
Agroforestry plot implemented on a Fairtrade certified coffee farm in Tanzania

Technical Paper: Carbon Footprints and Mitigation Opportunities in Fairtrade Supply Chains

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Jonathan Bird and Martin Eichhorn

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Contents

Glossary

Activity data: The key activities that result in greenhouse gas emissions and removals in the supply chain, such as farming practices, transport, storage, processing and packaging.

Adaptation: changes in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects. It refers to changes in processes, practices and structures to moderate potential damages or to benefit from opportunities associated with climate change. This report focuses primarily on adaptation of agricultural systems, which involves changing agricultural structures, practices, infrastructure, and processes in ways which will limit damage and maximize any benefits from climate change.

Afforestation: conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was not previously forested.

Biomass: Materials that are biological in origin, including organic material (both living and dead) from above and below ground, for example, trees, crops, grasses, tree litter, roots, and animals and animal waste.

CarbonCloud Agricultural model: the CarbonCloud agricultural model is a model of farm level emissions based on the IPCC guidelines (IPCC, 2019) complemented with estimates of emissions due to production of inputs.

CarbonCloud Software platform: the CarbonCloud online software platform provides the framework for climate footprint assessments of products within the scope of the study. The software gives access to a comprehensive library of agricultural products from different countries and regions and calculates the climate footprint of these products using the CarbonCloud agricultural model.

Carbon footprint of a product: a measure of the equivalent amount of carbon dioxide released into the atmosphere as a result of the activities of a particular product.

Carbon Sequestration: Terrestrial, or biologic, carbon sequestration is the process by which trees and plants absorb carbon dioxide, release the oxygen, and store the carbon. Geologic sequestration is one step in the process of carbon capture and sequestration (CCS) and involves injecting carbon dioxide deep underground where it stays permanently.

Carbon sequestration factors: the amount of carbon stored per unit of activity.

CO_2e conversion factors: a value used to convert emissions of various greenhouse gases (GHGs) into a common unit known as carbon dioxide equivalent[1] (CO_2e).

Ecosystem services: The benefits or "services" of an ecosystem to human life, such as clean water and the decomposition of organic matter.

Emissions factor: A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per barrel of fossil fuel consumed, or per pound of product produced).

Energy efficiency: Using less energy to provide the same output.

Evapotranspiration: The combined process of evaporation from the Earth's surface and transpiration from vegetation.

GHG: Greenhouse gas. Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include, carbon dioxide, methane, nitrous oxide, ozone, chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, sulphur hexafluoride.

Heat Waves: A prolonged period of excessive heat, often combined with excessive humidity.

HLO: Hired Labour Organisation. A hired labour organization is a company that relies on hired workers; this can be a farm, plantation, factory, manufacturing industry etc.

Inorganic fertilizer: A plant nutrient added to the soil that is manufactured from synthetically derived chemicals and minerals from the earth, but does not contain carbon.

Inorganic pesticide: A substance used to kill pests that are harmful to crops; it is inorganic as it does not contain carbon but is comprised of synthetically derived chemicals and minerals from the earth.

Insetting: The financing of a climate protection project within a company's value chain, which reduces or sequesters emissions and has a positive impact on communities, landscapes and / or ecosystems associated with the value chain.

Mitigation: A human intervention to reduce the human impact on the climate system; it includes strategies to reduce greenhouse gas sources and emissions, and increase greenhouse gas sinks.

Mitigation potential: An intervention's potential to mitigate the effects of climate change. For this study, it was decided that quantitative estimates of potential emissions reductions and removals were not required - this was judged to be unnecessary for the purpose of this analysis but may be essential when planning mitigation interventions in a specific location.

Mitigation strategy: An approach to reducing greenhouse gas emissions into the atmosphere. Given Fairtrade's position as a producer-led organization, this study focusses on 'producer-level' mitigation strategies, which include agricultural production, post-harvest and processing activities carried out by producers, as well as activities within producer households, such as cooking and lighting.

Nature-based solutions: Actions to protect, sustainably manage, or restore natural ecosystems, that address societal challenges effectively and adaptively, while providing positive benefits to human wellbeing and biodiversity.

Organic fertilizer: A plant nutrient added to the soil that is derived from natural sources, such as compost or manure. Only certain types of organic fertiliser were included in the analysis for this report, as outlined in the methodology.

Organic pesticide: A substance used to kill pests that are harmful to crops, which is derived from natural sources.

SPO: Small Producer Organisation. A membership body that represents smallholder producers who do not depend on hired workers all the time and run their farm mainly by using their own and their family's labour.

Regenerative agriculture: A conservation and rehabilitation approach to food and farming systems. This includes farming and grazing practices that reverse climate change by rebuilding soil and restoring biodiversity.

Reforestation: conversion of non-forested land to forested land through planting, seeding and/or the human-induced promotion of natural seed sources, on land that was previously forested but that has been converted to non-forested land.

Renewable energy: Energy resources that are naturally replenishing such as biomass, hydro, geothermal, solar, wind, ocean thermal, wave action, and tidal action.

Resilience: A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.

Reversal risk: the intentional or unintentional release of carbon back into the atmosphere due to storms, fire, pests, land use decisions and other factors.

Smallholder farmer: A person who owns or manages a small agricultural holding (usually defined as less than 10 hectares), and who relies primarily on their own and family labour to run it.

Soil Carbon: The solid carbon stored in soils, both in organic and inorganic forms.

Soil organic matter: any material produced originally by living organisms (plant or animal) that is returned to the soil and goes through the decomposition process. It is a major component of the terrestrial biosphere pool in the carbon cycle. The amount of soil organic matter in the soil is determined by the historical plant cover on the soil and how much was grown, which in turn depends on local climate conditions.

1. Introduction

Fairtrade, Fairtrade Programmes and Climate Justice

For three decades, Fairtrade has been working with farmers and workers in low-income countries to achieve a fairer future through fairer prices and fair production standards and practices.

Fairtrade certification, our best-known tool for bringing about change, is a critical step towards building resilient supply chains that improve economic, environmental and social outcomes for farmers and workers. It targets better working conditions and human rights, promotes fairer pay and improved livelihoods, while supporting sustainable farming methods which increase resilience to climate change, and protect biodiversity, the environment and farmer livelihoods.

Beyond certification, Fairtrade is deepening its impact by delivering specialist programmes, which are co-funded through strategic partnerships with commercial partners, institutions and private donors. Through these strategic partnerships, Fairtrade tackles the deep-rooted and systemic issues that block transformational change. Our holistic programmes are designed with farmer needs at heart and address challenges at the farm and community level and broader enabling environment. This is the most effective way to scale our work and achieve greater impact for farmers and workers.

Millions of farming families and their communities are on the front-line of a climate crisis they have done very little to cause. The vast majority cannot afford to adapt to the changes they are experiencing as hurricanes, cyclones, droughts, floods and other extreme weather events affect crop yields and, in some cases, wipe out a producer's only source of income.

Fairtrade is exceptionally well placed to coordinate systemic climate change mitigation and adaptation approaches across supply chains. A key challenge many actors face when attempting to promote changes within supply chains involving significant production on smallholder farms is that it is difficult to connect and develop long-term partnerships with smallholder farmers. With its established cooperative/SPO relationships and producer networks across the world, Fairtrade can ensure that millions of smallholder farmers and their families are meaningfully included as both actors and stakeholders in climate solutions.

We believe that sourcing Fairtrade certified products and ingredients is a critical first step to supporting farmers to adapt to and mitigate effects of the climate crisis via the Fairtrade Minimum Price, the Fairtrade Premium and compliance with Fairtrade Standards. Fairtrade provides further support and resources through Climate Programmes and the Centre of Excellence for Climate and Environment, defined below.

Fairtrade Minimum Price	The FTMP mechanism ensures that the revenue farmers receive from selling their produce is sufficient to meet the cost of production and acts as a safety net to manage shocks and hazards that could be climate related.
Fairtrade Premium	Fairtrade farmers can choose to spend the Fairtrade Premium on climate related projects such as tree planting, crop diversification, improved water management and clean energy, which support climate adaptation and mitigation objectives.
Fairtrade Standards	Each Fairtrade standard has a series of requirements specifying that farmers must make sustainable agriculture part of their farm management practice, considering issues such as soil erosion and water scarcity.
Fairtrade Centre of Excellence for Climate & Environment (CoE):	The CoE is a knowledge and innovation hub set up by the Fairtrade system to: • Generate, disseminate, and re-position relevant climate and environmental-related knowledge for use by key decision makers across the Fairtrade system. • Provide the innovative, technical, and operational tools and guidance needed to strengthen the Fairtrade system's overall capacity to meet the goals of the Global Strategy for Climate Change and Environment.

Identifying high-impact climate programme opportunities

Amidst a rapidly changing policy environment and the growing prominence of the Science-Based Target Initiative[2], Fairtrade Foundation's commercial partners are expanding their commitments to reduce greenhouse gas emissions within their supply chains. While Fairtrade is working hard with its producer networks to find ways to reduce and avoid emissions, many Fairtrade certified supply chains contain large numbers of farmers who are both highly vulnerable to climate change and face significant challenges in adapting to climate change effectively. It is therefore critical that the mitigation strategies Fairtrade Foundation supports are not purely carbon-focused, but are also designed to facilitate adaptation and achieve broader economic, environmental and social objectives for farmers and workers.

This context informs our position on climate action: Climate sustainability is more than reducing and avoiding greenhouse gas emissions. Climate sustainability should also prioritise improving the lives and livelihoods of smallholder farmers and workers and ensuring women and youth can participate equitably and access opportunities presented by the transition to sustainable economies.

The maturation of voluntary carbon markets and the growing commitment of commercial partners to reduce greenhouse gas emissions presents major opportunities for Fairtrade producers to access the climate finance they need to invest in adaptive farming practices and income diversification, while contributing meaningfully to climate change mitigation. This could be crucial to increase the adoption of nature-based solutions which achieve both adaptation and mitigation goals simultaneously, such as agroforestry.

Fairtrade Foundation has established the **Fairtrade Climate Programmes Facility (CPF)** to support producers and workers to make this a reality. The CPF is focused on financing and launching programmes with Fairtrade Africa that promote:

- **Sustainable Agriculture**: by accelerating the transition to sustainable agricultural land management (SALM),
- **Energy Access**: by increasing the availability, affordability and use of clean and off-grid energy technologies, and
- **Insetting**: by increasing the deployment of nature-based mitigation solutions with high adaptation and non-carbon benefits.

The CPF is designed to target (scalable) opportunities within our commercial partners' supply chains where mitigation and adaptation issues intersect and is pioneering Fairtrade Foundation's programmatic approach to carbon insetting and agroecology. The focus is on integrated solutions with the potential to achieve both greenhouse gas emissions reductions or removals, and improve smallholder livelihoods through income diversification and adaptive farming practices.

Objectives of this report

Within the framework outlined above, this report aims to further inform and guide Fairtrade's response to climate change. More specifically, for Fairtrade-certified commodities from 5 origins[3] which are at high risk of climate impacts, we aimed to:

- **Estimate the carbon footprint** and provide a breakdown for each of the major stages in the supply chain.
- **Identify producer-level[4] mitigation strategies** which could be relevant to each commodity and origin.
- **Assess the mitigation potential of these strategies** and identify broader economic, environmental, and social impacts of implementing these strategies.
- **Draw conclusions about how Fairtrade should develop climate programmes** which incorporate mitigation objectives.

The commodity origins selected for this research were:

- Coffee from Colombia
- Cocoa from Ghana
- Coco from Côte d'Ivoire
- Bananas from Dominican Republic

- Red Roses from Kenya

While this research may provide a foundation for the development of programmes within these supply chains, the broader aim of this report is to generate insights which can guide the development of climate programmes across all Fairtrade supply chains.

2. Methodology

The methodology involved three main steps:

- Selection of commodity origins for assessment
- Estimation of carbon footprints for selected commodity origins
- Selection and assessment of mitigation strategies for selected commodity origins

These steps are described in the sections below, together with a summary of relevant limitations.

2.1 Selection of commodity origins

In order to identify priority commodity origins for assessment, a commodity mapping and selection exercise was carried out. The exercise narrowed the research scope to five commodity origins, based on their significance to Fairtrade, their assessed climate threat, and their importance to Fairtrade's commercial partners.

The selection matrix below was used as a decision-making tool to select commodity origins. The research team developed an initial shortlist of four commodities – coffee, bananas, flowers, and cocoa – to be included in the research, given their strategic significance to Fairtrade Foundation. For these commodities, the research team then identified production origins facing high climate risk, based on the Fairtrade's climate change hotspot analysis[5]. This shortlist of commodity origins was then mapped against the climate priorities of Fairtrade Foundation's key commercial partners, as determined by Fairtrade Foundation commercial account managers. As a result of this process, six commodity origins emerged as: a) high relevance to Fairtrade b) exposed to high climate risk c) having high commercial importance.

A final screening for additionality narrowed the final scope to five, with Ethiopian Coffee excluded given the significant climate-related work already underway and the preference to avoid duplication. As a result, the following commodity origins were selected: Bananas from Dominican Republic, Coffee from Colombia, Cocoa from Ghana and Côte d'Ivoire[6], and Kenya Red Roses[7].

