



Unlocking crediting opportunities in
climate-smart agriculture



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Summary

Agricultural production and food security are fundamental to global climate change objectives. Climate-smart agriculture (CSA) is an approach to address food security, climate change adaptation and mitigation. Agriculture directly contributes about 13% of all greenhouse gas (GHG) emissions, but when land conversion and other food system processes are taken into account, the total contribution of the food system may be as high as 29%. Under the Paris Agreement, countries have agreed to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to foster climate resilience and low-emissions development in a manner that does not threaten food production. Ninety percent of Nationally Determined Contributions (NDCs) prioritize adaptation to climate change in the agriculture sector, and 80% of NDCs commit to action on agricultural GHG mitigation. These multiple goals are reflected in the three pillars of climate smart agriculture (CSA):

1. **Sustainably increasing agricultural productivity** to support equitable increases in farm incomes, food security and development;
2. **Adapting and building resilience** of agricultural and food security systems **to climate change**; and
3. **Reducing GHG emissions** and/or **enhancing removals**, where possible.

Another aim of the Paris Agreement is to make finance flows consistent with low-emission and climate resilient development. The World Bank manages several carbon funds that could potentially provide results-based finance through emission reduction crediting for verified emission reductions (VERs) from changes in policies and programs with transformative impact and sustainable development benefits. To date, there has been limited engagement of the agriculture sector with results-based carbon finance and other forms of climate finance.

The objectives of this report are to assess the value proposition of results-based carbon finance for CSA, and to provide high-level guidance for the development of CSA carbon crediting programs that considers the characteristics of both the agriculture sector and results-based carbon finance. Target audiences for this report include both stakeholders in climate finance and in the agriculture sector. In particular, the report aims to inform developing country governments about the opportunities for promoting transformative CSA interventions within the framework of results-based finance and its potential positioning in relation to other World Bank financing.

Chapter 2 describes the key features of climate smart agriculture and its GHG mitigation potential, highlighting key features of CSA that are relevant for results-based climate finance. Chapter 3 explains the common requirements of results-based carbon finance facilities, with a focus on aspects that require particular consideration when applied to CSA. Chapter 4 focuses on measurement, reporting and verification (MRV), a key requirement of carbon finance facilities that presents particular challenges in the CSA context. Chapter 5 explores how carbon crediting programs can be customized to support upscaling of CSA. Four approaches to carbon crediting are described (project-based, programmatic, policy and jurisdictional approaches) and illustrative ‘blueprints’ are described for how each approach can be adapted to support upscaling of CSA. Chapter 6 summarizes the key messages of this report.

Chapter 2 highlights that there is large technical potential to mitigate GHG emissions through agroforestry, improved management of nitrogen fertilizers, and improved livestock and grassland management. There is also significant potential to reduce methane emissions from rice cultivation, to sequester soil carbon through conservation agriculture, and additional options in post-harvest food supply chains. Common barriers to adoption of CSA practices include high costs of adoption (e.g., up-front investment) and delayed returns to investment, land tenure security, failures and distortions in input markets, and knowledge and information gaps. CSA programs should target overcoming identified barriers and recognize that the fundamental driver of CSA adoption will often be the direct benefits for agricultural production, with GHG mitigation as a co-benefit. Existing initiatives that have supported large-scale adoption of CSA

practices show that in addition to ensuring incentives for producers, scaling requires development of enabling policy and institutional environments. There is potential for large-scale adoption of CSA where:

- There is evidence for high biophysical potential for mitigation impacts through reductions in absolute emissions or emission intensity;
- Technologies and practices have been tested and adapted to context;
- There is evidence that adoption of CSA practices brings positive benefits to producers, since the value of agricultural production per unit area is much higher than the value of mitigation benefits at low carbon price;
- There is an enabling (technical, finance and policy) environment to catalyze, implement and sustain practice changes.

Where all these conditions are met, results-based carbon finance programs can provide direct support to incentivize host country governments or the private sector to increase the ambition of public or private investments. Where these conditions are not yet met, other World Bank financing instruments (e.g. PforR, Investment Project Financing) can build capacities and conducive conditions, with results-based carbon finance providing incentives to support scaling up of policies or demonstrating measures at large scale to inform subsequent institutionalization of the mitigation measures in national policies or plans.

Few countries have specific mitigation targets in their NDC or well-elaborated mitigation plans in the agriculture sector. Constraints include lack of data and evidence; limited integration of agriculture and climate change policies; and limited capacities for identification and design of agriculture sector mitigation policies and measures. The process of designing and implementing results-based carbon finance programs can support the development of national capacities for identifying, designing and delivering agricultural mitigation programs, which may contribute to strengthening national capacities for increased mitigation ambition in the sector.

Challenges in supporting CSA through results-based carbon finance include high transaction costs, challenges in monitoring and verification, non-permanence risks of soil and biomass carbon sequestration, and uncertainty in markets for carbon credits. For many interventions, results-based carbon finance programs will need to develop cost effective GHG estimation methodologies. Approaches to reduce the transaction costs of monitoring include activity-based monitoring in which farming practices are monitored as a proxy for changes in GHG emissions, using conservative assumptions, standardized baselines, and technological innovations for data collection and management. Limited use of higher tier methods in national agricultural GHG inventories and limitations on inventory data sources may require that programs analyze scenarios specific to the GHG sinks and sources, production systems, commodities or regions targeted by the carbon crediting program. It also points to opportunities for carbon finance programs to support improvements in national MRV systems.

Results-based carbon finance can support CSA scaling through project-based, programmatic, policy or jurisdictional approaches. Chapter 5 presents three blueprints for how programmatic, policy and jurisdictional approaches can support scaling of CSA, highlighting how results-based carbon finance can complement other World Bank finance to create an enabling environment for scaling CSA and to incentivize upscaled adoption of CSA practices through transformative programs with sustainable development benefits that contribute to achieving the goals of the Paris Agreement.

List of abbreviations and acronyms

AWD	Alternate wetting and drying (paddy rice growing practice)
BAU	Business-as-usual
C	Carbon
CDM	Clean development mechanism
CH ₄	Methane (a greenhouse gas)
CO ₂	Carbon dioxide (a greenhouse gas)
CSA	Climate-smart agriculture
DAP	diammonium phosphate (a fertilizer)
ERPA	Emission Reduction Purchase Agreement
ETS	Emission trading scheme
FAO	Food and Agricultural Organization of the UN
GHG	Greenhouse gas
ha	Hectare
IBRD	International Bank for Reconstruction and Development
ICT	Information and communication technology
IPCC	Intergovernmental Panel on Climate Change
K	potassium
KCSAIF	Kenya Climate Smart Agriculture Implementation Framework
MOP	Muriate of potash (a fertilizer)
MRV	Measurement, reporting and verification
MtCO ₂ e	Megatonne of carbon dioxide equivalent (a million tonnes)
MWh	megawatt hour
N	Nitrogen, most often nitrogen fertilizer
N ₂ O	Nitrous oxide (a greenhouse gas)
NAMA	Nationally Appropriate Mitigation Action
NCCP	National Climate Change Policy (Pakistan)
NDC	Nationally determined contribution to the UNFCCC Paris Agreement
NOS	National Offset Standard (hypothetical name for a national scheme)
P	phosphorous
SDG	Sustainable development goals
SMART	Strengthening Markets for Agriculture and Rural Transformation, a World Bank PforR program in Punjab, Pakistan
SOP	sulphate of potash (a fertilizer)
TCAF	Transformative Carbon Asset Facility (of the World Bank)
tCO ₂ e	Tonne carbon dioxide equivalent
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States dollar
VER	verified emission reductions

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1. Introduction

Agricultural production and food security are fundamental to global climate change objectives in the context of sustainable development. Agriculture and food systems make critical contributions to 16 of the 17 Sustainable Development Goals.¹ Under the Paris Agreement, countries have agreed to hold the increase in the global average temperature to well below 2°C above pre-industrial levels, and to foster climate resilience and low-emission development in a manner that does not threaten food production.² Agriculture directly contributes about 13% of all greenhouse gas (GHG) emissions, but when land conversion and other food system processes are taken into account, the total contribution of the food system may be as high as 29%.³ The importance of agriculture is also reflected in the Nationally Determined Contributions (NDCs). Ninety percent of the first round of NDCs prioritized adaptation to climate change in the agriculture sector, and 80% of NDCs committed to action on agricultural GHG mitigation.⁴ These multiple goals of agricultural production are reflected in the three pillars of climate smart agriculture (CSA):⁵

1. sustainably increasing agricultural productivity and incomes;
2. adapting and building resilience to climate change;
3. reducing and/or removing greenhouse gases emissions, where possible.

Another aim of the Paris Agreement is to make finance flows consistent with low-emission and climate resilient development. In 2016, the World Bank Group committed to increase the climate-related share of its portfolio from 21% to 28% by 2020, and issued a Climate Change Action Plan to focus on transformational impacts, including increasing deployment of concessional climate finance and carbon finance.⁶ To date, the agriculture sector has been underrepresented in both carbon markets and other climate finance flows.⁷ Yet, as the energy and other sectors decarbonize, and action to reduce forestry and land use emissions gains traction, the relative contribution of agriculture sector emissions will increase.

The World Bank's manages carbon finance facilities that provide results-based finance through emission reduction crediting for verified emission reductions (VERs) from changes in policies and programs with transformative impact and sustainable development benefits.⁸ Given the current early phase of implementing the Paris Agreement, some of these facilities are interested in achieving recognition for purchased VERs under Article 6 of the Paris Agreement. One such facility, the Transformative Carbon Asset Facility (TCAF), is briefly described in Annex C.

Targeting the mitigation pillar of CSA, results-based climate finance programs in the agriculture sector must also demonstrate their contribution to sustainable development. It is important therefore to understand how agricultural GHG mitigation can contribute to food security and climate resilience. While there is a large-body of knowledge to inform results-based climate finance programs in sectors such as energy or transport, there is relatively less experience with the use of climate finance mechanisms in the agriculture sector. Understanding the potential and limitations of results-based climate finance in the agriculture sector is critical to the positioning of results-based climate finance in relation to other sources of financing, including World Bank Group financing.

¹ FAO (2018) Transforming Food and Agriculture to Achieve the SDGs (<http://www.fao.org/3/I9900EN/i9900en.pdf>)

² Paris Agreement, Article 2 (https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf).

³ Vermeulen, S. et al. (2012) Climate change and food systems. *Annual review of environment and resources*, 37.

⁴ Richards, M. (2019) National plans to address adaptation and mitigation in agriculture: An analysis of Nationally Determined Contributions. (https://ccafs.cgiar.org/publications/national-plans-address-adaptation-and-mitigation-agriculture-analysis-nationally#.Xu8_Z2hKg2w)

⁵ FAO (2013) Climate Smart Agriculture Sourcebook (<http://www.fao.org/3/i3325e/i3325e.pdf>)

⁶ World Bank (2016) Climate Change Action Plan 2016-2020 (<https://openknowledge.worldbank.org/bitstream/handle/10986/24451/K8860.pdf>)

⁷ CPI (2019) Global Landscape of Climate Finance 2019 (<https://climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2019/>)

⁸ <https://www.worldbank.org/en/topic/climatechange/brief/world-bank-carbon-funds-facilities>

The objectives of this report are to assess the value proposition for CSA of results-based carbon finance, and to provide high-level guidance for the development of CSA programs that can harness results-based carbon finance. Given the limited engagement of similar facilities with the agriculture sector, target audiences for this report include stakeholders in both climate finance and agriculture. In particular, the report aims to inform developing country governments about the opportunities for promoting transformative CSA interventions within the framework of the results-based carbon finance, and to provide guidance to the World Bank staff on the use of results-based finance alongside the World Bank Group finance to agriculture sector operations.

Chapter 2 describes the key features of climate smart agriculture and its GHG mitigation potential, highlighting characteristics of CSA that are relevant for results-based climate finance. Chapter 3 explains requirements common to many carbon finance facilities, with a focus on aspects that require particular consideration when applied to CSA. Chapter 4 focuses on measurement, reporting and verification (MRV), a common requirement that presents particular challenges in the CSA context. Chapter 5 explores how results-based carbon finance can be customized to support upscaling of CSA. Project-based, programmatic, policy and jurisdictional approaches to carbon crediting are outlined and three blueprints are presented that illustrate how results-based carbon finance could support scaling of CSA adoption. Chapter 6 summarizes the key messages of this report.

2 Agriculture sector overview

2.1 Agriculture and climate change

Agriculture contributes 5.0–5.8 GtCO₂e yr⁻¹ or 13 % of anthropogenic greenhouse gas (GHG) emissions globally, and most agricultural emissions are in the form of nitrous oxide (N₂O) and methane (CH₄).⁹ This is about the same scale of emissions as the transport sector. Agricultural emissions have a large share in national emissions, contributing an average of 35% of GHG emissions in developing countries and 12% in developed countries.¹⁰ Figure 1 illustrates the magnitude and sources of agricultural emissions in different developing regions. While global emissions from land use, land use change and forestry have begun to stabilize, **agricultural emissions have continued to grow at about 1% per year** and are now larger than emissions from forests and other land use.¹¹

The agriculture sector is critical to meeting mitigation targets. In 2015-16, more than 100 countries pledged to reduce agricultural GHG emissions in their NDCs submitted to the United Nations Framework Convention on Climate Change (UNFCCC). Agriculture has the potential not only to reduce emissions, but also to sequester carbon. The energy sector is expected to be largely decarbonized in the coming decades, leaving agriculture as the largest source of remaining emissions.¹² Agriculture is also a major driver of deforestation, and additional emissions occur in food supply chains (e.g. storage, processing, transport and retail) that are attributed to the energy, transport and other sectors.¹³ Therefore, agriculture is a key sector for meeting the Paris Agreement's goals.

Adaptation to climate change is critical for future food security. Food production will need to increase by 70% relative to 2010 to meet 2050 needs.¹⁴ Yet projections for climate change indicate likely increases in heat stress, extreme events such as floods, droughts, and hurricanes, and changes in precipitation and seasonality (onset of rains, length of growing season), which threaten food production. Climate variability accounts for about one-third of

⁹ Smith, P. and Bustamante, M. (2007). Agriculture, Forestry and Other Land Use (AFOLU). IPCC Fifth Assessment Report Working Group 3, Chapter 11. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter11.pdf

¹⁰ Richards, M. et al. (2015) *Agriculture's contributions to national emissions*. (<https://cgspace.cgiar.org/bitstream/handle/10568/68841/National%20Ag%20Emissions.pdf>)

¹¹ Tubiello, F et al. (2015) The contribution of agriculture, forestry and other land use activities to global warming, 1990–2012. *Global Change Biology*, 21(7): 2655–2660.

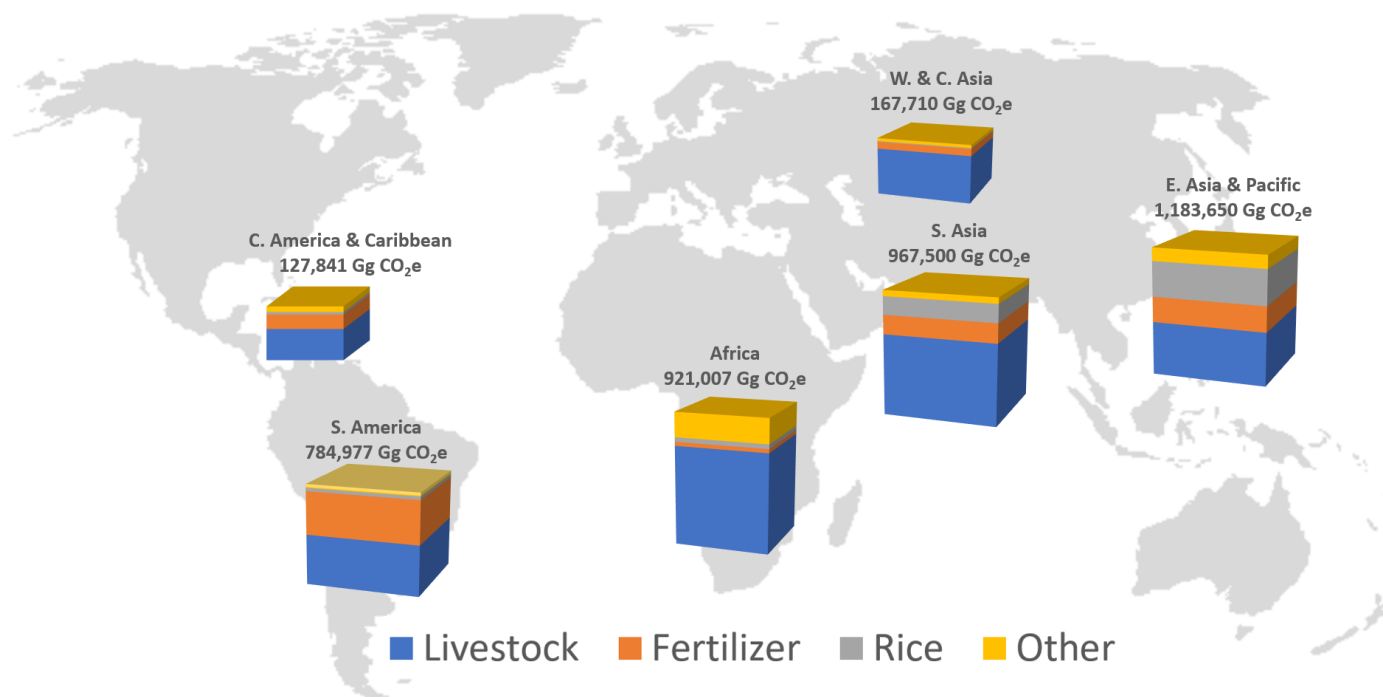
¹² Bajzelj, B. et al. (2014) The importance of food-demand management for climate mitigation. *Nature Climate Change* 4:924–929.

¹³ Vermeulen, S. et al. (2012) *op. cit.*

¹⁴ Alexandratos, N. and Bruinsma, J. (2012) *World agriculture towards 2030/2050: the 2012 revision* (<http://www.fao.org/3/a-ap106e.pdf>).

variation in the yield of major crops such as wheat, maize, rice and soybean globally, and about 60% of the variation in global breadbasket areas.¹⁵ The regions most severely threatened by climate change are also among those that are presently most vulnerable to food insecurity, including large parts of Africa, the Indo-Gangetic Plain and Central America. Safeguarding food security and ending hunger are fundamental priorities recognized in the Paris Agreement.

Figure 1 Agricultural GHG emissions and their composition in selected developing regions



Compiled from data in FAOSTAT

Agriculture also makes key contributions to other Sustainable Development Goals. In addition to ending food hunger (SDG 2), agriculture contributes to eliminating poverty and reducing inequalities (SDGs 1 and 10), providing employment both on- and off-farm (SDG 8). Agriculture is also central to protecting and enhancing natural resources (SDGs 14 and 15). In addition to food production, agriculture provides a range of other ecosystem services, such as soil fertility, regulation of water flows and water quality, and biodiversity conservation.¹⁶ Agriculture sector policies increasingly seek to balance multiple objectives, including climate change mitigation.

