestry systems are flexible in their design and characteristics, they can offer a context specific strategic approach for adaptation to current and future climate-change impacts.

Climate change affects producers across the globe, impacting both production and processing activities. It is important to understand that specific disruptions caused by climate change do not affect crop-growing areas uniformly. A direct consequence of climate change is increased plant stress due to drought, high temperatures, and intense rains. Climate impacts can also lead to increased incidence of pests and diseases, reducing plant growth, yields, and quality of end-products[12,13,14].

Trees within agroforestry systems create buffers against extreme weather events like floods, storms, and landslides. Trees reduce the impact of wind on the main crops, and their root systems retain soil and facilitate water infiltration. Trees in agroforestry systems reduce the impact of high temperatures and heatwaves by providing shade to the crop and creating buffers. They also connect forested areas, thus enhancing landscape-level biodiversity, crucial in ensuring long-term resilience in the face of climate change.

Agroforestry systems also play an important role in climate change mitigation. They act as carbon sinks, as trees absorb carbon dioxide from the atmosphere through photosynthesis and store it in their tissues—wood, leaves, and roots. They also act as carbon pools, storing carbon in soils in the form of highly stable organic matter such as humus. Healthier soils have a better capacity to absorb and store carbon. This forms the basis of regenerative agriculture, under which agroforestry systems can form a key part of a climate intervention strategy.

RESTORE AND CONSERVE BIODIVERSITY

We believe agroforestry systems provide an enabling environment for biodiversity to thrive in increasingly diverse habitats. The plant- and animal-associated diversity of agroforestry systems is generally low compared with forests, but compares much better than monocrops and tree monocultures[15,16].The animal diversity in agroforestry systems—including insects, birds, and bats—is greater in floristically diverse systems that provide habitats for species, conserving and protecting on-site biodiversity. But even within agroforestry systems, management intensity and structural design can affect biodiversity and other ecosystem services. For instance, more intensively managed systems that rely on agrochemical inputs (such as synthetic fertilizers, pesticides, or mechanization) present lower biodiversity than systems managed less intensively with more focus on overall ecosystem health[17].

Agroforestry systems also contribute to the conservation and protection of biodiversity in the wider landscape. While above- and below-ground diversity provides stability and resilience at farm level, agroforestry systems can also provide new habitats and resources for local plant and animal species that could not survive in a purely agricultural landscape. [18]

Additionally, it is assumed that the adoption of agroforestry systems—especially in tropical forest landscapes—reduces the pressure of deforestation through natural resource and ecosystem provision.

ENABLING FOOD SECURITY, NUTRITION, AND MORE EQUITABLE LIVELIHOODS

Agroforesty can be an essential component of improving the livelihoods, security, and gender equality of producers and their families. It offers producers a strategy to mitigate risks associated with climate change and price volatility, providing economic resilience throughout the year. Including trees with multiple purposes enables producers to diversify production, generate extra income, and contribute to food security.

Although all users of agroforestry system services are involved in natural resource management, women and men are involved differently. Women play an important role in more labor-intensive agroforestry activities that depend on other family labor, especially in the early implementation phase. As well as providing access to crucial services and resources, agroforestry systems can generate extra income for women, thus decreasing poverty and increasing food security.

Agroforestry also makes it possible to tackle gender imbalances. Women play a critical role in managing ecosystems through agriculture, because of their knowledge of the crops and animals they manage (trees, cash crops, food crops, small animals), and because they are more frequently based on the farm than men, who often temporarily migrate. As such, they are integral to creating and managing agroforestry systems. Women make up 50 percent—or more—of the agricultural workforce, and are usually responsible for collecting and storing food, as well as feeding their families and managing water supplies for domestic activities. In agroforestry systems, women can easily integrate crops that generate the food, fodder, and fuel a household needs. Agroforestry systems tend to be close to houses, so they are easy to reach, and work in them can be combined with other tasks.

To realize this potential, women's specific needs must be acknowledged, including better access to resources such as land and trainings.

