Carbon finance for smallholder farmers and agribusinesses

Analytical briefing on agroforestry solutions

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CASA
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Business Solutions to Poverty


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Who should read this report and why

Agribusinesses and farmer-producer organisations:

Understand whether carbon finance for smallholder agroforestry is likely to be an opportunity for your business and the smallholder farmers that you work with, and how to maximise the chances of success

Investors:

Understand whether your portfolio businesses and the smallholder farmers they work with could benefit from carbon finance for smallholder agroforestry

Multinational corporations and brands:

Understand which agribusiness partners are most likely to be viable partners in delivering emissions mitigation from smallholder agroforestry within your supply chain and how you can help them to succeed

Non-governmental organisations:

Identify opportunities to partner with agribusinesses in leveraging carbon finance for smallholder agroforestry, how to minimise implementation risks and optimise for meaningful smallholder impact

Donors:

Identify opportunities to catalyse carbon finance flows into smallholder agriculture via agribusinesses, as well as the key assumptions and risks behind investment

Policymakers:

Recognise the impact that carbon finance could unlock for farmers and climate, and what policy changes could support further development of the market

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Section 1

Introduction

Agribusinesses[1] are one of the key sources of income and expenditure for the majority of the world's 550 to 600 million smallholder farmers,[2] and are therefore a key potential point of leverage for governments and donors looking to improve smallholder livelihoods and support climate-change adaptation and mitigation. In practice, however, many agribusinesses struggle to invest in smallholder producers due to a combination of risk (both perceived and actual), long payback periods, and a lack of technical expertise.

The Commercial Agriculture for Smallholders and Agribusiness Technical Assistance Facility (CASA TAF), funded by the United Kingdom's Foreign, Commonwealth and Development Office (FCDO) and implemented by TechnoServe, launched in 2019 to address this challenge. CASA TAF supports agribusinesses that work with smallholder farmers, helping them to identify and execute successful investments into smallholder farming communities in ways that produce meaningfully improved livelihoods for farming families, broader benefits to nature and climate, and tangible commercial benefits for the agribusiness in order to ensure sustainability.

Agribusinesses that source commodities from smallholder farmers have a wide range of opportunities to invest in smallholder communities in ways that create "shared value" by both increasing the value of the business and by improving the livelihoods of the smallholder farmers who sell to the business. By investing in additional services, products, or assets for these farming communities, many agribusinesses could improve the quality and quantity of product they source, allowing them to grow faster and more profitably. Since 2019, CASA TAF has worked with seven impact investors and 24 businesses to identify opportunities to invest into smallholder communities, offering targeted packages of technical assistance to mitigate risks and shorten payback periods.

While we have had some notable successes in catalysing investment from our partners, significant barriers remain to scaling up commercial investment into longer-term, transformational initiatives that smallholder farming communities will need to adapt to climate change.[3]

Smallholder farmers are among those least responsible for the climate crisis but are disproportionately impacted by it, and they are in urgent need of financial support for climate adaptation. Climate adaptation finance flows to smallholder agriculture are growing but remain far below what is required. Voluntary carbon markets[4],

[1] Agribusiness as used in this paper describes a range of agriculture sector businesses that purchase commodities from smallholder farmers, in particular SME agri-traders and agri-processors, but also emerging ag-tech businesses. We use the term broadly to encompass a range of ownership models, including private businesses, farmer producer organisations / farmer co-operatives, and social enterprises

[2] Smallholder farms defined as those <5 ha; "Which farms feed the world and has farmland become more concentrated?", Lowder et al., World Development, 2021

[3] For more information on our work on inclusive business models for smallholder farmers, please refer to www.casaprogramme.com and www.technoserve.org/our-work/projects/commercial-agriculture-for-smallholders-and-agribusiness; a full overview of our Inclusive Business Plan methodology can be found at https://www.technoserve.org/wp-content/uploads/2022/01/IBP-Flyer_20220106-1.pdf

[4] This report is focused on voluntary carbon markets (VCM), a climate mitigation finance mechanism that is accessible on a voluntary basis to organisations and individuals seeking to mitigate their emissions; it does not address compliance carbon markets (CCM) in which regulated entities obtain and surrender emissions permits or offsets in order to meet regulatory targets

a rapidly growing mechanism for climate mitigation finance, offer an intriguing alternative source of capital for smallholders to invest in mitigating emissions while delivering adaptation benefits through carefully designed nature-based solutions.[5] Smallholder farmers are well placed to mitigate carbon emissions on their farms, which account for 94% of farms globally and 18% of the world's agricultural land,[6] and there are a range of nature-based solutions—including agroforestry and a number of improved land, production, and waste-management practices—that have the potential to deliver adaptation goals as well.

However, smallholders will require regular support over decades—not years—to achieve the targeted carbon benefits and capture the full rewards. This is an opportunity for agribusinesses that work with smallholder farmers: they can use a share of carbon income to extend their farmer support models in ways that allow them to create larger, longer-term shared value (e.g., subsidising investment into new tree crops and shade trees, or supporting ecological intensification of smallholder farms). But it is also a challenge: in order to achieve those benefits, agribusinesses will need to invest further in smallholder farming communities and support them through complex, long-term transformations.

There is a yawning "smallholder climate finance gap" that is not being addressed by conventional finance, whether public, private, or philanthropic. Meanwhile voluntary carbon markets are booming and could offer an alternative source of finance to close this gap. But how seriously should agribusinesses, investors, multinational corporations, donors, and policymakers take this opportunity? How large is the prize, what will it take to deliver, and what risks are involved?

This report examines the role carbon finance could play in the transition of smallholder agriculture to a more sustainable, productive, and resilient future. It focuses on agroforestry, which is seen to have high potential both to mitigate climate change through carbon sequestration and support climate adaptation through physical adaptation of farms and income diversification. It draws on qualitative research into 17 existing smallholder agroforestry carbon projects, quantitative analysis of three archetypal smallholder agroforestry opportunities, and discussions with more than 20 experts, summarising the current situation and detailing opportunities, challenges, and a potential path forward.

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[5] Per the International Union for Conservation of Nature (ICUN), nature-based solutions (NBS) are mitigation actions that "protect, sustainably manage, and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits"; accessible online at https://portals.iucn.org/library/sites/library/files/resrecfiles/WCC_2016_RES_069_EN.pdf

[6] "Which farms feed the world and has farmland become more concentrated?", Lowder et al., World Development, 2021

Section 2

Key takeaways

Voluntary carbon markets have grown rapidly in the last two years, reaching approximately $2 billion in 2021. They are expected to grow 10x by 2030, **with increasing demand for "carbon removal" credits generated by agriculture and forestry**, in particular from agri-food corporations seeking to mitigate emissions within their own value chain to meet commitments under the Science-Based Targets initiative (SBTi). **This is making the generation of carbon credits from smallholders an increasingly realistic prospect.**

There is an opportunity for carbon finance for smallholder agroforestry to address part of the vast smallholder farmer **climate adaptation gap** by funding the physical adaptation of farms to climate change and the diversification of smallholder incomes.

However, there is a **limited track record with smallholder carbon projects** to date, and projects with smallholder farmers face significant hurdles to viability including:

1. **High cost** due to small, fragmented landholdings and high support requirements;
2. **High reversal risk** due to changing farming opportunities and household needs over a typical project lifespan of 20-30 years;
3. **Unclear land rights** that increase risks for farmers and buyers of carbon credits;
4. **Complex incentive structures** needed to sustain farmer engagement given the long timeline for many tree species to start removing large amounts of atmospheric carbon;
5. **Additionality risk** that is created by funding commercially attractive tree species where farmers with the means may already be investing in seedlings;
6. **Inconsistent approaches to benefit- and risk-sharing** between smallholders, intermediaries, and financiers that erodes trust and hinders sector growth;
7. **Potential for negative impacts on smallholder farmers** if the agroforestry system fails or has unintended side-effects on farm productivity.

The sales price of carbon credits is a critical driver of viability, with **viability of some smallholder agroforestry projects likely to start in the $15-$25 range**. However, the **true price potential of smallholder agroforestry carbon credits is unclear** due to the small number of existing projects, opacity of the market, and rapid market development. At lower historical prices, these projects are unviable.

Due to these hurdles, the **majority of existing projects** identified by our research **were donor-subsidised** and **implemented by NGOs or social enterprises**; but if carbon finance is to scale to the point where it can play a meaningful role in addressing the smallholder climate finance gap, then opportunities need to be identified that work via organisations such as **agribusinesses, farmer producer organisations (FPOs), or social enterprises that have long-term incentives to participate meaningfully in smallholder markets.**

Agribusinesses looking to design successful carbon projects with smallholder farmers will need to make strategic choices around which projects and partners to select, as well as tactical decisions on project design. Viable projects require a **strong smallholder business case** for the short and long term, focused in a supply chain with **scale potential** and attractive **per hectare economics**, within a supportive **legal and political context.** Agribusinesses can improve the chances of success by paying close attention to these factors when deciding whether to pursue a carbon finance opportunity.

- **Smallholder business case:** meaningful income benefits for farmers relative to current farm revenues, with a combination of short-term cash incentives and long-term in-kind benefits (income diversification, climate adaptation, etc.);
- **Scale potential:** tens of thousands of hectares of project land in a traditional standalone project design, falling to several thousand under some approaches and/or methodologies (e.g., insetting, Rabobank ACORN);
- **Per hectare economics:** agroforestry design with potential to sequester several tonnes of CO2e p.a. per hectare of project land, with meaningful synergies between the agribusiness's existing operating model and the farmer support and monitoring requirements of the carbon project;
- **Legal and political context:** a stable and supportive legal and political landscape favourable to private investment generally, and particularly on climate issues

These factors are likely to vary by value chain, geography and business model; **we see distinctive opportunities for:**

Large trading businesses in high-value export commodity supply chains where certification is common, such as cocoa and coffee

Smaller, inclusive agro-processing businesses in high value export commodity supply chains where certification is common (e.g., nuts, spices)

Social enterprises or subsidised farmer producer organisations in low-value commodity supply chains where sourcing is typically opportunistic (e.g., staple crops)

Ag-tech businesses potentially addressing a range of high- and low-value commodities

Agribusinesses launching projects with smallholder farmers should bear in mind the following design principles for success:

1. **Treat smallholders as farmers, not carbon farmers:** we believe that **the primary value that carbon finance can create for smallholders will be in funding upfront investment into diversification and climate adaptation** of their current farms, with carbon revenue streams remaining modest compared to the potential of core farming income streams.

2. **Build in incentives for today and tomorrow: carbon revenue streams can be valuable as short-term incentives for changes in behaviour that create long-term value for farmers** but have short-term opportunity costs.

3. **Design projects around the core business model: we believe that this value is most likely to be accessible in commercial value chains where commodity buyers can channel carbon finance to strengthen their supply chains;** conversely where projects require agribusinesses to operate outside their core, there are risks to both scalability and sustainability.

4. **Build transparent and equitable partnerships:** value will need to be shared between farmers, buyers, and investors in order to guarantee long-term success; this will require thoughtful design of partnership structures that **allocate risk and reward fairly across long carbon project lifespans, in the face of informational and power asymmetries** between smallholder farmers and other stakeholders.

Donors and policymakers interested in poverty reduction and climate action **can play a pivotal role in opening up the smallholder agriculture sector to carbon finance.**

Donors should work with concessional and commercial investors to establish blended finance solutions that can fund upfront investments into smallholder agroforestry (and smallholder nature-based solutions (NBS) more generally) to be repaid at a later date through carbon credits ; this could be through establishing dedicated funds, or by deploying technical assistance funding to create ad hoc solutions with individual agribusinesses, FPOs, and NGOs.