Much of the agriculture sector is dominated by smallholder producers. Globally, there are about 300-400 million farming households.¹⁷ Small and medium farms (≤ 50 ha) produce 51–77% of nearly all commodities and nutrients. Large farms (>50 ha) dominate production in the Americas, but small farms (≤ 20 ha) produce $>75\%$ of most food commodities in Sub-Saharan Africa (SSA), Southeast Asia, South Asia, and China. Very small farms (≤ 2 ha) contribute about 30% of most food commodities in Sub-Saharan Africa, Southeast Asia, and South Asia.¹⁸ At the same time, food systems across all continents are undergoing rapid change, as urbanization changes the types of food product demanded by consumers, and the development of modern food supply chains changes the requirements for product

¹⁵ Ray, D. et al. (2015) Climate variation explains a third of global crop yield variability. *Nature Communications* 6: 5989.

¹⁶ FAO (2007) The State of Food and Agriculture 2007: paying farmers for environmental services.

<http://www.fao.org/3/a1200e/a1200e00.htm>

¹⁷ Samberg, L. et al. (2016) Subnational distribution of average farm size and smallholder contributions to global food production. *Environmental Research Letters*, 11(12), p.124010.

¹⁸ Herrero, M. et al. (2017) Farming and the geography of nutrient production for human use: a transdisciplinary analysis. *The Lancet Planetary Health*, 1(1): e33-e42.

quality and production processes.¹⁹ These changes provide opportunities for smallholders to produce high value crops, but smallholders may also require support to overcome barriers to accessing these markets.

The need for the agriculture sector to balance the growing demand for food in a changing climate, manage large and growing GHG emissions, and maintain and enhance contributions to sustainable development calls for examining the role of results-based carbon finance for transformative and scaled up GHG mitigation action in the agriculture sector.

2.2 Climate-smart agriculture

2.2.1 The Climate Smart Agriculture approach

Climate-smart agriculture (CSA) is an approach to food security, climate change adaptation and mitigation. The three pillars of climate smart agriculture are:

- **Sustainably increasing agricultural productivity** to support equitable growth in farm incomes, food security and development;
- **Adapting and building resilience** of agricultural and food security systems **to climate change**; and
- **Reducing GHG emissions** and/or **enhancing carbon sequestration**, where possible.

Many **farming practices** that increase productivity may also increase the resilience of farming systems to climate variability and climate risks. For example, soil management practices that improve soil quality often increase soil moisture retention, and thus increase the resilience of crops to rainfall variability. Many farming practices also have benefits for GHG mitigation, by reducing GHG emissions, increasing carbon sequestration or contributing to conservation of existing carbon stocks.²⁰ For example, adoption of soil nutrient testing can guide farmers in more efficient use of nitrogen fertilizer, reducing GHG emissions from fertilizer application and production, while increasing crop yield.

CSA practices are often adopted as packages rather than single practices. Adopting multiple practices together may help to fully realize the potential of CSA interventions in a production system, landscape or value chain. For example, restoring degraded rangelands (increase in soil carbon sequestration) may be more effective when combined with improved animal feeding and breeding (reduction in CH₄ emissions) and fertilizer management (reduction in N₂O emissions). Growing cover crops (increase in soil carbon sequestration) in a fallow period after grain harvest may be more effective if coupled with more efficient nitrogen fertilization (reduction in N₂O emissions) and introduction of trees in alley cropping (increase in carbon sequestration).

CSA practices can be broadly categorized by agricultural production system. Table 1 presents **core CSA interventions** and the potential adaptation benefits in each production system. Core interventions are practices or bundles of practices for specific production systems that can contribute to mitigating GHG emissions and enhancing resilience of agricultural systems. The most common adaptation benefits from GHG mitigation interventions are **improved resilience to water shortages** through water and soil conservation; resilience to temperature extremes through agroforestry; **economic risk reduction** through input savings (e.g. water, fertilizer, energy); and **increases in food production**. Implementing alternative wetting and drying (AWD) technology in rice paddies, for example, reduces GHG emissions and reduces water use and production costs.²¹ Therefore, AWD improves farmer income, food security and resilience to variability in rainfall or water shortages. Improved livestock and grasslands systems, especially those with agroforestry, contribute to climate adaptation by increasing soil fertility, water conservation, thermal comfort for

¹⁹ Reardon, T. and Timmer, C.P. (2014). Five inter-linked transformations in the Asian agrifood economy: Food security implications. *Global Food Security*, 3(2): 108-117.

²⁰ World Bank (2016) Greenhouse Gas Mitigation Opportunities in Agricultural Landscapes. <http://documents.worldbank.org/curated/en/631751473149949797/pdf/106605-WP-Greenhouse-P132432-PUBLIC.pdf>

²¹ Allen, J. and Sander, B. (2019) The diverse benefits of alternative wetting and drying. (https://cgspace.cgiar.org/bitstream/handle/10568/101399/AWD_Co-benefits%20v2.pdf)

animals, forage quality and farmer income and economic diversification. **The suitability of each CSA practice varies among locations and may vary among households.**

Table 1 Core interventions for climate-smart agriculture and their adaptation benefits

Production system	Core interventions	Examples of practices	Mitigation effects	Adaptation benefits
Paddy rice	Water and residue management	Alternate wetting and drying, midseason drainage; short duration varieties, direct seeding, laser leveling; removal of rice residues	Reduced methane emissions, reduced energy use in water pumping	Water saving (reduces water demand and consumption), reduces energy costs where water is pumped
Other crops (cereals)	Enhancing soil organic carbon storage	Cover crops	Soil carbon sequestration	Reduces agricultural water demand; reduces soil erosion and redistribution; increases soil fertility and maintains soil moisture.
		Reduced tillage with avoided residue burning	Soil carbon sequestration, reduced emissions from biomass burning	
Livestock	Grassland/pasture management	Grazing management, improved grasses, reduced burning, biological nitrification inhibitors.	Soil carbon sequestration; reduced emissions from biomass burning; reduced N ₂ O emissions	Water and soil conservation through improved water retention and vegetation cover
	Animal management	Improving feeding, breeding and animal health	Reduced emission intensity	Improves production efficiency
	Manure management	Bio-digesters (anaerobic digestion)	Reduced methane and N ₂ O emissions from manure; reduced energy emissions	Reduces inorganic fertilizer use. Application of livestock manure to soil can increase soil C content
		Active composting of solid manure	Reduced methane and N ₂ O emissions from manure	
Multiple production systems	Nitrogen management	Nitrogen application management (i.e. rate, timing, type and amount; urea deep placement, precision agriculture, laser leveling)	Reduced N ₂ O emissions from application of synthetic fertilizers; reduced CO ₂ emissions from fertilizer production	Long-term soil fertility, enhanced soil organic matter and moisture retention, energy savings
	Agroforestry	Increased biomass from trees on farmland	Soil and biomass carbon sequestration	Buffering of climate variability; increased soil fertility; enhanced biodiversity; diversified incomes

Evidence for specific CSA practices is not equally available in all countries. The evidence base on CSA practices is growing, but is far from complete. For example, a review of evidence on the three CSA pillars for Eastern and Southern Africa found that most available evidence is about cereal crops, with much less data on other crops or livestock, and that most data relates to productivity with some data on resilience and very little data on GHG effects.²² Data gaps are common even in countries with well-funded research systems. Despite these gaps, there is a growing body of evidence about the effects of CSA practices at farm level on productivity, resilience and mitigation. This tends to show synergies among the three objectives of CSA for the majority practices. However, **some CSA practices may imply trade-offs among CSA objectives.** For example, adoption of more productive animal breeds may increase yields and reduce GHG emission intensity, but may increase animals' vulnerability to heat stress or disease. The **lack of data on GHG**

²² Rosenstock, T. et al. (2019) What is the evidence base for climate-smart agriculture in East and Southern Africa? A systematic map. In *The Climate-Smart Agriculture Papers* (pp. 141-151). Springer, Cham. (https://link.springer.com/chapter/10.1007/978-3-319-92798-5_12)

mitigation effects of different practices is one reason why agricultural mitigation options are often not well specified in NDCs.

Many CSA practices represent incremental improvements within existing farming systems. Adaptation to climate change may also involve transformational adaptation, which aims to reduce exposure or sensitivity of farming systems to climate change risks.²³ Examples of transformational adaptation include change in the production enterprise (e.g., adopting a new crop that is less sensitive to climate risks, or shifting a sheep production enterprise from producing mutton to producing lamb), or diversification of the household enterprises (e.g. so that livestock-dependent farmers are less vulnerable to climate change impacts on the livestock enterprise).

Promoting good practices at farm level will often require **supporting changes in the enabling environment**, including input supply chains, advisory and extension services, access to finance and access to output markets, and landscape or watershed planning. Transformation of farm enterprises will require that enabling conditions are in place in the wider operating environment. The three goals of CSA can be pursued at different scales, from plot or farm level through to the level of a landscape or whole supply chains. This is why CSA is termed an 'approach', and is not just a set of farming practices.

2.2.2 GHG mitigation potential of CSA practices

Figure 1 indicates the scale of agriculture sector GHG emissions in 2010, and the mitigation potential by 2030 for the main emission categories. In 2010, total agricultural emissions were about 4600 MtCO₂e, more than two thirds of which were from livestock (enteric fermentation and manure). Application of synthetic and organic fertilizers contributed about 17% and rice contributed about 11% of total agricultural emissions. Loss of carbon in cropland soils and woody vegetation emitted a further 25% of emissions in the land use sector. Several global reviews have estimated the mitigation potential of agriculture mitigation options.²⁴ Drawing on those reviews' findings, Figure 2 suggests a global mitigation potential in 2030 of about 3500 MtCO₂e per year from the options identified. The figures represent the technical potential in each emission category, which does not consider barriers to adoption that would need to be overcome. **Agroforestry has the largest technical mitigation potential**, followed by **improved management of synthetic nitrogen fertilizers** and **improved livestock and grassland management**.²⁵ Agroforestry, in particular, has been identified as a strategy for reducing deforestation in about 50% of developing country REDD+ strategies, and can thus also support mitigation in the forestry sector.²⁶

There are also important mitigation opportunities in food supply chains downstream from food production.

Examples include interventions to reduce food loss and waste, improvements in energy efficiency or use renewable energy (e.g. solar panels, wind, hydropower, biogas and biodiesel) and bioenergy production substituting for fossil

²³ Vermeulen, S. et al. (2018) Transformation in practice: a review of empirical cases of transformational adaptation in agriculture under climate change. *Frontiers in Sustainable Food Systems*, 2: 65.

²⁴ Smith, P. et al. (2007) Greenhouse gas mitigation in agriculture. *Philosophical Transactions of the Royal Society B* 363:789-813. <https://dx.doi.org/10.1098/rstb.2007.2184>; Dickie et al. (2014) Strategies for Mitigating Climate Change in Agriculture: Abridged Report. <http://www.climateandlandusealliance.org/reports/strategies-for-mitigating-climate-change-in-agriculture/>; Scholes, B. et al. (2014) Agriculture and climate change mitigation in the developing world (<https://ccafs.cgiar.org/publications/agriculture-and-climate-change-mitigation-developing-world#.XvS5DChKg2w>); Griscom et al. (2017) Natural Climate solutions. *PNAS* 114:11645-11650 (<http://dx.doi.org/10.1073/pnas.1710465114>)

²⁵ Agroforestry mitigation potential assumes 908 Mha suitable for agroforestry; synthetic N fertilizer potential assumes baseline of 140 million t N in 2030, reduced by 31%, and reduced emissions include emissions from N application as well as production of synthetic N fertilizers; livestock mitigation assumes improved grassland management on 712 Mha of grassland, and improved feeding and animal management for 1400 M head of cattle; rice management applied to 163 Mha; and conservation agriculture based on cover crops on 352 Mha. See Griscom et al. (2017) for further details.

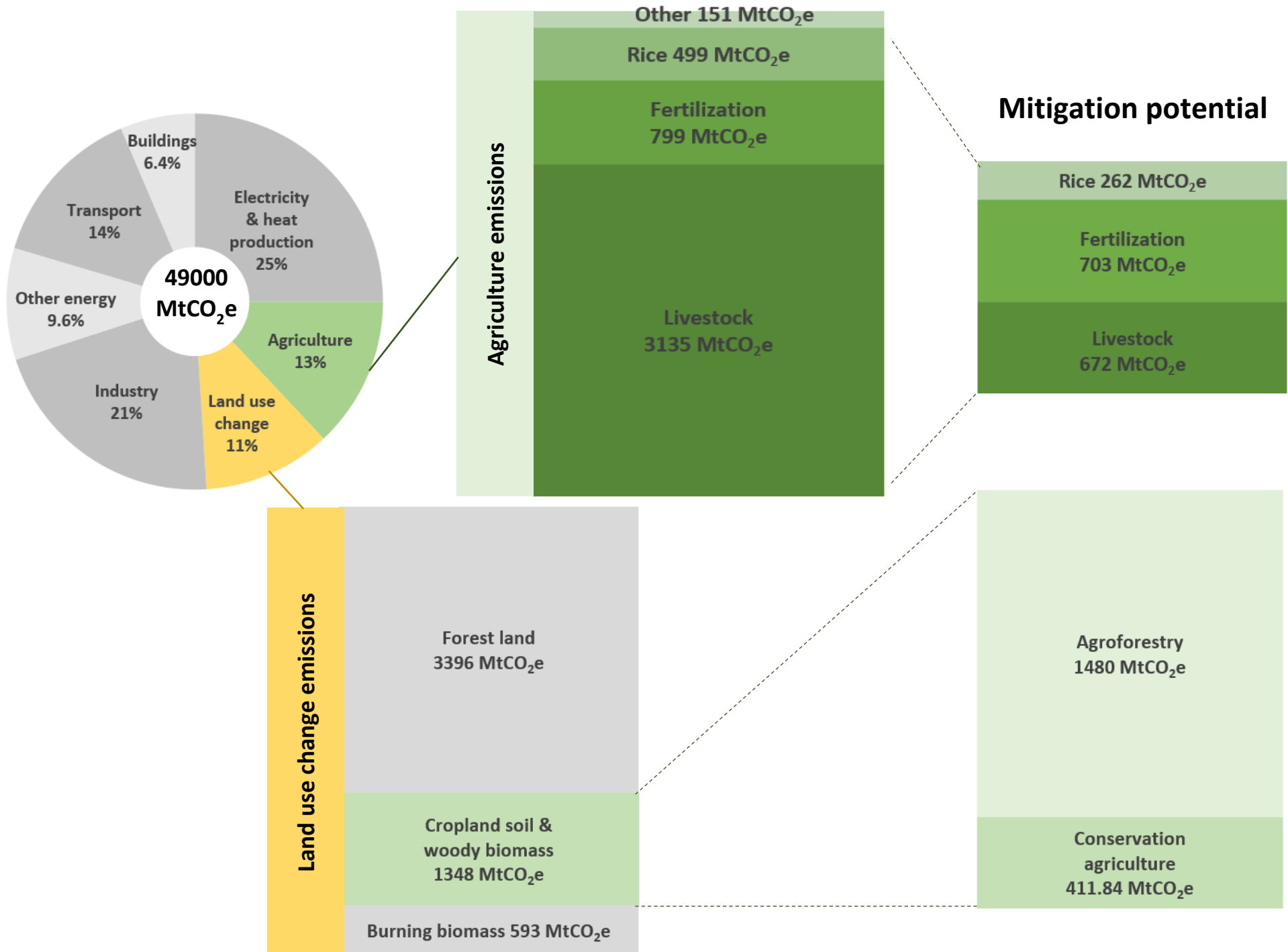
²⁶ Rosenstock, T. et al. (2019) Making trees count: Measurement and reporting of agroforestry in UNFCCC national communications of non-Annex I countries. *Agriculture, Ecosystems & Environment* 284: 106569 (<https://doi.org/10.1016/j.agee.2019.106569>).

fuels.²⁷ The total emission reduction potential in agricultural supply chains has been estimated to be nearly 2000 MtCO₂e per year by 2030.²⁸

²⁷ Dickie et al. (2014) *op.cit.*; Gromko, D. and Abdurasulova, G. (2018) Climate change mitigation and food loss and waste reduction: Exploring the business case (<https://cgspace.cgiar.org/handle/10568/100165>)

²⁸ Dickie et al. (2014) *op. cit.*

Figure 2 Agriculture emissions in 2010 (MtCO₂e) and technical mitigation potential by 2030 (MtCO₂e year⁻¹)



Most CSA interventions have a low to medium cost of implementation.²⁹ Agriculture could mitigate approximately 25% of its full potential at prices of up to USD 20 per tCO₂e. One-third of these mitigation practices can be delivered at a cost of ≤10 USD/tCO₂e.³⁰ The total economic mitigation potential for the sector ranges from 1.5 to 4.3 GtCO₂e yr⁻¹ at carbon prices of up to USD 20 and 100 / tCO₂e, respectively.³¹ Global implementation of CSA crop and livestock interventions is estimated to provide 21- 40% of cost-effective (≤20 USD/tCO₂e) climate change mitigation needed in the sector through 2030 in order to limit warming to 2 °C.³² These cost estimates refer to the cost of implementing technical measures, but do not include the costs of institutions and processes to support adoption. At low prices of implementation, the dominant strategies are incremental changes in farming practices with existing production systems (e.g., change in tillage method, fertilizer application method) while changes in production systems and the introduction of new technologies are more costly.³³

The highest technical mitigation potential is in production systems and regions where emissions are expected to increase most. Developing countries are the source of ~60% of global GHG emissions from livestock systems and where meat and milk production are expected to grow the fastest (1.8% per year) compared to the global average (1.2% per year) until 2050. The pattern is similar for cereals, where ~70% of the harvested area is in developing countries and production is projected to increase 1.2% annually, resulting in at least 0.8% annual growth in nitrogen fertilizer use in this region.³⁴ There is likely to be high mitigation potential in the top developing country GHG emitters in the agriculture sector (e.g., China, India, Brazil, Indonesia, Argentina, Pakistan, Ethiopia, Colombia and Vietnam). Significant mitigation outcomes may also be feasible in highly committed countries with low emissions, such as Ghana or Kenya, and experiences gained in these countries may also be able to support expansion of mitigation action within their regions. Table 2 shows the regional distribution of countries with high technical mitigation potential from the core interventions in each region.

²⁹ Smith et al. (2007) *op. cit.*

³⁰ Griscom et al. (2017) *op. cit.*, Smith et al. (2007) *op. cit.*

³¹ Smith et al. (2007) *op. cit.*

³² Wollenberg, E. et al. (2016) Reducing emissions from agriculture to meet the 2 C target. *Global change biology*, 22(12), pp.3859-3864.