MULTIPLE BENEFITS, BUT NOT A PANACEA; CONTEXT IS KEY

We maintain that agroforestry has an important role to play in creating more sustainable agricultural systems at varying scales—but must be contextualized. Agroforestry systems can have great benefits, but studies show that it is usually difficult to simultaneously maximize production, biodiversity conservation, and climate resilience and mitigation, and that trade-offs exist[19]. Studies have found that crop productivity in agroforestry systems strongly depends on the interaction of the tree species, their respective characteristics (such as root architecture), and the overall agronomic management of the system, such as shade management[20,21]. Under certain circumstances, shade trees can reduce crop productivity through competition for water, nutrients, and light. High shade levels in agroforestry systems can also cause high humidity rates, affecting productivity through increased incidence of certain pests and diseases.

However, studies have also demonstrated that agroforestry systems can achieve a suitable balance between these competing needs through appropriate shade management[22]. For example, the optimal shade cover for mature cocoa agroforestry in West Africa is often recommended at around 30 percent. At 70 percent shade cover, however, biodiversity is positively affected and productivity is negatively affected (Figure 1). So shade management is a key element favoring cocoa production, as well as maintaining tree diversity. Pruning shade trees is essential: it manages microclimatic conditions such as temperature and humidity, and allows for better light transmission, positively affecting crop production.