Commodity	At-Risk Origins	Commercial Importance	Selected?
Banana	Dom Republic	High	Y
	Colombia	Medium	N
Coffee	Peru	Medium	N
	Honduras	Medium	N

Commodity	At-Risk Origins	Commercial Importance	Selected?
	Colombia	High	Y
	Ethiopia	High	N
	Kenya	Medium	N
	Uganda	Medium	N
	Tanzania	Medium	N
Cocoa	Côte d'Ivoire	High	Y
	Ghana	High	Y
Flowers	Kenya	High	Y
	Ethiopia	Medium	N
	Ecuador	Low	N

Within the commodity origins selected in the above process, there are differences between the farm characteristics. For use in the subsequent analysis, a set of key parameters were defined, covering:

- Small (<5 Hectare) or large (>5 Hectare) farm size
- Small Producer Organisation (SPO) or Hired Labour Organisation (HLO)
- Fairtrade certified or not
- Conventional or organic production

For each commodity origin, these parameters were selected based on the most common characteristics for the commodity when purchased by UK based commercial partners of Fairtrade. The final selection is presented in the table below:

Commodity Origin	Farm Size	SPO or HLO	Fairtrade Certified	Conventional or Organic Production
Coffee: Colombia	Small	SPO	Fairtrade Certified	Conventional
Cocoa: Ghana	Small	SPO	Fairtrade Certified	Conventional

Commodity Origin	Farm Size	SPO or HLO	Fairtrade Certified	Conventional or Organic Production
Cocoa: Côte d'Ivoire	Small	SPO	Fairtrade Certified	Conventional
Bananas: Dominican Republic	Small	SPO	Fairtrade Certified	Conventional
Red Roses: Kenya	Large	HLO	Fairtrade Certified	Conventional

2.2 Estimation of carbon footprints

Estimation of carbon footprints was carried out as a collaboration between CarbonCloud and the core research team. CarbonCloud is a company which operates a digital platform based on software that provides access to a library of agricultural products, ingredients, packaging materials, and energy carriers, which support users to estimate carbon footprints for agricultural products. The methodology for each step in the estimation of carbon footprints is explained below.

(i) Mapping supply chains and defining system boundaries

To estimate carbon footprints in commodity supply chains, it is first necessary to define which process steps in the supply chain will be included and excluded from the calculations. The research team carried out an initial mapping of the process steps for each supply chain and defined which process steps would be included and excluded. For all commodities, the boundary at the start of the supply chain was drawn at the agricultural production step, though it should be noted that this includes associated emissions for all inputs used in production, such as fertilizer and electricity. The cut-off boundary along the supply chain was drawn at the point where the product arrived in the consumer country at the processor - in the case where further processing was required - or at the retailer – in the case where no further processing was required:

- **Coffee from Colombia:** roasted coffee beans at the point when they are at a factory in the UK for final processing.
- **Cocoa from Ghana and Côte d'Ivoire:** raw, dried cocoa beans at the point when they arrive at a factory in Belgium for processing.
- **Bananas from Dominican Republic:** fresh, ripe bananas, at the point when they arrive at a distribution point in the UK.
- **Red Roses from Kenya:** fresh, unbranded red roses when they arrive at a distribution point in the UK.

(ii) Calculation of carbon footprints for the agricultural stage

The carbon footprint estimations for the agricultural stage were carried using the CarbonCloud agricultural model, which is a model that calculates farm level emissions based on the IPCC guidelines (IPCC, 2019), complemented with estimates of emissions caused by the production of inputs. A list of mechanisms included and excluded from these estimations is provided in Annexe 1.

At the agricultural stage, different sources of data were used for the estimation of carbon footprints for different commodities:

- **For Kenyan red roses**, the Fairtrade Foundation research team gathered primary data about activities at the agricultural stage. This data was collected through a site visit and interview with the lead agronomist at Rainforest, a Fairtrade certified flower farm (hired labour organisation) in Naivasha, Kenya. The interview collected data on key processes, inputs and outputs related to agricultural production and postharvest for this specific farm.
- **For coffee (Colombia), cocoa (Côte d'Ivoire and Ghana) and bananas (Dominican Republic),** the input to the model was taken from a database of activity estimates provided by CarbonCloud which aims to provide representative data for the specified country and commodity. For example, estimates of fertilizer inputs are made by starting with FAO and IFA data on total fertilizer use within a country and / or crop group (FAOSTAT, 2021; Heffer, 2017) and attributing that to different crops in proportion to their nitrogen needs (modelled by using a mix of allometric data and specific factors such as nitrogen fixating mechanisms combined with production data).

In both cases, these sources aimed to provide data which was representative of average farms in each country given the parameters specified in Section 2.1 (farm size, SPO or HLO, Fairtrade certified or not, conventional, or organic production). Limitations related to these data sources are discussed in section 2.4.

(iii) Calculation of carbon footprints for the transport, processing, packaging and storage stages

For all commodities in this study, the calculation of carbon footprints for the transport, processing, packaging and storage stages was based on activity data collected in key informant interviews (KIIs). Semi-structured KIIs were conducted with Fairtrade staff, producer organisations and hired labour organisations to collect information on the processes at each stage of the supply chain, as well as inputs, outputs, and by-products These were then validated with representatives from Fairtrade's Producer Networks through interviews.

The research team then entered the activity data collected in the previous steps into the CarbonCloud software platform. The software calculated the carbon footprints using emissions factors and CO_2e conversion factors contained within the model, which are based on the IPCC 2019 guidelines[8]. Annexe 1 provides a list of emissions mechanisms included and excluded from these calculations. For a more comprehensive description of the methodology used by CarbonCloud, please refer to the Full Technical Reports[9] for each product.

2.3 Selection and assessment of mitigation strategies

(i) Defining categories of mitigation strategies to include in the analysis

Given that Fairtrade is best-positioned to support changes among producers and producer organisations, the analysis for this report focusses on 'producer-level' mitigation strategies. More specifically, the scope of 'producer-level' for the purpose of this report includes agricultural production, post-harvest and processing activities carried out by producers and SPOs/HLOs.

To compare different commodities, standardized categories of producer-level mitigation strategies were defined. The research team used desk research[10] to identify a comprehensive list of potential mitigation strategies, then selected the most relevant categories for the commodities being studied. This selection was based on an understanding of the greenhouse gas sources, carbon sinks and reservoirs relevant to each commodity.

Based on this process, the following categories of mitigation strategies were selected to be included in this analysis:

Category of mitigation strategies		Description
	**Sequestering carbon in soils**	Sequestering carbon in soils involves practices which capture carbon dioxide from the atmosphere and store it in soil as organic carbon. For the purpose of this analysis, the following practices were included: adding prunings to the soil; converting crop residues and other locally available biomass into organic fertilizer, compost or biochar and adding to the soil; mulching and growing cover crops.
	**Sequestering carbon in trees on farmland**	Planting tree species on farmland together with the primary crop, in agroforestry systems. These additional trees capture carbon dioxide from the atmosphere and store the carbon in their biomass, such as roots and stems.
	**Reducing deforestation caused by conversion of forest to cropland[11]**	There are many causes of deforestation. For the purpose of this analysis, only strategies to reduce conversion of forest for planting the crops selected (coffee, cocoa, bananas, red roses) were considered. All other strategies to reduce deforestation and forest degradation were excluded, but may be included in subsequent analyses carried out by Fairtrade.

Category of mitigation strategies		Description
	**Reducing nitrogen[12] fertilizer application**	Applying fertilisers which contain nitrogen contributes directly to GHG emissions (particularly nitrous oxide) from soils and water on cropland, in addition to emissions generated during fertilizer production and distribution. For the purpose of this analysis, 'Reducing nitrogen fertilizer application' involves reducing the overall quantity of nitrogen applied per unit of land, based on the volume of fertilizer applied multiplied by the percentage of nitrogen within the fertilizer. Nitrogen present in both organic and inorganic fertilizer application is included. Further details are provided below: Organic fertilizer includes animal manure and composted plant materials, but does not include urine and dung from grazing animals, integration of crop residues, green manures, or leaf litter falling on cropland. Inorganic fertilizer includes all types of fertilizer manufactured through chemical processes using mineral resources and industrial techniques. It is assumed that all fertilizers contain nitrogen. Most will also contain other crop nutrients.
	**Reducing pesticide application**	Pesticide manufacturing and distribution directly generates greenhouse gas emissions. Application on farms can also increase emissions indirectly in various ways, such as altering populations of soil microbial communities, which then affects their production or consumption of different greenhouse gases. For the purpose of this analysis, both organic and inorganic pesticides were included, and all contributions to greenhouse gas emissions from manufacturing, distribution and application on farms were included.

Category of mitigation strategies		Description
	Switching to renewable energy sources and/or increasing energy efficiency	For the purpose of this paper, this mitigation strategy could apply to either agricultural production (e.g. irrigation), post-harvest and primary processing stages, as long as they are carried out by producers or producer organisations.

Mitigation Strategies Related to Post-Harvest and Processing Activities

Mitigation strategies related to post-harvest and processing activities were only considered in cases where these activities are carried out by producers or worker and producer organisations. This is to align with Fairtrade's high potential to achieve influence at this level of the supply chain. Furthermore, only strategies with significant mitigation potential were included in this report, but given the diversity of methods and technologies available, there are many more strategies which exist and if a programme is planning mitigation interventions for a given commodity, it could be worth researching these further.

While strategies available under this category are extremely diverse, very limited research was identified assessing the economic, environmental, and social impacts caused by their implementation. The analysis of broader impacts was therefore not carried out for these strategies, but they are recorded under each commodity for consideration.

Mitigation Strategies Beyond the Supply Chain

Further categories were identified which do not relate to the production, postharvest activities and processing of a commodity, but could be carried out by producers, producer organisations or hired labour organisations. The most relevant for Fairtrade are:

- **Afforestation and reforestation[13] in areas surrounding croplands.**
- **Producer households switching to renewable energy sources and / or increasing energy efficiency.**

These categories were excluded from the core analysis, which aimed to focus on activities directly involved in the production, postharvest and processing activities for each commodity. However, they may be relevant to consider when planning climate programmes, because Fairtrade is well positioned to support these types of mitigation strategies. With this in mind, they are listed at the end of the section for each commodity.

(ii) Selecting categories of mitigation strategies for each commodity and origin

The research team selected categories of mitigation strategies based on relevance to each commodity and origin. This process led to the exclusion of categories which had either:

- Very low potential for emissions reductions or carbon removals
- Very limited feasibility

The final selection is detailed in the table below (Y = Yes, N = No), together with reasons for exclusion.

Mitigation Strategy	Coffee: Colombia	Bananas: Dominican Republic	Cocoa: Ghana & Côte d'Ivoire	Red Roses: Kenya
Sequestering carbon in soils	Y	Y	Y	N Limited feasibility within precision production systems, which are often hydroponic
Sequestering carbon in trees on farmland	Y	Y	Y	N Limited feasibility within greenhouse production systems
Reducing deforestation caused by conversion of forest to cropland	N Expansion of coffee production not currently a significant driver of deforestation in Colombia	Y	Y	N Expansion of Red Rose production not currently a significant driver of deforestation in Kenya
Reducing nitrogen fertilizer application	Y	Y	N Currently, volumes applied are relatively low	N Very unlikely to reduce fertilizer application, within their precision production systems, which

				are often hydroponic
Reducing pesticide application	N Very low emissions reductions per hectare	N Very low emissions reductions per hectare	N Very low emissions reductions per hectare	N Very low emissions reductions per hectare
Switching to renewable energy sources and/or increasing energy efficiency	N Very low energy use in smallholder farming	N Low energy use in farming and producer-level post-harvest activities	N Very low energy use in smallholder farming	Y

This selection process helped increase the focus of the analysis in this report significantly. However, it should be noted that:

- At smaller geographic scales, some of these strategies may still have potential in the origins where they are marked as N above.
- The situation is dynamic and needs updating over time. For example, climate change may drive expansion of Colombian coffee production into higher altitudes, which could increase the rate of deforestation in future.

(iii) Assessment of Mitigation Potential

For each commodity and origin, the mitigation potential was then assessed for each category of mitigation strategy, providing a broad indication of the scale of greenhouse gas emissions reductions and carbon removals - rated High/Medium/Low. While there may be a high level of subjectivity in these ratings, the aim is to develop a framework that supports comparison and decision making, not one that informs the development of carbon mitigation interventions directly. Were verified carbon projects to be developed on the basis of this research, for example, it would still be necessary to fulfil project development requirements and complete studies to assess emission reductions and removals for the specific locations targeted by the project. It was therefore decided that quantitative estimates of potential emissions reductions and removals would be misleading and not required for the analysis.

Mitigation potential was assessed through a review of relevant literature on emissions reductions and carbon removals for each strategy. The assessment considered the:

- Per hectare potential for emissions reductions and carbon removals.
- Potential land area on which the strategies could be applied, given factors such as the total land area cultivated by farmers for each commodity origin and any factors which could limit adoption.
- Potential emissions reductions and carbon removals per Kg of crop produced.

- Risk of 'reversal'. This is the risk that the emissions reductions or carbon removals could be reversed. For example, if farmers plant timber trees which sequester carbon, there could be a risk that they cut them down to sell the timber and do not replant them.

The rating of the mitigation potential was then assigned and the rationale for each rating is outlined in the accompanying narrative.

(iv) Assessment of broader impacts

As mentioned in the introduction, Fairtrade believes that mitigation initiatives with producers should also contribute to climate resilience and achieve broader economic, environmental and social impacts for both producers and their communities. Broader impacts for each mitigation strategy were identified through desk research and categorized for use in this report. Both positive and negative impacts were considered for each category.

Impact category	Main types of impact considered
Agronomic & Economic	• Agronomic: includes impacts on soil, water and relevant ecosystem services which support agricultural production, pests, and diseases. Also includes impacts on farm productivity, including resilience of production to climate change. • Economic: impacts on farm profitability, including resilience of incomes to climate change. Also includes income diversification.
Environmental	• Biodiversity • Deforestation and forest degradation/restoration • Land degradation/restoration • Water management • Pollution: including water, waste, air
Social	• Rights at work: particularly health & safety, child labour, working hours • Skills development • Gender: includes division of labour, access to productive resources and economic benefits from production • Empowerment of marginalised groups • Social cohesion and security

2.4 Limitations

The methodology outlined above is appropriate to achieve the objectives of this research. However, there are several limitations which should be acknowledged:

(i) Estimation of carbon footprints

Estimations do not cover the full supply chain or complete product life cycle. The methodology drew boundaries at specific points in the supply chain where the product was no longer in its primary export format. For example, in the case of cocoa the boundary was drawn at the factory in the consumer country where the cocoa bean in ground into powder. This means that emissions from subsequent steps in the supply chain and product life cycle are not included. For cocoa, this means that emissions from secondary processing (e.g. chocolate manufacture), other ingredients (e.g. sugar), transport to the retail stores, end-user consumption and disposal activities are not taken into account.