³³ Smith et al. (2007) *op. cit.*

³⁴ FAOSTAT (<http://www.fao.org/faostat/en/>)

Table 2. Countries with the largest technical mitigation potential for each core intervention

Production system	Top 10 countries			Production system	Top 10 countries		
	Africa	Asia	LAC		Africa	Asia	LAC
Paddy rice	Nigeria	India	Brazil	Conservation agriculture (other crops)	Nigeria	China	Brazil
	Madagascar	China	Ecuador		Niger	India	Argentina
	Tanzania	Indonesia	Peru		Ethiopia	Indonesia	Mexico
	Guinea	Thailand	Venezuela		Sudan	Kazakhstan	Paraguay
	Mali	Bangladesh	Domin. Rep.		Tanzania	Pakistan	Bolivia
	Cote d'Ivoire	Myanmar	Guyana		Mali	Bangladesh	Peru
	DR Congo	Vietnam	Mexico		Morocco	Thailand	Colombia
	Sierra Leone	Philippines	Uruguay		Burkina Faso	Turkey	Guatemala
	Guinea-Bissau	Cambodia	Nicaragua		D.R. Congo	Iran	Ecuador
	Burkina Faso	Pakistan	Panama		Algeria	Vietnam	Uruguay
Grassland and livestock	Ethiopia	India	Brazil	Agroforestry (cropping systems)	Nigeria	China	Brazil
	Sudan	China	Argentina		Niger	India	Argentina
	Tanzania	Pakistan	Mexico		Ethiopia	Indonesia	Mexico
	Chad	Kazakhstan	Colombia		Sudan	Kazakhstan	Paraguay
	Nigeria	Bangladesh	Paraguay		Tanzania	Pakistan	Bolivia
	South Africa	Myanmar	Venezuela		Mali	Bangladesh	Peru
	Kenya	Indonesia	Uruguay		Morocco	Thailand	Colombia
	South Sudan	Mongolia	Bolivia		Burkina Faso	Turkey	Guatemala
	Uganda	Uzbekistan	Peru		D.R. Congo	Iran	Ecuador
	Niger	Turkey	Nicaragua		Algeria	Vietnam	Uruguay
Nitrogen management	Egypt	China	Brazil	Agroforestry (silvopastoral systems)	Ethiopia	India	Brazil
	South Africa	India	Mexico		Sudan	China	Argentina
	Zambia	Indonesia	Argentina		Tanzania	Pakistan	Mexico
	Morocco	Kazakhstan	Colombia		Chad	Kazakhstan	Colombia
	Mali	Pakistan	Peru		Nigeria	Bangladesh	Paraguay
	Ethiopia	Bangladesh	Chile		South Africa	Myanmar	Venezuela
	Kenya	Thailand	Venezuela		Kenya	Indonesia	Uruguay
	Sudan	Turkey	Ecuador		South Sudan	Mongolia	Bolivia
	Tanzania	Iran	Guatemala		Uganda	Uzbekistan	Peru
	Algeria	Vietnam	Uruguay		Niger	Turkey	Nicaragua

2.2.3 Promoting adoption of CSA

An understanding of barriers to adoption of CSA practices is fundamental to identifying policies and mechanisms to incentivize and enable adoption. Table 3 illustrates the types of technical measures and enabling conditions that are necessary to support adoption of the core CSA interventions, including:

1. Increasing the availability and **access to inputs, equipment and infrastructure**;
2. **Developing capacity** for good practices among farmers and the organizations supporting them;
3. **Strengthening incentives** through market linkages and financial or policy incentives.

In smallholder production systems, there are often multiple barriers to adoption, and multiple measures are required to address those barriers.³⁵ Relevant policy measures may include rural credit programs, input and output pricing policies, regulations, property rights and extension services, as well as the implementation of safety net programs to reduce producer risk.³⁶ In addition to public policies, **private sector engagement through targeted policies and measures can promote widespread adoption** through responsible sourcing policies, supplier advisory services, or product standards.

Table 3. Inputs, enablers and policy measures for core interventions

Production system	Mitigation and adaptation core interventions	Inputs, enabling conditions and policy measures
Paddy rice	Water and residue management	Irrigation infrastructure, land leveling services, land reform for farm consolidation, flood control, credit, water pricing reform
	Nitrogen fertilizer application	Supply of low-emission fertilizer types, advisory services linked to input supply, fertilizer subsidy reform
Grassland and livestock	Grazing and pasture management	Access to pasture seeds, agricultural credit policies, grassland use rights reforms, common property institutions
	Nitrogen fertilizer application	Advisory services linked to fertilizer input supply; fertilizer subsidy reform
	Animal feeding, breeding and health	Access to advisory, animal health and breeding services, access to inputs and credit, market access
	Manure composting, anaerobic digestion	Access to credit for infrastructure investment; animal waste management regulations and policies
Agroforestry in livestock systems	Agroforestry / silvopastoral systems	Access to seedlings, land and tree rights, common property institutions
Other crops	Cover crops and residue management	Advisory services linked to input supply; regulations on residue burning
	Soil and water conservation	Advisory services, access to equipment, land rights policy
	Nitrogen fertilizer management	Supply of low-emission fertilizer types, advisory services linked to input supply, fertilizer subsidy reform
Agroforestry in cropping systems	Agroforestry (alley cropping, boundary trees, hedgerows, woodlots)	Access to seedlings, land and tree rights
Supply chains	Food loss and waste reduction	Advisory services, capacity development, access to credit
Energy	Energy efficiency and use of renewable energy inputs	Energy policy and subsidies, efficient market and distribution networks

³⁵ World Bank (2017) Making Climate Finance Work in Agriculture (<http://documents.worldbank.org/curated/en/986961467721999165/pdf/ACS19080-REVISED-OUO-9-Making-Climate-Finance-Work-in-Agriculture-Final-Version.pdf>)

³⁶ FAO (2012) Developing a climate smart agriculture strategy at the country level (<http://www.fao.org/3/ap401e/ap401e.pdf>)
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Cross-cutting	--	Standards and regulations, payments for environmental services, agricultural information platforms, bioenergy policy, agricultural intensification policies, extension services
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Interventions to promote adoption of climate smart practices should focus on farmers who are most likely to adopt, address the barriers to adoption, and support positive incentives for adoption. Although many CSA practices are widely known, common barriers to adoption include:

- High costs of implementation, often involving up-front investments that are higher than producers' ability or willingness to pay, or operation and maintenance costs that make adoption financially unviable;
- Insecure land tenure, which undermines producers' willingness to invest;
- Limited access to inputs and technologies due to market failures;
- Knowledge and information gaps.

Barriers to adoption vary by production system and location, and may be different for different farm types, for men and women farmers, or for people in different wealth groups.³⁷ Producers are most likely to adopt CSA practices when they perceive that adoption results in net benefits.

At low carbon prices, the monetary value of GHG mitigation per hectare (or per animal) is often much smaller than the value of agricultural production per unit area (or animal). For example, reduced water and fertilizer costs due to adoption of AWD in paddy rice production can deliver increased profits in the range of US\$100 to US\$400 and can reduce GHG emissions by 0.5 - 1.6 tCO₂e per ha, suggesting that improved profitability would be the main driver of adoption at low carbon prices. Therefore, **the fundamental driver of CSA adoption will often be the benefits for agricultural production** and incomes that producers can obtain from adopting CSA practices.

Once CSA practices have been adopted, there may also be a risk of dis-adoption. Dis-adoption in the short-term may be due to unsuitability of CSA practices. Long-term dis-adoption may be associated with structural changes in production systems.³⁸ Where soil or biomass carbon sequestration is the main GHG mitigation mechanism, dis-adoption implies a risk that GHG mitigation attributable to a policy or program may be non-permanent. Unlike carbon sequestration, **measures that reduce methane or nitrous oxide emissions do not face non-permanence or reversal risks.**

2.3 Experience with scaling CSA implementation

To better understand the evidence for CSA project feasibility, 14 projects were selected as examples of large-scale implementation of CSA practices, and an additional ten projects were selected as examples of CSA carbon credit projects (Annex A). For both categories, projects were in different stages of implementation, so the evidence for impacts and information available is not strictly comparable or complete. Nevertheless, some trends are evident.

Existing experience demonstrates that significant agricultural adaptation, yield and income benefits are feasible for large numbers of farmers. In Sub-Saharan Africa, 2 million smallholder farmers adopted drought-tolerant maize, resulting in 20-30% yield increases. In China, 2.5 million households received payments for restoring 2 million ha of land. In Bangladesh, 2.5 million farmers used urea deep placement to reduce fertilizer inputs by 25% and increase yields by 18-25%. Laser leveling in India reduced irrigation times on 500,000 ha, raising yields by 7% and increasing profitability by USD 113-175/ha/yr. More than 200,000 small-scale dairy farmers in East Africa increased total monthly milk production from just over 0.5 million to 8 million liters. The largest numbers were typically in countries with high populations.

Significant mitigation impacts are also possible. The largest impacts were mostly for biomass and soil carbon sequestration, such as in China, where soil and biomass carbon sequestration have been estimated at 42 and 87

³⁷ Lan, L. (2018) Farm-level and community aggregate economic impacts of adopting climate smart agricultural practices in three mega environments. *PLoS one*, 13(11), p.e0207700.

³⁸ Neill, S. and Lee, D. (2001) Explaining the Adoption and Disadoption of Sustainable Agriculture: The Case of Cover Crops in Northern Honduras. *Economic Development and Cultural Change* 49(4): 793–820.

MtCO₂e, respectively. In Niger, 200 million trees were planted on 5 million hectares, and in Ethiopia, 8 million people (12% of population) mitigated ~3.4 MtCO₂e per year through land restoration. Carbon sequestration has been the focus of a majority of mitigation projects in agriculture in the last two decades. A global survey of 50 agricultural mitigation projects in 2010 showed that restoration of degraded lands and agroforestry were the most common project activities for mitigation.³⁹

There are also examples of large-scale interventions to reduce N₂O and CH₄ emissions. Precision nutrient management practices have been promoted in six state-level programs in India, reducing N₂O emissions by 8%. Urea fertilizer deep placement practices in rice paddies, which reduces urea use by 25%, is being applied on half a million hectares in Bangladesh. Alternative wetting and drying of rice paddies, which reduces methane emissions by 30-70% as well as energy use in groundwater pumping, is being adopted by 50,000 farmers in Bangladesh. The Thai Rice Nationally Appropriate Mitigation Action expects to reduce emissions (mostly CH₄) by 1.664 Mt CO₂e using water-saving techniques.

2.3.1 Factors for successful implementation

Barriers to adoption and their corresponding policy measures are diverse. Interventions have thus addressed both farmers' demand for CSA technologies and supply constraints.

Demand-side measures: **Institutions** have key roles in overcoming information and knowledge gaps as well as facilitating collective action by farmers. Most of the initiatives reviewed have used and strengthened existing networks of farmer organizations to influence farmers' demand for CSA technologies through extension activities, farmer field days and demonstration plots. Improved irrigation practices, grassland management and agroforestry often also require collective action among farmers in order to enable adoption by individual farmers. Community-based institutions and links with supporting institutions at other levels are critical to create an enabling environment for adoption of practices by community members. **ICT tools** are increasingly being used to provide farmers with access to information. Direct **subsidies** for production inputs and/or **incentive payments** have also been used to overcome up-front investment costs and to increase the relative profitability of the promoted practices. Some measures have been promoted through project-based mechanisms, but other examples illustrate the large-scale potential when CSA measures are promoted as part of national programs. **Regulatory measures** have also been used. Tenure security through legislative change, for example, was critical to incentivize farmers in Niger to plant trees in agricultural landscapes. Changes in national regulations and industry standards were key measures in addressing waste pollution from large-scale pig farms in China.

Supply-side measures: Supply-side measures include **access to finance, inputs and markets**. Several case studies reviewed highlight adoption subsidized through public budgets, but in some initiatives, such as the ABC Plan in Brazil and Plan Maroc Vert in Morocco, also leverage additional finance through banks. The supply of CSA technologies may require use of specialized inputs. For example, urea deep placement in Bangladesh was enabled through support to micro- and small enterprises that manufacture urea briquettes for sale to farmers. Sapling nurseries received support to increase supply of inputs for large-scale agroforestry programs in China and Niger.

Overall, large-scale impacts are more likely where systemic change is introduced through **national policy** that enables large-scale deployment of multiple measures focusing on CSA targets.⁴⁰ In most cases studied, the agriculture sector has been the main driver of policy change, although there are a few cases, such as Brazil, where climate change policy has been a key driver of policies and programs in the agriculture sector.

Experience from the projects reviewed suggests several features of successful CSA program design that can inform the design of results-based carbon finance programs (Table 4).

³⁹ Seeberg-Elverfeldt, C. and Tapio-Biström, M. (2010) Global survey of agricultural mitigation projects (<http://www.fao.org/3/al388e/al388e00.htm>).

⁴⁰ Wigboldus, S. et al. (2016) Systemic perspectives on scaling agricultural innovations. A review. *Agronomy for Sustainable Development* 36 (3): 46.

Table 4. Features of successful CSA program design

Principles	Features of successful large-scale CSA projects
Technology transfer and infrastructure	<ol style="list-style-type: none"> 1. Strong value proposition for farmers beyond carbon payments 2. Farmer- and local government-driven decisions about practices 3. Effective technical change agents with capacity for large-scale outreach 4. Farmer access to integrated support services (on-line knowledge platforms for climate information services and technical option feasibility and suitability analysis, ICT-based services, carbon accounting linked to project activities, centers for input and service delivery)
Finance	<ol style="list-style-type: none"> 1. Subsidy or credit used to catalyze new practices 2. Results-based carbon payments to provide incentives or to fund the enabling conditions for sustained adoption 3. Aggregated carbon payments to communities to reduce transaction costs, increase reward size and incentivize collective action 4. Public-private partnership, with public support to de-risk farmer transitions and private investment, and private funds to drive scale 5. Low entry requirements for participation in enterprises or carbon schemes 6. Low transaction costs for delivery of finance (e.g. automated payments)
MRV	<ol style="list-style-type: none"> 1. Low-cost MRV methodologies specific to practices, e.g. activity-based monitoring 2. Continuous improvement of modeling and science to verify GHG effects
Policy	<ol style="list-style-type: none"> 1. National policy mandate for change in practices (not necessarily climate policy) 2. Inter-ministerial and administrative coordination, including among national and local governments
Cross-cutting	<ol style="list-style-type: none"> 1. Change at national level for cost-effective impact, rather than multiple expensive pilots 2. Promoting participation with low entry requirements, especially for carbon payment projects 3. Targeting countries, production systems, value chains and participants with potential for success 4. Synergies across technologies, finance, carbon accounting and standards, and policy 5. Building on existing successful policy measures or programs 6. Use of meaningful environmental and social safeguards

2.3.2 Challenges in supporting CSA through results-based carbon finance

Because of design features of the Clean Development Mechanism (CDM), it was successful in promoting only a few types of agricultural offset projects, such as biogas and biomass energy projects.⁴¹ For other agricultural projects, voluntary carbon markets have been the main drivers of demand, but volumes and prices have been depressed in recent years, which has discouraged innovation in linking agriculture to carbon markets. Agriculture projects have been allowed in some national and sub-national schemes, such as the Australian Carbon Farming Initiative and the Alberta Emission Offset System. Reasons for limited uptake of carbon markets in the agriculture sector include:

(1) High transaction costs: All carbon projects incur transaction costs in project identification and design, approvals under a standard, project management and monitoring. These costs vary significantly by project type, and are particularly high for project types that involve large numbers of farmers and require context-specific design. Biogas

⁴¹ Larson, D. (2012) *Agriculture and the clean development mechanism*.

(<https://documents.worldbank.org/en/publication/documents-reports/documentdetail/537451468162534877/agriculture-and-the-clean-development-mechanism>)

projects, by contrast, include many elements that are replicable resulting in reduced transaction costs. With limited demand for agriculture offsets, supply of finance for developing innovative project types has been limited.

(2) Monitoring and verification: Monitoring and verification incur transaction costs, but also face other challenges in the agriculture context. Direct measurement of agricultural GHG fluxes is expensive and often impractical if large samples are required for representative estimates. One alternative has been to use carbon models together with activity data from participating farmers to estimate GHG effects. The uncertainty associated with modelled results has been dealt with in different ways under different carbon standards, such as discounting estimated emission reductions.⁴² However, calibrating models and designing monitoring systems to capture accurate activity data from large numbers of farmers can be a significant component of project development costs.

(3) Non-permanence risks: Soil and biomass carbon projects face the risk that carbon sequestered may subsequently be released if management practices or land uses change. The CDM dealt with this by issuing tCERs, but demand for this type of credit was low. Some other standards use buffer reserves to pool reversal risks across projects.⁴³ Soil carbon sequestration rates and tree growth rates may be affected by climate variability and longer-term climate change. These present additional risks to the non-permanence of carbon sequestered in soils and trees. Project activities that target reductions in CH₄ and N₂O emissions are not affected by non-permanence risks.

(4) Market uncertainty: From the agriculture perspective, linking with carbon markets has not always been attractive, as carbon prices have been volatile, low, and influenced by political factors.

The influence of these factors can be seen in the experience of some past and ongoing crediting schemes. For example, farmer participation in the Australian Emissions Reduction Fund was low for methodologies where monitoring costs were high, risk-adjusted returns were low, and long-term commitment to maintaining practices was required. The Australian Emissions Reduction Fund found that enrollment was highest for vegetative carbon sinks, driven primarily by the ease of monitoring.⁴⁴ In Canada, few livestock projects were registered under the early Alberta Offset Protocol methodologies because even well-managed livestock farms in Alberta did not maintain documentation for monitoring required parameters.

Some of these challenges have been overcome where project developers have found ways to overcome the high transaction costs of project development and MRV. For example, the World Bank BioCarbon Fund supported Kenya Agricultural Carbon Project has integrated data collection with extension support to farmer groups, thus reducing the transaction costs of reaching more than 30,000 farmers.⁴⁵ The standardized baselines developed under the CDM mechanism have also simplified measurement and monitoring requirements, pointing to approaches that large-scale agricultural mitigation programs could adopt under Article 6 mechanisms. Further guidance on MRV in the CSA context is provided in Chapter 4 below.

2.4 Further resources

General information: General information on the CSA approach can be found in the [Climate Smart Agriculture Sourcebook](#), the [CSA section of the FAO website](#), under the [CSA topic on the World Bank website](#), and in a [learning tool produced by CCAFS](#).

Country-specific information: Country [CSA profiles](#) can be a useful entry-point for obtaining general information about the status and options for CSA at country-level, and [CSA Investment Plans](#) have been developed for a small number of countries. Other information on CSA in specific country contexts can be found in publications of [FAO](#), [the World Bank](#), [CCAFS](#) and from institutions in each country.

⁴² See, e.g. <https://verra.org/wp-content/uploads/2018/03/VM0017-SALM-Methodolgy-v1.0.pdf>

⁴³ VCS (2013) VCS AFOLU Requirements (<https://verra.org/wp-content/uploads/2016/05/FactSheet-AFOLU-2013-UPDATED.pdf>)

⁴⁴ Keating, B. (2019) Phone interview with Meryl Richards and exchange with Eva Wollenberg .

⁴⁵ Tennigkeit, T. et al. (2013) Carbon intensification and poverty reduction in Kenya: Lessons from the Kenya agricultural carbon project. *Field Actions Science Reports*. (Special Issue 7).

Tools to support identification of CSA options include:

- World Bank [Climate Smart Agriculture Indicators](#): This includes a set of indicators for assessing a country's CSA potential in terms of technologies, policies and readiness.
- [CSA-MOT](#) is a tool that can be used for rapid assessment of the mitigation potential of different CSA practices.
- The [Ex-Ante Carbon Balance Tool](#) can be used to make more in-depth assessment of a program's mitigation potential, and is used in World Bank project appraisal.
- [GLEAM-i](#) is a web-based tool for ex ante assessment of mitigation potential for the livestock sector.