FIGURE 1

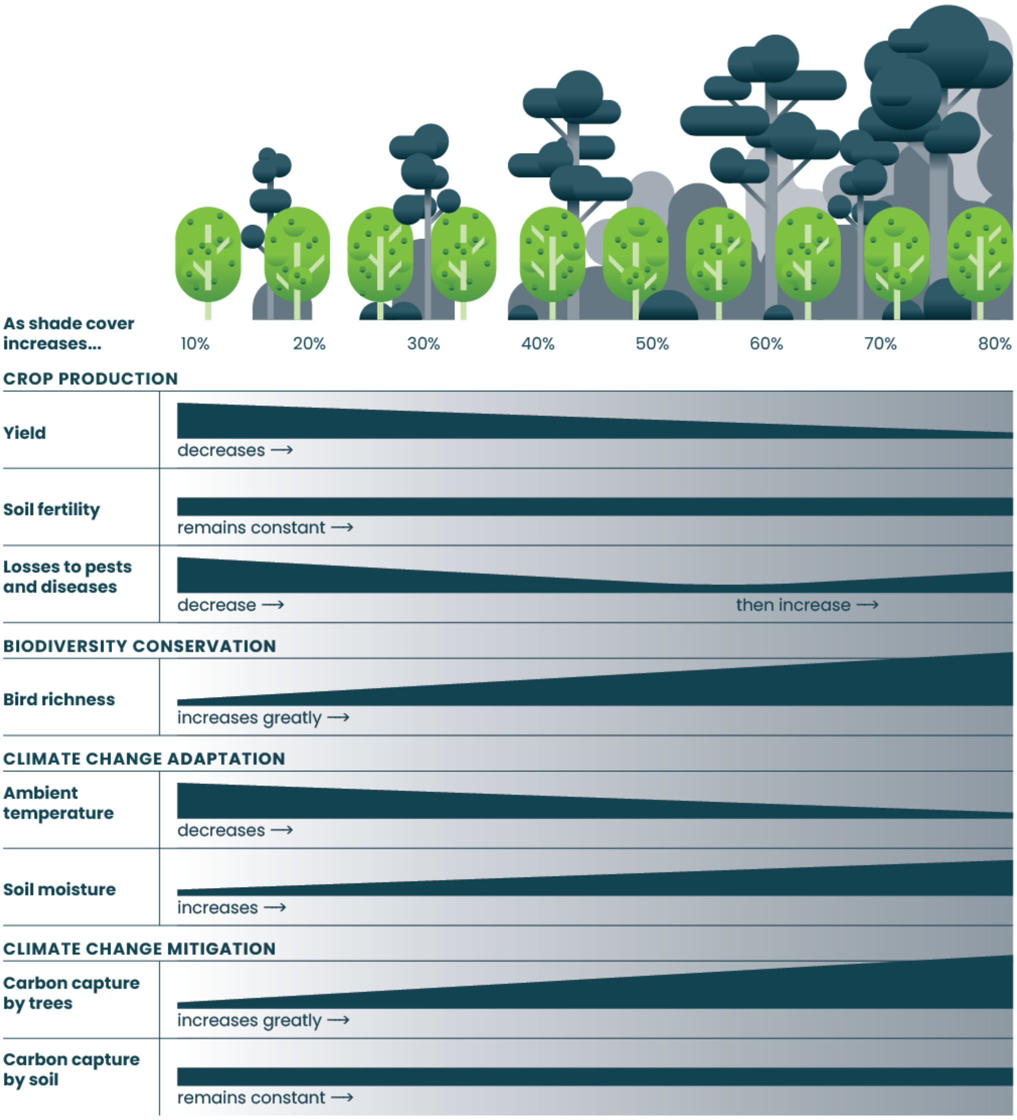

Figure 1: *Trade-off analysis of the effect of shade cover on ecosystem services*
Source: modified from Blaser et al. (2018)

Optimization of an agroforestry system therefore depends on the context, and optimal shade conditions cannot be generalized. Current and future climate conditions are key, and must be considered when defining the optimum shade management for an agroforestry system. In order to successfully adapt to climate-change impacts, it is fundamental to understand the heterogeneity of local contexts. It is then possible to prioritize context-specific, climate-smart agriculture interventions to address climate variability. Many of these interventions are already part of agroforestry systems, and can be adapted to specific circumstances. In areas severely affected by climate change, when dealing with impacts such as drought, for instance, agroforestry systems should be more diverse in terms of species composition, emphasizing species better adapted for those conditions; practices such as mulching and water harvesting infrastructure would also be priorities[23].

FIGURE 2

Figure 2: *A tea agroforestry system on a Rainforest Alliance Certified farm. Photo: Charlie Watson*

How the Rainforest Alliance works on Agroforestry

INCREASING REGENERATIVE PRODUCTIVITY, RESILIENCE TO CLIMATE CHANGE, AND BIODIVERSITY CONSERVATION

Agroforestry as a Means to Achieve Natural Vegetation on Farms

In our **Certification Program**, the Rainforest Alliance focuses primarily on the conservation of natural vegetation on farms. Agroforestry is one option for achieving this. Conservation areas within farms, riparian buffers, border planting or tree windbreaks, and living fences can also make a contribution. We maintain that every Rainforest Alliance Certified farm should have a minimum amount of natural vegetation (10 percent for farms growing non-shade-tolerant crops; 15 percent for those growing shade-tolerant crops). These conservation areas provide habitat for wildlife and enhance functional biodiversity (such as pollinators and natural enemies of pests and disease). For smallholder cocoa and coffee farmers in particular, agroforestry is the preferred option to reach the required percentage of natural vegetation, while having a positive impact on productivity and farm ecosystem services.

Agroforestry as a Self-Selected Requirement

In the Rainforest Alliance Sustainable Agriculture Standard [24], there is a specific requirement on agroforestry (6.2.5). This self-selected agroforestry requirement strengthens the importance of achieving optimal agroforestry shade coverage for specific regions and crops. The Rainforest Alliance uses the latest scientific literature to define optimal shade cover parameters. We have developed guidance on assessing the area under natural vegetation on a farm, and the shade tree cover at plot level[25]. Producers can follow the Rainforest Alliance optimal parameters if there are no accepted national recommendations for agroforestry shade coverage.

This requirement aims to encourage producers to implement agroforestry systems. However, as the establishment and implementation of agroforestry systems can be capacity- and capital-intensive, we emphasis the need to share this responsibility throughout the supply chain.

Partnership with Supply Chain Actors

Certification is certainly a good starting point, but for companies "interested to have an even bigger impact, the Rainforest Alliance's **Tailored Supply Chain Services** supports supply-chain actors to implement projects that deliver multiple positive outcomes via agroforestry.

For example, the Rainforest Alliance has engaged with various supply chain actors in defining context-specific agroforestry frameworks and in testing field approaches to agroforestry. For one such initiative, we engaged with a private sector company to pilot and field test methods for estimating shade cover on cocoa farms. During this collaboration, shade-cover data was both collected in the field and visually estimated using satellite imagery. This helped improve understanding of opportunities for rehabilitation, shade optimization, and more accurate management decisions regarding inputs.