Estimations of emissions for activities within each process step are not provided. The CarbonCloud outputs do not provide these breakdowns. For example, the carbon footprint of agriculture is provided, but not the carbon footprint of specific activities, such as fertilizer application.

Estimations are based on the average situation for producers and other actors in the supply chains. However, there will be differences between farms and locations within each country, due to factors such as climate, soil, hydrology and farming practices, transport distances, processing and storage methods, among many others. These factors mean that there may be farms which have carbon footprints which vary significantly from the average figures calculated in our estimations. The same is also true for other actors in the supply chain. It is important to take this into account when planning interventions in a specific area, because the situation in that area may differ significantly from the national average.

(ii) Selection and assessment of mitigation strategies

Assessment of mitigation potential is not quantified in CO_2e units.

- Because broad categories of mitigation strategies were used as the basis of analysis, there could be a large variety of activities carried out under each category. For example, carbon sequestration in trees on Colombian coffee farms could involve diverse tree species, at different planting densities and with different pruning practices. All variations in practices and management have a significant effect on the scale and rates of carbon sequestration.
- Studies used to assess mitigation potential are not always comparable and often have gaps in analysis. For example, gaps in data covering intensity and maturity of adoption of each practice, factors affecting the likelihood of adoption, and typical levels of reversal for those who initially adopted practices but then dropped out.
- Rather than trying to produce quantitative estimations across multiple practices under each category, based on incomplete data, it was decided that quantitative estimates of potential emissions reductions and removals would be misleading and not required for the analysis. The paper presents a general indication of the level of mitigation potential (high/medium/low), based on the information available.
- While sufficient to meet the objectives of this paper, carbon projects and programes aiming to achieve mitigation outcomes will require more detailed quantitative assessment that is project, context and practice specific.

Assessment of the broader impacts of implementing mitigation strategies was based on desk research. This is sufficient to provide a generalized analysis of typical impacts for each commodity origin. However, it may not be sufficient to inform the planning of programmes targeting specific social groups, in specific locations, which may differ in key characteristics. Further location-specific assessment would likely be needed to validate the impacts and capture important nuance and context.

3. Carbon footprints and mitigation opportunities

The sections below present carbon footprints and producer-level mitigation strategies for each commodity origin, together with the broader impacts of implementing each strategy.

3.1 Coffee: Colombia

(i) Producer context

The coffee sector in Colombia is characterized by the production of high-quality, specialty coffee, grown on small farms by families who often rely on coffee production as their primary source of income. The estimated 560,000 smallholder coffee growing families are responsible for approximately 69% of Colombia's total coffee production.[14]

In 2021, over 197,000 ha of coffee production land in Colombia was Fairtrade certified, with 72,000 smallholder farmers producing around 240,000 MT of coffee. Of this, 36,100 MT were sold on FT terms, generating premiums for producer organizations and their members of EUR 13.1m.

(ii) Carbon footprint

The outputs of the CarbonCloud model show that 1 kg of coffee beans roasted in Glasgow results in 13 Kg CO^2e emissions and that the agriculture stage of the supply chain causes 96% (12.48 Kg CO2e) of these emissions.

Compared to the figures reported in similar studies, the results for Colombian coffee are broadly in line, but higher. For example, one study[17] reported that the average carbon footprint for four production systems[18] was 8.3Kg CO2e for 1 Kg of parchment coffee[19]; another study[20] reported that 1Kg parchment coffee produced by smallholder farmers in Kenya had an average carbon footprint of 4kg CO2e. These studies excluded emissions from all processes after parchment coffee was produced. As such, they should be compared to the 'agricultural stage' from the Carbon Cloud data, which was 12.48Kg CO2e per Kg of coffee beans. This comparison suggests that Colombian coffee has similar, but larger emissions than in the production systems which were reported in these studies.

The 'agricultural stage' emissions from coffee are considerably higher than those of the other commodities assessed in this paper. In part, this is because post-harvest processing activities are included in the methodology used to calculate the agricultural stage, particularly wet[15] processing, which generates significant quantities of methane. The methodology used for the carbon footprint estimations in this paper did not provide a breakdown of the GHG emissions caused by wet processing. However, other research for the Latin American region has estimated that this makes up a large proportion of on-farm emissions. For example, one study[16] across five Latin American countries estimated that emissions from fermentation and wastewater production contributed 66% of the on-farm carbon footprint for shaded monoculture coffee.

The diagram provides a breakdown for each stage in the supply chain and the full technical report[21] contains further information on the methodology and outputs.

(iii) Producer-level Mitigation Opportunities

Sequestering Carbon in Soils on Farmland

Various practices can increase soil carbon sequestration in coffee farming. These include:

- Adding prunings to the soil. These could be from coffee trees or other species, including tree crops grown alongside coffee in agroforestry models
- Converting crop residues and other biomass into organic fertilizer or biochar and adding to the soil.
- Mulching and growing cover crops.

Deep Dive: Sequestering carbon in soils

The basic logic of carbon sequestration in agricultural soils is straightforward. It involves carrying out practices which either increase carbon inputs to soils (mainly in the form of dead plant material or manure) or reduce the loss of carbon from soils (mainly through decomposition, leaching and erosion). However, the processes through which agricultural practices lead to accumulation and retention of carbon in soil are actually very complex. To give a few examples:

Some agricultural practices which add carbon to soil cause processes to take place which further increase sequestration. For example, adding organic fertiliser will add carbon to soils, but it can also improve soil nutrient availability and this fertilisation effect can increase production of crop biomass. If these crop residues are then returned to the soil, they will add further carbon to the soil and increase soil carbon sequestration.

Conversely, in some cases adding carbon and nitrogen to soils can decrease soil carbon by 'priming' microorganisms to become more active and consume more of the previously stored carbon.

Furthermore, implementing agricultural practices which sequester carbon within fields can also cause other GHG emissions. For example, cover crops may increase emissions of nitrous oxide and off-site emissions are also generated in the manufacture and transport of organic fertilizers.

The impacts of each practice on soil carbon are also mediated by a number of other factors, such as previous land use, soil type and climate, among many others.

Together, these complex interactions lead to surprising results. For example, some studies report that the addition of carbon inputs to the soil reduced soil carbon.[22]

There are also questions about the additionality of many practices which sequester carbon in soils. For example, adding manure to a specific field may generate a measurable increase in carbon stocks within that field. However, if we assume that there is a finite amount of manure in the world, adding it to one field simply means it has been taken away from another.

There are also weaknesses in the available data. One recent review[23] of available studies identified several issues. They noted that there is now agreement among scientists that soil carbon measurements need to be taken at a depth of 1 meter and adjusted to take account of the density of soils at different depths to generate accurate measurements of carbon content. However, they concluded that vast quantities of soil data have not been collected in accordance with these practices.

It is beyond the scope of this research to explore this complexity, but it is crucial to take this into account when planning mitigation interventions to increase soil carbon in a given area.

Mitigation Potential	
Low	As highlighted in the Deep Dive box above, the wide variety of measures under this category, the complex processes through which carbon is accumulated and retained in soils, and the limited availability of data make it difficult to provide precise quantitative estimates for potential carbon sequestration per hectare in soils. For example, coffee agroforestry systems have high potential to increase carbon inputs to the soil, through the addition of prunings and leaf litter. However, the effects of these practices on long term soil carbon sequestration are variable, with some studies reporting increases[24] in soil organic carbon and some reporting decreases.[25] Equally, cover crops can reduce soil erosion from a specific farm, but they may increase nitrous oxide emissions.[26] Likewise, the addition of manure to one coffee field may simply mean it is not applied to other fields, which does not generate a net increase in soil carbon. If a larger quantity of manure or

Mitigation Potential	
	compost is produced to enable coffee farmers to add more to their fields, this would also increase the off-site GHG emissions. Fairtrade certified coffee production is carried out on 197,000 Hectares of land in Colombia, which is a relatively large area. As such, any practices which are proven capacity to sequester carbon in soils could theoretically be carried out on a large scale. However, these practices are already carried out by Colombian coffee farmers to some extent. Further research at sub-national would be needed to determine exact numbers of farmers carrying out each practice, but this is likely to limit the potential scale of new adoption. If farmers stop carrying out[27] the required practices, the level of soil organic carbon will start to reduce, which creates a risk of 'reversal'. This risk is lower for the practices related to planting trees alongside coffee – such as adding tree prunings to the soil – because farmers have typically made a long-term decision to maintain these trees.

Broader Impacts	
Agronomic & Economic	• Soils with higher quantities of organic matter have several properties[28] which can contribute to increases in farm productivity and resilience to climatic shocks.[29] • Practices carried out to increase soil organic matter – such as mulching and adding organic fertilizer – can also have a variety of agronomic benefits[30] which may increase farm productivity and resilience to climatic shocks. • Increases in farm productivity have potential to increase farm profitability, but this depends on other factors, such as additional costs of production due to changing farming practices. • Additional labour[31] and input costs (eg. organic fertilizer) are incurred when implementing some farming practices under this strategy. Productivity gains need to be sufficient to outweigh these additional costs.
Environmental	• Soils with more organic matter exhibit lower rates of leaching and runoff of inorganic fertilizer and pesticides, which can reduce negative environmental impacts.[32]

Broader Impacts	
	• Soils with high organic matter levels contribute to biodiversity by providing habitat and nutrients for a diverse range of soil organisms.[33]
Social	• In households where women are expected to carry out most of the domestic work due to prevailing socio-cultural norms, women could be overburdened by additional farming tasks caused by practice changes.

Sequestering Carbon in Trees on Farmland

This strategy involves planting tree species on farmland together with coffee in agroforestry systems. These tree species can deliver diverse agronomic functions such as providing beneficial shade to coffee plants, increasing soil organic matter, fixing nitrogen, and reducing soil erosion. They can also generate marketable products, such as nuts, fruits, and timber.

Mitigation Potential	
High	Broadly speaking, planting trees on coffee farms has high mitigation potential per hectare due to the large quantities of carbon trees sequester in above and below ground biomass. Exact quantities depend on the species and density of trees planted, amongst other factors. To give an example of this variance in sequestration paper, a 2018 study reported[34] that additional carbon fixed per hectare by planting shade trees on coffee farms could range as much as 0 to 7.3 tCO2e per annum. It is important to note that the quantities of carbon sequestered by trees will also vary over time.[35] Again, given Fairtrade certified coffee production in Colombia is carried out on 197,000 ha, the potential scale of adoption is significant – and far higher than it is for e.g. bananas from Dominican Republic or Red Roses from Kenya. Recent estimates[36] report that 37.2% of land under coffee production in Colombia has some form of agroforestry system, which means that there are still large areas of land which could potentially adopt this practice. The extent

Mitigation Potential	
	to which adoption takes place will depend on incentives and the ability to do so profitably. While agroforestry is associated with improved agronomic and economic performance, it also involves significant capital investment and labour. The reversal risk for agroforestry is likely to be relatively low, given once trees alongside coffee have been established, their subsequent removal would be costly and energy intensive. By this point, farmers may also have a tangible financial motive to continue with the new trees – especially when the agroforestry system generates additional products and food that can be sold or consumed by the household.

Broader Impacts	
Agronomic & Economic	• Shade trees moderate the amount of light reaching coffee plants. This has potential to increase productivity to a certain extent, provided the shade trees are well-managed. Poor management can lead to negligible impact or even reduced productivity. • The canopy provided by trees grown alongside coffee can help protect coffee plants from heat stress, heavy winds, and intensive rainfall, can reduce soil erosion caused by weather events, and can decrease soil temperatures and evapotranspiration. • Leaf litter from tree species grown alongside coffee can act as a mulch and increase soil organic matter, with diverse benefits mentioned in the previous section. • If leaf litter from tree species is added to the soil and if nitrogen-fixing (e.g. leguminous) tree species are grown, this will also increase soil nutrient levels, with positive effects on productivity and profitability. • Growing trees in the agroforestry system that generate marketable products such as fruit and nuts can help diversify farmer incomes and increase the overall income generating potential of the plantation. • Diversified production can also help reduce vulnerability to pests and diseases and therefore lower associated risks of productivity loss and crop failure. • High levels of carbon sequestration per hectare increases the potential to generate carbon revenues, from credits and / or associated payments. • Again, productivity gains will need to be sufficient to offset any additional production and labour costs. While increased demand for

Broader Impacts	
	farm labour could lead to job creation and higher employment, resource poor farms may require additional tasks to be absorbed by household members.
Environmental	• By growing tree species which provide habitat and food for a variety of species, agroforestry can contribute to increased biodiversity in coffee growing landscapes. These species may provide further ecosystem services, such as pollination.
Social	• New farming practices to implement agroforestry models may increase demand for household labour. In households where women are expected to carry out the majority of domestic work due to prevailing socio-cultural norms, women may be expected to carry the burden of additional farming tasks caused by practice changes. • If women take the lead on growing tree crops which generate new income streams, this has potential to increase women's economic empowerment, if there is equitable decision-making power and division of resources within households. • Growing trees alongside coffee could have effects on land tenure.[37] These effects can be variable and may strengthen or weaken tenure.

Reducing Nitrogen Fertilizer Application

As mentioned in the methodology section, for the purpose of this research we created a specific definition for 'reducing fertilizer application.' Specifically:

- Fertilizer includes both organic[38] and inorganic[39] fertilizers.
- It is assumed that all fertilizer contains nitrogen.
- 'Reducing nitrogen fertilizer application' means reducing the quantity of nitrogen in the fertilizer applied to a given land area.

This could involve:

- Using a different type of fertilizer which contains less nitrogen.

- Reducing the quantity of fertilizer applied.
- Combinations of the above.

Switching to organic fertilizer could also be part of a broader shift to organic production, accompanied by other changes such as ceasing to use inorganic pesticide. The relationship between fertilizer application and greenhouse gas emissions is particularly complex, as the box below explains.

Deep Dive: the complex relationship between fertilizer application and GHG emissions

When applied to soils, fertilizers containing nitrogen generate greenhouse gas emissions[40] through a series of interactions between nitrogen, soil micro-organisms and environmental conditions. This is the case for both inorganic and organic fertilizers.