3. Scaling CSA with results-based carbon finance

Results-based carbon and climate finance funds each have their own specific procedures and requirements, but there are often several requirements in common:

- Programs should be aligned with national mitigation priorities and international mitigation objectives;
- Mitigation programs should have benefits for sustainable development;
- Program impacts should be sustained after the project ends;
- Programs should have a transformational impact on emission pathways;
- Mitigation outcomes should be additional to what would have occurred in the absence of the project;
- Baselines and crediting thresholds can be set to incentivize enhanced ambition and performance;

The sustainable development benefits of the CSA approach have been addressed in the previous chapter. Robust MRV is also a core parameter and is discussed separately in Chapter 4. The sections that follow highlight key considerations in the CSA context of other common requirements of results-based carbon finance programs.

3.1 Coherence with national mitigation priorities and support to increased ambition

Carbon and climate finance funds expect that programs should be consistent with or derived from the country's Nationally Determined Contribution (NDC), and should align with domestic policy objectives and sector priorities. Alignment can signal the host country's commitment to implementing GHG mitigation measures. Support to increased ambition means that programs should demonstrate that they enable the host country to increase its national mitigation target, or enhance the implementation of mitigation actions and policies beyond what it would achieve with its own efforts.

Agriculture sector mitigation priorities are not articulated in detail in most countries' NDCs. Less than 50% of the top ten developing countries with the largest potentials to scale up CSA practices have included CSA interventions in their first NDC (UNFCCC n.d.). Six of the top ten countries included livestock or grassland improvement (Chad, Ethiopia, China, Argentina, Brazil and Mexico), five included paddy rice interventions (China, Indonesia, Bangladesh, Myanmar and Vietnam) and two focused on other crops (China and Brazil). Forty percent of NDCs included some form of agroforestry.⁴⁶ Most countries that referred to specific agricultural adaptation or mitigation options in their NDC did not mention specific targets. In many countries, policies and programs to support agricultural adaptation or mitigation actions have not yet been fully elaborated. Integration of climate change goals into agriculture sector policies, and analysis of potential mitigation benefits of agriculture sector policies and measures are at the early stage and ongoing in most countries.

⁴⁶ Rosenstock, T. et al. (2019) Making trees count: Measurement and reporting of agroforestry in UNFCCC national communications of non-Annex I countries. *Agriculture, Ecosystems & Environment* 284: 106569 (<https://doi.org/10.1016/j.agee.2019.106569>).
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In part, this reflects different strategies for pursuing climate commitments in agriculture.⁴⁷ Some countries are prioritizing adaptation rather than mitigation in the agriculture sector (e.g. India, Philippines, Thailand, Tanzania, Sudan). Others have expressed clear agriculture mitigation commitments (e.g. Costa Rica, Mexico, Brazil, Uruguay). Still others are willing to mitigate under conditions of fairness (e.g. China, Vietnam, Colombia), or finance (e.g. Kenya, Ethiopia, Nigeria, Indonesia, Pakistan). These differences reflect national approaches to balance climate and agriculture sector objectives, and may also reflect countries' strategies in relation to international negotiations. The limited elaboration of agriculture sector policies, measures and targets also reflects limited data and capacities for development of mitigation strategies in the agriculture sector. Where there is political will, demonstrated evidence of potential for adoption of CSA practices and adequate scientific basis for GHG estimation, there may be **opportunities for carbon and climate finance to support the development of national mitigation programs and to enhance ambition in the agriculture sector**. Agriculture sector strategies and plans are the key entry-points for engaging with countries.

3.1.2 Pathways to self-sustaining impacts

Programs should demonstrate a credible path for CSA practices adopted to become self-sustaining and to ensure sustainability of emission reductions after results-based payments end. There are several possible pathways to catalyzing self-sustaining programs in the agriculture, including:

- **Crowding-in private finance:** The private sector – including individual farmers – is by far the most important source of investment in the agriculture sector in most developing countries.⁴⁸ Therefore, success of CSA adoption and the resulting climate mitigation and adaptation actions will largely depend on proactive private sector engagement. Where legal and policy frameworks are conducive, programs could provide direct support to the private sector to scale up adoption of mitigation practices. Elsewhere, programs could be linked to public policies that crowd-in private sector investment from farmers, agri-businesses or the financial sector.
- **Catalyzing public sector policy and investment:** Transformative agricultural growth requires an enabling environment.⁴⁹ Evidence-based policies and targeted public investments are essential tools. In the agriculture sector, analysis to support the development of low-emission agricultural policy measures is often lacking. **Programs could support the development of national or sub-national government policies and programs that provide the enabling environment and incentives for adoption of CSA measures in the sector.** These policies may not explicitly put a price on GHG emissions, but could support an implicit price through taxation, subsidies or other incentives for adoption of CSA practices.
- **Support for explicit carbon pricing:** A small number of countries are considering or implementing emission trading schemes.⁵⁰ **Results-based carbon finance could either directly support upscaled implementation of CSA programs with strong mitigation outcomes, or indirectly support the development of capacity and infrastructure for integrating agricultural offsets into emission trading schemes.** Countries may have an interest in other Article 6 mechanisms of the Paris Agreement. While there is evidence of the potential for CSA programs to go to scale (see Section 2.3), there is less experience with supporting large-scale implementation through results-based carbon finance. Pilot programs could have a significant demonstration effect in countries with willingness to promote and scale up agricultural offsets as part of domestic and international mitigation action.

⁴⁷ Hönle, S. et al. (2018) Climate change mitigation strategies for agriculture: an analysis of nationally determined contributions, biennial reports and biennial update reports. *Climate Policy* 19(6) 688-702.

⁴⁸ FAO (2012) State of Food and Agriculture 2012 (<http://www.fao.org/publications/sofa/2012/en/>)

⁴⁹ Boettinger, S. et al. (2017). *Readiness for agricultural transformation* (<https://www.mckinsey.com/industries/chemicals/our-insights/readiness-for-agricultural-transformation>)

⁵⁰ World Bank (2020) State and Trends of Carbon Pricing 2020 (<https://openknowledge.worldbank.org/bitstream/handle/10986/33809/9781464815867.pdf?sequence=4&isAllowed=y>)

3.1.3 Transformational change

While transformational change is a common terminology, each fund follows their own definition.⁵¹ There is often no single metric used to measure transformational change. Rather, it is understood as the combined effect of several elements. For example, transformational change may include the potential for programs to achieve a large volume of emission reductions, be sustainable over time, catalyze increased domestic ambition, and contribute to the development and implementation of domestic carbon pricing policies and catalyze a new and scaled-up international market mitigation action under Article 6 of the Paris Agreement.⁵² These elements are interlinked in the CSA context.

While carbon funds may prioritize the **volume of emission reductions** during a crediting period, agriculture sector stakeholders may be more likely to value the contributions of large-scale mitigation programs to agriculture and food system objectives, such as food security, food safety, employment, export earnings, resilience to climate risks or ecosystem goods and services. **Ensuring synergies with agriculture sector objectives is critical to achieving broad stakeholder buy-in on agriculture sector mitigation programs.** Given the early stage of progress in many countries in integrating agriculture and climate change policy objectives, programs may have transformational impacts by developing national capacities to identify, elaborate and deliver feasible policy measures, and contributing to the development of domestic carbon pricing policies. **Results-based carbon finance operations may build on World Bank operations that strengthen agriculture sector policy and/or agriculture-climate change linkages through investment project or development project financing.**

Sustainability can be assessed in relation to three dimensions: technologies, policies and finance. Successful upscaling and long-term adoption of CSA technologies are likely when:

- technologies have been tested, adapted and validated in the target production systems or regions;
- the evidence for strong benefits of farmer adoption is clear; and
- stakeholders involved in CSA technology promotion (e.g. public or private extension services, input suppliers, rural financial institutions, farmer organizations) have demonstrated capacities for delivery at large scale;
- policy measures and mechanisms have been successfully piloted.

Since CSA programs may target specific sub-sectors or regions, in-depth assessment of the sub-sector is required to assess the suitability of the CSA approaches with high potential. Policy mechanisms for upscaling may be pre-existing national policies and programs. Investment project financing and Program for Results mechanisms that support policy delivery can also provide a basis for results-based carbon finance to explore upscaled ambition for implementation and financing of CSA policy in partnership with national governments.

A clear rationale is essential for sustainability of programs in the period after the end of results-based payments.

Programs are expected to be sustainable by leveraging public or private funds or creating the enabling conditions for scaled up technology adoption after the end of the program. Examples include:

- Results-based payments channeled to agricultural producers as direct incentive payments where public funds are expected to replace results-based payments upon completion of successful demonstration program;
- Results-based payments channeled to financial institutions during the program period, with upscaled implementation to leverage financial institutions' own resources or public sector support to conditional credit lines after program period;
- Results-based payments reward a program that demonstrates implementation feasibility at scale and informs development of new non-carbon pricing policy;
- Results-based payments for verified emission reductions (VERs) from demonstration projects with replication potential and domestic demand.

⁵¹ <https://climateactiontransparency.org/icat-toolbox/transformational-change/>

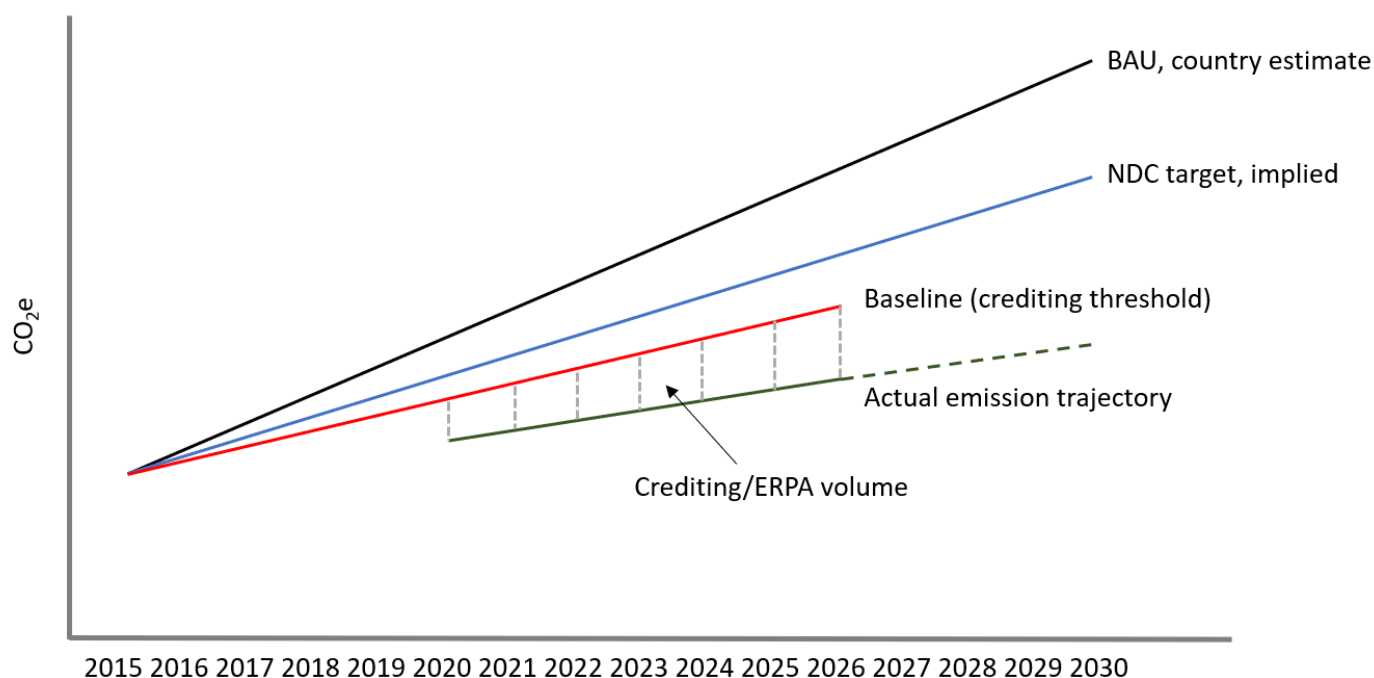
⁵² See, e.g. <https://tcaf.worldbank.org/>.

3.1.4 Baseline setting and crediting thresholds

Few countries have specific mitigation targets for the agriculture sector, and very few have targets for specific sub-sectors. This opens up several possibilities for setting program-specific business-as-usual (BAU) scenarios and crediting thresholds in consideration of a country's unconditional target, either within the framework of an existing economy-wide target, or in addition to existing NDC targets where there is no target for agricultural emissions in a country's NDC.

In order to support enhanced ambition, baselines for results-based carbon finance programs could be set as the lower of either a country's BAU emission scenario or the emission trajectory implied by a country's unconditional target in their NDC. Crediting thresholds may be set even lower in order to incentivize and reward enhanced ambition and performance (Figure 3).

Figure 3 Country BAU, program baseline and crediting thresholds



In some countries, the trajectory of BAU emissions from specific agricultural sources can be identified in the national GHG inventory and matched with the agricultural sinks and sources impacted by the result-based carbon finance program in order to characterize the BAU scenario. Unconditional targets can rarely be identified for specific agricultural GHG sources in NDCs, but may be identified in the GHG inventory, agriculture sector analysis or climate change plans aligned with the NDC targets. These plans may include targets for uptake of CSA practices that can be used to construct unconditional targets.

Setting baseline and crediting thresholds in the agriculture sector may often not be straightforward. Few developing countries have explicit targets for the agriculture sector, let alone for specific agricultural production systems. Agriculture sectors cover several agro-ecological zones and production systems, and mitigation measures are often targeted to specific production systems, agricultural commodities or high-potential regions within a country (i.e., policy-rather than sector-based measures).⁵³ The GHG inventories on which NDCs are often based may not be suitable for setting policy-specific baselines or crediting thresholds because of shortcomings in GHG inventory quality. For example, although agroforestry is mentioned as a mitigation option in many countries' NDCs, trees outside forests are not included or are not explicitly represented in most GHG inventories.⁵⁴ Very few developing countries have GHG inventories that represent specific livestock production systems or other categories below the species level.⁵⁵ And where agriculture is represented in BAU scenarios, trajectories were often estimated by simple extrapolation of historical trends assuming no change in production technologies, yet high potential agricultural sub-sectors may be very dynamic.

Results-based carbon finance programs may need to develop BAU scenarios specific to the GHG sinks and sources, production systems, commodities or regions targeted by the mitigation measures. Program-specific BAU scenarios can be developed using assumptions that are consistent with, or that improve on the NDC BAU scenario assumptions in

⁵³ Wilkes, A. and Tennigkeit, T. (2010). Carbon finance in extensively managed rangelands: issues in project, programmatic and sectoral approaches. In *Grassland carbon sequestration: management, policy and economics*, 11, p.211.

⁵⁴ Rosenstock, T. et al. (2019) Making trees count: Measurement and reporting of agroforestry in UNFCCC national communications of non-Annex I countries. *Agriculture, Ecosystems & Environment*, 284, p.106569.

⁵⁵ Wilkes A. (2017) Measurement, reporting and verification of greenhouse gas emissions from livestock: current practices and opportunities for improvement. CCAFS Info Note (<https://cgspace.cgiar.org/handle/10568/80890>)

terms of their ability to represent trends in the targeted sector. These assumptions may be based on historical trends, existing climate and agriculture sector policies and programs, and other sector-specific analysis. Other approaches used in crediting mechanisms, such as the CDM, may also be applicable to developing a BAU scenario, such as standardized baselines that represent prevailing practice or performance benchmarks.

3.2.3 Additionality and attribution of the contribution of results-based carbon finance

Additional emission reductions are emission reductions that are additional to those that would have occurred without the contribution from the carbon fund. There are two common approaches to additionality, which may be applied together. The first approach relies on setting crediting thresholds below program BAU baselines, as was just described. The second approach follows a climate finance logic in which the net present value of the ERPA is estimated as a share of all international finance sources contributing to the program, and mitigation outcomes allocated accordingly.

This has particular implications in the agriculture context because results-based carbon finance alone may be insufficient to enable adoption of CSA practices that generate mitigation outcomes. First, direct incentive payments typically do not address non-price constraints to adoption of improved practices. Institutions, capacities and access to affordable finance are often critical aspects of the enabling environment, which may be better supported through grants, concessional finance or various blended finance mechanisms. Second, for some CSA practices, financial returns or other benefits to farmers are delayed (e.g. due to gradual increases in soil fertility or biomass over time). Incentives will be needed to offset any direct or opportunity costs of adopting CSA practices in the transition period until financial returns are realized. Therefore, **results-based climate finance may need to be combined with other financing instruments and policy measures to address multiple barriers to adoption**. Estimating the value of the results-based carbon finance contribution will therefore be a critical part of program design and ERPA negotiation.

3.2 Further resources

Agriculture in the NDCs:

- The roles of agriculture in the first round of NDCs has been analyzed for each developing region by [FAO](#) and globally by [CCAFS](#).

Transformational change:

- [ICAT Transformational Change Guidance](#) provides a methodology for assessing the transformational potential and impacts of policies and actions to reduce GHG emissions.
- The approach of the Green Climate Fund to transformational change is presented [here](#).
- The approach of the NAMA Facility is presented [here](#).

Baselines and crediting thresholds:

- Options for setting baseline and crediting thresholds for carbon or climate finance funds in the context of the Paris Agreement have been analyzed by the [Partnership for Market Readiness](#).

Additionality:

- Options for determining additionality in the context of Article 6 of the Paris Agreement are discussed in papers by [Axel Michaelowa](#) and the [OECD](#).
- The two-layered approach to additionality assessment adopted by TCAF is described in [Core Parameters for TCAF Operations](#).