Donor-funded technical assistance can play an important role in designing smallholder carbon projects with long-term impact, as well as promoting transparency and consistency in how smallholder carbon projects are delivered, ensuring both that the voices of the farmers are represented and their rights respected and that the distribution of carbon revenues among project stakeholders is proportionate to the value they provide.

Donors should consider investing in industry coordination to help agribusinesses achieve the scale necessary to attract carbon finance into the sector, for example by brokering partnerships between agribusinesses in promising value chains and geographies.

Donors should consider longer-term investments into innovative farmer support models that can capture and disseminate the local agroforestry knowledge essential to long-term project success while reducing the long-term cost of support.

Policymakers and donors should support efforts to **clarify legal frameworks for carbon finance and initiatives to improve smallholder security of land tenure** such that both smallholder farmers and the private sector can benefit from the opportunity.

Nevertheless, **significant barriers will remain** to establishing carbon finance as a long-term source of funding for smallholder farmers and inclusive agribusiness given the **higher cost and risk of smallholder-implemented NBS**; donors and policymakers should accordingly **calibrate their support and focus firmly on opportunities with the greatest potential to be commercially sustainable** in the longer term.

With an annual smallholder climate finance gap likely to be in the tens—if not hundreds—of billions of dollars, carbon finance for smallholders would need to scale massively before it can make a significant impact. **Policymakers must therefore continue to expand climate adaptation finance for smallholder farmers more broadly**, even as they explore the potential of carbon finance to meet some of the need.

Section 3

Smallholder carbon project background

The smallholder climate finance gap

The 2016 Paris Agreement aims to limit global warming to less than 2° centigrade above pre-industrial levels, effectively requiring net emissions of greenhouse gas (GHG) to fall by 50% by 2030. Meeting this challenge will require massive investment both to reduce GHG emissions ('climate mitigation') and to adapt to climate change already in the pipeline ('climate adaptation').

The field of international climate finance has emerged in recent decades in response to climate challenges, encompassing a range of public, private and alternative sources of funding for mitigation or adaptation measures for actions that will address climate change.[9] Annual flows of climate finance have grown rapidly and are estimated to have reached $632 billion in 2019-20;[10] but still fall far short of the sum required to meet the climate objectives, which is assessed at $4.3 trillion—approximately 10 times the GDP of Nigeria, Africa's largest economy.[11]

To date, the vast majority (approximately 90%) of climate finance at the global level has been focused on climate mitigation (primarily in the energy and transport sectors), with only $46 billion flowing to adaptation in 2020.7 Although funding for adaptation is increasing, adaptation finance today falls well below the level needed to respond to the impacts of climate change, with estimated annual adaptation needs in developing economies estimated at between $155 billion and $330 billion by 2030.[12] Furthermore, the public sector continues to provide almost all adaptation financing, limiting opportunities to resolve adaptation challenges at scale.

Within the agriculture, forestry and other land use (AFOLU)[13] sector globally, the share of tracked climate finance capital allocated to smallholder farmers, agri-entrepreneurs, and the value chain actors serving them was estimated at $10 billion for 2018.[14] In contrast to the global picture, there has been a greater focus on climate adaptation (79% for adaptation or joint adaptation and mitigation),[15] but initiatives have been financed almost entirely by public sources (95%) and predominantly focused on general rural community initiatives.[16] While there is no exact quantification of global climate finance needs in smallholder agriculture, overall financing needs are in the order of hundreds of billions of dollars per year and it is clear that climate financing needs are substantially in excess of the $10 billion that was flowing into the segment in 2018.[17]

9 United Nations Framework Convention on Climate Change
10 Global Landscape of Climate Finance, Climate Policy Initiative, 2021
11 World Bank 2021, GDP data in current US dollars
12 Adaptation Gap Report, United Nations Environment Programme, 2021
13 Also known as the Forest, Land and Agriculture (FLAG) sector
14 "Examining the Climate Finance Gap for Small-Scale Agriculture", Climate Policy Initiative in collaboration with IFAD, 2020
15 Ibid.
16 "Agri-SME Finance – State of the Sector", ISF Advisors, 2022
17 Ibid.

The challenge is particularly acute in Sub-Saharan Africa (SSA), which—although responsible for only 4% of annual global GHG emissions—is disproportionately exposed to the impacts of climate change.[18] Across Africa, land degradation caused by climatic and anthropogenic factors affects 80% of cultivated land area, impacting at least 485 million people.8 Need for adaptation finance alone in SSA is conservatively estimated at $53 billion annually by 2030, but as of 2020 stood at only $11 billion (21% of need),[19] of which $3 billion flowed into the AFOLU sector.

The annual adaptation finance gap in SSA is therefore at least $40 billion and likely to be substantially higher, with heavy consequences for the 60% of the population whose livelihoods depend on smallholder agriculture.[20] Furthermore, this falls within the context of an annual agricultural finance gap for smallholder farmers of $36 billion in SSA (with finance currently meeting only $6 billion, or 14%, of the financing need),[21] and is paralleled by a finance gap of $75 billion among agribusinesses in SSA, which are receiving only $16 billion (17% of their need).[22] Radically greater investment is clearly required, both at the smallholder and intermediary level if the sector is to grow and adapt to meet future challenges.

There is increasing interest in carbon finance as a mechanism to help address this smallholder climate finance gap. Carbon finance is a mechanism for incentivising the reduction, avoidance, or removal of GHG emissions, in which buyers pay for mitigation outcomes, typically in order to meet a legal obligation or voluntary commitment to reduce their carbon footprint.[23] Buyers of carbon credits pay for climate mitigation outcomes, but the solutions that they fund can promote climate adaptation by improving climate resilience of smallholder farms and diversifying smallholder incomes as well as mitigating emissions. We focus in this report on agroforestry solutions, which have high potential to both mitigate climate change through carbon removal and to improve smallholder farmer livelihoods through physical adaptation of their farms and diversification of income sources.

The smallholder carbon finance opportunity

Carbon markets have evolved over the last three decades through a combination of private sector innovation and policy developments. While the first carbon projects were voluntary arrangements, the first carbon market was the Clean Development Mechanism (CDM) established under the 1997 Kyoto Protocol, which allowed developed countries to meet emission reduction obligations by financing mitigation in developing countries where costs were lower.[24] A range of carbon markets have since evolved encompassing both public "compliance" markets for heavily polluting industries (energy, heavy manufacturing, airlines, etc.) as well as private "voluntary" markets serving organisations in other sectors such as agri-food that wish to offset their emissions. Within voluntary markets, companies can either purchase credits outside their supply chain ("offsetting") or support the development of carbon projects within their own supply chain ("insetting").

Voluntary carbon markets are currently experiencing a dynamic period of growth, both in volume and price, driven by national and corporate net zero

[18] "Climate Finance Regional Briefing: Sub-Saharan Africa", 2020, Heinrich Böll Stiftung, Washington DC
[19] "Financial Innovation for Climate Adaptation in Africa", Global Center on Adaptation in collaboration with Climate Policy Initiative, 2022
[20] "The future of agriculture in Sub-Saharan Africa", IFAD, 2020
[21] "Pathways to Prosperity: Rural and Agricultural Finance State of the Sector Report", ISF Advisors and Rural and Mastercard Foundation Agricultural Finance Learning Lab, 2019
[22] "The state of the agri-SME sector – Bridging the finance gap", ISF Advisors, 2022
[23] World Bank
[24] United Nations Framework Convention on Climate Change

commitments. Voluntary offset markets reached an annual transaction value of $2.0 billion in 2021, a fourfold increase on the prior year.[25] The last few years have seen a significant number of agri-food multinationals commit to net zero targets under the Science-Based Targets Initiative (SBTi), committing themselves to large reductions in indirect emissions in their value chain (so-called "Scope 3" emissions)—with some, including AB InBev, Barry Callebaut, Coca Cola,[26] Danone, Mars, Nestlé, and Starbucks—targeting significant short-term reductions.[27] The impact has been to boost interest from major agri-food businesses in "insetting" projects in which they fund climate mitigation action within their supply chain—Nestlé alone has committed to achieving seven million tCO2e carbon removals through agroforestry by 2030.[28] Whichever approach companies pursue, the Taskforce for Scaling Voluntary Carbon Markets estimates likely growth of 10x by 2030 and 30x by 2050 as companies pursue increasingly ambitious net zero targets.[29]

Meanwhile, average voluntary carbon market prices rose nearly 60% to $4.00, in part reflecting a shift towards higher priced nature-based solution credits with social and biodiversity co-benefits (on average Forestry and Land Use credits traded at $5.80 and Agriculture credits at $8.81).[30] Agroforestry credits are valued particularly highly among AFOLU credits as they create carbon emissions removals (in which carbon is being removed from the atmosphere and stored in biomass) rather than emissions avoidance (which relies on a counterfactual emissions scenario to quantify the extent of emissions mitigation). Currently, the majority of AFOLU carbon credit supply is from avoidance projects, notably the REDD+ mechanism established under the UNFCCC to reduce emissions from deforestation and forest degradation by funding enhanced forest management.[31] Avoidance credits such as those generated by REDD+ have received negative publicity linked to concerns around their additionality,[32] and market price signals indicate that customers are willing to pay a meaningful premium for carbon removals.[33] Indeed, the long-term vision for SBTi is to only allow carbon removals, which could drive exponential growth in pricing of carbon removal credits such as agroforestry–one recent analysis finding that this could lead to prices of about $200 by 2030.[34]

It is essential to note that meaningful barriers and risks remain for voluntary carbon markets in general. First, it is possible that carbon market growth slows, both in terms of volume and price. For example, corporates could row back from net zero targets as the costs and challenges of delivery become clearer. Secondly, regulation of voluntary carbon markets is still nascent, and there is potential for disagreements around oversight, ownership, and taxation at an international level that could have significant impacts on corporate investments into mitigation initiatives. At a global

25 "State of the Voluntary Carbon Markets 2022 Q3", Ecosystem Marketplace, August 2022
26 The Coca Cola Company, Coca Cola European Partners and Swire Coca Cola Limited
27 Science-Based Targets Initiative signatory database, accessed September 2022
28 "Nestle's Net Zero Roadmap", Nestle, 2021
29 "A blueprint for scaling voluntary carbon markets to meet the climate challenge", McKinsey & Company, 2021
30 "State of the Voluntary Carbon Markets 2022 Q3", Ecosystem Marketplace, August 2022
31 REDD+ represented ~65% of AFOLU transactions by value in 2021, ibid.
32 Debate centres around challenges in defining a counterfactual scenario for the amount of deforestation that would have occurred without the intervention, and the inherent risk that the project baseline overestimates avoided emissions; see discussion in e.g., https://www.spglobal.com/commodityinsights/en/market-insights/blogs/energy-transition/062821-voluntary-carbon-markets-redd-credits-forest-protection
33 Carbon credits can broadly be categorised as removal credits (RCs) or avoidance credits (ACs). RCs involve removing carbon from the atmosphere and storing it in biomass or in geological sinks, and are often seen as being of higher quality because atmospheric carbon is actually being reduced; ACs are generated by avoiding emissions that would have occurred under a BAU scenario, and are common in renewable energy (e.g., clean cookstoves and conversion of coal/wood to clean energy sources) but also relevant to the conservation of natural ecosystems
34 "Carbon Offset Prices Could Increase Fifty-Fold by 2050", BloombergNEF, 2022

level, Article 6 of the Paris Agreement established principles around international cooperation on carbon mitigation that could impact voluntary carbon markets. Negotiations around the "rulebook" that will guide implementation of Article 6 are progressing through the Conference of Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC), but substantial questions remain around issues including the relationship between countries' Nationally Determined Contributions and voluntary carbon markets.[35] At a national level, some countries are already intervening in carbon markets, as can be seen from a moratorium on international sales of new voluntary carbon credits imposed by the Indonesian government in April 2022.[36] While issues of governance are being addressed at international and national levels, as well as through industry bodies such as the Taskforce for Scaling Voluntary Carbon Markets (TSVCM), Integrity Council for Voluntary Carbon Markets (ICVCM) and the Voluntary Carbon Market Integrity Initiative (VCMII), we are at an early stage in the journey.