For both inorganic and organic fertilizer, reducing quantities applied will reduce emissions from a given area of land. However, this does not necessarily mean less emissions for the volume of crops produced and when assessing the impact of reducing fertilizer use on emissions, it is critical to also consider the impacts on production per hectare, or yields.

However, **the relationship between quantities of fertilizer added, yields and emissions is very complex. Each crop requires specific quantities of nitrogen for healthy growth and good yields**, and the soil must contain sufficient quantities of available nitrogen to meet these requirements. In some cases, soils may already contain sufficient quantities. But when they do not, then they can be increased through adding fertilizers or integrating nitrogen fixing plants.

In fields where the levels of available nitrogen are low and fertilizer application is the only practice being used to increase these levels, then **reducing the application of either organic or inorganic fertilizers can mean that the soil contains insufficient levels of nitrogen,** and this can reduce yields.

However, it is **not always the case that less fertilizer = lower yields**. Farmers may have been applying too much fertilizer,[41] or they may have been applying it incorrectly with negligible impact on yields.[42]

In summary, while **reducing fertilizer application will certainly reduce emissions per hectare,** the relationship between **emissions per hectare and emissions per unit of output is far more nuanced.** This should always be considered when planning mitigation interventions.

Mitigation Potential	
Low	This nuanced relationship between fertilizer applications and emissions per unit of output is highly relevant to coffee. A study[43] on the topic covering five

Mitigation Potential	
	Latin American countries found that when excessive[44] amounts of fertilizer were applied, reducing fertilizer application to the recommended amount yielded the same output while reducing both emissions per hectare and per Kg of coffee. The potential for reduced fertilizer application to reduce emissions per Kg of coffee is therefore heavily dependent on the current levels of fertilizer application. Average nitrogen fertilizer on coffee farms in Colombia has been estimated to be 81Kg of N per hectare per year.[45] This is significantly below the national[46] recommendation of 300Kg of N per hectare per year by Federación Nacional de Cafeteros.[47] If the average farmer reduced the amount they apply then – even though their total emissions would fall – yield could fall proportionately more, meaning emissions per unit actually went up. There will be farmers who are not the average and who are applying excessive amounts of fertilizer at present. No research was identified which specified the number of farmers in this category. However, this could be a significant number given that Fairtrade certified coffee production is carried out by 72,000 farmers over a large area of land (197,000 Ha). Another factor which may affect the scale on which this mitigation strategy is adopted is farmer perceptions. If farmers perceive that reducing fertilizer application will reduce yields, then they may choose not to do so. There is also a significant risk of reversal for this mitigation strategy. Specifically, if farmers reduce nitrogen application one year, it is easy for them to reverse this and apply more fertilizer the next.

Broader Impacts	
Agronomic & Economic	• In addition to the complex relationship between fertilizer applications, output and relative emissions, these factors all influence farm profitability. This makes it difficult to generalize about the agronomic and economic impacts of reducing fertilizer application. For example: • In some cases, reducing fertilizer application will reduce yields and the corresponding income farmers receive. • If farmers reduce fertilizer application, this will typically reduce costs. If the same yields are achieved this may increase farmer profits. One exception is when farmers switch to a much more expensive type of

Broader Impacts	
	fertilizer. In this case, applying less could actually cost more than the fertilizer previously applied. • If organic fertilizers are adopted in place of inorganic, this will increase soil organic matter which has various positive impacts on farm productivity, profits, and resilience. The longer the organic fertilizer is used, the greater these positive impacts will be.
Environmental	• Reducing fertilizer application can help reduce these negative impacts can reduce runoff and leaching of nitrogen into surrounding ecosystems. The addition of excess nitrogen into these ecosystems can cause certain plant species to thrive at the expense of others, affecting ecosystem balance and biodiversity. In aquatic ecosystems, it can also cause eutrophication. • Can reduce pollution of groundwater, which will reduce harmful impacts on people and animals drinking this water. • If organic fertilizers are adopted in place of inorganic this will increase soil organic matter. In water catchment areas, this can help reduce runoff from farms during periods of heavy rainfall, which reduces flood risks and soil erosion.
Social	• Can reduce the labour requirements associated with fertilizer use. • If organic fertilizers are adopted in place of inorganic, this can reduce worker health and safety risks associated with inorganic fertilizer use.

(iv) Mitigation Strategies Related to Post-harvest and Processing Activities

There are significant opportunities for mitigation of emissions from farm-level coffee processing activities in Colombia. The post-harvest processing of almost all Colombian coffee follows the wet[48] processing method. As noted in the carbon footprint section above, the methodology used for the carbon footprint estimations in this paper did not provide a breakdown of the GHG emissions caused by wet processing. However, other research for the region has estimated that this makes up a large proportion of on-farm emissions. For example, one study[49] across five Latin American countries estimated that emissions from fermentation and wastewater production contributed 66% of the on-farm carbon footprint for shaded monoculture coffee. The same study recommended that the emissions could be reduced by using fermentation methods that reduce the amount of wastewater produced and projects in Colombia have already promoted adoption of some of these methods.[50]

(v) Mitigation Strategies Beyond the Supply Chain

As mentioned in the methodology, further categories of mitigation strategies were identified which do not involve changes to the production, post-harvest or processing of the selected commodity, but could still be carried out by producers, SPOs and HLOs. In the case of Colombian coffee, afforestation and reforestation initiatives in coffee producing regions was identified as one such mitigation strategy.

3.2 Cocoa: Ghana and Côte d'Ivoire

(i) Producer Context

The cocoa sector is a vital component of the economies of Ghana and Côte d'Ivoire, providing employment and income to millions of smallholder farmers and their families. Côte d'Ivoire is the world's largest producer of cocoa and Ghana is the second largest. Together they produce and export over 60% of the world's cocoa.

In both countries, smallholder farmers account for the vast majority of production. In 2021, 271,963 Fairtrade certified farmers in Côte d'Ivoire produced over 512,000 (MT) of cocoa and 104,456 Fairtrade certified farmers in Ghana produced around 93,700 (MT). Climate change poses significant additional threat to cocoa farmers in both countries, who must already navigate the composite challenges of low and declining productivity, pests and diseases, ageing trees, and low soil fertility.

(ii) Carbon Footprint

The outputs of the CarbonCloud model show that:

- 1 kg of Ivorian cocoa beans exported to Europe results in 1.3 Kg CO2e emissions and that 68% of these emissions occur at the agricultural stage within Côte d'Ivoire.
- 1 kg of Ghanaian cocoa beans exported to Belgium results in 1.4 Kg CO2e emissions and that 73% of these emissions occurred at the agricultural stage within Ghana.

These figures are similar to results reported in academic literature for these countries. For example, one study[51] reported that 1kg of cocoa beans produced in Côte d'Ivoire generates 1.47 Kg CO2e of emissions and another study[52] reported that 1kg cocoa beans produced in Ghana generates 0.32 Kg of CO2e emissions.

The diagrams provide a breakdown for each stage in the supply chain and the full technical reports[53] contains further information on the methodology and outputs.

(iii) Producer-level Mitigation Strategies

The high proportion of emissions arising from the production stage in both countries mean that there is significant potential for mitigation activities at producer level.

Sequestering Carbon in Soils on Farmland

Various practices can increase soil carbon sequestration in cocoa farming. These include:

- Adding prunings to the soil. These could be from cocoa trees or other species, including tree crops grown alongside cocoa in agroforestry models.
- Converting crop residues and other biomass into organic fertilizer or biochar and adding to the soil.
- Mulching and growing cover crops.

Mitigation Potential	
Medium	As the Deep Dive box under section 3.1 explored, the processes involved in soil carbon sequestration are complex and determined by many factors. For cocoa production, there is also very limited data available and studies differ in the processes they use to measure soil organic carbon.[54] There is evidence that cocoa agroforestry systems with pruning and incorporation of organic residues into the soil generate increases in soil organic carbon stocks under certain conditions. For example, one long-term study[55] in Ghana of farms planted with cocoa and shade trees reported that soil organic carbon stocks increased by an average of 1.57 metric tonnes per hectare per year over 42 years at 0-60cm soil depth. However, the additional contribution of the shade trees to this process is less clear. One study in Ghana found no significant differences in soil organic carbon sequestration between cocoa fields intercropped with shade trees and without.[56] The same study also demonstrated that high planting densities of cocoa with shade trees actually resulted in loss of soil organic carbon at the average rate of 100Kg per hectare per year over 19 years at 0-45cm soil depth. While integrating crop residues into soils (directly or after composting) can increase soil organic carbon, no identified studies could quantify this. It is also important to note that when farmers leave cocoa pods to decompose on top of the soil, this produces methane emissions.[57] Furthermore, while applying organic fertilizers has potential, farmers face economic constraints in reality.[58] No studies were identified which could quantify the potential of cover crops or mulching to increase soil organic carbon in cocoa. Fairtrade certified cocoa production is carried out on a combined area of 1,301,979 ha in Ghana and Côte d'Ivoire (as of 2021), which is much larger than any of the other commodity origins included in this research. Any practices which have proven capacity to sequester carbon in soils could theoretically be carried out on a large scale. If farmers stop carrying out[59] the required practices, the level of soil organic carbon will start to reduce, which creates a risk of 'reversal'. This risk is lower for the practices related to planting trees alongside cocoa – such as adding

Mitigation Potential	
	tree prunings to the soil – because farmers have typically made a long-term decision to maintain these trees.

Broader Impacts	
Agronomic & Economic	• As with coffee production, soils with higher quantities of organic matter have several properties[60] which help increase productivity and resilience of cocoa farms and the practices carried out to increase soil organic matter (e.g. mulching) can have a variety of other agronomic benefits.[61] • Similarly, these improvements have the potential to increase farm profitability, but this depends on other factors, such as additional costs of production due to changing farming practices. • Additional labour[62] may be required to implement new farming practices and productivity gains need to be sufficient to offset additional cost.
Environmental	• Soils with more organic matter exhibit lower rates of leaching and runoff of inorganic fertilizer and pesticides, which can reduce negative environmental impacts, such as eutrophication of aquatic ecosystems. • Soils with high organic matter levels contribute to biodiversity by providing habitat and nutrients for a diverse range of soil organisms, including bacteria, fungi, nematodes, earthworms, and insects. • Increased soil fertility reduces the need to clear forests to access fertile land for production. This is significant in Ghana and Côte d'Ivoire, where clearing forest to plant cocoa on fertile land is a key cause of deforestation.[63]
Social	• Child labour is already prevalent within cocoa production in Ghana[64] and Côte d'Ivoire,[65] with children using sharp tools and being exposed to agrochemicals. If the introduction of new farming practices increases demand for household labour, there is an increased risk of child labour, which needs to be mitigated. • In households where women are expected to carry out most of the domestic work due to prevailing socio-cultural norms, women could carry the burden of new farming tasks caused by adopting new practices.

Sequestering Carbon in Trees on Farmland

This strategy involves planting tree species on farmland together with cocoa within an agroforestry system. These tree species can deliver diverse agronomic functions, such as providing beneficial shade to cocoa plants, increasing soil organic matter, fixing nitrogen, and reducing soil erosion. They can also generate marketable products, such as fruits and nuts. The figure below illustrates examples of cocoa agroforestry.

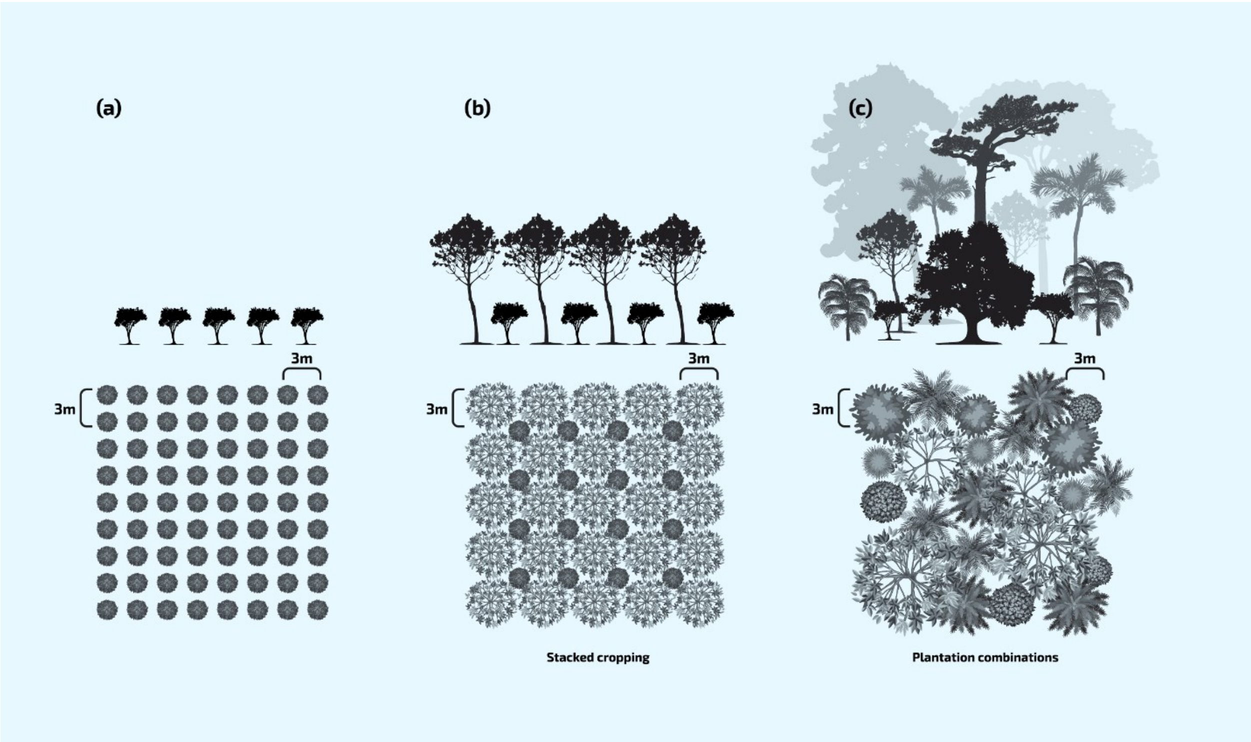

Figure 1: Illustration of full sun cocoa and cocoa agroforestry systems. a) Full Sun b) Tree intercropping c) Multi-strata agroforestry. Reproduced from Thomson and König (2020).