4. Monitoring, reporting and verification

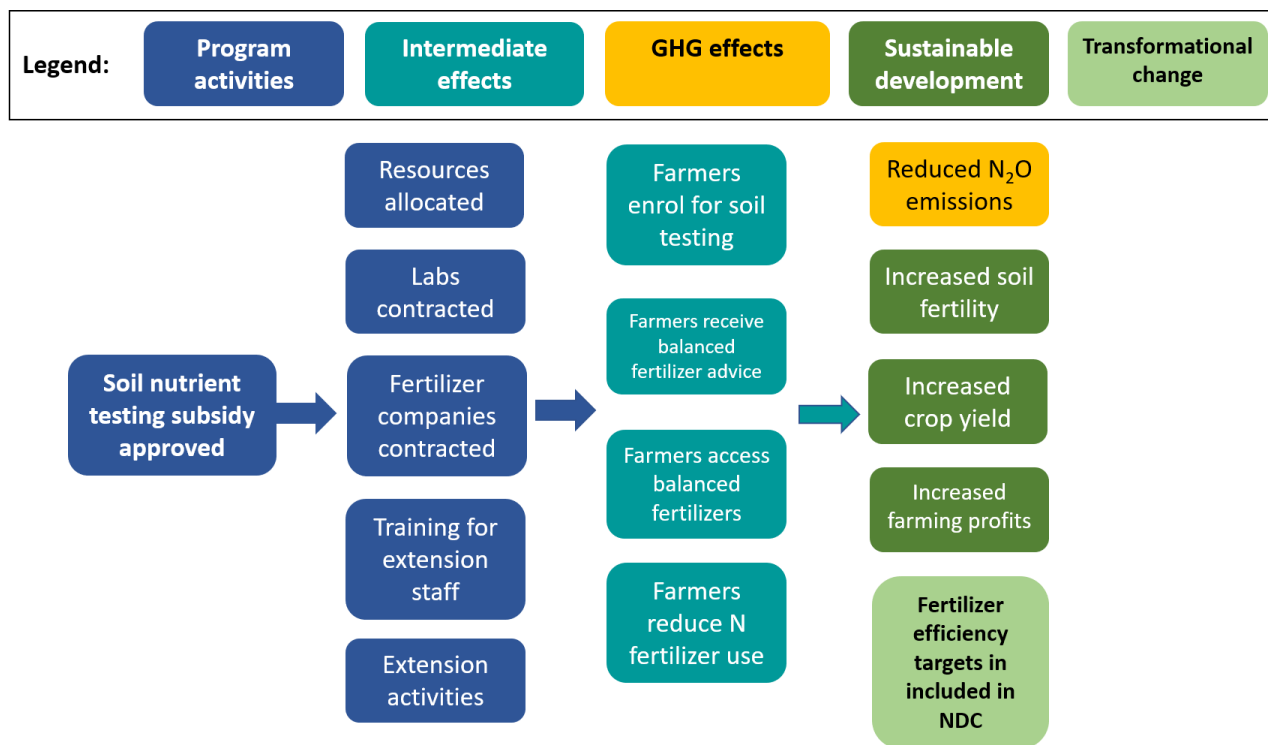
Monitoring, reporting and verification (MRV) is also a requirement of all carbon and climate finance funds. Because MRV has often been seen as a barrier to engaging the agriculture sector in results-based climate finance, it is discussed separately in this chapter.

MRV often applies to emission reductions, transformational change, and sustainable development, as well as environmental and social standards.

The overall approach to monitoring in carbon finance programs is similar to the results-based measurement approach applied in World Bank and other investment banks' operations. It is standard practice in World Bank operations to develop a project results framework based on the project's underlying theory of change.⁵⁶ A theory of change describes the causal pathways from the planned interventions to the intended outcomes. It clarifies why the project, program, or policy's inputs and activities will lead to intermediate effects (e.g. change in farmers' practices); and why those intermediate effects are likely to lead to longer-term outcomes or impacts (e.g. sustainable development benefits, transformational change).

Mapping the program's theory of change can help clarify monitoring indicators to include in the results-based carbon program's results framework. In many programs, intermediate effects that should be monitored will include both GHG mitigation effects (i.e. emission reductions) and non-GHG effects. These non-GHG effects should include indicators of sustainable development benefits as well as indicators of transformational change. An illustrative example is given in Figure 4.

Figure 4 Example theory of change for hypothetical program targeting nitrogen fertilizer use



⁵⁶ World Bank (2012) Designing a Results Framework for Achieving Results: A How-to Guide. *Unlocking crediting opportunities in climate-smart agriculture – 20 January 2021*

4.1 MRV of mitigation effects

There are few established GHG estimation methodologies applicable in the agriculture sector, and some existing methodologies are listed in Annex B. Those that do exist were mostly designed for small-scale projects, but could be adapted for application to policy measures. Many CSA programs will need to develop cost-effective GHG estimation methodologies. MRV of mitigation in agriculture is challenging for a number of reasons, including high transaction costs of monitoring large numbers of producers, and high cost and uncertainty in estimating agricultural GHG emissions. Results-based carbon finance program MRV systems should balance accuracy and cost by developing cost-effective MRV methods. Experience from previous results-based climate finance projects points to several ways to address the challenges of GHG estimation in the CSA context.

Activity-based monitoring: Activity- or practice-based monitoring takes change in adoption of CSA practices as a proxy for GHG effects and can significantly reduce the cost and complexity of MRV activities. CSA program results-frameworks will typically identify changes in farmers' management practices as important intermediate effects. Changes in farming practices are also included in the core sector indicators that all agriculture sector World Bank projects must monitor.⁵⁷ Examples include "land area where sustainable land management practices have been adopted as a result of the project (ha)", which can be monitored through project-specific indicators such as "increase in area of levelled land (ha)" or "increase in area adopting balanced fertilization (ha)". Indicators of CSA adoption can be used to estimate GHG effects using carbon models or default emission factors. Annex B provides examples of activity-based indicators that can be used to estimate the GHG effects of changes in farming practice. Although activity-based monitoring can significantly reduce the cost and complexity of monitoring during the program period, parameterizing carbon models and estimating default emission factors in the project development phase can be costly if there is limited prior scientific evidence.

Compared to monitoring for World Bank project operations, results-based carbon finance program MRV is likely to have specific requirements for the accuracy and precision of activity data collected and may require that uncertainty is estimated and addressed. When carbon models or default emission factors are used together with activity data, the uncertainty of GHG emission reduction estimates may be increased.⁵⁸ Stratification of land or livestock in a project area into smaller sub-categories can increase the accuracy of estimates based on carbon models or appropriate default values. Another approach adopted in the CDM and other carbon standards is to **use conservative assumptions, default emission factors and procedures to estimate emission reductions**, so that emission reductions are not over-estimated. Conservative default values can be estimated on the basis of the most recent data in the 2019 Refinement to the IPCC 2006 Guidelines or using results of meta-analysis, such as those for water management in paddy rice,⁵⁹ grassland management,⁶⁰ cropland management,⁶¹ nitrogen fertilizer,⁶² or agroforestry.⁶³

Standardized baselines or performance benchmarks: The CDM introduced standardized baselines to reduce the transaction costs of monitoring in under-represented sectors, such as agriculture. Standardized baselines have been developed and submitted to the CDM for rice cultivation, where representative direct measurement of methane

⁵⁷ World Bank (2013) Core Sector Indicators and Definitions.

⁵⁸ Seebauer, M. et al. (2013) Carbon accounting for smallholder agricultural soil carbon projects. In Wollenberg, E. et al. (eds) *Climate Change Mitigation and Agriculture*. Earthscan, Abingdon.

⁵⁹ Jiang, Y. et al. (2019) Water management to mitigate the global warming potential of rice systems: A global meta-analysis. *Field Crops Research* 234:47–54.

⁶⁰ Conant, R. et al. (2017) Grassland management impacts on soil carbon stocks: a new synthesis. *Ecological Applications* 27(2):662–668.

⁶¹ Powlson D., et al. (2011) Soil carbon sequestration to mitigate climate change: a critical re-examination to identify the true and the false. *European Journal of Soil Science* 62(1):42–55.

⁶² Albanito, F. et al. (2017) Direct nitrous oxide emissions from tropical and sub-tropical agricultural systems - a review and modelling of emission factors. *Scientific Reports* 7:44235.

⁶³ Cardinael, R. et al. (2018) Revisiting IPCC Tier 1 coefficients for soil organic and biomass carbon storage in agroforestry systems. *Environmental Research Letters* 13(12):124020; Kim, D. et al. (2016) Carbon sequestration and net emissions of CH₄ and N₂O under agroforestry: Synthesizing available data and suggestions for future studies. *Agriculture, Ecosystems and Environment* 226:65–78; Feliciano, D. et al. (2018) Which agroforestry options give the greatest soil and above ground carbon benefits in different world regions? *Agriculture, Ecosystems & Environment* 254:117–129.

emissions would be prohibitively costly.⁶⁴ GHG estimation methodologies could also use performance benchmarks set on the basis of representative surveys in a region or sub-sector. The performance benchmarks can be determined in terms of farming practices (e.g. kg nitrogen applied per ha) to facilitate monitoring, and can be set conservatively so that only best practices are rewarded.

Using technological innovations: There are several examples demonstrating that using ICT innovations, such as smart-phone based apps, can collect reliable data and showing that linking monitoring with provision of advisory services can incentivize farmers to provide data. MRV can also be linked to existing data management systems, such as traceability systems in support of animal disease control.⁶⁵ Increasingly, remote sensing data is being used to collect activity data, especially for agroforestry and rice.⁶⁶

Aligning with national MRV systems: Aligning with national MRV systems can also reduce the costs of program MRV. Activity data can be collected through national statistical systems where these are well-functioning. However, agricultural statistics and monitoring and evaluation in the agriculture sector are common weaknesses in many developing countries.⁶⁷ GHG estimation may also be able to use national GHG inventories where these are capable of representing the effects of policy measures on the targeted GHG sinks and sources. In many cases, however, GHG quantification methods and activity data sources used in agriculture sector GHG inventories may not be of sufficient resolution to directly capture the effects of policy measures in the GHG inventory. This is because the vast majority of developing country inventories use IPCC Tier 1 methods.⁶⁸ More advanced Tier 2 or Tier 3 methods and program-specific activity data collection may be required. **Developing policy-based MRV systems to support results-based carbon finance MRV can thus strengthen national capacities for MRV and agricultural policy decision-making.**

4.2 MRV of non-GHG effects

In general, monitoring of the sustainable development effects of results-based carbon finance CSA programs will be similar to existing CSA program results measurement frameworks. CSA program results frameworks often include indicators at the development objective or intermediate outcome level measuring program impacts on crop or livestock yields, food security, farmer incomes, or changes in beneficiaries' adaptive capacity or resilience to climate change.⁶⁹ Indicators for adaptation outcomes should be selected based on the anticipated outcomes identified in the theory of change for the program or policy. Resilience is multi-dimensional, and the appropriate indicators will vary depending on which particular domains of resilience or adaptive capacities the program seeks to strengthen. In some cases, use of CSA practices by farmers may also be used as a proxy for adaptation outcomes, to the degree that there is strong evidence that the practice confers resilience benefits. Annex B provides some examples of indicators that may be relevant to measuring the adaptation benefits of CSA core interventions. However, results-based carbon finance operations may also build resilience by strengthening adaptive capacities at the community level, so indicators for changes at larger scales may also be desired.

Results-based carbon finance programs should also monitor indicators of transformational change. As described in Section 3.1.3, transformational effects of carbon finance programs can be defined in terms of (i) the volume of emission reductions; (ii) sustainability of emission reductions over time; (iii) effects on increasing ambition over time (leverage);

⁶⁴ Republic of Philippines (2019) Standardized Baseline for Methane Emissions from Rice Cultivation in the Republic of the Philippines (https://cdm.unfccc.int/methodologies/standard_base/2015/sb121.html)

⁶⁵ White, J. (2018) Tracking mitigation in the livestock sector: country experiences (<https://ccafs.cgiar.org/blog/tracking-mitigation-livestock-sector-country-experiences#.XvHVmWhKg2w>)

⁶⁶ Rosenstock, T. et al. (2018) *op. cit.*

⁶⁷ World Bank (2010) Global Strategy to Improve Agricultural and Rural Statistics (<https://openknowledge.worldbank.org/handle/10986/12402>); Haddad, L. et al. 2010. The sorry state of M&E in agriculture: Can people-centred approaches help? *IDS Bulletin*, 41(6), pp.6-25.

⁶⁸ Wilkes, A. (2017) *op. cit.*; Rosenstock, T. et al. (2018) *op. cit.*

⁶⁹ World Bank (2017) World Bank Resilience M&E Good Practice Case Studies <https://openknowledge.worldbank.org/bitstream/handle/10986/28387/119939-WP-PUBLIC-P155632-28p-ReMECaseStudiesFinal.pdf?sequence=1&isAllowed=y>

and (iv) catalyzing effects on carbon pricing. Results-based carbon finance programs should take a practical approach in which appropriate indicators are defined according to each program's theory of change. Table 5 gives illustrative examples of indicators of transformational effects of CSA programs. In terms of a program's theory of change, these indicators may refer to program objectives, outcomes or intermediate outcomes, or may be process or financial indicators. Similar to disbursement linked indicators in Program for Results instruments, these qualitative or quantitative indicators should have a protocols describing how the specific indicators will be measured and verified.⁷⁰

Table 5. Illustrative examples of transformational change indicators for results-based carbon finance CSA programs

Criteria	Illustrative indicators
Size	Volume of ERs (tCO ₂ e) Number of direct project beneficiaries, of which female (percentage)*
Sustainability - Technology - Policy - Financing	Number of CSA technologies demonstrated in the project areas* Number of farmers who have adopted a CSA technology promoted by the project* Area provided with irrigation and drainage services (ha)* Number of regulatory or policy documents supporting CSA adoption issued Reforms in forest policy, legislation or other regulations supported* Number of operational IT systems to track subsidy beneficiaries Number of entities receiving capacity support for policy delivery Private sector financing invested in CSA extension services Host country budget allocation to CSA pricing policy
Leverage - Financial - Ambition	Ratio of total funding to carbon fund financial flows Inclusion of CSA-specific commitment in country's NDC GHG benefits explicitly targeted in national CSA strategy document
Carbon pricing	\$/tCO ₂ received Number of enterprises benefiting from pricing policy Number of policy decisions to include CSA in ETS offset scheme Number of programs replicated

* denotes that the indicator maps to a core sector indicator in World Bank (2013) Core sector indicators and definitions. World Bank, Washington D.C.

4.3 Further resources

- FAO has produced [Operational guidelines for the design, implementation and harmonization of monitoring and evaluation systems for climate-smart agriculture](#), which covers both national and program level issues, with a focus on harmonizing different M&E systems.
- The [RALI GHG MRV Harmonization Framework](#) focuses on harmonization of national GHG inventories with other GHG MRV systems.
- The World Resources Institute's [Policy and Action Standard](#) provides guidance on accounting and reporting for the effects of policies and mitigation actions, including GHG and sustainable development benefits.
- The Initiative for Climate Action Transparency has produced a [Policy Assessment Guide for the Agriculture Sector](#), which focuses on GHG effects.
- The [AgMRV platform](#) contains a wealth of materials about MRV in the agriculture sector, including the UNFCCC MRV architecture, national GHG inventories and MRV of mitigation actions.
- The [CSA Programming Tool](#) covers planning, targeting, monitoring and evaluation and can be used to identify indicators aligned with the key objectives of CSA interventions.

⁷⁰ IEG (2016) Program for Results: an early-stage assessment of the process and effects of a new lending instrument. <https://ieg.worldbank.org/sites/default/files/Data/Evaluation/files/program-for-results-full.pdf>

Selected approved agricultural carbon market methodologies are listed in Annex B.

Other general resources on planning and MRV can be located through the NDC Partnership's [Climate Toolbox](#).

5. Customizing results-based carbon finance support to CSA

5.1 Types of carbon crediting

Carbon finance incentivizes adoption of mitigation practices by purchasing the credits generated, thus giving investors a return on their investment in adoption. There are four general approaches to the design of carbon crediting initiatives:⁷¹

- (1) **Project-based initiatives:** Individual projects are designed, often focusing on a single technology or defined set of technologies. While project design may be relatively straightforward and have proven to be an effective mechanism for leveraging private investment, projects have limited potential to achieve scale, and individual projects carry a risk of leakage (i.e., displacement of emissions outside the project boundary) and may create perverse incentives. There are numerous project-based initiatives in the agriculture sector worldwide,⁷² and to date this has been the most common mechanism through which agriculture has engaged with carbon markets. Project-based approaches have been widely used to promote agroforestry⁷³ and manure management.⁷⁴ Methodologies applicable to addressing livestock enteric fermentation have also been approved, but there are few registered projects to date.⁷⁵ Other practices that sequester soil carbon have also been supported in projects, such as the Kenya Agricultural Carbon Project, supported by the World Bank BioCarbon Fund.⁷⁶
- (2) **Programmatic approaches:** Emerging in the CDM, programmatic approaches involve replication of multiple small-scale projects.⁷⁷ Programmatic approaches are typically applied to single technologies or packages of technologies that can be easily replicated and whose GHG effects vary little between each application. One strength of the programmatic approach is that it can enable replication of similar activities, and it is one way in which micro-scale mitigation actions have been promoted at scale. Programmatic approaches similarly may have risks of leakage and perverse incentives. Examples of programmatic approaches in agriculture include dedicated credit lines for CSA technologies, such as drip irrigation and methane avoidance in rice cultivation.⁷⁸
- (3) **Policy approaches:** This type of program supports a policy instrument that results in mitigation outcomes. Examples much include pricing policies (e.g., taxes, subsidies) or regulatory policies (e.g., low-emission standards). Policies may directly put a price on carbon (e.g., carbon markets, carbon taxes), or indirectly (e.g., subsidies or incentive payments for activities with mitigation outcomes). Policy approaches are more complex and costly to design. MRV is often based on economic modelling of policy effects, rather than solely based on tracking uptake of technologies. One strength of policy approaches is the potential to achieve scale and have transformative impacts on the emission pathway in the target sector. If policies are applied across a whole sector, the risks of leakage and perverse incentives are lower. To date, there have been few examples of policy approaches to supporting CSA in the context of results-based carbon finance.
- (4) **Jurisdictional approaches:** Developed in relation to REDD+ activities, jurisdictional approaches define a sector or administrative region as the project boundary.⁷⁹ Mitigation targets are set for the jurisdiction as a whole, and crediting is applied to mitigation outcomes at the jurisdiction level, not to individual mitigation actions within the jurisdiction. In some jurisdictional REDD+ initiatives, agriculture is being included within the scope of

⁷¹ TCAF (2020). Different approaches to carbon crediting.

https://tcaf.worldbank.org/sites/tcaf/files/Carbon%20crediting%20approaches_FIN_1.pdf

⁷² FAO (2013). Agriculture, Forestry and Other Land Use Mitigation Project Database. <http://www.fao.org/3/i3176e/i3176e.pdf>

⁷³ Foster, K. and Neufeldt, H. (2014). Biocarbon projects in agroforestry: lessons from the past for future development. *Current Opinion in Environmental Sustainability*, 6, pp.148-154. <https://www.sciencedirect.com/science/article/pii/S1877343513001954>

⁷⁴ Clemens, H. et al. (2018). Africa Biogas Partnership Program: A review of clean cooking implementation through market development in East Africa. *Energy for Sustainable Development*, 46, pp.23-31.

⁷⁵ See list of selected methodologies in Annex B.

⁷⁶ <https://www.biocarbonfund.org/node/82>

⁷⁷ South Pole (2010). Developing CDM Programme of Activities: a guidebook.

https://cpf.wbcarbonfinance.org/sites/cpf_new/files/PoA_Guidebook_SouthPole.pdf

⁷⁸ E.g. CDM PoAs for [micro-irrigation](#) and [methane avoidance in rice](#).

⁷⁹ Fishbein, G. and Lee, D. (2015). Early Lessons from Jurisdictional REDD+ and Low-Emissions Development Programs.

https://www.forestcarbonpartnership.org/sites/fcp/files/2015/January/REDD%2B_LED_web_high_res.pdf

mitigation targets alongside forestry, so that land use can be addressed in an integrated manner. Leakage can often be more easily addressed when a whole jurisdiction is targeted. While this approach may also be able to achieve scale, delivery risks are potentially high if activities causing emissions within the jurisdiction are affected by multiple external factors.