If, however, demand continues to grow, and carbon prices continue to climb, this will create a window of opportunity for smallholder carbon finance. By definition, the costs of mitigating carbon emissions through large numbers of dispersed smallholder farmers are high and credit price growth will help to increase demand by making more smallholder projects viable at competitive prices.

The opportunity for carbon finance to address the smallholder climate finance gap, at least in part, is therefore clear in principle. In the context of smallholder agroforestry, carbon finance can help to provide upfront investment into farms that can produce new sources of income (grow timber, fruits, nuts, fuelwood, etc.), help to adapt farms to climate change (increase shade, moisture retention, soil fertility, etc.), or provide an additional cash income stream from carbon removals. For agribusinesses facilitating these investments, carbon finance presents the prospect of a revenue stream that can fund deeper and more consistent farmer support, reducing competitive pressure on private extension services and unlocking shared value in their smallholder supply base.

The smallholder carbon finance track record

A number of pilots have been launched in the last decade by IGOs, NGOs (sometimes with participation by private sector players) and social enterprises and have adopted both landscape and individual farmer approaches. We studied 17 carbon projects based in smallholder agroforestry, or more specifically agrisilviculture,[37] in order to understand successes and challenges in early pilots—many of which are still ongoing given the long duration of agroforestry interventions. While by no means comprehensive, the sample of projects provides important context for new generations of projects with wider sets of public and private sector partners.

[35] Article 6.2 of the Paris Agreement established a basis for countries to trade in GHG emissions reductions (referred to as Internationally Transferred Mitigation Outcomes, or ITMOs) through bilateral or multilateral agreements, while Article 6.4 created a basis for a centralised carbon market overseen by a UN entity. COP26 clarified rules for "corresponding adjustments" between countries that sell and buy carbon credits under Articles 6.2 or 6.4, in order to avoid double-counting when tracking progress against NDCs. While voluntary carbon markets technically fall outside the scope of Article 6, a range of knock-on effects are possible including government involvement in authorisation of voluntary carbon market projects. For further discussion of these issues, see e.g., "Article 6 of the Paris Agreement and implications for the voluntary carbon market", International Carbon Reduction and Offset Alliance, 2021; and "COP 26 Key Takeaways", Carbon Market Institute, 2021

[36] Carbon project developer South Pole notes that this is continuation of increasing efforts made in the last few years by the government of Indonesia to direct carbon pricing and clarify the role of voluntary carbon credits with regard to Indonesia's nationally determined contributions (NDCs); S&P Global Commodity Insights, 7 April 2022

[37] Agrisilviculture systems incorporate a mix of crops and trees, such as shade systems or border planting, as compared to silvopastoral systems (which combine trees and animals) or agrosilvopastoral systems (which integrate all three: trees, crops and animals)

The earliest projects our research identified were led by development agencies like the World Bank and covered both climate adaptation and mitigation activities. For example, the Kenya Agriculture Carbon Project, a pioneering project set up in 2011 by the World Bank in collaboration with Vi Agroforestry, combined agroforestry with a range of soil health interventions focused on increasing crop productivity and resilience. An increasing range of organisations have subsequently entered the space, whether with tailored carbon financing propositions (e.g., Rabobank ACORN Fund) or with portfolios of carbon projects (e.g., Comaco, One Acre Fund). Most of these projects are ongoing and have had varying measures of success, both in their environmental and social outcomes.

Notably, the majority of the projects depend on the involvement of a not-for-profit to act as an anchor partner. Given the novelty of carbon finance and the complexity of partnering with smallholder farmers, this is logical—but also poses a challenge for scale, which will require greater collaboration with private sector players with limited budget to spare for experimentation. Increasingly, organisations are looking to leverage agribusiness partners as they look to achieve scale in carbon projects, both to access larger numbers of farmers, and to achieve synergies on project overhead costs.

Key challenges to viability

The projects we have studied highlight a number of additional challenges in developing agroforestry carbon projects with smallholder farmers, compared to more traditional AFOLU projects that work with a smaller number of partners with larger landholdings.

1. High cost: Small landholdings require aggregation of a large number of dispersed farmers to achieve meaningful volumes, active support and management of the farmer network to achieve carbon sequestration targets, and comprehensive monitoring, reporting and verification—necessarily driving higher costs per hectare relative to projects on larger estates or farms. The majority of carbon projects for which information was available were supported by soft capital either directly through grants or indirectly by leveraging the resources of donor-supported organisations, e.g., farmer extension services, etc.

2. High reversal risk: Working through a wide range of smallholder farmers implies a range of increased risks, both to achieve initial carbon sequestration targets within a typical project lifetime of 20-30 years, and to keep carbon sequestered permanently—sometimes defined as 50+ years but with no upper time limit under some protocols.[38] Farmers vary in their level of motivation and skill, while farms develop over time to reflect changing agronomic opportunities and challenges as well as the changing needs of the households they support. During the course of 20-30 years, a smallholder farm may experience boom and bust in a key crop, a change in ownership, and a wide (and increasing) range of climatic challenges. While not all of those challenges are unique to smallholder farmers, the wide range of potential responses increases the risk of upfront investment into seedlings, training, etc., compared to traditional large-scale carbon projects. Ability for smallholder-focused carbon projects to access finance has therefore historically been limited. As noted above, all carbon projects for which information was available have therefore accessed soft capital to derisk their investments either through a mixture of direct subsidy or by finding synergies with project partners (in some cases including private sector partners).

3. Unclear land rights: Many countries with large numbers of smallholder farmers, especially in the

[38] For example, under the Science-Based Targets initiative (SBTi), the GHG protocol currently recommends no upper time limit to permanence monitoring

tropical regions highly suitable for agroforestry have limited documentation of land and/or tree tenure, which can create risks over the ownership of carbon credits generated within the project boundary, as well as over ownership of trees funded by carbon finance–potentially allowing a timber company to legally remove trees planted for the carbon project. Furthermore, planting of new tree stock is likely to improve land value, increasing risk of land grabs where rights are unclear. Land rights issues have come under particular scrutiny in the context of jurisdictional REDD+ projects,[39] but are also relevant for the agroforestry projects that we have examined, with a number of projects investing resources to confirm land tenure prior to launching the project.

4. Complex incentive structures: Smallholders need to be incentivised to create and maintain agroforests through and indeed beyond the carbon project lifespan, and a range of solutions were developed by different projects in our sample. Cash incentives are one common mechanism (particularly during the early years of new tree planting when carbon sequestration is trivial) but good agroforestry design is typically the larger long-term guarantee of project durability / permanence as it ensures that new sources of income, benefits to farm productivity, and improvements to climate resilience are sufficiently attractive to guarantee long-term land use under agroforestry.[40]

Purely financial incentives disbursed as carbon payments could be meaningful to farmers in project designs that offer high carbon prices, focus on denser agroforestry models with high per hectare carbon sequestration potential, and are structured to allocate a meaningful share of the resulting carbon income to farmers (vs. covering costs to intermediaries of farmer support or servicing debt on upfront investments).[41] However, for many projects, financial incentives from the carbon project are relatively small in comparison to their farm incomes, and their primary role is as a short-term incentive to support the agroforestry system until long-term benefits are achieved.

5. Additionality risk: Additionality relies on understanding the commercial attractiveness and viability of the activity in the first place, a nuanced argument particularly for those agroforestry species that would be most commercially attractive, and in which farmers might therefore invest without carbon finance. Agribusinesses and NGOs may know that in practice the chances of smallholder farmers investing in theoretically attractive tree crops and timber species are low due to cost, risk, and a long payback period. Furthermore, carbon removals will only be achieved where the commercial proposition to the farmer is sufficiently attractive to drive adoption and maintain the agroforest. But this logic needs to be established on a case-by-case basis and successfully communicated to potential buyers of carbon credits, who in many cases—even for corporations investing in insetting projects occurring within their own value chain—will not be intimately familiar with the challenges faced by smallholder farmers.

Potentially riskier from a reputational standpoint is that in some areas particular attractive tree crop species may be associated with smallholder-driven deforestation—

[39] "Status of Legal Recognition of Indigenous Peoples', Local Communities' and Afro-descendant Peoples' Rights to Carbon Stored in Tropical Lands and Forests", Rights + Resources Initiative, 2021

[40] "How durability in forest carbon forces us to think about livelihoods", Taking Root, September 2022

[41] For example, at a carbon price of $25, a farmer sequestering 6 tCO2e p.a., and retaining 50% of credit value would receive ~$75 p.a. This is a meaningful increase in incomes, but relatively insignificant compared to net incomes from cash crops such as cocoa of coffee which could be in the order of $500-1000 for a typical smallholder farmer in SSA

for example palm oil or cashew in southeast Asia—while in other geographies or in specific project designs this is not the case.[42]

6. Inconsistent approaches to benefit and risk sharing: Carbon revenue can be shared with farmers either upfront, in anticipation of future carbon sequestration (for example in the form of farm investments, or cash incentives), or at a later date "on delivery" of carbon removals (typically several years after planting as the seedlings take time to start sequestering meaningful quantities of carbon). Given the upfront costs and labour required to establish new agroforestry systems, a number of the projects we examined provided some upfront investment or payment to facilitate setup.

However, those investments required financing, which resulted in different arrangements around future carbon revenue sharing between projects–with some projects providing upfront financing and incentives in return for all future carbon revenues, or a fixed price on future carbon revenues, and others offering a defined share of future carbon income to farmers.[43]

While there is a moral argument for offering farmers a share in any future carbon price upside, this needs to be judged against the risk appetite of the entity financing the project—whether that is a business investing within its own supply chain or a third-party investor aiming to sell those credits onto a final carbon offtaker. The technical complexity of carbon finance and the diversity of potential models creates significant potential for confusion around where benefits and risks sit, exacerbated by the information asymmetries between smallholder farmers and other project stakeholders.

Risks should not (and realistically will not) be borne by smallholder farmers, but should they fall predominantly on intermediary organisations (such as agribusinesses or NGOs) or on financial speculators in the carbon markets? When it comes to benefits, should financial upside from any future increases in carbon prices accrue to farmers or intermediaries? If upside is shared with the farmer, who bears the downside risk? There are as yet no consistent answers to these questions, with different solutions adopted by different projects.

7. Potential for negative impacts on smallholder farmers: Smallholder farmers have limited capacity to absorb negative outcomes, e.g., the failure of the agroforestry system or unintended side-effects on crop yields. While there is a range of literature on the relationship between agroforestry and crop yields, studies are typically context-specific and as yet there is limited consensus on their overall impact on farm productivity (through, for example, enhanced soil fertility).44 Furthermore, carbon projects potentially complicate synthetic fertiliser use, as any additional fertiliser application should be netted off against the atmospheric carbon removed by the trees. Yet synthetic fertiliser use underpins crop yields globally, both in key cash crop sectors such as cocoa and coffee, as well as in staple crops such as maize and therefore has major implications for smallholder incomes and food security. Projects will need to be designed very carefully to mitigate risks to the livelihoods of some of the world's poorest people.