Mitigation Potential	
High	Broadly speaking, planting trees on cocoa farms has high mitigation potential per hectare due to the large quantities of carbon which trees can sequester in above and below ground biomass. For example, planting shade trees such as Terminalia superba or Milicia Excelsa at a density of 30 per hectare, would remove approximately 2 tCO2e per hectare per year.[66] A study in Cameroon estimated a total carbon stock (above and below ground biomass of cocoa and

Mitigation Potential	
	shade trees, soil and litter) of 60 tC/ha in full-sun plantations, 81 tC/ha in partial-shade systems and 201 tC/ha in high-shade agroforestry systems.[67] It is also important to note that the quantities of carbon sequestered by trees will also vary over time.[68] As Fairtrade certified cocoa production is carried out on a very large of land in Ghana and Côte d'Ivoire (over 1.3 million hectares), there is theoretical potential for adoption on a large scale. The diverse benefits to farmers listed in the broader impacts section below help increase the likelihood of farmers adopting this practice. Factors constraining agroforestry adoption in cocoa are the long timeframes taken for benefits to accrue, insecure land tenure, and lack of access to quality planting material for relevant species. Provided that the planting of trees on cocoa farms delivers tangible benefits, then reversal risk would be relatively low.

Broader Impacts	
Agronomic & Economic	• Shade trees moderate the amount of light reaching cocoa plants. This has potential to increase crop health and productivity, provided the shade trees are well-managed. • The canopy provided by shade trees grown alongside cocoa can help protect cocoa plants from heat stress, heavy winds and intensive rainfall, reduce soil erosion caused by weather events, and decrease soil temperatures and evapotranspiration. • Leaf litter from tree species grown alongside cocoa can act as a mulch and increase soil organic matter, with diverse benefits mentioned in the previous section. • If leaf litter from tree species is added to the soil and if nitrogen-fixing (eg. leguminous) tree species are grown, this will also increase levels of nutrient in the soil, which can increase productivity and profitability of cocoa farms. • If farmers grow trees which generate marketable products (e.g. fruit, nuts) in their agroforestry models, this can help increase and diversify their income, improving their resilience to cocoa production issues and price volatility. • The high levels of carbon sequestration per hectare for this strategy mean that there is significant potential to generate carbon credits and associated payments.

Broader Impacts	
	• Again, additional labour may be required to implement new farming practices and productivity gains need to be sufficient to outweigh any additional costs.
Environmental	• By growing tree species which provide habitat and food for a variety of species, agroforestry can contribute to increased biodiversity in cocoa production landscapes. These species may provide further ecosystem services, such as pollination.
Social	• If the new practices needed to implement agroforestry models increase demands on household labour, this could increase the risks of child labour. • In households where women are expected to carry out the majority of domestic work, women could be overburdened by additional farming tasks caused by practice changes. • Growing trees alongside cocoa could have either positive or negative impacts on land tenure.[69]

Reducing Deforestation Caused by Conversion of Forest to Cropland

Deforestation and forest degradation continue to occur in cocoa producing areas of Ghana and Côte d'Ivoire, and conversion of forest to cropland for cocoa production is a key cause.[70] Mitigation strategies implemented by Fairtrade include:

- The Fairtrade Cocoa Standard does not allow the certification of farms on which deforestation or forest degradation occurred after 31 December 2018. It also includes requirements to ensure producers have their own geolocation data and that they assess and monitor the risk of deforestation.
- Fairtrade finances programmes to support producers in collecting geolocation data and works with leading remote sensing companies to give access to producers to satellite deforestation monitoring alerts.
- By the end of 2025, Fairtrade plans to have geolocation and land use cut-off data available for all cocoa SPOs, not just those participating in programmes. This will also be available for coffee – even though coffee is considered a lower deforestation risk than cocoa.

- Fairtrade delivers programmes which support farmers to implement practices that increase yields from the same area of land, based on the logic that this reduces the need for farmers to expand production into forested areas which may be more fertile.

Given the complex nature of both the causes of deforestation and the solutions, the impact of these interventions is most effective when combined with broader initiatives at national and international levels. These include protected areas, legal frameworks for timber and effective enforcement, recognition of IPLCs and REDD+ programmes.[71] Of particular note, the EU Deforestation Regulation includes cocoa on its list of commodities which must be 'Deforestation Free' in order to be sold on the EU market or exported from it.

Mitigation Potential	
Medium	Given the very high carbon stocks per hectare in forests and the large areas of forest land around cocoa production areas in Ghana and Cote d'Ivoire, then interventions which prevent deforestation have high mitigation potential if they are effective. However, the drivers of deforestation in Ghana and Cote d'Ivoire are diverse - including commercial logging, fuelwood collection and mining.[72] As such, it is unclear to what extent deforestation would be reduced by stopping conversion to cropland. To be effective, initiatives to prevent deforestation must also be holistic and continuous

Broader Impacts	
Agronomic & Economic	• Maintaining forests in water catchment areas can reduce flooding during periods of heavy rainfall and its negative impacts on production for cocoa farms. • Maintaining forests can also help sustain other ecosystem services which support agriculture, such as pollination or increasing populations of natural enemies[73] of key crop pests. • Maintaining forests is critical for communities who depend on them for their livelihoods.
Environmental	• Reducing deforestation can play a major role in maintaining biodiversity. • Maintaining forests in water catchment areas can reduce flooding during periods of heavy rainfall and their negative environmental impacts.

Broader Impacts	
Social	• In addition to sustaining livelihoods, maintaining forests is crucial to Indigenous groups – such as the Ashanti[74] - for social, cultural, and religious reasons.

(iv) Mitigation Strategies Related to Post-harvest and Processing Activities

There are clear opportunities for mitigation of emissions from farm-level cocoa post-harvest activities in Ghana and Côte d'Ivoire. One practice which is currently a significant cause of GHG emissions is the disposal of cocoa pods. When farmers leave cocoa pods to decompose on top of the soil, this produces large volumes of methane emissions.[75] Various strategies have been proposed for reducing these emissions. These include improved composting methods[76] and using the cocoa pods to produce household fuels[77] or biochar.[78]

(v) Mitigation Strategies Beyond the Supply Chain

As mentioned in the methodology, further categories of mitigation strategies were identified which do not involve changes to the production, postharvest and processing activities for the selected commodity, but could still be carried out by producers or small producer organisations. In the case of cocoa from Ghana and Côte d'Ivoire, two such mitigation strategies were identified as being relevant:

- **Afforestation and reforestation in cocoa producing regions.**
- **Reduce fuelwood use by producers** through fuel-efficient cookstoves and biogas.

3.3 Bananas: Dominican Republic

(i) Producer Context

In the Dominican Republic, Fairtrade certified bananas are produced on both smallholder farms and large plantations. In 2021, the number of Fairtrade certified smallholder farmers was 1,769 and number of workers from Fairtrade certified HLOs was 4,847.

Around 242,000 MT of bananas were produced on 13,070 hectares of Fairtrade certified land. Of this, 85% was sold on Fairtrade terms, generating Fairtrade premiums of around EUR 9.56m for farmers and workers. Over 50% of banana exports from Dominican Republic are organic (FAO, 2017) and a significant proportion of Fairtrade certified bananas have dual Organic-Fairtrade certification.

(ii) Carbon Footprint

The outputs of the CarbonCloud model show that 1 kg of bananas from the Dominican Republic arriving in the UK generates 0.52 Kg CO2e and that the agriculture stage of the supply chain causes 30% of these emissions. The transport stage makes up over half (52%) of the emissions, while the remainder is caused by packaging (5%) and storage (13%) steps.

These figures are closely aligned with findings reported in academic literature within the region. For example, one study[79] reported that 1kg of fresh bananas produced under organic agriculture in Ecuador generates 1.13 Kg of CO2e by the time it reached the distribution centre in Spain; another study[80] reported that 1 Kg of fresh bananas produced in Ecuador generates between 0.45 to 1.04 kg CO2-equivalent/kg banana by the time it reached the European port (Hamburg); and another study[81] estimated that 1Kg of fresh bananas produced in Costa Rica generated 1.37 kg CO2e by the time they are sold by retailers in Norway.

The diagram below provides a breakdown for each stage in the supply chain and the full technical report[82] contains further information on the methodology and outputs.

(iii) Producer-level Mitigation Strategies

Given that emissions arising from the production stage are significant, there is potential for impactful mitigation activities at producer level.

Sequestering Carbon in Soils on Farmland

Various practices can increase soil carbon sequestration in banana farming. These include:

- Adding prunings to the soil. These could be from banana plants or other species, including tree crops grown alongside bananas in agroforestry models.
- Converting crop residues and other biomass into organic fertilizer or biochar and adding to the soil.
- Mulching and growing cover crops.

Mitigation Potential	
Low	As the Deep Dive box under section 3.1 explored, soil carbon sequestration is complex and determined by multiple factors. There is also limited data available measuring changes in soil organic carbon resulting from implementing different practices on banana farms. Individual studies demonstrate increases in soil organic carbon as a result of straw mulching[83] and applying organic fertilizer[84]. But further research in comparable agro-climatic conditions is needed to draw conclusions about exact potential of different practices to sequester carbon. Fairtrade certified banana production is carried out on a combined area of 13,070 Ha in Dominican Republic. This is significantly below that of the cocoa and coffee commodity origins, for example, and this reduces the aggregate mitigation potential of targeted projects and programmes. There is also the possibility that these practices are already widely adopted. The high proportion (approximately 50%) of certified organic banana exports from Dominican Republic, and given many of these practices are common to organic production, it will be important to assess additionality when it comes to soil carbon sequestration. Finally, there is also significant risk of reversal with soil carbon sequestration strategies given the level of soil organic carbon will naturally fluctuate if and when farms stop carrying out these practices.

Broader Impacts	
Agronomic & Economic	• As with coffee production, soils with higher quantities of organic matter have several properties[85] that promote productivity and resilience of banana farms, and practices carried out to increase soil organic matter – such as mulching – can have a variety of other agronomic benefits too.[86]

Broader Impacts	
	• As with all strategies, any additional costs – such as labour - associated with a new practice must be offset by sufficient productivity gains to be viable to implement. • In HLO contexts, any increase in labour demands has potential to: add to the workload of existing workers, to lead to the creation of additional jobs, or to represent a cost barrier prohibitive to sufficient implementation.
Environmental	• Soils with more organic matter exhibit lower rates of leaching and runoff of inorganic fertilizer and pesticides. This can limit or even prevent negative environmental impacts like the eutrophication of aquatic ecosystems. • Soils with high organic matter levels contribute to biodiversity by providing habitat and nutrients for a diverse range of soil organisms, including bacteria, fungi, nematodes, earthworms, and insects. • Increased levels of soil organic matter and cover crops in water catchment areas can help reduce runoff from farms during periods of heavy rainfall, reducing flood risks and soil erosion.
Social	• None identified

Sequestering Carbon in Trees on Farmland

This strategy involves planting tree species on farmland together with banana, in an agroforestry system. These tree species can deliver diverse agronomic functions, such as providing wind-breaks and beneficial shade to banana plants, increasing soil organic matter, fixing nitrogen and reducing soil erosion. They can also generate marketable products, such as coffee, cocoa, and vanilla.

Mitigation Potential	
Low	Broadly speaking, planting trees on banana farms has high mitigation potential per hectare given the large quantities of carbon that trees sequester

Mitigation Potential	
	in above and below ground biomass. Research has demonstrated this potential. For example, a Ugandan study[87] reported that aboveground biomass was 16% higher under banana-coffee farming systems than banana monoculture farming systems, and total carbon stocks[88] were 26% higher. This carbon sequestration potential depends on the tree species planted, and on management decisions such as planting density and maintenance. Given Fairtrade certified banana production is carried out on 13,070 Ha of land in Dominican Republic, which is lower than the cocoa and coffee commodity origins, the potential for adoption at scale is relatively lower but not prohibitive. Finally, any reversal risks are likely to be low, provided any additional trees planted on banana farms deliver tangible benefits to farmers.

Broader Impacts	
Agronomic & Economic	• If implemented effectively, planting different trees species with banana in agroforestry models can help protect banana trees from heavy winds and intensive rainfall, reduce soil erosion caused by weather events, and decrease soil temperatures and evapotranspiration. • Leaf litter from tree species grown alongside banana can act as a mulch and increase soil organic matter. • If leaf litter from tree species is added to the soil and if nitrogen-fixing (e.g. leguminous) tree species are grown, this will increase levels of nutrients in the soil and in turn increase productivity and (most likely) profitability of banana farms. • If farmers grow trees which generate marketable products (e.g. cocoa) in their agroforestry models, this can increase and help diversify incomes. • Banana production faces severe losses caused by pests and diseases.[89] Diversified incomes help reduce any economic vulnerability felt by banana farmers. • High levels of carbon sequestration deliver relatively high potential to generate carbon revenues and associated payments.

Broader Impacts	
	• Additional labour may be required to implement new farming practices. Productivity gains need to be sufficient to outweigh these additional labour costs.
Environmental	• By growing tree species which provide habitat and food for a variety of species, agroforestry can contribute to increased biodiversity in banana production landscapes. These species may provide further ecosystem services, such as pollination. • Increased number of trees in water catchment areas can help reduce runoff from farms during periods of heavy rainfall, reducing flood risks and soil erosion.
Social	• Growing trees on farmland could have diverse effects on the likelihood of land grabs. It could be the case that more trees will make land grabs more likely, especially if the trees on the land have value as timber. • It could equally be the case that land grabs are less likely, given additional trees further demarcate the land area and make it a more complex and conspicuous process to seize the land - particularly when land is cleared for non-agricultural purposes.