5.2 Approaches to scaling CSA

There is relatively more experience with project-based approaches in the agriculture sector (see further resources in Section 5.3). The following sections present illustrative blueprints that highlight the potential relevance of programmatic, policy and jurisdictional approaches in the agriculture sector.⁸⁰ The approaches outlined are not intended to indicate recommended approaches, but are provided to illustrate some of the types of support that results-based carbon finance may be able to provide for scaling CSA. The blueprints illustrate how the common requirements of carbon finance facilities described in Chapters 3 and 4 can be operationalized in the CSA context.

5.2.1 Blueprint for a programmatic approach

Programmes of activities (PoAs) developed under the CDM as a mechanism to facilitate scaling up of micro-or small-scale mitigation activities. Unlike the project-based approach, in which the location of all mitigation activities must be specified in advance, PoAs can add new instances of the target activity as the program expands. The program, which can last from several years to more than two decades, serves as a framework to include multiple sub-projects. This is suitable for programs that roll-out a specific technology over time or that are implemented through multiple investment phases. PoAs can be multi-country, regional programs, which may also facilitate achieving scale. Some carbon standards have also issued streamlined approval processes for specific activities within a PoA, which reduces the transaction costs associated with producing verified carbon credits compared to multiple individual projects.

PoAs may be suited to programs that promote pre-determined and relatively standardized mitigation activities, such as particular technologies or agricultural practices. If a new technology replaces a previous technology in a relatively homogeneous region or agricultural sub-sector, the GHG mitigation effects can be estimated using data from a representative baseline survey, standard coefficients applicable to the target region or sub-sector, and annual monitoring data. Separate baselines may be required for different regions or sub-sectors and for activities rolled out in different phases.

In the agriculture sector, the programmatic approach has been used in several household biogas and rural energy programs (e.g., cookstoves) in which new households adopting the target technology are added to the program as it expands. Detailed description of such programs can be found in the project registries of the [CDM](#) and [Gold Standard](#). Agricultural technology promotion often involves a combination of measures, including:

- Technology testing, refinement and demonstration;
- Supply of credit to enable adoption of eligible technologies by the target clients;
- Provision of technical assistance to technology adopters; and
- Business development services for technology supply companies.

To illustrate how carbon finance might support a program to promote agricultural mitigation technologies, the following case study presents an outline of a program to promote laser levelling and drip irrigation in the sugar cane sub-sector. The case study draws on material from several related initiatives, so the details presented should be considered illustrative only.

Agriculture sector background: About 40% of global sugar cane is produced in Asia. Water is a main limiting factor in the productivity of sugar cane. In some areas of South Asia, sugar cane consumes up to 20,000 L of water per hectare, mostly drawn from groundwater supplies. The costs of water use (water fees) and pumping (energy costs) often make up about 25% of farmers' total costs. These costs increase as groundwater supplies are depleted, as is the trend in many regions. Technologies are needed that economize on water use without adversely affecting productivity. Several water-saving techniques have been widely demonstrated, including laser levelling of fields, drip irrigation, skip furrow irrigation and changes in the timing of irrigation. Among these, laser levelling and drip irrigation have been shown to have benefits

⁸⁰ Annex D includes further examples of how results-based carbon finance could support different types of pricing policy.
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for reducing water use as well as use of other agricultural inputs. Reduced input costs often translate into increased farming profitability. With drip irrigation, water use can decrease by 40% or more. Nutrients can be supplied through drip tubes (a practice known as 'fertigation'), which target nutrients to plant roots, increasing nutrient use efficiency and reducing the total amounts of fertilizer required. Drip irrigation can reduce fertilizer use by 30%. Similarly, laser levelling of fields increases the efficiency of water and nutrient use, reducing irrigation time (and thus energy costs), total water use and fertilizer requirements. Savings in agricultural input costs increase profitability of sugar cane cultivation. However, the initial costs of installing drip irrigation systems are often beyond the means of sugar farmers. Laser levelling is also costly, and may need to be repeated every 3-5 years.

Policy alignment and support for increased ambition: Increasing water use efficiency in agriculture is a priority for national and sub-national governments throughout semi-arid regions of South Asia. Until recently, policies tended to focus on reducing water losses in irrigation supply systems (e.g. rehabilitation of canals and watercourses). Increasingly this is supplemented by a policy focus on reducing water demand from agricultural production. Irrigation pumping is also a significant cause of agricultural energy use in some regions. Measures such as increasing pump efficiency and shifting from fossil fuel to renewable energy sources have been listed in several policy documents. Therefore, measures to reduce irrigation water demand cut across the agriculture, water and energy sectors, and have been given a high priority in agriculture, energy, water and climate policies. The issue is also highlighted in several countries' NDCs, but to date none have specified targets for reductions in water use or associated GHG emissions. Therefore, development of a program to promote water-saving technologies, could assist in both demonstrating the potential to scale adoption of these technologies and quantifying the GHG benefits of wide-scale promotion. This could support countries to integrate water-saving CSA practices into their national plans and climate commitments.

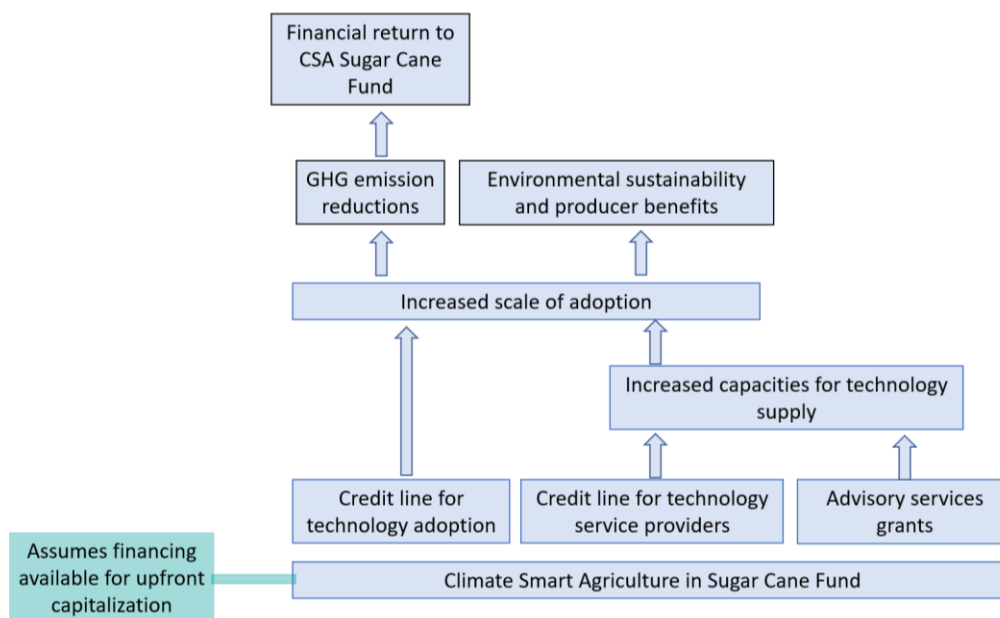
Sustainable development benefits: Adoption of laser levelling and drip irrigation reduces water demand and therefore reduces the sensitivity of crops to drought risks, and increases climate resilience. There are also wider benefits as groundwater resources are spared and less nutrients are lost through run-off, thus reducing nitrogen pollution of water sources. For farmers, the main value proposition is increased profitability of farming, which is mainly due to lower water and fertilizer input costs.

Transformational change: Figure 5 illustrates the theory of change behind a program to promote laser levelling and drip irrigation. The technologies will be promoted in the procurement catchment areas of the main sugar mills where sugar cane is consistently cultivated. These technologies have been tested, adapted and demonstrated at pilot scale in this region by an ongoing investment project. The program involves establishing a fund with three financial mechanisms:

- (1) An intermediated credit facility operated by state or commercial banks. Loans are given by the banks to individual farmers or to sugar cane cooperatives who further on-lend to individual farmers. The loans are for laser levelling services or drip irrigation systems installed by accredited providers.
- (2) A credit line for laser levelling service providers to purchase machinery or to drip irrigation companies to support stock inventory.
- (3) Grants to sugar cane cooperatives or NGOs to provide technical assistance to farmers on the planning and use of these technologies, and grants for business development advisory support for technology service providers.

The credit lines will be initially financed through a combination of funds from donor investment projects, local government resources and the funds of the banks involved. The ambition is that the fund can operate as a revolving fund, and increase in scale as local government increases its investments and private banks gain greater experience of loan operations in this sector. Thus, the fund is designed to be sustainable in the long-term and its operations should increase in scale over time. Sustained impacts will also be achieved by supporting laser levelling and drip irrigation service companies to develop cost effective business models for providing services at scale.

Figure 5 Theory of change for water-saving irrigation technology promotion program



Up-front finance will be needed to capitalize the fund. Finance for grant support to farmer and business advisory services may come from either international loan projects or local government funds. A results-based carbon finance program would therefore have to be aligned with other sources of finance. The revenues from carbon payments would be small relative to the size of the credit fund, but could make useful contributions to fund sustainability and effectiveness if revenues are used to support ongoing provision of technical assistance and advisory service grants. The program could have transformational impacts through:

- **Leveraging other financial resources:** The technology promotion fund would leverage resources from local government and commercial banks, as well as farmers' own co-investments. Ultimately, the program aims to demonstrate to local and national governments financial mechanisms that they can adopt and integrate into government policies and plans.
- **Scale:** Preliminary analysis suggests that laser levelling on 10,000 ha per year and drip irrigation on 10,000 ha per year could reduce GHG emissions by 70,000 tCO₂e per year. There is technical potential to reach a much larger scale than this, and a phased scaling approach would be devised to estimate the program's mitigation potential in different phases.
- **Sustainability:** The fund is designed as a revolving fund to sustain operation over time. Technologies to conserve water resources have been demonstrated (**technology sustainability**). The investments are aligned with national and local government policy priorities and investment plans (**policy and financing sustainability**).

Mitigation potential, baselines and crediting options: The program would adapt existing CDM methodologies to account for emissions from irrigation energy use⁸¹ and fertilizer use.⁸² Baseline setting and monitoring would follow these methodologies and CDM rules on PoAs. In PoAs, eligible technologies can pass additionality tests based on a positive list. For a results-based carbon fund, the VERs claimed would depend on the contribution of the ERPA relative to the contribution of other sources of finance.

5.2.2 Blueprint for a policy approach

In many situations, the revenues per unit area (or animal) from agricultural production will be much greater than the value of GHG emissions from adopting improved production practices. Pricing policies that affect input costs or the value

⁸¹ AMS.II.F. Energy efficiency and fuel switching measures for agricultural facilities and activities

⁸² AMS-III.A.: Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland

of agricultural output may be one mechanism for incentivizing adoption of CSA practices. Examples of pricing policies that directly affect producer incentives include:

- Targeted subsidies for production inputs that increase productivity and reduce GHG emissions;
- Subsidized agricultural credit tied to adoption of GHG mitigation measures with sustainable development benefits or tied to agricultural production certification schemes;
- Reform of taxes on production inputs that reduce GHG emissions or on agricultural products with low carbon footprint;
- Performance-based payments for environmental services that have strong synergies with GHG mitigation.

To illustrate how carbon finance may provide direct support to implicit carbon pricing policies, the following case study presents an outline for support to a smart fertilizer subsidy program. The case study is based on TCAF assessment of the mitigation potential of the Strengthening Markets for Agriculture and Rural Transformation in Punjab (SMART) Program, a World Bank Program-for-Results (PforR) financing to the Government of Punjab (Pakistan).

Agriculture sector background: Fertilizer use in Punjab is both low and imbalanced. About 75% of fertilizer sold in Punjab is urea (phosphates ca. 24%, potash ca. 1%). Imbalanced fertilizer use causes soil nutrient imbalance, limits crop yield and raises production costs. Plant utilization of nitrogen (N) inputs is increased when N, P (phosphorous) and K (potassium) nutrient inputs are balanced. Furthermore, because urea is produced through energy-intensive methods and has a high nitrogen content, GHG emissions per unit of urea use are much higher than for other fertilizers. P and K fertilizers are mainly used at planting as basal fertilizer applied together with urea. An increased use of P and K can only partially substitute urea use in crop production.

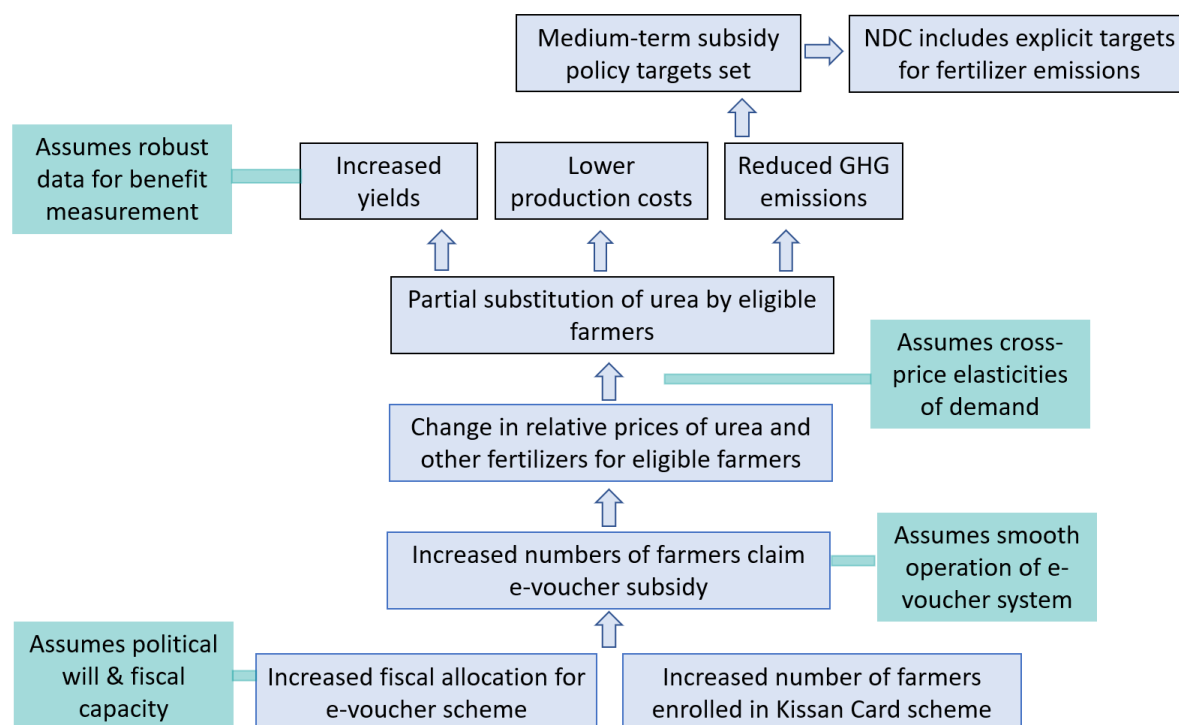
Imbalanced use of fertilizers is strongly driven by current subsidy policies to the sector. Subsidies to urea account for 33% of total subsidies to the agriculture sector in Punjab. The subsidies are mainly supply-side subsidies to companies that are not passed on to farmers. Subsidies also affect the relative prices of fertilizers, contributing to imbalanced fertilizer use. Reform of gas subsidies to urea manufacturers, import and distribution subsidies and sales tax breaks on fertilizers have been discussed for many years and continues to be contentious. Since 2015, the Government of Punjab has piloted delivery of demand-side subsidies for purchase of fertilizers other than urea through an e-voucher scheme. A pre-paid voucher is stitched inside each bag of subsidized fertilizer. Farmers can redeem the voucher code by SMS from a mobile phone. To ensure that small farmers (with < 5 hectares [ha] of land) are targeted, the applicant's mobile phone number is verified against records held by the administering agency. After verification, the subsidy is transferred to the buyer. Subsidies have been targeted to diammonium phosphate (DAP), potash fertilizers (muriate of potash [MOP], sulphate of potash [SOP]) and phosphate fertilizers (NPK, nitrophosphate). Initial pilots of subsidies for potash fertilizer were successful. Sales of potash fertilizer increased by 84% and significant productivity increases were observed. In contrast to the other fertilizer sector subsidies, the e-voucher subsidy aims to directly change the relative prices faced by small farmers. Delivery of the e-vouchers is linked to the government's Kissan scheme, in which 5.2 million small farmers with <5 ha of land are being enrolled in a digital database to enable access to various forms of government support.

The PforR Strengthening Markets for Agriculture and Rural Transformation (SMART) in Punjab, Pakistan, is an IBRD-funded concessional loan supporting delivery of the e-voucher fertilizer subsidy, among other activities. One disbursement linked indicator has targets to increase the number of farmers receiving the e-voucher based fertilizer subsidy from 25,000 in 2017 to 200,000 by 2021. Achievement of annual targets are verified by a third-party contracted to verify performance reports based on original data held in the database of the Government of Punjab fertilizer subsidy administration agencies.

Policy alignment and support for increased ambition: Support to a smart fertilizer subsidy is in line with existing national and provincial agricultural policies. The national goals for the agriculture sector include increasing food crop yields and farmer profitability, and improving the efficiency of agricultural input use. The Government of Punjab's Agriculture Policy 2018 includes objectives to increase farmer profitability, reduce input costs, and optimize subsidy programs through targeting and ICT technologies. The E-voucher fertilizer subsidy is the main policy measure for increasing access to quality and affordable fertilizer inputs targeting small farmers.

Pakistan's NDC⁸³ commits to a 20% reduction of its projected 2030 GHG emissions conditional on international support. The agriculture sector is included in the analysis underlying Pakistan's NDC. The NDC assumes that agricultural emissions will rise by 4% per year until 2030, slightly higher than the historical rate of 3%. The NDC identifies mitigation priorities in the agriculture sector, including increasing the efficient and targeted use of fertilizer, which is also highlighted in the National Climate Change Policy (NCCP). The NDC and NCCP do not present the mitigation potential, targets or specific policy actions, as the technical basis for this is currently lacking.

Figure 6: Theory of change for e-voucher fertilizer subsidy intervention



Transformational change: Figure 6 illustrates the theory of change behind a carbon finance program to support the e-voucher subsidy for fertilizers. The subsidy to fertilizers other than urea changes the relative price of fertilizers, leading to partial substitution of urea with low-emission fertilizer categories. This would reduce GHG emissions, as well as increase crop yields and reduce production costs (**indicators of sustainable development benefits**). The e-voucher scheme has already been piloted at small scale, and the SMART program has supported its scale up. A carbon finance program could have transformational impacts by:

- **Leveraging policy for fertilizer efficiency:** Incentivizing the Government of Punjab to increase the scale of the e-voucher fertilizer subsidy policy and to elaborate specific and enhanced medium-term targets for fertilizer use in its agriculture sector policies; a carbon finance program could also provide the basis for explicit targets related to fertilizer emissions in future NDCs (**indicators of transformational change**).
- **Carbon pricing:** A carbon finance program could establish the technical evidence base for the GHG impacts of the e-voucher fertilizer subsidy and demonstrate a pathway to link policy impacts to Article 6 mechanisms.
- **Scale up potential:** Significant emission reductions could be achieved if the scale of the subsidy is increased to cover 1 million or more farmers.
- **Sustainability:** Subsidy support to balanced fertilizer use meets current agriculture sector needs, but the subsidy mechanism does not lock Punjab into unsustainable long-term pathways (**technology sustainability**). It is based on fiscal policy and mechanisms that are financed through government budget (**indicators of policy and financing sustainability**).