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[42] These additionality challenges could be addressed by excluding removals from the crop trees themselves when calculating carbon credits, although this would weaken return on investment outside an insetting context (in which the agribusiness could benefit commercially through increased access to commodities from the crop trees).

[43] One alternative solution to this issue is for farmers and supporting organisations to be paid on the basis of forecast (ex ante) future carbon removals, but this approach has fallen out of favour due to greenwashing concerns, with corporate buyers increasingly searching for actual (ex post) credits where part of the payment is advanced to farmers at the risk of the financing organisation (either the end buyer or an intermediary such as a carbon project developer depending on the scenario)

Section 4

Smallholder carbon project case studies

Given the complexity of working with smallholder farmers and the need to draw together multiple partners to maximise chances of success, careful design of each project is essential. Projects need to be tailored to reflect the biological, economic, socio-cultural, and political realities of their contexts. In order to illustrate key considerations for project design, we have analysed three archetypal carbon project opportunities in smallholder agroforestry, reflecting different agroforestry configurations, smallholder farming contexts, agri-SME business models and geographies. For each, project viability is determined by a number of key variables:

1. **Smallholder business case:** how large is the net income benefit for farmers who engage in the project, and when do these benefits accrue? How meaningful are these benefits in the context of overall farm income, both in the short and long term?
2. **Scale potential:** how many hectares of land can plausibly be aggregated into a single project based on the number of farmers in the value chain, average farm sizes, and the market share of leading SMEs in the value chain?
3. **Per hectare carbon sequestration potential:** how much carbon can be removed each year per hectare of project land, based on the proposed agroforestry design?
4. **Upfront investment per hectare:** how much capital is required per hectare of project land to set up the project, based on the proposed agroforestry design and support model?
5. **Ongoing monitoring and verification costs:** how costly is the ongoing monitoring and verification of the project? What opportunity is there to leverage new methodologies and technologies to minimise unit costs and reduce scale requirements for project viability?
6. **Operating cost synergy potential:** to what extent can carbon projects leverage existing agribusiness farmer support operations such as training, communications, and payments?
7. **Legal and political risk:** to what extent does the legal and political landscape of a particular country influence project viability?
8. **Cost of capital:** how do financing expectations of intermediaries influence viability, and to what extent can concessional financing terms enhance project viability?

[44] For example, see "Regenerative Agriculture: An agronomic perspective", Giller et al, in Outlook on Agriculture, 2021

We have made a series of assumptions around each of these key determinants, summarised in each case study and detailed in the appendix, in order to create a base case which represents a well performing project—achieving full scale potential and carbon sequestration potential per hectare, effectively leveraging agribusinesses' existing farmer support models to the extent possible, and assuming that adverse legal and political scenarios are avoided. We assume that carbon finance is being provided at commercial rates, as this will ultimately be the test of its longer-term potential to address the smallholder adaptation finance gap. We also assume that monitoring and verification costs are per current technology and methodologies, although new programmatic approaches that leverage remote sensing technology, such as Rabobank ACORN, are emerging that have the potential to significantly reduce these costs.

It is also necessary to make certain assumptions around carbon market conditions, in particular around the level of demand and willingness to pay for carbon mitigation provided by smallholder farmers, with all the biodiversity and social co-benefits this could support. Standard AFOLU credits traded on the voluntary market at around $5.80 per tonne CO2e in 2021.[45] However, carbon market participants that we interviewed for this paper believed that credits generated by smallholder agroforestry should trade at higher values, with estimates ranging between $15 and $30 per tonne CO2e. In some cases, interviewees believe willingness to pay could be towards the higher end of this range or even exceed it. This reflects both the biodiversity and social co-benefits of smallholder agroforestry and the fact that credits are derived from removals of atmospheric carbon, typically regarded as higher quality credits by the carbon markets. We have taken a conservative midpoint value of $20 as the central scenario for our case studies, but it should be noted that the market is evolving rapidly, and the true level of demand and pricing potential is not yet known, even if market signals are currently encouraging.

The following case studies are based on high-level assumptions with the aim of identifying areas of greatest opportunity and illustrating key factors that determine project viability. In reality, the economic viability of carbon projects is highly dependent on fundamentally local factors related to climate, soil, and water, making it challenging to make meaningful generalisations across large areas without a level of ground research. The analyses that follow should therefore be regarded as helpful heuristics rather than conclusive findings. They are signposts to opportunity, but only the start of the journey.

[45] "State of the Voluntary Carbon Markets 2022 Q3", Ecosystem Marketplace, August 2022

Case study 1

Shade tree carbon financing for smallholder cocoa producers in Ghana

Case study 1

Shade tree carbon financing for smallholder cocoa producers in Ghana

Cocoa cultivation in Ghana

Ghana has the second-largest economy in West Africa, and a track record of consistent economic growth averaging ~5% p.a. over the last three decades, but agriculture remains a mainstay of the economy, employing around 45% of the workforce. Cocoa is Ghana's most important agricultural export, and the third largest category by value after gold and crude petroleum. Ghana is the second largest producer of cocoa globally, contributing 25% of global supply and generating approximately $2 billion annually in foreign exchange. The crop is cultivated by approximately 850,000 smallholder farmers across the country, implying that approximately 3.7M people, or ~12% of the population, rely on the crop for their livelihoods.

Cocoa market in Ghana

Cocoa aggregation in Ghana is highly regulated, with a small number of Licensed Buying Companies (LBCs) authorised by the Ghana Cocoa Board (COCOBOD) to purchase cocoa from smallholder farmers. Cocoa purchase price is fixed by COCOBOD, meaning that LBCs compete with each other by maximising operational efficiency and by providing services to farmers. The top six LBCs each hold on average 10% market share, implying a smallholder supplier base of approximately 85,000, cultivating cocoa on ~260,000 ha.

Carbon finance opportunity

Cocoa is an understory species and so cultivation is traditionally under tree canopy. However, intensification in recent decades has led to a significant reduction in shade tree coverage and, on many farms, the total elimination of shade trees. Global warming is expected to cause yield losses of 10-20%,[46] with full sun cocoa plantations most exposed. Carbon finance could provide funding for smallholder farmers to purchase shade trees for their cocoa plots, sequestering carbon while increasing climate resilience and improving access to valuable non-timber forest products such as fruits, nuts, fodder, or fuelwood.

[46] CGIAR Info Note 'The Economic Case for climate action in cocoa production', August 2018

Carbon sequestration potential

Planting a hectare of full-sun cocoa with an appropriate number of a recommended shade tree variety such as Terminalia superba or Milicia excelsa with the potential to enhance soil fertility[47] as well as boost shade (source: Cocoa Research Institute of Ghana) could conservatively remove an average of 2t CO2e per ha p.a. during the first twenty years of tree growth. Assuming the carbon project were implemented with the entire supplier base on half of their cocoa plots, overall annual sequestration potential would be 260,000t CO2e p.a. for each of the major LBCs. Scale potential would be constrained in practice by the presence of suitable intermediaries and geographical variations in carbon sequestration potential.

Commercial benefit

A share of the carbon finance could be allocated to LBCs to fund long term extension to smallholder farmers in the supply chain, minimising the financial risk in investing in high quality smallholder support. Deeper and more consistent support to farmers should drive improvements in cocoa quality and yield, as well as improve LBC share capture by increasing presence and reducing pressure to side-sell.

Smallholder impact

Key benefits to farmers would be through improved climate resilience and soil health driven by the new shade trees, as well as co-benefits such as improved forage and fuelwood availability, or potentially through direct payment of financial incentives. Given that typical cocoa farmer gross incomes are in the range of $900-1200 p.a., improved climate resilience and sustainability is likely to be somewhat more valuable to farmers than cash payments

Avoiding 20% yield loss due to a warming climate would be worth $180-240 in a given year

Forage and fuelwood from shade trees is likely to be worth <$50 p.a.

Carbon income on the assumed 1.5 ha. of cocoa plot contained within the project is likely to be worth <$90 p.a., with only a proportion of this going to the farmer once project overhead is covered

[47] Asitoakor et al, 'Selected shade tree species improved cocoa yields in low-input agroforestry systems in Ghana', Agricultural Systems, October 2022
[48] The FCPF is a multi-donor trust fund managed by the World Bank that supports countries to get "ready" for REDD+ and purchases REDD+ offsets
[49] "Ghana Signs Landmark Deal with World Bank to Cut Carbon Emissions and Reduce Deforestation", World Bank, July 2019

Project-specific risks and potential mitigations

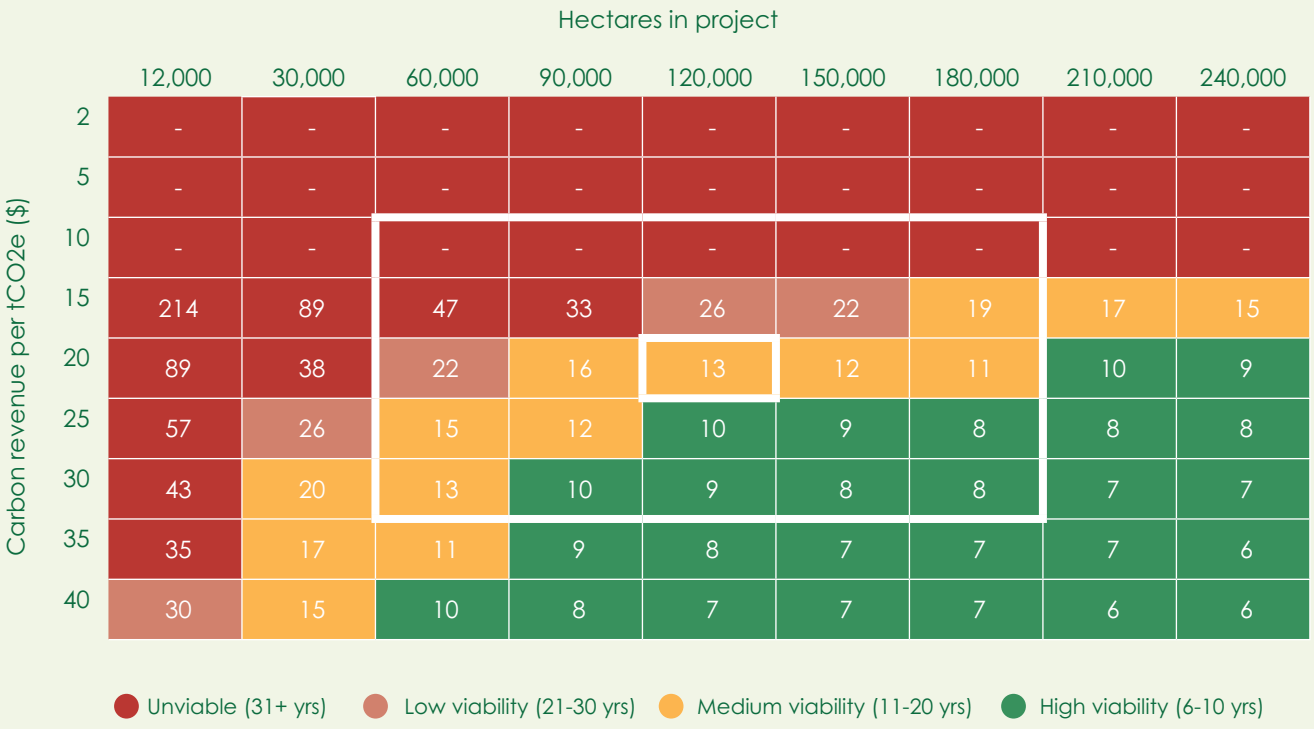
- ***Variable farmer group/co-operative capacity –*** Many cooperatives have limited capacity and governance, which limits the pool of eligible farmers, creates risk around the longevity of relationships, and could require investment into traceability and payments systems in the event that direct cash payments were to be made to farmers. To mitigate the risk, the LBC would need to grow the project carefully, onboarding trusted farmer group / cooperative partners over time.
- ***Risk of carbon credit nationalisation –*** The Government of Ghana committed all forest carbon credits to the Forest Carbon Partnership Facility[48] (FCPF) in a 2019 deal which limits the ability for independent carbon projects to be established within areas designated as forest land for a five-year period.[49] While this does not preclude establishment of new voluntary carbon projects on cocoa farms situated on crop land,[50] this provision would materially restrict the number of eligible farms in the short term. Depending on the scope of future REDD+ agreements (e.g., a pending submission to the Lowering Emissions by Accelerating Forest Finance (LEAF) Coalition) these limitations could also extend beyond the life of the FCPF contract.
- ***Complex system of land tenure*** – Ghana has a wide range of forms of land tenure, often poorly documented by smallholders themselves, and no functional rural land registry to resolve disputes. This creates operational complexity and increases reversal risks, with only partial mitigation possible through careful diligence of farmer tenure.
- ***Additional complexity from tree tenure legislation*** – Under Ghanaian law, the Government of Ghana by default owns all naturally occurring trees. While reforms in recent years have attempted to increase smallholder rights (for example through the implementation of a tree registration system), in practice any private investor into smallholder agroforestry carbon projects would need to negotiate directly with the Government to ensure they can claim rights to the carbon. Combined with an already complex land tenure system, this has significant potential to increase the cost and complexity of setting up new carbon projects.