Reducing Deforestation Caused by Conversion of Forest to Cropland

Relevant mitigation strategies include:

- Implementation of the Fairtrade Standard for Small Producer Organisations, which includes provisions that aim to prevent deforestation.
- Globally, Fairtrade implements dedicated programmes to reduce conversion of forest to cropland.

As mentioned under the cocoa section, given the complex nature of both the causes of deforestation and the solutions, the impact of these interventions is most effective when combined with broader initiatives at national and international levels.

Mitigation Potential	
Low	In one of the major banana producing provinces – Barahona – there are significant areas of primary forest remaining.[90] Deforestation continues to occur in the Dominican Republic and a major cause is the conversion of forest to cropland.[91] However, no specific data was identified on the conversion of forest to cropland under banana production, which makes it difficult to assess the potential of strategies to prevent such conversion. The factors contributing to deforestation in Dominican Republic are also complex and include regulation favouring agricultural uses over forest management, various demographic and economic pressures.[92] This makes it unclear to what extent deforestation would be reduced by stopping conversion to cropland for banana production alone.

Broader Impacts	
Agronomic & Economic	• Maintaining forests in water catchment areas can reduce flooding during periods of heavy rainfall and its negative impacts on banana production. It should be noted that deforestation around the Yaque del Norte river has increased the scale of floods, and reduced the available water in the river during droughts.[93] • Maintaining forests can also help reduce the intensity of wind as it reaches nearby farms, reducing wind damage to crops. This is particularly relevant for banana production in the Dominican Republic, which is vulnerable to strong winds and hurricanes.
Environmental	• Reducing deforestation can play a major role in maintaining biodiversity. • Maintaining forests in water catchment areas can reduce flooding during periods of heavy rainfall and their negative impacts on the surrounding ecosystems.
Social	• Maintaining forests is crucial to Indigenous groups such as the Kalinago, for social, cultural, and religious reasons.

Reducing Nitrogen Fertilizer Application

Reducing the quantity of inorganic fertilizers applied in banana production can lead to emissions reductions.

Mitigation Potential	
Low	As the Deep Dive box in section 3.1 highlighted, the potential for reduced fertilizer application to reduce emissions per Kg of bananas depends on the current levels of fertilizer application. Average nitrogen fertilizer on smallholder banana farms in Dominican Republic has been estimated to be 25.7Kg of N per hectare per year, with 18.7Kg N from organic and 7Kg N from inorganic fertiliser.[94] Given that recommended application of N ranges from 150-600Kg per hectare,[95] current volumes applied are well below these recommended amounts. So, if the average farmer were to reduce N applications they would reduce their emissions per hectare, but not necessarily emissions per unit of output given the effect would probably also negatively affect yields. The low average volumes currently applied suggest limited scope for reducing application. There will be farmers who are not the average and who are applying excessive amounts of fertilizer at present. No research was identified which specified the number of farmers in this category. But given that Fairtrade certified banana production is carried out on a relatively small area of land (12,938 Ha), any potential scale of adoption in the Dominican Republic is constrained. Another factor which may affect scale of adoption is farmer perceptions. If farmers perceive that reducing fertilizer application will reduce yields, they are less to make this change. There is also significant risk of reversal for this mitigation strategy, because it is easy for farms to go back to applying large quantities of fertilizer and there could be many reasons they might decide to do this.

Broader Impacts	
Agronomic & Economic	• As we explored in the Deep Dive box in the Colombian Coffee section, the relationship between quantities of fertilizer applied, yields and farm profitability is complex. Together this makes it difficult to generalize about the agronomic and economic impacts of reducing fertilizer application. • If organic fertilizers are adopted in place of inorganic, this will increase soil organic matter which has various positive impacts on farm productivity, profits and resilience. It should be noted that approximately 50% of FT banana exports from Dominican Republic are already dual-certified as organic, which limits further adoption.
Environmental	• Can reduce runoff and leaching of nitrogen into surrounding ecosystems. The addition of excess nitrogen into these ecosystems through runoff and leaching can cause certain plant species to thrive at the expense of others, affecting ecosystem balance and biodiversity. In aquatic ecosystems, it can also cause eutrophication. As such, reducing fertilizer application can reduce these negative impacts. • Can reduce pollution of groundwater, which will reduce harmful impacts on humans drinking this water. • If organic fertilizers are adopted in place of inorganic, this will increase soil organic matter. In water catchment areas, this can help reduce runoff from farms during periods of heavy rainfall, which reduces flood risks and soil erosion.
Social	• Can reduce the labour requirements associated with fertilizer use. Theoretically this could reduce the number of workers required on large farms. • If organic fertilizers are adopted in place of inorganic, this can reduce worker health and safety risks associated with inorganic fertilizer use.

(iv) Mitigation Strategies Beyond the Supply Chain

For bananas from the Dominican Republic, one further strategy was identified which sits outside of the supply chain, but could still be carried out by producers, small producer organisations or hired labour organisations:

- **Afforestation and reforestation in banana producing regions.** As with coffee and cocoa, Fairtrade is well positioned to support producers and small producer organisations to implement this strategy, so it is recommended that it is included in future scoping of programmes which aim to achieve mitigation outcomes.

3.4 Red Roses: Kenya

(i) Producer Context

The Kenyan red rose sector is a significant component of the country's horticultural industry, with most production occurring in the highlands surrounding Lake Naivasha. Fairtrade certified red roses from Kenya are exclusively produced by Hired-Labour Organisations, which are typically large farms. In the sector more broadly, production of roses in Kenya is mostly carried out on large-scale commercial farms, with smallholder farmers accounting for a small portion of production. The roses are grown in greenhouses, with a significant proportion[96] using hydroponic systems. These systems permit a high level of control over the growing environment and allow for precise application of pesticides and fertilizers.

The supply chain primarily serves European markets, with strong vertical integration and high usage of certification schemes – such as Fairtrade and GlobalGAP – to assure buyers of quality and sustainability. In 2021, approximately 2.6bn stems were grown on Fairtrade certified farms covering 1,909 Ha of land. Around 20% of this production was sold on Fairtrade terms, generating over EUR5.5m in Fairtrade Premium for the 38,743 workers on Fairtrade-certified farms in the country.

(ii) Carbon Footprint

The outputs of the CarbonCloud model show that 1 kg of Kenyan Red Roses imported to London results in 11 Kg of CO_2e emissions and that the production stage of the supply chain causes 9% (0.99Kg CO_2e) of these emissions. The carbon footprint supply chain diagram is provided in Annexe 7.7. and the full technical report[97] contains further information on the methodology and outputs.

As mentioned in the methodology section, the activity data used for the calculation of the carbon footprint for Kenyan Red Roses was gathered from one company. Although this farm was selected to represent a typical farm in broad terms, it does not mean that the data provided by this farm represents the statistical average for all Fairtrade farms in Kenya. However, the estimations produced by the Carbon Cloud model are broadly in agreement with those generated by Intep (2023), which were based on average data from a survey of a larger sample of five Fairtrade certified farms in Kenya. Specifically, Intep (2023) reported that the agricultural stage in Kenya produces 0.4Kg CO_2e per Kg of red roses,[98] which is broadly similar to the 0.99Kg CO_2e estimated in this research.

It is also worth noting that the carbon footprint of the agricultural production of red roses in Kenya is much lower than red roses produced in Europe. For example, Intep (2023) reported emissions from the agricultural stage of red rose production in the Netherlands to be 23.2 Kg CO_2e Kg of red roses, which is significantly higher than the 0.99Kg CO_2e in Kenya. The main cause of the additional emissions in European production systems is natural gas consumption for heating greenhouses and electricity consumption for artificial lighting.

(iii) Producer-level Mitigation Strategies

Compared to the other commodities in this report, there are fewer opportunities for mitigation within the production stage of the Kenyan red rose supply chain. Partly this is due to the fact that the emissions from rose production are relatively low, as the section above highlighted. Another reason is that several of the mitigation strategies which have high potential for other commodities are not relevant for rose production, as outlined in section 2.3. In particular, agroforestry is not considered a viable option within the current production model, which takes place within greenhouses. In addition, expansion of red rose production in Kenya is not a key driver of deforestation, which limits the relevance of interventions which aim to reduce deforestation.

For red roses from Kenya, the majority of greenhouse gas emissions from the supply chain occur at the transport stage. Although it is beyond the scope of this report to analyse mitigation strategies for the transport stage, it is worth noting that various options have identified[99] for achieving this goal. It is also worth noting that there are several relevant mitigation strategies available which are not related to production, but could be adopted either on the farm premises or by communities living close to farms. These strategies are highlighted in the final section below.

Switching to Renewable Energy Sources and/or Increasing Energy Efficiency

If farms switched to renewable energy sources for their operations, this could significantly reduce their usage of energy coming from non-renewable sources and the associated emissions.

Mitigation Potential	
Low	In Kenya, an average of 0.021 kWh of electricity is used to produce each harvested rose.[100] There is potential for reducing the associated emissions through the use of renewable energy. In total, Fairtrade certified red rose farms in Kenya cover 1909Ha of land. This is a smaller scale of production than the other commodity origins in this report. A proportion of farms have already adopted solar and other renewable energy production on-site, which limits the additional potential for adoption. Renewable energy may not be able to meet energy requirements at all times when it is needed, which could also affect the level of adoption.

Broader Impacts	
Agronomic & Economic	• Over the long term, there could be potential for cost-savings from a switch to renewable energy, which could increase the profits of companies producing red roses. Strong financial performance has the

Broader Impacts	
	potential to enable Hired Labour Organisations to expand and employ more workers on fair terms.
Environmental	• Depending on the technologies adopted there could be negative environmental impacts of the equipment generating renewable energy. For example, emissions from solar panel manufacturing, distribution and disposal, or potential biodiversity impacts depending on the location and nature of the installation.
Social	• If a large number of farms switch to renewable energy, this could increase the presence of distributors and service staff for key equipment. This has the potential to make adoption of renewable energy technologies easier and cheaper for communities in surrounding areas.

(iv) Mitigation Strategies Beyond the Supply Chain

For Red Roses, two further strategies were identified which sit outside of the supply chain, but could be relevant for Fairtrade programmes to support, because they can be carried out by workers and hired labour organisations:

- **Reduce fuelwood use by workers for household consumption:** through fuel-efficient cookstoves and biogas.
- **Sequestering carbon in trees planted on land owned by farms:** this would involve planting and maintaining trees in areas outside of the greenhouses where red rose production takes place.

4. Conclusions

As mentioned in the introduction, this report aimed to estimate the carbon footprints of selected Fairtrade supply chains, identify mitigation strategies which producers could implement to reduce these footprints, and to assess the mitigation potential of these strategies, as well as their broader economic, environmental and social impacts. The results of this analysis are provided in the sections for each selected commodity origin and summarized at the start of section 3. The report then aimed to use this analysis to draw conclusions about how Fairtrade should develop climate programmes incorporating mitigation objectives. These conclusions are outlined below.

Significant opportunities exist for emissions reductions and removals within Fairtrade certified supply chains

The sections above highlighted that agriculture generates a significant proportion of the carbon footprint of the selected Fairtrade-certified commodities, which ranges from 9% for Kenyan red roses to 96% for Colombian coffee. This report also outlined a range of mitigation strategies which could be implemented at producer-level within Fairtrade certified supply chains to reduce emissions or increase carbon removals. These include:

- Sequestering carbon in soils
- Sequestering carbon in trees on farmland
- Reducing deforestation caused by conversion of forest to cropland
- Reducing nitrogen fertilizer application
- Reducing pesticide application
- Switching to renewable energy sources and / or increasing energy efficiency for farm level production and post-harvest processes

The exact mitigation potential for each of the producer-level strategies listed above will vary between and within commodities and origins, due to many factors.[101] But if implemented effectively and at scale, these strategies could generate significant emissions reductions and carbon removals.

Given strong existing relationships and capacity to support farmers, Fairtrade has significant potential to facilitate adoption of mitigation strategies. In addition to their contribution to national and global efforts to mitigate climate change, these emissions reductions and removals could:

- **Support corporate insetting initiatives, by reducing scope 3 emissions** for businesses which purchase these commodities, in fresh or processed forms
- **Generate carbon credits**, which can be sold on voluntary carbon markets and create new revenue streams for farmers. At current prices, these revenues are relatively small, but could increase significantly if demand grows quicker than supply

- **Achieve broader benefits to farmers, workers and the environment**, if planned and implemented effectively

Mitigation strategies can also contribute to adaptation, and have broader economic, environmental, and social impacts

The analysis above highlighted various **broader positive impacts** which can be achieved by implementing mitigation strategies, in certain circumstances. These include **agronomic and economic impacts**, which can increase productivity and farmer incomes, or facilitate adaptation to climate change. For example, planting shade and fruit trees alongside coffee bushes can increase coffee yields, increase and diversify incomes, if managed effectively. They also include broader **environmental impacts** – particularly on deforestation and biodiversity – as well as **social impacts**, such as improvements in worker safety and health. However, the analysis also highlighted **potential negative impacts** - economic, environmental and social - which could be caused by implementing each mitigation strategy. For example, if new farming practices increase labour demands on resource-poor smallholders, this can increase the risk of child labour.

Both the positive and negative **impacts can manifest at different levels**, from the individual farm, to community, to the landscape in which producers are located. **The impacts of each mitigation strategy are also mediated by other factors**, such as the capacity of farmers to successfully implement new farming practices, climatic factors, changes in markets, among many others. This broader analysis underlines the importance of assessing all potential impacts at all levels, before promoting specific mitigation strategies.

There are also numerous **interactions between mitigation strategies**, and the broader impacts they generate. Although it was beyond the scope of this report to explore them, it is crucial to take into account these interactions when selecting combinations of mitigation strategies to implement together. In particular, **mitigation strategies should be packaged together with complimentary strategies**. For example, coffee farmers could combine a shift to organic fertilizer together with planting tree crops which fix nitrogen and increase levels of various crop nutrients decomposition of tree leaf litter, among various other agronomic benefits.