⁸³ Government of Pakistan (2015). Pakistan's Intended Nationally Determined Contribution (<https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Pakistan%20First/Pak-INDC.pdf>)
Unlocking crediting opportunities in climate-smart agriculture – 20 January 2021

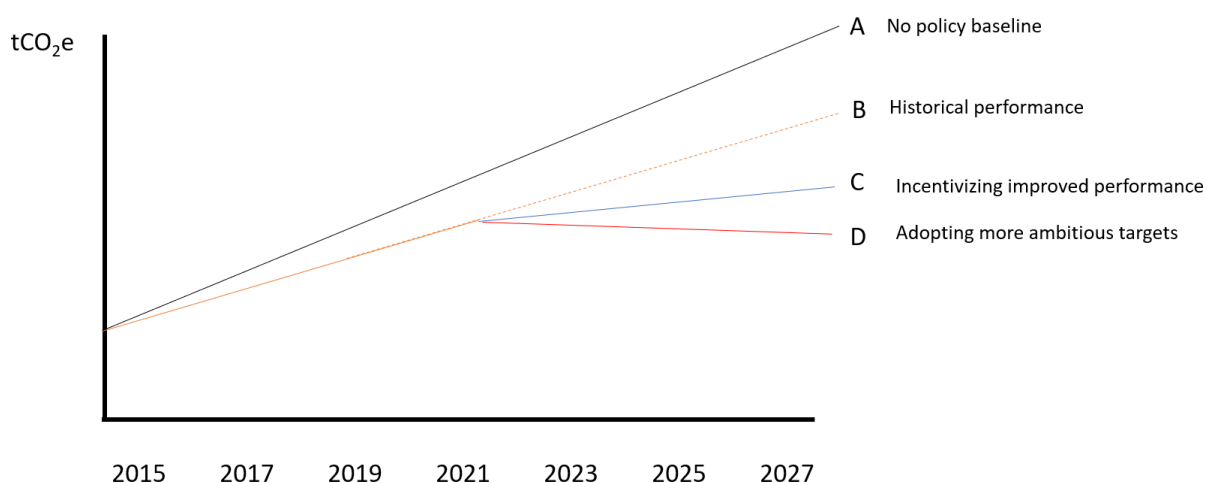
Sustainable development benefits: Balanced fertilizer use increases soil fertility and crop yields. Change in structure of fertilizer types applied can reduce production costs and increase farm profitability. The program is targeted at small farmers, many of whom are poor. More stable and higher crop yields should enhance farmers' resilience to climate variability and other climate risks.

Mitigation potential, baselines and crediting options: Quantifying the GHG benefits of urea fertilizer substitution requires a novel, policy-specific GHG quantification methodology in which substitution rates are estimated using empirically-derived cross-price elasticities for potash and urea fertilizers, and emission factors for each fertilizer type. Mitigation potential also depends on how baselines and crediting thresholds are set. Four alternative scenarios have been identified (Figure 7), including:

- A. No fertilizer subsidy BAU scenario
- B. A BAU scenario based on historical performance;
- C. A crediting threshold set to incentivize improved policy delivery within current policy targets, and
- D. A crediting threshold set to incentivize enhanced policy targets.

The difference between current policy implementation and the no-policy scenario (i.e. B-A in Figure 7) does not demonstrate additionality. One option could be to incentivize improved performance of the e-voucher subsidy scheme by crediting emission reductions that exceed historical performance of the scheme (i.e. C-B in Figure 7). Another option could be to credit only performance that exceeds current policy targets (i.e. D-C in Figure 7). Establishing the baseline and crediting thresholds would require in-depth analysis of existing barriers to upscaling the scheme and negotiation between all partners involved in the program.

Figure 7. Alternative baseline and crediting scenarios for fertilizer subsidy scheme



5.2.3 Blueprint for a jurisdictional approach

There are several examples of jurisdictional approaches to carbon crediting applied in relation to REDD+ and sustainable landscape management (see further resources in Section 5.3). The example presented here is intended to illustrate how investment project financing (IPF) and carbon finance could support integration of agriculture – in this case livestock – into sustainable landscape management. The example is based on the Oromia Forested Landscape Program (OFLP),⁸⁴ a program of the Initiative for Sustainable Forest Landscapes (ISFL), and the World Bank Livestock and Fisheries Sector Development Project (LFSDP) in Ethiopia.⁸⁵

⁸⁴ <https://www.biocarbonfund-isfl.org/programs/oromia-forested-landscape-program>

⁸⁵ <https://projects.worldbank.org/en/projects-operations/project-detail/P159382>

Program background: Oromia Region contains about 50% of Ethiopia's forest, including 1.2 million ha of protected areas, wildlife reserves and community-managed forests. Crop and livestock farming are the dominant economic activities for the rural population in the region and have been identified as drivers of deforestation and forest degradation. The OFLP builds on the experience of existing REDD+ projects in the region and will promote low-emission development through participatory forest management and reforestation. When the OFLP becomes operational, the existing REDD+ projects will be accounted for as one unit using a baseline set for the whole of Oromia Region. Supported by the World Bank BioCarbon Fund, OFLP will be implemented in two phases: a five-year mobilization grant, followed by an ERPA of up to \$50 million over 10 years. Livestock emissions are the second largest emission source in Oromia Region, and emissions are increasing more rapidly than other key emission sources. Work is currently ongoing to incorporate livestock emissions in the future ERPA. Historically, the increase in livestock emissions has been driven by increasing livestock populations. Reducing absolute numbers of livestock is not currently feasible, so OFLP stakeholders are exploring options for crediting reductions in the intensity of GHG emissions from livestock due to increases in productivity and marketed off-take. The World Bank LFSDP is one of the main loan investment projects in livestock development in Ethiopia, and includes activities to increase the productivity of dairy cattle, other cattle, small ruminants and poultry in 23 of 266 districts in the region. LFSDP's design includes reduction in GHG intensity of livestock production as a results framework indicator.

Policy alignment and support for increased ambition: Forestry and livestock are among the four sectors highlighted in Ethiopia's Climate Resilient Green Economy Strategy (CRGE), which formed the basis for the country's first NDC. Increasing productivity and marketed output of cattle through improvements in breed, feed, animal health and market access are highlighted as key GHG mitigation options in the CRGE and quantitative targets for emission reductions have been set. However, to date, Ethiopia has not been able to report progress towards the targets, due to lack of an operational system for measurement, reporting and verification in the livestock sector. Therefore, LFSDP contributions to livestock emission reductions in Oromia Region can demonstrate both the feasibility of implementing mitigation activities at scale and the feasibility of MRV. It is intended that the demonstration effects of integrating LFSDP into the OFLP can increase Oromia Region's abilities to upscale mitigation activities and also support increased ambition in national targets in the livestock sector.

Transformational change: Analysis conducted for the LFSDP identified several scalable practices that would reduce the GHG intensity of livestock production. For example, improvements in feed quality, animal health and reproduction have been identified as key determinants of the GHG intensity of milk production. LFSDP activities to address related constraints could result in an increase in milk yields that is several times greater than the corresponding increase in GHG emissions. Establishing farmer, private sector and local government capacities to promote significant increases in the yield and marketed output of livestock products would fundamentally change the emission pathway of livestock production in Oromia Region.

Sustainable development benefits: Livestock production makes critical contributions to food and nutrition security. Livestock manure is a key input to crop farming. Increased productivity and marketed output can improve household nutrition by increasing household consumption of milk, eggs and other products, and by increasing income available to purchase foods. Increased control over production and income by women has particularly clear effects on the nutrition of women, children and other vulnerable household members.

Mitigation potential, baselines and crediting options: In order to be eligible for crediting under the ISFL, baselines must be set following the ISFL methodology requirements. To establish a baseline for livestock emissions in Oromia Region, a GHG inventory for cattle in Oromia was compiled using the IPCC Tier 2 approach. Data gaps have been identified and a historical baseline covering the last 10 years will be defined when existing data gaps have been filled. The inventory will be updated annually, allowing OFLP to monitor livestock emissions and emission intensity at the regional level. A methodology to account for emission reductions due to improvements in GHG intensity of livestock production is under development. In general, emission reductions will be quantified by comparing the annually monitored emission intensity with the historical trend. As a loan project, mitigation outcomes credited as a result of LFSDP activities could either contribute to Ethiopia's NDC or be sold through the OFLP ERPA. Since absolute emissions from livestock will most likely

continue to increase, it is likely that ISFL will require that there is a cap on emission reductions credited from the livestock sector. How this cap will be set is still under negotiation.

5.3 Further resources

Project-based approaches:

- [FAO \(2011\) Climate Change Mitigation Finance For Smallholder Agriculture](#).
- Two articles, [Building local institutional capacity to implement agricultural carbon projects](#) and [Implementing smallholder carbon projects](#), reflect on experiences from two projects in Africa.

Programmatic approaches:

- The [CDM registry](#) contains project documents for several programmes of activity in agriculture and related sectors.
- [Developing CDM Programme of Activities: a guidebook](#) and the [Handbook for Programmes of Activities](#) give guidance specific to the CDM, but much of it is applicable in other contexts.

Policy approaches:

- [Annex D](#) describes four types of support results-based carbon finance could provide to pricing policies, and presents blueprints for support to implicit carbon pricing (i.e., incentives for agricultural practices that reduce GHG emissions) and for explicit carbon pricing (e.g., in the context of domestic ETS).

Jurisdictional approaches:

- Experience with jurisdictional approaches are reviewed in [Tackling Deforestation through a jurisdictional approach](#), [The State of Jurisdictional Sustainability](#), and [Jurisdictional Approaches to REDD+ and Low Emissions Development](#).

General guidance on developing mitigation programs:

The [Mitigation Action Assessment Protocol](#) is designed to assist in assessing mitigation actions that have already been designed, but reference to the dimensions and criteria in the MAAP is also useful for designing mitigation actions.

UNDP's [Climate Impact Tool](#) can be used to assess the contributions of climate actions to the Sustainable Development Goals and the FAO publication [Climate-smart agriculture and the Sustainable Development Goals](#) includes guidelines for CSA implementation in the context of the SDGs and NDCs.

The CSA Guide contains a [chapter on CSA planning](#) and covers 1) situation analysis, 2) targeting and prioritizing, 3) program design, and 4) monitoring and evaluation.

6. Conclusions

Climate smart agriculture is an approach to achieving food security, climate change adaptation and GHG mitigation and is critical to achieving the objectives of the UNFCCC and the Paris Agreement. This report identifies a significant technical potential to reduce GHG emissions and increase carbon sequestration through agroforestry, improved nutrient management and improved grassland and livestock management. There are also mitigation opportunities in paddy rice systems and in agri-food supply chains. The mitigation impacts of interventions vary with the bundle of practices used, the extent of implementation and context.

At low carbon prices, the fundamental driver of CSA adoption will often be the benefits of CSA practices for agricultural production. In smallholder dominated agricultural production, multiple barriers to adoption of CSA practices are likely. Policies and measures should be targeted to overcome barriers to adoption and a wide range of measures may be required to address diverse barriers. Pricing policies, such as input subsidies and input or output taxes, may have a role to play in incentivizing uptake of CSA practices in some contexts, but typically will not address institutional or capacity constraints. Results-based carbon finance may need to be combined with other financing instruments to address a wide range of barriers to adoption. Results-based carbon finance can be used either to make direct incentive payments to farmers or to finance the operations of policy mechanisms that support farmer adoption. Therefore, it will be critical for each program to identify how ex post results-based payments can be positioned in relation to domestic financing sources and other World Bank investments. Important considerations will include both the barriers to adoption that each financing mechanism addresses and the timing of each type of finance and the activities supported.

Experience from large-scale CSA initiatives demonstrate that significant agricultural adaptation, yield and income benefits are feasible for large numbers of farmers along with significant GHG mitigation impacts. It also suggests that successful upscaling and long-term adoption of CSA technologies are likely when:

- technologies have been tested, adapted and validated in the target production systems or regions;
- the evidence for strong benefits of farmer adoption is clear; and
- stakeholders involved in CSA technology promotion (e.g. public or private extension services, input suppliers, rural financial institutions, farmer organizations) have demonstrated capacities for delivery at large scale; and
- policy measures and mechanisms have been successfully piloted.

Analysis of reasons for limited engagement of agriculture with results-based climate finance highlights challenges related to transaction costs, challenges in MRV, the risk that carbon sequestration could be reversed and the uncertainty associated with volatile carbon markets. Experience also highlights some approaches that can be used to address these challenges, including using activity-based monitoring, conservative assumptions and ICT-based MRV systems to overcome the challenges of monitoring GHG emissions with large numbers of farmers.

Carbon and climate finance aim to support achievement of the goals of the Paris Agreement. While many countries include agriculture in the scope of their NDC, few have developed specific policies, measures and targets. There may be opportunities for carbon finance facilities to support the development of national mitigation programs and to enhance ambition in the agriculture sector. Results-based carbon finance programs could have sustainable effects if they can crowd-in private sector investment, catalyze public sector policies and investments or increase the engagement of the agriculture sector with explicit pricing instruments, such as carbon markets.

Results-based carbon finance can support scaling of CSA activities through project, programmatic, policy or jurisdictional approaches. Project approaches to carbon finance are relatively more common in the agriculture sector and have been widely used to promote carbon sequestration through agroforestry and reduce manure management emissions. There have been some applications of programmatic approaches for reducing agricultural energy emissions and rice methane emissions. Jurisdictional approaches, which are commonly adopted in REDD+ projects, have also engaged with agriculture as part of landscape carbon finance initiatives. There is relatively less experience with policy approaches. Three 'blueprints' are presented in Chapter 5 to illustrate how results-based carbon finance programs can be designed

to support programmatic, policy and jurisdictional approaches to scaling up implementation of CSA. They illustrate how programs could help incentivize and support both the creation of an enabling environment for CSA and upscaled adoption of CSA practices, and show CSA initiatives can support carbon finance facilities' objectives of promoting sustainable development through transformative programs that contribute to achieving the ambitions of the Paris Agreement in the agriculture sector.

Annexes

Annex A: Case studies of large-scale CSA initiatives and agricultural carbon credit programs

A.1 Large-scale CSA initiatives

Title	Location	Adaptation and mitigation practice	Farmer incentives	Scaling	Scale achieved	Sources	
Drought-tolerant maize for Africa	Africa	Increased stability of yields. Reduced loss of maize growing area. Small increases in soil carbon possible if crop residues returned to soil.	Yields 20-30% higher than traditional varieties, even under moderate drought conditions. Drought-tolerant varieties adapted to local requirements, including cooking, milling and pest and disease resistance.	Farmers tested and provided input to variety development in 13 countries. Adoption highest among farmers with easy access to seeds and markets and repeated visits by extension staff.	2006-2016: 2 million smallholder farmers in sub-Saharan Africa	<u>Climate-smart agriculture success stories from farming communities around the world</u>	<u>Large-scale implementation of adaptation and mitigation actions in agriculture. CCAFS Working Paper</u>
Alternate wetting and drying (AWD) of irrigated rice in Bangladesh	Bangladesh	Up to 30% improvement in water use efficiency; reduced ground-water extraction; 30-70% reduction in methane emissions; increased farmer income.	Farmers save up to 30% on irrigation water, reducing water pumping fees. Can increase yields and decrease pests and diseases.	Grassroots network has led stakeholder meetings, training, farmer-to-farmer sharing of experiences, field trials. A Climate Technology Park served as a demonstration site.	Target: 50,000 farmers	<u>Progressing towards climate resilient agriculture: top ten success stories from CCAFS in South Asia</u>	

Precision nutrient management in South Asia	Bangladesh, India, Nepal	Increased productivity with lower fertilizer use. Reduced water pollution from excess nitrogen, reduced N ₂ O emissions (~8%).	Saves money on fertilizer, while maintaining or increasing yields. Improves productivity.	Methods were demonstrated to farmers, private sector, and extension agents and awareness raised in travelling seminars and farmers' fairs. Local service providers and business cases were developed.	State-level nutrient management programs in Punjab, Haryana, Bihar, Maharashtra, Karnataka, Orissa in India and Nepal.	Progressing towards climate resilient agriculture: top ten success stories from CCAFS in South Asia	Cost-effective opportunities for climate change mitigation in Indian agriculture
Transboundary Agro-ecosystem Management Project for the Kagera River Basin (Kagera TAMP)	Burundi, Rwanda, Tanzania, Uganda	Degraded lands were restored, which sequestered carbon and improved agricultural biodiversity.	Increased area and yield of pastures and leguminous fodders increased dairy productivity; increased income from fruit trees.	Capacity building at farmer and institutional levels for catchment planning and local level governance. Farmer field schools used to train farmers.	Target 2010-2014 100,000 hectares, 200 communities	FAO success stories on CSA	Kagera TAMP website
Grain for Green Program (GGP): A case study of the Loess Plateau	China	Converted sloped farmland to forest or grassland. Reduced erosion, increased productivity, increased carbon sequestration.	Payments for ecosystem services through seeds, grain and cash payments. Many farmers increased off-farm income. The measures reduced flooding and decreased erosion.	Government initiative, scaled up through quasi-voluntary participation requirements.	2000-2008: 2 million ha, 2.5 million households; soil and biomass carbon increased to 11.54 and 23.76 Mt C, respectively	Climate-smart agriculture success stories from farming communities around the world	Large-scale implementation of adaptation and mitigation actions in agriculture. CCAFS Working Paper.