Viability

If the full 130,000 ha. of cocoa were included at a target price of $20, a carbon project should be commercially attractive, paying back around Year 13 to smallholder farmers in our indicative assessment (see appendix for model assumptions). Project viability is heavily determined by carbon revenue per tonne CO2e, with borderline viability at lower price points (e.g., $15 range). Challenges around risks of credit nationalisation in Ghana, and the additional cost and complexity of dealing with land and tree tenure issues, in practice weaken the business case both by limiting scale and increasing risk for investors. Nevertheless, there is a case to be made that commercially financed carbon projects in cocoa agroforestry could be viable in the short to medium term.

[50] "Rooted in the ground: reforming Ghana's forest laws to incentivise cocoa-based agroforestry", O'Sullivan et al., 2021

Payback period (years)



Case study 2

Shade tree carbon financing for smallholder coffee producers in Tanzania

Case study 2

Shade tree carbon financing for smallholder coffee producers in Tanzania

Coffee cultivation in Tanzania

Tanzania has a fast-growing economy with a heavy reliance on agriculture, which employs over half of the workforce. Coffee is a significant crop, accounting for ~5% of all national exports and employing 300,000-400,000 smallholder farmers, of whom around two thirds are cultivating lower value robusta variety (predominantly in the north-western region of Kagera), while around one third cultivate higher value arabica (mostly around Kilimanjaro and the Southern Highlands). This implies that approximately 1.5-2 million people rely on the crop for their livelihoods, or ~3% of the population.

Coffee market in Tanzania

The top three coffee exporters in Tanzania each hold roughly 20% market share, implying a smallholder supplier base of approximately 60,000-80,000 in the supply chain of each company, farming coffee on ~30,000-40,000 ha. of land. As of 2019, coffee exporters are allowed to work directly with arabica coffee Agricultural Marketing Cooperative Societies (AMCOS), creating a basis for greater investment into the supply chain.

Carbon finance opportunity

Traditionally, coffee is grown in the shade of taller trees, but in the latter half of last century many farmers switched to full-sun cultivation. This tends to produce higher yields in favourable conditions, but leaves the crop more vulnerable to climatic extremes. Coffee yields are expected to be heavily impacted by climate change, in particular the higher value arabica variety which requires cooler, higher altitude conditions. Carbon finance could provide funding for smallholder farmers to purchase shade trees for their coffee plots, sequestering carbon while increasing climate resilience and improving access to valuable non-timber forest products such as fruits, nuts, fodder, or fuelwood.

Carbon sequestration potential

Planting a hectare of full-sun coffee with 30 shade trees of a recommended variety such as Cordia africana or Albizia schimperiana[51] could remove an average of 2t CO2e per ha p.a. during the first

[51] "Ecosystem Services and Importance of Common Tree Species in Coffee-Agroforestry Systems: Local Knowledge of Small-Scale Farmers at Mt. Kilimanjaro, Tanzania", Wagner et al., 2019

twenty years of tree growth. Assuming the carbon project was rolled out across both arabica and robusta farmers, this could drive removals of 60,000-80,000t CO2e p.a. within the supply chain of any of the top three coffee exporters. In practice, however, the government is only allowing exporters to work directly with arabica AMCOS, which limits scale potential to 25,000-35,000t CO2e p.a., and only a subset of these AMCOS would be viable partners in the short term due to governance challenges.

Commercial benefit

A share of the carbon finance could be allocated to exporters to fund long term extension to smallholder farmers in the supply chain, minimising the financial risk in investing in high quality smallholder support. Deeper and more consistent support to farmers should drive improvements in coffee quality and yield, as well as improve exporter share capture by increasing presence and reducing pressure to side-sell.

Smallholder impact

The key benefit to farmers would be through improved climate resilience due to the new shade trees, with co-benefits such as improved forage and fuelwood availability, or potentially through direct payment of financial incentives. Given that typical arabica farmer gross incomes are in the range of $600-800 p.a., improved climate resilience is likely to be somewhat more valuable to farmers than carbon payments

Avoiding 20% yield loss due to heat would be worth $120-160 in a given year

Forage and fuelwood from 30 trees is likely to be worth <$50 p.a.

Carbon income on a typical 0.5 ha. coffee plot is likely to be worth <$30 p.a., with only a proportion of this going to the farmer once project overhead is covered

Project-specific risks and potential mitigations

- ***Variable AMCOS capacity –*** Many AMCOS have weak capacity and governance, which limits the pool of eligible farmers, creates risk around the longevity of relationships, and could require investment into traceability and payments systems in the event that direct cash payments were to be made to farmers. To mitigate the risk, the exporter would need to grow the project carefully, onboarding trusted AMCOS partners over time.
- ***Volatile regulatory environment –*** Coffee exporters have only recently been able to start buying arabica coffee directly from AMCOS, following a period in which they were obliged to buy through a national auction system. Given the long timeline to sequester carbon, exporters are likely to want to limit financial exposure to AMCOS in case the regulations on direct purchase change again. To

mitigate this risk, the exporter is likely to require either a higher share of carbon income or subsidy (and potentially ongoing support) from donors.

- ***Limited documentation of land tenure –*** Many Tanzanian smallholder households lack formal documentation to their land and property, limiting potential for carbon finance agreements. Work is underway to improve the security of land tenure, notably through the $150 million Feed the Future Tanzania Land Tenure Assistance programme,[52] with potentially positive benefits for carbon finance projects, but in the medium-term, land tenure challenges are likely to limit the scale and add to the costs of smallholder carbon finance projects.

Viability

If the full 30,000 ha. of coffee were included at a target price of $20, a carbon project should be moderately feasible, paying back by Year 14. However, the commercial case quickly becomes weaker at a lower scale, which would present a material risk for this project given the practical limitations imposed by low capacity of AMCOS and insecure land tenure. Carbon revenue per tonne CO2e is also a key determinant of viability, and the project would not be viable at lower price points (e.g., $10-15). Overall project viability is therefore likely to remain borderline in the medium term, until such a time as either credit prices increase significantly, or the regulatory landscape evolves to allow larger scale supply chain investment by coffee exporters.

Payback period (years)

Hectares in project

Carbon revenue per tCO2e ($)	3,000	7,500	15,000	22,500	30,000	37,500	45,000	52,500	60,000
2	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-
15	233	96	51	35	28	23	20	18	16
20	96	41	23	17	14	12	11	10	10
25	62	28	16	13	11	10	9	8	8
30	46	22	13	11	9	8	8	7	7
35	38	18	12	9	8	8	7	7	7
40	32	16	10	9	8	7	7	7	6

Unviable (31+ yrs) Low viability (21-30 yrs) Medium viability (11-20 yrs) High viability (6-10 yrs)

[52] "Tanzania: New World Bank Financing to Secure Land Rights for Up to Two Million Citizens", World Bank, December 2021

Case study 3

Smallholder vanilla agroforestry in Tanzania

Case study 3

Smallholder vanilla agroforestry in Tanzania

Vanilla cultivation in Tanzania

Tanzania is a niche producer of vanilla globally, accounting for <1% of global production. Vanilla is primarily cultivated in the north-western region of Kagera, however many areas of Tanzania have a favourable climate for vanilla and pockets of production are scattered throughout the country. Vanilla is a vine, typically cultivated in an agroforestry setting alongside other trees which it relies on for shade and support. While planting new vanilla vine cuttings generally needs only a small cash investment, vanilla is both labour and knowledge intensive to grow and requires substantial time and effort from the farmer before generating income. The number of active vanilla farmers is estimated to be in the tens of thousands today, but is growing with the support of a vanilla processing business that supports farmers with the inputs, training, and market access required to drive new planting.

Vanilla market in Tanzania

Tanzania is a small origin for vanilla both in comparison to its neighbour Uganda (400t green vanilla, or about 5% of global production) and at a global level, where the market is dominated by Madagascar and Indonesia (collectively 5,000t, or 70% of global production). Production levels in Madagascar in particular have a large influence on global prices, leading to large swings in price that are often exacerbated by government intervention. International vanilla buyers, such as multinational food and beverage brands and flavour and fragrance houses, are therefore looking for an alternative source of high-quality vanilla, increasing interest in Tanzania as a vanilla origin. The key player in the Tanzanian market is an inclusive vanilla processing business that directly supports and sources from farmers, but there are also a range of smaller exporters with more transactional farmer relationships.

Carbon finance opportunity

Vanilla vines themselves contain minimal carbon; however, the trees that provide vanilla with shade and support have high potential for carbon sequestration, and vanilla can provide a strong economic incentive for managing the agroforest. Vanilla requires careful management of the vine and its microclimate over the course of the season, as well as individual hand pollination of each flower in order to produce meaningful quantities of vanilla. Furthermore, new vanilla vine cuttings typically take three years to mature and start producing vanilla, meaning that there are high barriers to entry for smallholder

farmers. At the same time, there is substantial longer term earning potential from vanilla if cultivated correctly. The carbon finance opportunity would be to support agroforest setup including funding the upfront costs of vanilla vine cuttings and shade/support tree seedlings that sequester carbon, with the high value vanilla vines providing a guarantee of longer term durability. Carbon credits could also help to cover some of the ongoing costs incurred by the intermediary in training farmers in vanilla agronomy, supporting farmers with the highly specific pruning requirements of the agroforestry setup, etc.

Carbon sequestration potential

Planting a hectare of agroforestry with a mixture of Gliricidia sepium for initial shade and support and slower growing, higher density tree species for long term shade could remove an average of 10t CO2e per ha p.a. during the first twenty years of tree growth. Assuming the carbon project was rolled out across 10,000 farmers with half a hectare each, this could drive removals of 50,000t CO2e p.a. within the supply chain of Tanzania's largest vanilla processor.