Working in Landscapes with Communities: Adapting to Climate-Change Impacts through Agroforestry

The Rainforest Alliance aims to support producers in adapting their farming systems to climate-change impacts via its **Landscapes and Communities intervention strategy**. A collaboration with CGIAR centers, for example, assessed the impacts of climate change on future crop suitability for cocoa in Côte d'Ivoire and Ghana, and for tea in Malawi. The assessments were translated into climate-change impact maps, visually identifying areas with higher vulnerability and different requirements for adaptation strategies (Figure 3). Tailored agricultural practices were recommended to achieve different levels of resilience against climate hazards for specific impact zones. Across all assessed countries and crops, agroforestry was idenitifed as a key strategy for a tailored approach; in Ghana, for example, by adjusting shade cover in cocoa systems, farmers have addressed and dealt with drought conditions, competition for nutrients, and sub-optimal water or soil characteristics.

FIGURE 3

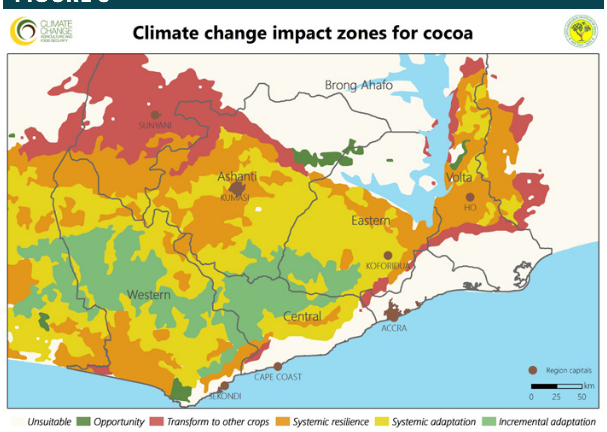

Figure 3: *Climate change impact map for the main cocoa regions in Ghana. Source: Dohmen et al. (2018)*[26]

ENABLING FOOD SECURITY AND NUTRITION, AND MORE EQUITABLE LIVELIHOODS

Encouraging Companies and Governments to Scale up and Facilitate the Implementation of Agroforestry Systems

Many companies and governments have committed to halting deforestation and scaling up agroforestry initiatives. To create an effective enabling environment for agroforestry, sectors need to move with full force from commitment to implementation. For governments, this means creating favorable policies, such as making tree ownership for farmers more accessible. In this context, the Rainforest Alliance has worked on strengthening the **advocacy capacities** of local civil society organizations—such as Impactum[27] in Côte d'Ivoire—to advocate for a tree-tenure policy and facilitate producers' understanding of the policy. The Rainforest Alliance is in continuous dialogue with companies and government organizations to scale up agroforestry efforts in their sustainability agendas and commitments.

Furthermore, via its Tailored Supply Chain Program, the Rainforest Alliance uses a combination of tools to flag supply chain and sourcing activity key risks to partners. Building on this risk analysis, the Rainforest Alliance works with brands, traders, and other stakeholders to develop a regenerative, climate-smart policy framework, with accompanying milestones to measure progress. This service is ideal both for companies that are just beginning to explore regenerative, climate-smart practices—including agroforestry—and for companies with long-standing policies that want help aligning with best practices.

Conclusion

The Rainforest Alliance believes that agroforestry systems have the potential to help solve five major global challenges: restoring and conserving biodiversity; increasing the sustainable intensification of agriculture; increasing resilience to climate change; mitigating climate change; and improving food security, livelihoods, and gender equality. Although agroforestry is not advantageous in every context—and trade-offs exist between production, biodiversity conservation, and climate goals—agroforestry systems can balance these competing goals. The Rainforest Alliance's Sustainable Agriculture Standard contains specific criteria for certification which highlight the importance of achieving context-specific optimal agroforestry shade coverage, aiming to encourage producers to implement agroforestry systems. We believe the responsibility for establishing and implementing these systems should be shared throughout the supply chain, and we encourage companies and governments to scale up and facilitate agroforestry systems.

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