Fairtrade's mitigation programmes should not just be carbon-focused. They must deliver multiple impacts for producers

Mitigating climate change is an urgent priority and agriculture has a key role to play in both reducing greenhouse gas emissions and increasing carbon removals. However, implementing mitigation strategies involves time, effort, and often financial investment for farmers, all of which they are unlikely to commit unless they see clear benefits in doing so. This is particularly the case for farmers living in poverty.

In some cases, the broader impacts of implementing mitigation strategies- such as increases in farm productivity, increased or diversified incomes - may deliver sufficient benefits to incentivize farmers to implement practice changes. Payments from voluntary carbon markets also have the potential to incentivize farmers, but at current prices the revenues from carbon credits are insufficient to provide major incentives for smallholder farmers to implement mitigation strategies.[102]

Beyond just ensuring that farmers are incentivized to make changes, Fairtrade programmes should aim to maximise the combination of positive outcomes which implementing mitigation strategies achieves for producers and their communities. This includes supporting adaptation to climate change, as well as achieving broader economic, environmental and social objectives. As the sections above outlined, there are often decisions to be made about trade-offs between these impacts.

Farmers must drive decision-making about which mitigation strategies to implement

Following on from the above point, it is crucial to engage farmers in selection of mitigation strategies that they will implement. At the very least, they must see sufficient benefits to be willing to commit to make the practice changes required. But they can also play a key role in selecting which mitigation strategies deliver the best combination of impacts, including difficult decisions about trade-offs. In many cases, producer organizations can provide effective representation for large numbers of farmers, which can help make this engagement process more efficient.

Smallholder farmers need support to implement mitigation strategies successfully

The analysis underscored the importance of effective implementation to the success of mitigation strategies. For example, growing shade trees on cocoa farms has the potential to increase cocoa yields, while also sequestering carbon. However, poor management can lead to excessive shading and reduce cocoa yields. Effective implementation of this strategy requires technical knowledge and practical skills, which farmers must develop. This is the case for many mitigation strategies and demonstrates the need for support to be provided to ensure farmers are able to benefit from effective implementation of the practice change.

Implementing mitigation strategies may also require additional financial investment by farmers and access to new inputs. If emissions reductions and removals will be verified in order to generate carbon credits, there can be further requirements for farmers, such as providing data about the changes they have made to farming practices.

In many Fairtrade-certified supply chains, farmers will need both technical and financial support in order to learn new skills and implement mitigation strategies effectively. Given strong relationships with producer organisations and technical capacity in promoting sustainable agriculture, Fairtrade is well positioned to provide this support directly or facilitate other actors to deliver it.

Models for engaging farmers in verified carbon projects need to be effective, equitable, and linked to a sound business case

When designing verified carbon projects, there are potential risks, rewards and investments for all parties. When smallholder farmers are engaged, there are often additional informational and power asymmetries, which leave these farmers more vulnerable to exploitation.[103]

With this in mind, it is critical that partnership models develop fair and effective divisions of roles, risks, rewards and investments. These also need to create sufficient incentives for all actors to maintain their efforts throughout the course of the project. Fairtrade is currently developing and piloting models which aim to deliver equitable, transparent and effective partnerships.

5. Notes

1. CO_2e is a standardized unit which expresses the total warming effect of a mixture of different greenhouse gases, taking into account their varying global warming potentials (GWP) over a specified time period.
2. The Science-Based Targets Initiative (SBTi) is a collaborative effort aimed at mobilizing companies to set science-based targets (SBTs) to reduce greenhouse gas (GHG) emissions. For further information see: www.sciencebasedtargets.org.
3. Commodity origin refers to the geographical location or source from which a commodity, such as a raw material or product.
4. For the purpose of this analysis, 'Producer-level' includes agricultural production, post-harvest and processing activities carried out by producers, as well as household activities, such as cooking and lighting. As outlined in the methodology section, these were selected because Fairtrade has the biggest potential to achieve influence at this level of the supply chain.
5. BFN-HAFL & VUA. 2021. Fairtrade and Climate Change: Systematic Review, Hotspot Analysis and Survey. Amsterdam and Zollikofen: European Union.
6. Cocoa from Ghana and Cote d'Ivoire were combined, given the significant similarities in production, processing and distribution from these origins. However, the carbon footprints were calculated separately.
7. Kenya flowers was revised to Kenya red roses, to provide a greater focus to the analysis and given that red roses form the most significant sub-sector for Fairtrade.
8. IPCC. 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Edited by E. Calvo Buendia, K. Tanabe, A. Kranjc, J. Baasansuren, M. Fukuda, S. Ngarize, A. Osako, Y. Pyrozhenko, P. Shermanau, and S. Federici. Switzerland: IPCC, 2019.
9. Colombia Roasted Coffee Beans: https://apps.carboncloud.com/climatehub/product-reports/id/215738003559.
   Ghana Cocoa: https://apps.carboncloud.com/climatehub/product-reports/id/329346589100.
   Cote d'Ivoire Cocoa: https://apps.carboncloud.com/climatehub/product-reports/id/205473901122.
   Dominican Republic Ripe Bananas: https://apps.carboncloud.com/climatehub/product-reports/id/385335509247.
   Kenya Bouquet of Red Roses: https://apps.carboncloud.com/climatehub/product-reports/id/215706028162/.
10. Shukla et al. (2022), Roe et al. (2021) and Schulte et al. (2020) were the primary sources for this step. See bibliography for full citations.
11. Forest land: includes all land with woody vegetation consistent with thresholds (eg. % canopy cover) used to define Forest Land in national statistics. Cropland: includes all land used for the production of crops for harvest.
12. Nitrogen fertilizer was selected for this analysis because the emissions from nitrogen application are far greater than for other crop nutrients. This is largely due to a complex

series of interactions between nitrogen, soil micro-organisms and environmental conditions which lead to significant greenhouse emissions, particularly N_2O.

13. Afforestation: conversion of non-forested land to forested land through planting, seeding and / or the human-induced promotion of natural seed sources, on land that was not previously forested. Reforestation: conversion of non-forested land to forested land through planting, seeding and / or the human-induced promotion of natural seed sources, on land that was previously forested but that has been converted to non-forested land.
14. Gomez, A. 2018. "Coffee Annual: Colombian Coffee Production Decreases after Five Years of." Global Agricultural Information Network Report.
15. Wet post-harvest processing includes receiving cherries, mechanical pulp removal, fermentation to remove degraded mucilage, washing, drying, and storing coffee beans.
16. Henk Rikxoort, Götz Schroth, Peter Läderach, Beatriz Rodríguez-Sánchez. Carbon footprints and carbon stocks reveal climate-friendly coffee production. Agronomy for Sustainable Development, 2014, 34 (4), pp.887-897.
17. Henk Rikxoort, Götz Schroth, Peter Läderach, Beatriz Rodríguez-Sánchez. Carbon footprints and carbon stocks reveal climate-friendly coffee production. Agronomy for Sustainable Development, 2014, 34 (4), pp.887-897.
18. Productions systems studied were: traditional polyculture, commercial polyculture, shaded monoculture and unshaded monoculture.
19. 'Parchment coffee' refers to coffee beans at the point where only the outer layer, a protective layer of the cherry, has been removed but the parchment remains. This point is before hulling has taken place.
20. Maina, Joan J., Urbanus N. Mutwiwa, Gareth M. Kituu, and M. Githiru. "Evaluation of greenhouse gas emissions along the small-holder coffee supply chain in Kenya." (2016).
21. Colombia Roasted Coffee Beans: https://apps.carboncloud.com/climatehub/product-reports/id/215738003559.
22. Noponen, M. R., Healey, J. R., Soto, G., & Haggar, J. P. (2013). Sink or source - The potential of coffee agroforestry systems to sequester atmospheric CO2 into soil organic carbon. Agriculture, ecosystems & environment, 175, 60-68.
23. Searchinger, Tim, Richard Waite, Craig Hanson, Janet Ranganathan, Patrice Dumas, Emily Matthews, and Carni Klirs (2019).. "Creating a sustainable food future: A menu of solutions to feed nearly 10 billion people by 2050. Final report."
24. Tumwebaze, Susan Balaba, and Patrick Byakagaba. "Soil organic carbon stocks under coffee agroforestry systems and coffee monoculture in Uganda." Agriculture, Ecosystems & Environment 216 (2016): 188-193.
25. Noponen, M. R., Healey, J. R., Soto, G., & Haggar, J. P. (2013). Sink or source - The potential of coffee agroforestry systems to sequester atmospheric CO2 into soil organic carbon. Agriculture, ecosystems & environment, 175, 60-68.
26. Henk Rikxoort, Götz Schroth, Peter Läderach, Beatriz Rodríguez-Sánchez. Carbon footprints and carbon stocks reveal climate-friendly coffee production. Agronomy for Sustainable Development, 2014, 34 (4), pp.887-897.

27. Farmers may stop carrying out these practices for many reasons. For example, if they perceive that there is no short term financial gain or they lack the labour required to implement them continuously.
28. These include acting as a reservoir for soil nutrients; improving nutrient and water holding capacity; improving soil structure, which enables better movement of air and water; reducing soil erosion and increasing populations of beneficial soil biota (including microorganisms, earthworms, nematodes, arthropods, molluscs and vertebrates).
29. For example, increasing soil organic matter can prevent soil erosion caused by heavy rainfall.
30. For example, organic fertilizer improves soil nutrient levels and mulching can increase soil moisture and reduce soil temperatures and erosion.
31. Additional labour costs in the case where farms hire additional labourers, or the opportunity costs in farms which rely on household labour.
32. For example, the eutrophication of aquatic ecosystems by nitrogen fertilizers.
33. For example, bacteria, fungi, nematodes, earthworms, and insects.
34. Bockel, L., & Schiettecatte, L. S. (2018). Life cycle analysis and the carbon footprint of coffee value chains. In Achieving sustainable cultivation of coffee (pp. 377-400). Burleigh Dodds Science Publishing.
35. The growth rates of different tree species vary, but typically they are low in the first few years, then increase with age until a plateau is reached.
36. Gmünder, S., Toro, C., Acosta, J. M. R., Valencia, N. V. (2019). Environmental footprint of coffee in Colombia: guidance document.
37. It could be the case that more trees will make land grabs more likely, especially if the trees on the land have value as timber. It could equally be the case that land grabs are less likely because the additional trees further demarcate the land area and make it a more complex and conspicuous process to seize the land, particularly if the plan is to clear it and use it for non-agricultural purposes.
38. Organic fertilizer includes animal manure and composted plant materials, but does not include urine and dung from grazing animals, integration of crop residues, green manures, or leaf litter falling on cropland.
39. Inorganic fertilizer includes all types of fertilizer manufactured through chemical processes using mineral resources and industrial techniques.
40. Primarily N2O emissions, but also CO2 and CH4.
41. If excessive volumes of fertilizer were previously being applied, this could have been causing a variety of negative impacts on soil health which may have been reducing yields. These include soil acidification, salinization, reducing populations of beneficial soil biota, among others.
42. Including timing, placement and application methods, among others.
43. Henk Rikxoort, Götz Schroth, Peter Läderach, Beatriz Rodríguez-Sánchez. Carbon footprints and carbon stocks reveal climate-friendly coffee production. Agronomy for Sustainable Development, 2014, 34 (4), pp.887-897.
44. 'Excessive' means in excess of the volume required to meet crop nutrient demands and maximise crop productivity.

45. Gmünder, S., Toro, C., Acosta, J. M. R., Valencia, N. V. (2019). Environmental footprint of coffee in Colombia: guidance document.
46. Precise estimations of nutrient requirements take into account the nutrient requirements for a specific field and are supported by soil analysis. However, generic figures for the national level in Colombia are provided by the Federación Nacional de cafeteros.
47. Gmünder, S., Toro, C., Acosta, J. M. R., Valencia, N. V. (2019). Environmental footprint of coffee in Colombia: guidance document.
48. Wet post-harvest processing includes receiving cherries, mechanical pulp removal, fermentation to remove degraded mucilage, washing, drying, and storing coffee beans.
49. Henk Rikxoort, Götz Schroth, Peter Läderach, Beatriz Rodríguez-Sánchez. Carbon footprints and carbon stocks reveal climate-friendly coffee production. Agronomy for Sustainable Development, 2014, 34 (4), pp.887-897.
50. For example: https://lwr.org/blog/2016/preserving-environmental-legacy-colombian-coffee-growers.
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52. Ntiamoah, A., & Afrane, G. (2008). Environmental impacts of cocoa production and processing in Ghana: life cycle assessment approach. Journal of Cleaner Production, 16(16), 1735-1740.
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    Cote d'Ivoire Cocoa: https://apps.carboncloud.com/climatehub/product-reports/id/205473901122.
54. In particular, studies measure soil organic carbon at different depths and some account for soil bulk density whereas some do not.
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59. Farmers may stop carrying out these practices for many reasons. For example, if they perceive that there is no short term financial gain or they lack the labour required to implement them continuously.
60. These include acting as a reservoir for soil nutrients; improving nutrient and water holding capacity; improving soil structure, which enables better movement of air and water; reducing soil erosion and increasing populations of soil biota.

61. For example, organic fertilizer increases soil nutrient levels and mulching can increase soil moisture and reduce soil temperatures and erosion.
62. Additional labour costs in the case where farms hire additional labourers, or the opportunity costs in farms which rely on household labour.
63. Pacheco, P. M.-A. (2021). Deforestation fronts: Drivers and responses in a changing world. WWF: Gland, Switzerland.
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68. The growth rates of different tree species vary, but typically they are low in the first few years, then increase with age until a plateau is reached.
69. It could be the case that more trees will make land grabs more likely, especially if the trees on the land have value as timber. It could equally be the case that land grabs are less likely because the additional trees further demarcate the land area and make it a more complex and conspicuous process to seize the land, particularly if the plan is to clear it and use it for non-agricultural purposes.
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72. Pacheco, P. M.-A. (2021). Deforestation fronts: Drivers and responses in a changing world. WWF: Gland, Switzerland.
73. Organisms that help control crop pest populations by preying on or parasitizing them.
74. Asante, E.A., Ababio, S. and Boadu, K.B., (2017). The use of indigenous cultural practices by the Ashantis for the conservation of forests in Ghana. Sage Open, 7(1).
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78. For example: https://www.barry-callebaut.com/en/group/media/news-stories/cocoa-shells-biochar-power-reduce-carbon-emissions-and-produce-green.