Commercial benefit

A share of the carbon finance could be allocated to the agribusiness to fund long term extension to smallholder farmers in the supply chain across both vanilla and agroforestry trees—which could include tree crops such as cocoa or macadamia and/or other varieties providing forage, brushwood, etc. Consistent, skilled support to farmers across their entire agroforestry plot will help to maximise the economic potential of each hectare from both vanilla and other NTFPs, reducing pressure to side-sell and protecting farmers against vanilla price fluctuations. For the agribusiness, this will provide a new long-term source of vanilla supply and support an economic case for deep, consistent extension to farmers in the supply chain in the face of commercial pressure from smaller, more transactional vanilla exporters.

Smallholder impact

A new vanilla agroforestry plot spread over half a hectare could generate vanilla incomes of between $300 and $600 p.a. depending on market prices, with the agroforest providing hundreds more dollars of additional income in cash (e.g., from fruit, nuts, or other cash crops) or in kind (e.g., from brushwood, fodder for livestock, etc.). Assuming that each agroforestry plot is capable of sequestering 5t CO2e, carbon payments on the plot could plausibly be worth <$100 p.a., with only a proportion of this going to the farmer once project overhead is covered. Potential income impact from the farm is clearly more significant than the carbon payments, but by comparison to the coffee and cocoa shade tree projects examined above, both modalities generate meaningful income benefits.

Project-specific risks and potential mitigations

- ***Additionality –*** While vanilla agroforestry creates significant long term financial incentives for smallholders to maintain and manage the agroforest, this also increases the risk that credit buyers will have concerns over additionality given the prima facie financial case for farmers to adopt the practice themselves. In practice, capital and expertise barriers are both significant, and require financing and the long-term support of an intermediary to ensure success.
- ***Support requirements –*** More so than the cocoa and coffee shade tree projects examined above, vanilla agroforestry is reliant on ongoing training and support to help farmers successfully manage

their agroforestry plots and maximise incomes. Typical support models, such as private extension teams managed by agribusinesses, are costly and can be challenging to sustain in more competitive markets—potentially putting project durability at risk. To mitigate this risk, a meaningful allocation of carbon credit value would need to go to the intermediary to fund ongoing support in the face of competitive pressure.

- ***Limited documentation of land tenure –*** Many Tanzanian smallholder households lack formal documentation to their land and property, limiting potential for carbon finance agreements. Work is underway to improve the security of land tenure, notably through the $150 million Feed the Future Tanzania Land Tenure Assistance programme,[53] with potentially positive benefits for carbon finance projects, but in the medium-term, land tenure challenges are likely to limit the scale and add to the costs of smallholder carbon finance projects.

Viability

If the full 10,000 ha. of new vanilla agroforestry was included at a target price of $20, a carbon project should be moderately feasible, paying back by Year 16. In contrast to the cocoa and coffee shade tree projects, the commercial case remains viable at a lower scale due to the higher carbon sequestration potential per hectare from vanilla agroforestry. Carbon revenue per tonne CO2e is also particularly important here, and higher price points (e.g., $30-40) would make projects of this nature significantly more likely to be feasible.

Payback period (years)

Hectares in project

Carbon revenue per tCO2e ($)	1,000	2,500	5,000	7,500	10,000	12,500	15,000	17,500	20,000
2	-	-	-	-	-	-	-	-	-
5	5,844	2,341	1,173	784	589	472	394	339	297
10	324	133	69	48	37	31	26	23	21
15	169	71	38	27	21	18	16	14	13
20	115	49	27	20	16	14	12	11	11
25	88	38	22	16	13	12	11	10	9
30	72	32	18	14	12	10	9	9	8
35	61	27	16	12	11	9	9	8	8
40	53	24	15	11	10	9	8	8	7

Unviable (31+ yrs) Low viability (21-30 yrs) Medium viability (11-20 yrs) High viability (6-10 yrs)

[53] "Tanzania: New World Bank Financing to Secure Land Rights for Up to Two Million Citizens", World Bank, December 2021

Section 5

Smallholder carbon project design principles

As the case studies demonstrate, the viability of smallholder carbon projects is sensitive to a wide range of factors. Agribusinesses looking to design successful carbon projects with smallholder farmers will need to make strategic choices around which projects and partners to select, as well as tactical decisions on project design. Viable projects require a **strong smallholder business case** for the short and long term, focused in a supply chain with **scale potential** and attractive **per hectare economics**, within a supportive **legal and political context**; agribusinesses can improve the chances of success by paying close attention to these factors when deciding whether to pursue a carbon finance opportunity.

A **strong smallholder business case** is the foundation of a successful smallholder agroforestry carbon project, as project success is contingent on the long-term engagement of smallholder farmers and communities more broadly. Because seedlings typically take several years to mature and produce meaningful revenues (whether from carbon removals or from yields of fruit, nuts, etc.), projects typically support farmers by financing upfront investments, and engage them by sharing cash incentives for particular activities or outcomes. Projects can focus on cash incentives in earlier years and supporting agroforestry yields in later years to maintain farmer engagement and ensure project durability beyond the project lifespan.

As can be seen from the case studies, **scale potential** is determined by both the number of hectares (and therefore farmers) that can be aggregated in a single project, and by the carbon sequestration per hectare of the intervention. The case studies demonstrate wide differences in the area that can aggregated in a project depending on value chain, country, and market structure: cocoa cultivation is ubiquitous across much of Ghana, and the cocoa aggregation market is relatively consolidated, giving a large potential project area through any of the major players; by comparison, vanilla is a niche crop in Tanzania, and the number of hectares that an agribusiness in the value chain could draw into a carbon project is limited.

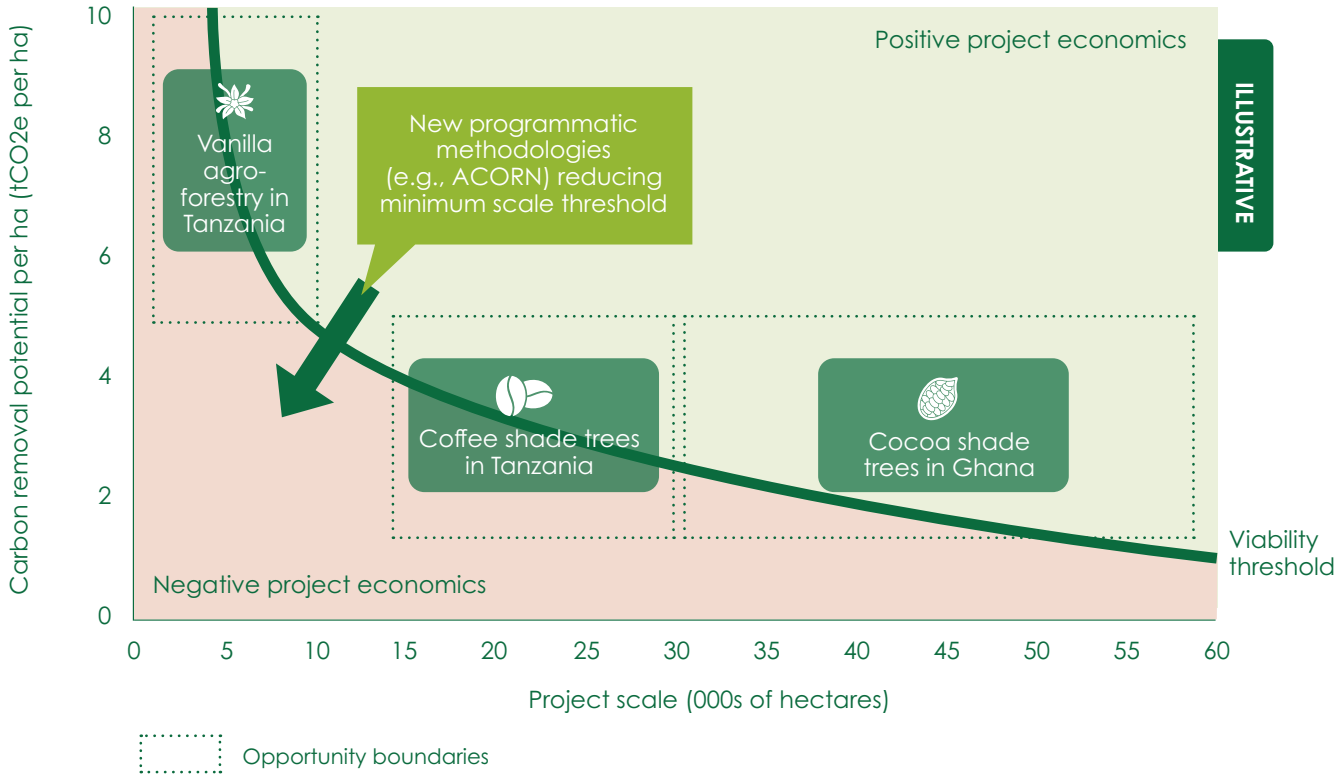
But that is not the full picture, because carbon sequestration potential can vary significantly between agroforestry interventions, and vanilla agroforestry is more "carbon dense" (as new agroforest is being established on degraded or fallow land with a limited carbon stock), while cocoa and coffee shade trees are more "carbon light" (as there is only selective new planting occurring on cultivated land). Both models could in fact be viable with the correct strategy and partner: agribusinesses operating in niche value chains, or challenger businesses in large value chains, should focus on opportunities that maximise the per hectare carbon sequestration potential of the agroforestry intervention in order to cover overhead costs on a smaller pool of farmers. Businesses with greater scale, however, are likely to be better positioned to consider less intensive interventions such as adding shade trees.

Attractive per hectare economics are driven by both the incremental costs to set up and run the project, and the sales price of carbon credits. **Incremental running**

cost is a key variable, likely to be driven primarily by farmer support and monitoring costs.[54] The case studies illustrate two different strategies to limit additional cost here—planting cocoa and coffee shade trees should be relatively straightforward and therefore require limited support from agribusiness extension officers to be successful, while vanilla agroforestry is likely to require significant ongoing support due to its greater complexity—but because the business already works closely with farmers, there is limited incremental cost. This suggests that more inclusive agribusinesses, which already provide farmer support as core to their business operations, can set their sights on more complex agroforestry transformations, while those with looser links to farmers should focus on simpler interventions that pay back at scale.

Incremental setup cost is the other key component of cost, covering both the cost of seedlings, labour, inputs, and so on; and one-off project costs such as project design, stakeholder consultation, project validation, and farmer recruitment. One-off project costs are high, resulting in large minimum scale requirements that are challenging for smallholder projects to achieve—as can be seen below. However, new programmatic methodologies enabled by satellite technology (e.g., Rabobank ACORN) are emerging that allow smallholder carbon projects to be aggregated and set up at significantly lower cost. By reducing upfront costs, such methodologies should enable projects to achieve viability at significantly lower scale, opening up projects to smaller agribusinesses and FPOs.

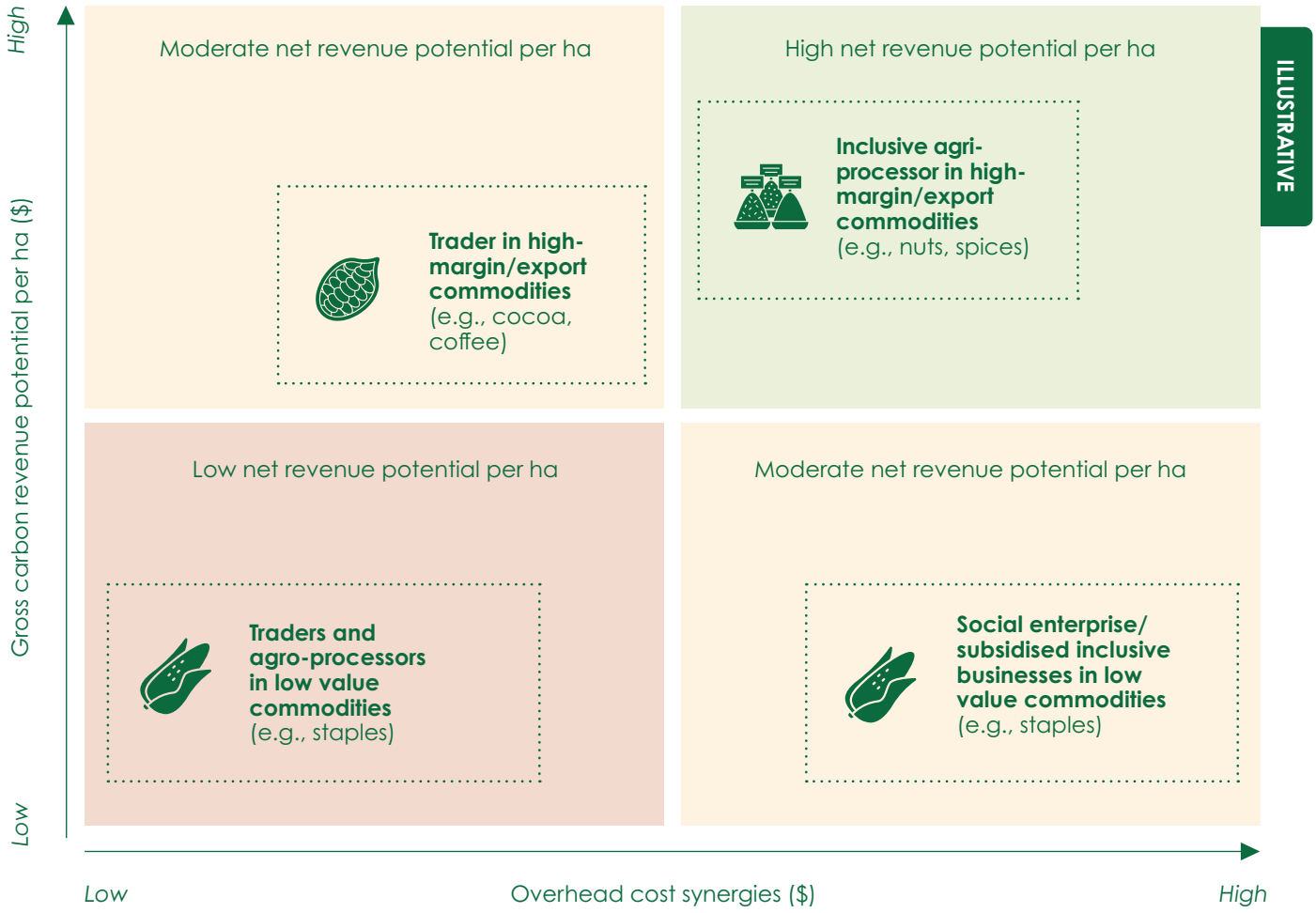
Sector opportunity map: carbon removal potential based on business scale and per hectare sequestration potential



[54] Provided the projects can reach sufficient scale, otherwise fixed carbon project overhead (monitoring, audit, etc.) would become prohibitively expensive

Sales price of carbon credits generated by each project is of course also a critical driver of project viability, with unit economics generally starting to work in the $15-$25 range. Pricing potential of smallholder agroforestry carbon projects is difficult to know given the small number of existing projects, opacity of the market, and rapid development in demand. On the one hand, standard AFOLU credits (e.g., from plantation projects in the global north) trade at about $9 per tCO2e, while on the other hand some market participants believe that corporates looking to develop credible insetting platforms (e.g., chocolatiers buying cocoa, coffee roasters buying arabica, and cosmetic brands buying vanilla extract) are willing to pay above $20. Agribusinesses operating in high value export commodity supply chains should therefore be pursuing long-term insetting agreements with customers, while those serving domestic and regional markets—for example, those that focus on staple crops—will need to identify approaches that function at the lower end of the price range, potentially including social enterprise / subsidised business models such as One Acre Fund.

Where to play: net carbon revenue potential by business model



Finally, each case study illustrated specific legal and political risks. In Ghana, legal structures related to carbon finance are relatively well developed, but it is challenging for businesses to navigate legal barriers. In Tanzania, on the other hand, legislation on carbon finance is at an earlier stage, creating greater risk that future policy developments will affect the viability of carbon projects with smallholder farmers. Governments across the world are studying carbon credits to understand their potential, and carbon markets are likely to come under further scrutiny. Carbon financiers or donors wishing to support carbon finance for smallholder farmers must be prepared to assume these risks, as neither agribusinesses nor smallholder farmers are able to. Donors and policymakers, meanwhile, can help to drive forward carbon finance regulatory frameworks, reducing legal risk over time.

These case studies demonstrate that if agribusinesses can identify opportunities with sufficient scale potential, attractive per hectare economics, and a broadly supportive legal and political context, smallholder carbon projects could in theory be viable for a range of agribusinesses. However, carbon finance providers are themselves commercial entities and require not only sufficient returns to cover implementation costs and risks (both of which are likely to be higher in projects involving smallholder farmers), but also to compete with opportunities in alternative NBS. Consequently, although all the projects examined in the case study have theoretical viability, only cocoa in Ghana currently appears to be attracting the interest of larger commercial players in the carbon finance space.[55] For smaller projects, donor support will most likely be required to reduce risks of upfront investment and to reduce perceived opportunity costs by facilitating complex negotiations between farmers, agribusinesses, and carbon financiers.

Once a decision has been taken to assess an opportunity, adhering to key design principles for smallholder carbon projects can help to maximise chances of project durability. In particular the following points should be borne in mind:

1. Treat smallholders as farmers, not carbon farmers: the economic value of credits under most scenarios is likely to be relatively small compared to farm income. For example, at a carbon price of $25, a farmer sequestering 6 tCO2e p.a., and capturing 50% of credit value as cash payments would receive $75 p.a. This is a meaningful sum, but still small compared to cash crop net incomes of $500-$1000 p.a. for a typical smallholder farmer in SSA, and would remain relatively small even at carbon prices of $50 or $75 per tCO2e. The opportunity for the majority of farmers is likely to be in building the long-term productive capacity of their farms in the face of climate change, whether through physical adaptation of farms or income diversification. The goal of project design should therefore be to identify those opportunities and assess what role carbon finance can play in making them a reality, rather than to identify carbon mitigation opportunities and find ways to bolt them onto existing farming practices. Projects should therefore focus first on identifying opportunities to strengthen smallholder farms through agroforestry, and then see what role carbon payments play in this process rather than seeing "carbon farming" as a meaningful source of income in and of itself.

2. Build in incentives for today and tomorrow: leaving aside natural threats (e.g., extreme weather, forest fires), the durability of smallholder agroforestry carbon projects is determined by the economic opportunities that farmers see in the project. Without sufficient ongoing incentives, farmers will prioritise land use options that lead to immediate returns. Smallholder agroforestry projects must progressively layer on upfront

[55] Industry participants indicated in discussions that several initiatives are in planning or execution in the cocoa sector in Ghana

financial incentives, short term crop harvests (e.g., through annual intercrops), collection of wood waste, and longer-term harvests of tree crops and timber.[56] It is also likely that, given the increasing impacts of climate change in SSA, farmers will increasingly appreciate the climate adaptation benefits of agroforestry.

3. Design projects around the core business model: larger trading businesses with limited field presence may be better placed to focus on simpler interventions with low support requirements (e.g., shade trees in cocoa or coffee), while smaller agro-processors with a heavier field presence can build on their existing farmer support activities and may be better positioned to target more sophisticated dynamic agroforestry projects with greater carbon sequestration potential. Carbon finance will have the most enduring impact when it can work with the grain of an agribusiness's sourcing model to fund deeper, more committed relationships with smallholder suppliers that leverage the existing investments (of labour and capital) of both parties. Conversely, where projects require agribusinesses to operate outside their core operating model, there are meaningful risks to both scalability and sustainability of the model.

4. Build transparent and equitable partnerships: projects must ensure that farmers, intermediaries, and finance providers receive an equitable share of the carbon revenue, proportionate to the value they provide. While the emphasis should be on maximising value to the smallholder, where intermediaries such as agribusinesses or project developers are incurring real costs and risks to finance projects and support farmers to ensure successful outcomes, sufficient value will need to be shared with them to incentivise participation. Projects should look to build in transparency around the balance of risk and reward between stakeholders from the design phase, creating a basis for the long term partnerships with farming communities that the project will need to succeed.

5. Balance income potential against additionality risk: carbon finance has the potential to fund investment into new trees that generate higher farmer incomes, but focusing heavily on attractive options for farmer investment inherently raises additionality risks. How likely is it that these farmers would have gone ahead anyway and purchased seedlings without carbon finance? The risk is greatest with more attractive tree crops such as palm oil, cashew, and so on, and it is possible that decisions to fund these crops at scale will come under scrutiny in the future if the additionality case is not built scrupulously—particularly in crops which are associated with deforestation. Projects should be careful to assess the opportunities and barriers in order to articulate a clear narrative around additionality to eventual buyers of carbon credits.

[56] "How durability in forest carbon forces us to think about livelihoods", Taking Root, September 2022

Section 6

Recommendations for donors and policymakers

Carbon markets are currently experiencing rapid growth in both volume and price, and a range of organisations are exploring how to funnel carbon finance towards agriculture funding. However, carbon projects with smallholder farmers have a limited track record, and to date have generally been heavily subsidised by donors. If carbon finance solutions for smallholder farmers are to scale in the long term, then projects will ultimately need to wean themselves off limited pools of donor subsidy.

In order to maximise the chances of long-term success, donors should actively look to support projects that are designed to strengthen the business model of organisations—such as agri-SMEs— that have long-term incentives to participate in agricultural markets. The full potential of carbon finance for smallholder agriculture will only be realised when a functional equilibrium can be found between carbon financiers, the smallholder farmers that mitigate carbon emissions, and the organisations that support them to do so. Judiciously targeted donor funding can play an important role in figuring out what works and why.

At the same time, the challenges involved in taking smallholder carbon finance from a curiosity to a true alternative source of capital for the sector should not be underestimated, and donors must ensure that scarce resources are focused on those opportunities with the greatest chances of success and replication. Donors and policy-makers will need to be realistic about how many viable opportunities will be identified, as many agribusinesses lack either sufficient scale to be viable or the depth of engagement to provide meaningful synergies on farmer-support costs. We believe that donors and policymakers are well placed to support the development of a smallholder-inclusive carbon finance ecosystem in the following ways:

1. Donors should work with concessional and commercial investors to establish blended finance solutions that can fund upfront investments into smallholder agroforestry (and smallholder NBS more generally) to be repaid at a later date through carbon credits. Limited solutions currently exist to bridge the upfront costs incurred by smallholder farmers with the future payments available for high quality, verified credits. Upfront costs have historically been met by donor capital, and while commercial funding is starting to flow into the space, the level of risk involved in providing this finance implies high return expectations which limit the potential to share value back with smallholder farmers.

Blended finance solutions could take the form of dedicated funds with a mandate to invest across multiple opportunities; or be ad hoc applications of technical assistance funding to create tailored solutions for individual agribusinesses, FPOs and NGOs and a carbon project developer partner.

2. Donor-funded technical assistance can play an important role in designing smallholder carbon projects with long-term impact, as well as promoting transparency and consistency in how smallholder carbon projects are delivered. At the project level, technical assistance funding could be used to subsidise the high design costs that smallholder carbon projects incur on account of their complexity and the need to consider smallholder impact holistically; or indeed to cover additional costs related to setting up a high-quality farmer training and support model. Technical assistance can help to ensure that the farmer is represented and their rights respected, and that the distribution of carbon revenues among project stakeholders is equitable and transparent.