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85. These include acting as a reservoir for soil nutrients; improving nutrient and water holding capacity; improving soil structure, which enables better movement of air and water; reducing soil erosion and increasing populations of soil biota.
86. For example, organic fertilizer increases soil nutrient levels and mulching can increase soil moisture and reduce soil temperatures and erosion.
87. Zake, J., Pietsch, S. A., Friedel, J. K., & Zechmeister-Boltenstern, S. (2015). Can agroforestry improve soil fertility and carbon storage in smallholder banana farming systems?. Journal of Plant Nutrition and Soil Science, 178(2), 237-249.
88. In this study this included: aboveground plant carbon; belowground plant carbon; soil organic C in the topsoil layer; soil organic C in the subsoil layer.
89. For bananas in Dominican Republic, TR4 poses a particularly high risk.
90. https://www.globalforestwatch.org/dashboards/country/DOM/
91. Global Forest Watch reported that from 2001 to 2022, Dominican Republic lost 358 kha of tree cover, equivalent to a 14% decrease in tree cover since 2000 and maps show significant losses in the main banana producing provinces: Valverde, Monte Cristi, Azua and Barahona. In 2022, 1.43kha of tree loss cover was caused by commodity driven deforestation. https://www.globalforestwatch.org/dashboards/country/DOM/.
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98. The carbon footprint figures reported in the Intep (2023) study were converted from Kg CO2e per bunch of 20 roses to Kg CO2e per Kg of roses, based on an average weight per rose of 25g (as reported by Intep, 2023).
99. See Brandmayr et al. (2020), for a summary of potential options.
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7. Annexes

7.1 Mechanisms included in carbon footprint estimations

The mechanisms included in the carbon footprint estimations are listed below.

(i) Agricultural Mechanisms

- CO_2emissions from organic soils
- Nitrous oxide (N_2O) emissions from organic soils
- CO_2 emissions from deforestation
- CO_2 emissions from production of fertilizers
- N_2O emissions from production of fertilizers
- N_2O emissions from soil organic processes. Specifically, direct N_2O emissions, indirect N_2O emissions from volatilization of N and from leeching and runoff of N. These are caused by the application of both synthetic and organic fertilizers, and from nitrogen in crop residues left in the fields
- CO_2 emissions from application of lime
- CO_2 emissions from application of urea
- CO_2 emissions from pesticide production
- CO_2 emissions from use of farm equipment
- CO_2 emissions from drying of cereals, pulses and other crops typically dried at the farm
- Methane (CH_4) emissions from rice cultivation
- Energy consumption associated with irrigation
- N_2O and CH_4 emissions from manure management
- CH_4 emissions from enteric fermentation of ruminants
- Emissions of CO_2, N_2O and CH_4 from feed production and grazing

(ii) Mechanisms Regarding Packaging

- Extraction of raw materials
- Production of raw materials
- Production of packaging from raw materials
- Recycling of packaging
- Transportation of packaging
- Oxidation and release of fossil carbon stored in the material, from incineration or decomposition of packaging material

(iii) Transportation and Distribution Mechanisms

- Emissions from extraction, production, transportation and combustion of fuels

- Fuel consumption for all transportation stages within the system boundary of the study, such as transportation/distribution:
- From farms to food
- Between factories
- To warehouses
- Distribution from factories or warehouses to markets
- The following aspects of transport were considered:
- Distance
- Temperature controlled transportation
- Leakage of refrigerant for temperature controlled transportation
- Fuel consumption as a function of capacity utilization of the vehicles
- Empty returns of vehicles during distribution
- The high-altitude climate effects of aviation

(iv) Food Processing Mechanisms

- Direct emissions of fossil carbon or other greenhouse gases from ingredient reactions
- Energy consumption for food processing
- Food waste during production
- Overhead operations (e.g. facility lighting, ventilation, air conditioning)
- Leakage of refrigerants
- Waste treatment

(v) Land Use and Land Use Change (LULUC)

- Land use
- Land use change

(vi) Mechanisms Excluded

- Mechanisms explicitly excluded were:
- Maintenance of farm equipment
- Commute of personnel to and from the farms
- Housing of personnel working at the farms
- Albedo changes due to the production of crops
- Transportation from store shelf to consumers
- Energy consumption for preparation of food products by consumers
- End-of-life treatment of products and packaging
- Mechanisms excluded unless it is expected to have significant impact on the result of the study:
- Manufacture of capital goods (e.g., machinery, trucks, infrastructure)
- Mechanisms not considered were:
- Corporate activities and services (e.g., research and development, administrative functions, company sales and marketing)

7.2 Individuals interviewed to gather and validate supply chain activity data

- **Fairtrade Foundation Programmes Team:** Libby Scott – Project Manager.
- **Fairtrade Foundation Supply Chain Team:** Emma Mullins and Edward Harvey (Coffee), Joanna Carsons and Anna Pierides (Bananas), Alastair Stewart and David Finlay (Cocoa), Amy Collis and Mahsa Yeganeh (Flowers).
- **Fairtrade International:** Silvia Campos (Bananas), Sam Dormer (Cocoa), Melanie Durr (Flowers).
- **Producer Networks:** The Latin American and Caribbean Network of Fair Trade Small Producers and Workers (Alfredo Zabarain, Colombia Coffee; Andrea Fuentes, Dominican Republic Bananas) and Fairtrade Africa (Gonzaga Mungai and Paul Ayalo, Flowers; Ouattara Sally Sonndia, CDI Cocoa; Abubakar Afful, Ghana Cocoa).
- **Producer Organisations:** Gustavo Gandini and Lisbeth Heredia, Banelino; Bonniface Kiama, Rainforest Farmlands Kenya.
- **Local partners:** Dr Isaac Boakye, Input Distribution Officer, Cocobod.
- **The CarbonCloud Science Team** also provided guidance throughout this process.

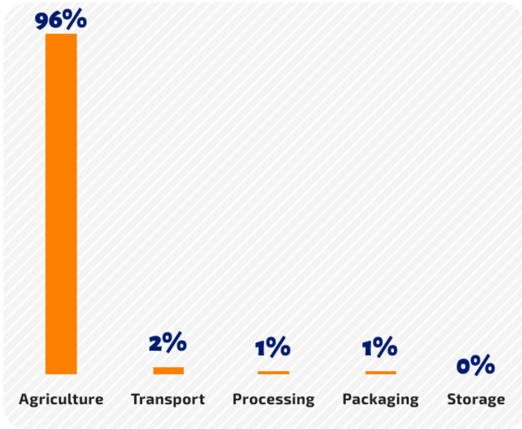
Coffee from Colombia

Fairtrade

Footprint at factory

13 CO_2e/kg

carbon footprint with CarbonCloud.com



"Roasted coffee beans" currently has a carbon footprint of 13kg CO_2e/kg. This value is updated when there are changes in the way the product is made, and when we update our calculations to match the latest climate science. See the table below to see the updates this product's carbon footprint.

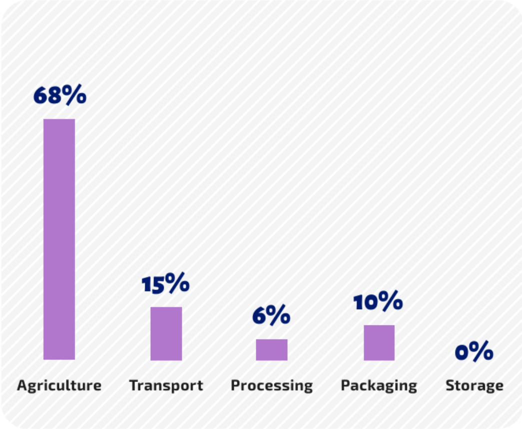
Cocoa from Cote d'Ivoire

Fairtrade

Footprint at factory

1.3 CO_2e/kg

carbon footprint with CarbonCloud.com



"Cocoa Beans for Processing" currently has a carbon footprint of 1.3kg CO_2e/kg. This value is updated when there are changes in the way the product is made, and when we update our calculations to match the latest climate science. See the table below to see the updates this product's carbon footprint.

FAIRTRADE FOUNDATION

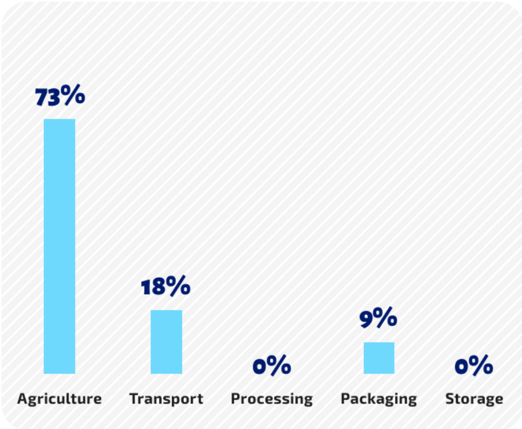
Cocoa from Ghana

Fairtrade

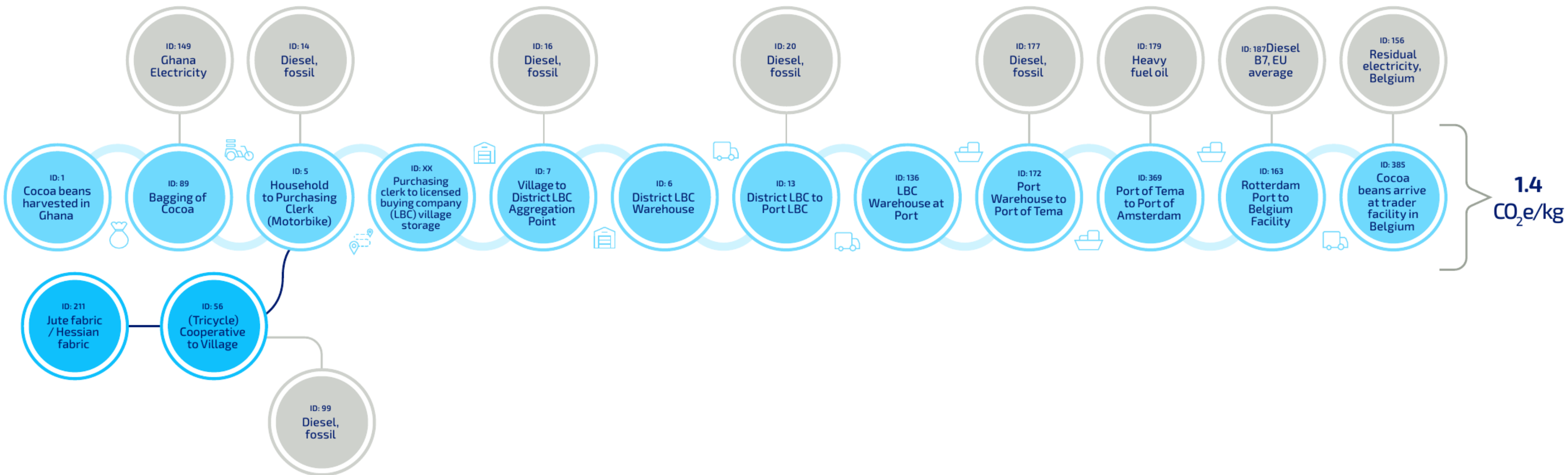
Footprint at factory

1.4 CO_2e/kg

carbon footprint with CarbonCloud.com



"Cocoa Beans" currently has a carbon footprint of 1.4kg CO_2e/kg. This value is updated when there are changes in the way the product is made, and when we update our calculations to match the latest climate science. See the table below to see the updates this product's carbon footprint.



FAIRTRADE FOUNDATION

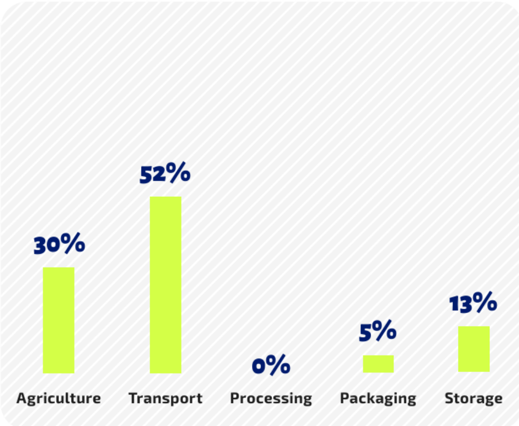
Bananas from the Dominican Republic

Fairtrade

Footprint at distribution center

0.52 CO_2e/kg

carbon footprint with CarbonCloud.com



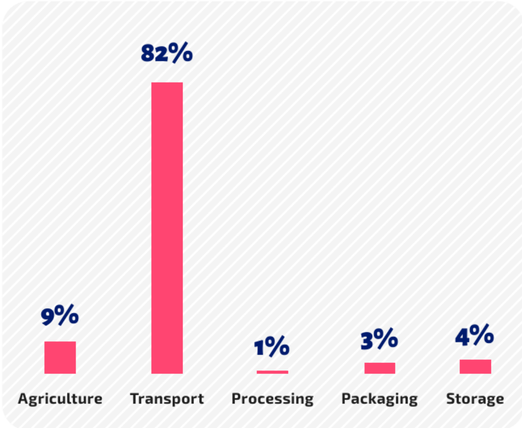
"Bananas Ripe" currently has a carbon footprint of 0.52kg CO_2e/kg. This value is updated when there are changes in the way the product is made, and when we update our calculations to match the latest climate science. See the table below to see the updates this product's carbon footprint.

Red roses from Kenya

Fairtrade

11 CO_2e/kg

carbon footprint with CarbonCloud.com



"Red roses from Kenya" currently has a carbon footprint of 11kg CO_2e/kg. This value is updated when there are changes in the way the product is made, and when we update our calculations to match the latest climate science. See the table below to see the updates this product's carbon footprint.