Carbon markets for smallholder farmers are nascent and technically complex, and both farmers and agribusinesses generally lack the capacity to engage productively with potential partners, such as carbon developers. In particular, farmers will be dependent on others with more knowledge and expertise to access carbon markets, which creates significant potential for power imbalances between stakeholders. Donors could deploy funding through technical assistance facilities to play an enabling role as an honest broker between different stakeholders, helping to ensure that the business case stacks up for farmers and agribusiness partners alike, and promoting consistency in approaches between projects.

3. Donors should consider investing in industry coordination to help agribusinesses to achieve the scale necessary to attract carbon finance into the sector, for example by brokering partnerships between agribusinesses in promising value chains and geographies. While increasing carbon prices and cost-saving technological and methodological innovation should allow a greater range of projects to cover their running costs in the future, the fragmented nature of smallholder value chains means that the overall carbon opportunity that can be accessed via individual agribusinesses will be relatively small in absolute terms.

Outside a select group of value chains and geographies (e.g., cocoa in Ghana or Côte d'Ivoire, coffee in some East African geographies), carbon projects anchored solely in the supply chain of one company are likely to create opportunity costs for major commercial carbon project developers, who could access higher risk-adjusted returns elsewhere in their portfolios. While it is possible that some value chains and geographies with lower scale will still be attractive to corporate inset partners, many opportunities are likely to require the aggregation of multiple agribusinesses in pre-competitive partnerships or platforms. Donor funding could be usefully deployed to build these platforms, whether through targeted technical assistance or through dedicated programmes.

4. Donors should consider longer-term investments into innovative localised farmer support models that can capture and disseminate the local agroforestry knowledge essential to long term project success, while reducing long term costs of farmer support. Achieving significant scale with smallholder agroforestry projects will require capacity building at a local level, given the specificity of local climate, soil, cultural and market factors in identifying viable agroforestry setups. Donors could investigate, for example, whether there is a business model for local agroforestry entrepreneurs, drawing on indigenous knowledge and acting in partnership with agribusinesses, to support farmers to deliver smallholder carbon projects in which they are empowered.

5. Policymakers and donors should support efforts to clarify legal frameworks for carbon finance and initiatives to improve smallholder security of land tenure such that both smallholder farmers and the private sector can benefit from the opportunity. Only if policymakers set up carbon-rights frameworks in such a way as to allow the private sector to make carbon claims will there be private investment into NBS, and debates around carbon credit nationalisation or taxes, as well as a detailed framework for implementation of Article 6 of the Paris Agreement, all require urgent engagement. Similarly, underlying issues around security of land tenure must also be resolved in order for smallholder carbon finance to reach its full potential, and donors and policymakers could both consider supporting further initiatives to address this gap systematically.

Section 7

Path forward

Funnelling carbon finance to smallholder farmers has the potential to yield enormous rewards: by financing long-term transformations to smallholder farms that can drive productivity, increase climate resilience, and enhance biodiversity, carbon finance could address a long-standing finance gap that commercial capital struggles to fill due to returns horizons and perceived risk, and that donor capital struggles to reach due to budgetary constraints. The promise of carbon finance is to support the transition of smallholder agriculture to a more sustainable, productive and resilient future, in ways that benefit smallholder farmers and the broader agricultural sectors of less economically developed countries.

At the same time, significant risks and uncertainties remain. While there is a clear appetite from corporations to invest in carbon mitigation both inside and outside their direct supply chains, the costs and risks inherent to working with smallholder farmers limit the ease with which intermediaries (whether carbon project developers or agribusinesses themselves) are able to provide upfront investment.

We believe that blended finance is likely to be required to mitigate risks and subsidise setup costs for initial pilots until the benefits and costs of these initiatives are better understood. Despite the uncertainties, there is much to be gained from thoughtful, targeted pilots of smallholder carbon projects by agribusinesses. Adhering to the principles identified in this paper will help the sector to quickly establish whether carbon finance as a climate solution for smallholder farmers can work at scale and at speed.

Finally, policymakers looking to find ways to reduce poverty, increase food security and mitigate the impact of climate change in the developing world must not lose sight of the scale of the challenge. Voluntary carbon markets are themselves at an early stage of development, and while the current trajectory is promising, they could also develop in ways that are less favourable for the viability of smallholder carbon projects. Furthermore, there is wide variation in the depth of income and adaptation benefits produced by different projects—carbon finance will not be relevant to every smallholder farmer, and impact will vary significantly even among those for whom it is. With an annual "smallholder climate finance gap" likely to be in the tens, if not hundreds of billions of dollars, carbon finance for smallholders would need to scale massively before it can make a significant impact. Policymakers must therefore continue to prioritise climate finance for smallholder farmers more broadly, even as they explore the potential of carbon finance to meet some of the need.

Appendix 1

Glossary

Additionality: core principle that carbon finance should only be used to fund investments into climate mitigation that otherwise would not occur

Avoidance: preventing GHG emissions that would otherwise have occurred, e.g., through deforestation

Blended finance: finance that comprises tranches of market rate and sub-market rate capital, e.g., concessional capital or grants

Carbon payments: see "Payments for ecosystem services"

Concessional finance: finance offered below market rate by impact investors, public bodies, etc.

CO2e: Carbon dioxide equivalent, standard unit that normalises different GHGs relative to carbon dioxide based on their emissions

Durability: core principle that any nature-based solution must continue to exist after the initial project period, typically for a period of at least 50 years, in order for climate mitigation benefits to be claimed

FPO: Farmer-Producer Organisation, for example a farming co-operative

Insetting: carbon project developed within the supply chain of the carbon credit buyer, e.g., a chocolate manufacturer funds suppliers to mitigate emissions, potentially at production, aggregation, processing, and/or onward distribution steps

Nature-based solution: sustainable land and water management practices that address climate, biodiversity, water challenges etc.

Offsetting: carbon project developed outside the supply chain of the carbon credit buyer

Payments for ecosystem services (PES): payments made in return for activities that address climate and biodiversity, often funded through carbon revenue

Permanence: see "Durability"

Removal: removal of GHGs in the atmosphere, in the context of agroforestry through conversion to biomass; see also "Sequestration"

Sequestration: see "Removal"

Appendix 2

Featured carbon projects in smallholder agroforestry

We drew on the following sample of smallholder agroforestry carbon projects as part of our study. The list is not comprehensive, but we believe it is sufficient to draw general lessons from efforts to date.

Projects	Primary value chain	Country	Start year and status
One Acre Fund Tanzania	Multiple, focus on tree crop species	Tanzania	2021, active
One Acre Fund Zambia	Multiple, focus on soil health tree species	Zambia	2021, active
Rabobank ACORN Fund	Multiple	Multiple countries	2021, active
NAMA-Café	Coffee	Costa Rica	2015, active
Taking Root Communitree	Coffee, native tree species, silvopasture	Nicaragua	2010, active
Pur Projet Rwenzori	Coffee, Cocoa, Vanilla	Uganda	2015, active
Pur Projet Sidama	Coffee	Ethiopia	2015, active
Pur Projet West Africa	Cocoa	Ghana, Côte d'Ivoire	2018, active
Pur Projet Costa Rica	Coffee	Costa Rica	2019, active
Pur Projet Guatemala	Coffee	Guatemala	2014, active
Pur Projet Cauca Caficultura Forestal	Coffee	Colombia	2019, active
Pur Projet Cauca y Nariño	Coffee	Colombia	2014, active
Pur Projet Aprosacao	Cocoa	Honduras	2012, active
Pur Projet Alto Huayabamba	Cocoa	Peru	2008, active
Pur Projet Jubilacion Segura	Coffee, Cocoa	Peru	2010, active
Vi Agroforestry Kenya Agricultural Carbon Project	Multiple	Kenya	2009
World Bank, COMACO	Maize, Ground-nut	Zambia	Ran 2015-2019

Appendix 3

Model assumptions

The quantitative analysis in this report has been conducted through a simple carbon project model designed to allow high-level comparison of scenarios in different geographies, climates, altitudes, and agroforestry designs. In practice, the key assumptions that determine the economic viability of a carbon project are highly specific to each project context and require a full assessment. The figures shown in this report are therefore to be considered illustrative. Nevertheless, we have endeavoured to make sensible generalisations for key assumptions based on a triangulation of top-down and bottom-up data from a range of sources.

Key assumptions for the case studies presented above are as follows:

Assumption	Shade trees for cocoa in Ghana	Shade trees for coffee in Tanzania	Vanilla agroforestry in Tanzania
Carbon credit price	Central assumption of $20 based on mid-point of pricing observed by market participants we interviewed		
Project scale	Value-chain and country specific scenario		
Project scale	120k ha based on market scenario	30k ha based on market scenario	10k ha based on market scenario
Carbon sequestration potential per ha	2t CO2e per ha, based on additional 30 shade trees per ha of existing cocoa plot, removing ~67kg C02e p.a. in growth phase; assumes that some shade is already present, but below optimal level	2t CO2e per ha, based on additional 30 shade trees per ha of existing coffee plot, removing ~67kg CO2e p.a. in growth phase; assumes that some shade is already present, but below optimal level	7.5t CO2e per ha, based on indicative potential of 5-10t CO2e per ha in dynamic agroforestry settings in Tanzania
One-off setup costs – seedlings and labour	$30 per ha, assuming low cost shade tree species and farmers' own labour given small number being planted		$400 per ha, assuming that a mix of higher value tree species are being planted, and hired labour is required due to large number of trees being planted
One-off setup costs – project overhead	$16 per ha, driven by stakeholder consultation and farmer onboarding, as high scale dilutes impact of fixed costs of project design, validation, registry fees, etc.	$21, driven by stakeholder consultation and farmer onboarding; similar fixed costs to cocoa scenario, but relative lower scale drives higher costs per ha	$22, driven by fixed costs of project design, validation, registry fees, etc.; synergies achieved on stakeholder consultation and famer onboarding due to inclusive operating model

Assumption	Shade trees for cocoa in Ghana	Shade trees for coffee in Tanzania	Vanilla agroforestry in Tanzania
Cost of capital	An ROI of 2x on initial setup costs is assumed as representative of commercial expectations; this figure could be lower if blended finance were deployed, or in an insetting context where ROI for the buyer can also be generated through improved access to supply, enhanced brand, etc.		
Recurring costs – carbon payments	Assumed 20% of carbon revenue flows to farmers as carbon payments on average (share may be higher in earlier years and then taper to incentivisze upfront engagement and encourage long term durability)		
Recurring costs – incremental running costs	~$15 per ha, assuming that farmer support and monitoring activities are largely incremental given typically light field presence of many LBCs	~$15 per ha, assuming that farmer support and monitoring activities are largely incremental given typically light field presence of many coffee traders	~$5 per ha, assuming that most farmer support and monitoring activities can be incorporated within existing farmers support activities
First year of carbon revenue generation	Year 5, based on a typical timeline for a transplanted seedling to start adding on material biomass though growth		

As noted in the project design principles section, new methodologies and technologies (e.g., Rabobank ACORN) have the potential to significantly reduce project overhead costs, both for setup and ongoing support in the future. As indicated above, this could have a significant impact on minimum viable scale for commercially funded smallholder carbon projects.

Commercial Agriculture for Smallholders and Agribusiness

CASA aims to drive global investment for inclusive climate-resilient agri-food systems that increase smallholder incomes. The programme makes the case for increased agribusiness investment by demonstrating the commercial and development potential of sourcing models involving empowered smallholder producers and by tackling the information and evidence gaps holding back investment.

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For further information:

Ana Herrera

CASA TAF Team Lead
aherrera@tns.org