Ethiopian Productive Safety Net Program (PSNP)	Ethiopia	Land restoration, soil and water management	Cash and food support. Support to income generation and household assets. Improved agricultural practices, leading to increased yields (38% increase in maize yields).	Public workfare projects, including area enclosures, woodlots, hillside terraces, shallow wells. Sister program helped build assets and agricultural productivity.	2005-2014: 8 million people (12% of population), mitigates 3.4 MtCO ₂ e per year (+/-20%).	<u>Climate-smart agriculture success stories from farming communities around the world</u>	<u>Land restoration in food security programmes: synergies with climate change mitigation</u>
Climate-smart villages (CSVs) in India	India	Laser-land levelling, zero-tillage, residue management, direct dry-seeded rice, rice paddy water management, precision nutrient management, agroforestry, crop diversification and climate information services.	Production costs and labor inputs reduced, increasing profitability of farming. Improved health and nutrition from increased food availability.	Demonstration sites for farmer-to-farmer learning scaled up by local government, private sector, and using ICT. Informed subsequent large-scale CSA investments and policy.	2015: 500 CSVs in Haryana, CSV pilot projects across 5 other Indian states (237,000+ ha)	<u>Progressing towards climate resilient agriculture: top ten success stories from CCAFS in South Asia</u>	<u>Climate-Smart Villages: an A4RD approach to scale up climate-smart agriculture</u>
Laser land leveling in rice and wheat in Haryana	India	Laser land leveling, resulting in yield increases, reduced irrigation time and reduced energy use for irrigation.	Increased yields (7%+) and profitability by US\$113-175/ha/yr. Additional production of 155,000 tons wheat and 175,000 tons rice.	Pilot and scale up by state government with subsidies for equipment. Farmers rent equipment or form cooperatives to share costs.	2015 Haryana: 500,000 hectares, 82,000 tCO ₂ e reduced, 1 million cubic meters of water saved	<u>Laser land levelling: How it strikes all the right climate-smart chords</u>	<u>Impacts of Laser Land Leveling in Rice-Wheat Systems of the North-western Indo-Gangetic Plains of India.</u>

East Africa Dairy Development (EADD) Program	Kenya, Rwanda, Uganda	Improved feed via fodder banks, improved pasture species, feed legumes and use of crop by-products; manure management.	Increased yield and production value: In 2013 farmers earned 50% more per liter than in 2008. Access to financial services saved farmers US D10 million. USD 131 million earned in milk sales by farmers.	Improved market access. Business hubs provide agricultural inputs, animal health services, finance, and health care. Banks provide access to credit. Processors provide milk supply contracts, technical assistance, farmer training, access to inputs and transport.	2008-2013: 203,778 small-scale farmers. Monthly milk intake at the dairy enterprises increased from 529,000 to 8 million liters.	<u>Evidence of impact: climate-smart agriculture in Africa</u>	<u>EADD webpage</u>
Anchor Farm Project	Malawi	Integrated soil fertility management (ISFM), high quality farm inputs for maize and soybean production.	Increased yields: Average soybean yields increased from 0.7 t/ha to 1.3 t/ha; maize yields from 1.3 t/ha to 3 t/ha. Improved access to loans.	Large commercial "anchor" farm managed demonstration plots and held field days to show ISFM impacts, train farmers and teach business skills. Project organized farmer clubs and links to credit and large soybean buyers.	2010-2014: 28,000 farmers (35% women), 9,000 ha additional districts in Malawi and Tanzania.	<u>Evidence of impact: climate-smart agriculture in Africa</u>	<u>AGRA webpage</u>
Plan Maroc Vert	Morocco	Increased productivity, intensification and diversification of value chains, expected reduction of 1.44 tCO ₂ e/ha/yr from soil carbon sequestration.	Increased productivity in multiple sectors and stages in the value chain, agricultural job creation. From 2005-2007 to 2011, production increased by 190% in the olive sector, 20% for citrus, 52% for cereals, 45% for dates, 48% for red meat.	Public sector investment in agricultural production chains, from input supply to product marketing. Targeted high economic value agricultural products. Additional loans for agricultural industry development.	Expected to benefit 3 million rural workers with increased incomes, and 1.5 million new, permanent jobs.	<u>Climate-smart agriculture success stories from farming communities around the world</u>	<u>Large-scale implementation of adaptation and mitigation actions in agriculture. CCAFS Working Paper.</u>

Farmer-managed natural regeneration	Niger	Enables re-growth of trees in fields through pruning instead of clear cutting. Trees in fields improve crop yields and sequester carbon.	Minimal establishment cost. Agriculture and tree productivity increased within a year. Particularly clear benefits for women.	Built on a traditional practice, spread through radio dissemination; integrated into agriculture extension, land tenure policy.	1980 - 2008: 5 million hectares, 200 million trees	Climate-smart agriculture success stories from farming communities around the world	Large-scale implementation of adaptation and mitigation actions in agriculture. CCAFS Working Paper.
Fertilizer / urea deep placement (UDP)	Nigeria	Urea deep placement with an average 25% decrease in urea use and 18-25% increase in yields. Decreased emissions from fertilizer (>25%).	Increased income due to yield increases (18-25%) and reduced urea costs (25% less).	Agronomic and economic benefits delivered through capacity building and information-sharing by partners.	2018: 2.5 million farmers and expanding to 1 million more farmers in Bangladesh. 2009: began informing policies in 13 countries in Africa	FAO success stories on CSA	IFDC Fertilizer Deep Placement
Sustainable intensification of rice production	Vietnam	Reduced flooding, and use of agro-inputs (e.g. chemical fertilizers, pesticides) by combining organic and inorganic fertilizers. Reduced fertilizer and rice paddy emissions.	Increased yields by 9-15% using 70-75% less seed, 20-25% less nitrogen fertilizer, 33% less water and less pesticide. Farmer income increased by US\$ 95-260/ha/crop season.	Initiated as a pesticide reduction project in 1994. National mass media campaign in 2003 'Three Reductions – Three Gains'. Since 2006 promoted through farmer field schools (FFS) and farmer-to-farmer extension.	1994 - 2011: 185,000 hectares in 22 provinces, 1 million farmers	Climate-smart agriculture success stories from farming communities around the world	Large-scale implementation of adaptation and mitigation actions in agriculture. CCAFS Working Paper.

A.2 Agriculture and results-based carbon payment initiatives

Initiative description	Scale and mitigation impact	Implementation features and lessons
<p>ABC Plan, Brazil 2010-2020 http://www.agricultura.gov.br/assuntos/sustentabilidade/plano-abc/plano-abc-agricultura-de-baixa-emissao-de-carbono</p> <p>Ambitious national program providing low-interest loans for best practices and low-carbon agriculture, including agroforestry, efficient nitrogen fertilizer use, rehabilitating degraded pasture, crop-livestock-forest integrated systems, no till agriculture, biological N fixation, and planted forest and reforestation.</p> <p>https://www.dropbox.com/s/jgupjfhqccn9jit/Presentation%20Beata%20Madari.pt?dl=0#</p>	<p>14 states + federal district have completed plans; 11 states have plans in preparation.</p> <p>Aims to restore pasture (15 million ha), integrated crop livestock forestry (4 million ha) no-till (8 million ha), N fixation, (5.5 million ha) planted forests (3 million ha), treatment of animal waste (4.4 million m³)</p> <p>Mitigation target: reduced emissions by 38% compared to BAU by 2020 (i.e. 134-163 million tCO₂e)</p> <p>Mitigation achieved 2010 to 2018: 100 - 154 million tCO₂e</p>	<p>Technology transfer Developed state and municipal plans. Participation promoted through demonstration units, field days, lectures, seminars, workshops, contracted technical assistance.</p> <ul style="list-style-type: none"> ➤ Best practice requirements were loosened in 2011, making the policy more about sustainable agriculture than GHG mitigation. State and local plans were intended to be flexible to address local conditions.
		<p>Finance R\$ 197 billion (USD 70 billion) in 2010. R\$157 billion made available through budgetary sources or lines of credit to project participants. Included US\$ 2 million endowment from federal government and other sources, including private funds. Operated through Bank of Brazil networks, and links to farmers unions, and public and private advisory services. Credit limit of 0.5 million dollars per farmer (~1.000.000,00 R\$ as per 2010/11); Grace period of up to 8 years; maximum payback period of up to 15 years. Interest rate of 5-8.5%.</p> <ul style="list-style-type: none"> ➤ Almost no funds lent in 2010-11 due to stricter environmental requirements than other available loans and poor promotion of the scheme. In 2011, loosened technical practice requirements (included GHG emitting practices and organic agriculture) and reduced interest rates. Loans volumes increased, peaking in 2014-2015. Recent decline possibly due to an increase in interest rates (average 5–5.5% to 8–8.5%) and competition with other credit lines. ➤ Constraints 1) Insufficient knowledge about the ABC Plan and Program; technical capacity of farmers, technical support, and training of staff and managers in commercial banks that can approve ABC Program loans; 2) credit process is administratively burdensome and property registration is required; 3) Insufficient incentives for farmers to invest and take on risk of changing practices, especially small- and medium-sized farmers. Later programs addressed these key constraints of ABC.
		<p>GHG accounting and standards</p> <ul style="list-style-type: none"> ➤ Embrapa monitoring platform https://www.embrapa.br/en/meio-ambiente/plataforma-abc ➤ SEEG independent GHG monitoring by civil society http://seeg.eco.br
		<p>Policy support and alignment</p> <ul style="list-style-type: none"> ➤ Aims to implement National Policy on Climate Change Law 12.187 (2009) ➤ ABC Program incorporated into the national 2011/12 Harvest Plan (2011) ➤ Many elements now mainstreamed in agricultural policy ➤ Synergies with national environmental policy ➤ Aligned with subsidy policies of the green box discipline under the World Trade Organization ➤ Synergies with Amazon Fund, Climate Fund Program (Fundo Clima)

Initiative description	Scale and mitigation impact	Implementation features and lessons
<p>Rural Sustentável, Brazil 2013-present http://www.ruralsustentavel.org/en/</p> <p>Facilitates access to information, technical assistance, rural credit, and financial incentives to support participation in ABC Program in 70 municipalities in seven Brazilian states.</p> <p>Promotes integrated crop-livestock-forestry systems; restoration of degraded forest or pasture, development of commercial plantation forests; and sustainable management of native forests.</p>	<p>11 m producers trained, 3,360 farms (“Multiplying Farms”) successfully acquired ABC loans</p>	<p>Technology transfer</p> <ul style="list-style-type: none"> ➤ Technical assistance to submit and implement technical proposals through farmer-technician partnerships. ➤ Established 350 demonstration farms across seven states, which will host 2600 field days. ➤ Provided on-line courses, website. ➤ Certifies technicians.
		<p>Finance</p> <ul style="list-style-type: none"> ➤ USD 18.55 mil (R\$ 70 mil) ➤ Provides cash payments to small and medium producers to adopt low carbon agriculture. Farmer-extension agent teams jointly develop and submit proposals for ABC loans. Results-based payments to farmer-extension agent teams if proposals are approved and successfully implemented. ➤ Funded by the International Climate Fund the UK’s Department for Environment and Rural Affairs (Defra), and the Inter-American Development Bank (IDB).
		<p>GHG accounting and standards</p> <p>No information</p>
		<p>Policy support and alignment</p> <p>ABC Plan</p>
<p>PESCA, Alta Floresta, Brazil 2015-present with the Althelia Climate Fund https://pecsa.com.br/en/</p> <p>Strategy: Provision of commercial services for sustainable livestock management. Commercial enterprise partners with farmers to rehabilitate degraded pasture, restore forest and build farm infrastructure.</p>	<p>6 large farmers, 10,000 ha, 34,000 head of cattle</p> <p>90% reduction in emission intensity plus soil carbon offsets</p>	<p>Technology transfer</p> <ul style="list-style-type: none"> ➤ Pilot projects, technical assistance, commercial extension and management service ➤ Implementation was poor when farmers were expected to pay for technical assistance themselves. This led to development of a professional company to take on service provision to farms. The issue of aging and absentee farmers having lower capacity to take on new management practices was also addressed by the service provider model.
		<p>Finance</p> <ul style="list-style-type: none"> ➤ Impact investment (Althelia) of EUR 13 million 2015-2017 to form and operate PESCA Investment of ~1000/ha. ➤ Payback period is <10 years. ➤ In practice payback period has been longer than calculations due to the need to learn what worked through trial and error.
		<p>GHG accounting and standards</p> <ul style="list-style-type: none"> ➤ Working with SAN on sustainability assurance rather than certification. ➤ Monitor and verify farmers annually.
		<p>Policy support and alignment</p>

Initiative description	Scale and mitigation impact	Implementation features and lessons
		<ul style="list-style-type: none"> ➤ EMBRAPA Good Practice guidelines for livestock ➤ Need for favorable business environment
<p>NAMA Café, Costa Rica 2016-present</p> <p>Improves production of low emission coffee, and increases cost-efficiency through use of low-emission processing in coffee mills; promotes market access through sustainability certification.</p>	<p>56 contracts, 6000 farmers trained on 12,973 ha (target: 25,000 ha)</p> <p>Mitigation achieved 38,624 tCO₂e (target: 120,000 tCO₂e)</p>	<p>Technology transfer Technical capacity building to increase production and reduce mill costs, finance options, contracts with buyers for sustainable coffee</p> <p>Finance</p> <ul style="list-style-type: none"> ➤ EUR 4.5 million ➤ NAMA Facility funding 2016 to 2019 for EUR 7 million. Selected projects that are highly profitable and result in high emission reductions. ➤ Provided guarantees for low-interest credits for the implementation of larger-scale low-emission technologies with loans disbursed through national financial institutions. <p>GHG accounting and standards Facilitated access to new or future markets by certifying sustainable coffee.</p> <p>Policy support and alignment Country Carbon Program Neutrality 1.0, launched in 2012, with national strategy and plan 2017 Programa País de Carbon Neutralidad 2.0, a national plan to be carbon neutral by 2021.</p>
<p>Thai Rice NAMA, Thailand 2018-2023 Implemented by Government of Thailand, SRP, GIZ, IRRI</p> <p>Seeks to increase farmer income and sustainable rice production through improved practices and by facilitating sale of low-emission rice to the growing market for sustainable rice. Trains farmers how to implement Alternate Wetting and Drying (AWD) on laser land-levelled fields and shift to sustainable best practices in rice production. Established revolving fund to cover startup costs for mitigation service provision.</p> <p>https://www.asean-agrifood.org/download/press-release-thai-government-ministries-cooperate-</p>	<p>100,000 rice farming households in 6 provinces</p> <p>1.664 Mt CO₂e cumulative over the 5-year lifespan of the project with increasing annual mitigation potential. Reduced rice emissions compared to baseline by more than 26 per cent.</p>	<p>Technology transfer</p> <ul style="list-style-type: none"> ➤ Trains farmers how to implement mitigation technologies and sustainable best practices in rice production. ➤ Supports business development by leveraging a national green credit program for capital investment to provide mitigation technology services to farmers such as land laser leveling, alternate wetting and drying, site-specific nutrient management, and straw/stubble management. ➤ GIZ provides technical support. <p>Finance</p> <ul style="list-style-type: none"> ➤ NAMA Facility financing for EUR 14.9 million plus direct financial investments from the private sector of EUR 21.5 million for the implementation of innovative financial incentives. The Royal Thai Government also earmarked at least another EUR 25 million annually. ➤ Established a Revolving Fund to cover startup costs for mitigation service provision. Farmer credit is linked to technology package. <p>Carbon accounting and standards Developed Sustainable Rice Practice standard based on Sustainable Rice Platform (SRP) Standard</p> <p>Policy support and alignment</p> <ul style="list-style-type: none"> ➤ Partner Ministries in NAMA: Ministry of Agriculture and Cooperatives; Ministry of Natural Resources and Environment.

towards-ghg-emissions-reduction-from-rice-farming/?wpdmdl=11596		<ul style="list-style-type: none"> ➤ Aims to integrate the project into the Thai government's workplan, projects and budget at all levels.
<p>Kenya Agricultural Carbon Project (KACP), Nyanza and Western Provinces, Kenya 2008- present supported by Vi Agroforestry, BioCarbon Fund</p> <p>Scaling up sustainable agricultural land management and purchase of carbon credits by Biocarbon Fund. http://projects.worldbank.org/P107798/kenya-agricultural-carbon-project?lang=en Tennigkeit et al. 2013 available at https://journals.openedition.org/factsreports/2600 https://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/2213/The%20Politics%20of%20Agricultural%20Carbon%20Finance.pdf?sequence=1</p>	<p>60,000 farmers in 3000 farmer groups on 45,000 ha.</p> <p>Mitigation achieved: 1.37 tCO₂/ha yr⁻¹, mainly from increased soil carbon.</p> <p>20% increase in revenues from crop yields.</p>	<p>Technology transfer</p> <ul style="list-style-type: none"> ➤ Farmer field schools, agroforestry training centers, demonstration plots, farmer tours and exposure visits. ➤ 28 field advisers in 28 administrative locations, with each advisor working with 600 farmers per year in each location. ➤ Farmer group commitment contracts with Vi Agroforestry. <p>The roll-out phase for the implementation of sustainable agricultural land management (SALM) activities is planned to last nine years until more than 90% of farmers have adopted SALM practices. Vi Agroforestry is one of the strongest farmer extension organizations in East Africa, with more than two decades working on the ground with farmers and using farmer-led methods</p> <p>Finance</p> <ul style="list-style-type: none"> ➤ Swedish International Development Agency funded 38% of the project costs while the implementing agency, Foundation Vi Planterar träd (SCC-ViA), contributes 32% of the costs. ➤ The BioCarbon Fund buys verified emission only upon delivery. ➤ Farmers contribute about 30% of the eventual carbon revenue to fund remaining costs. <p>First credits earned in 2014.</p> <p>GHG accounting and standards</p> <p>Methodology of 'Adoption of Sustainable Agricultural Land Management (SALM) practice approved in 2011. Activity baseline and monitoring survey (ABMS) and estimation of soil carbon stock changes using Roth C carbon model.</p> <p>Policy support and alignment</p> <p>Cooperation with county extension services.</p>
<p>Kolar Biogas Project, India 2008, 2012, 2013, 2015 (multiple project start and end dates) for 3-20 years. Supported by SKG Sangha (Indian NGO) and Foundation MyClimate, and CH4NGE Limited (UK) https://cdm.unfccc.int/Projects/DB/SGS-UKL1287587238.03/view Provides small-scale biogas units to households in Kolar District, Karnataka, India, to replace traditional cooking stoves with biogas stoves. Reduces methane from cattle manure and</p>	<p>44,000 beneficiaries</p> <p>7,600 units installed</p> <p>490t fertilizer avoided</p> <p>Mitigation expected 450,000-550,000 tCO₂e over ten years (CDM)</p>	<p>Technology transfer</p> <p>Project participants build units with help and supervision of SKG Sangha. Village focal person trained to maintain units and answer participant questions.</p> <p>Finance</p> <ul style="list-style-type: none"> ➤ Small-scale Clean Development Mechanism (CDM) project no. 4058 (2015) ➤ Initial costs and lack of access to finance have been biggest barrier. ➤ CH4NGE Limited provides finance for project implementation in return for which it will receive title to all CERs on certification. Each participant is responsible for financing 15% of the material necessary to build the biogas plant. The rest is covered by the carbon credits organized and supervised by Foundation MyClimate, which buys all carbon credits. <p>No public funding is used, but SKG experience in building 50,000 prior biogas units during the last 15 years was funded with government subsidies.</p> <p>Carbon accounting and standards</p> <ul style="list-style-type: none"> ➤ CDM methodologies, Gold Standard

<p>fuelwood collection. Slurry is used as fertilizer.</p> <p>Mitigation is achieved by (i) displacement of kerosene, (ii) displacement of non-renewable biomass and (iii) capture and destruction of methane from animal manure.</p> <p>https://krishijagran.com/success-story/kolar-biogas-project/ https://de.myclimate.org/fileadmin/myc/klimaschutzprojekte/zpdf/7149/Kolar-Biogas-Project-in-Karnataka-India.pdf https://www.myclimate.org/information/climate-protection-projects/detail-climate-protection-projects/india-biogas-7149/</p>		<ul style="list-style-type: none"> ➤ Nested system from household to project level: Households maintain records; a village focal point monitors and reports on systems and is responsible for accurate and transparent record-keeping, quality control and monitoring the functionality of the biogas units. ➤ A sample of households (30% in year 1, and at least 5% thereafter) is surveyed by a local monitoring team annually to discuss results of record-keeping. ➤ Project-level random checks then performed for quality assurance /quality control. <p>Policy Prior national subsidies for biogas</p>
<p>Carbon Farming Initiative (CFI) 2011-2014</p> <p>Emissions Reduction Fund (ERF) 2014 – 2029</p> <p>Australia</p> <p>CFI was a national emissions reduction offsets scheme of the Australian Government that covered the land and landfill waste sectors.</p> <p>In 2014, legislative amendments expanded the CFI to become the ERF, covering mitigation across the land and industrial sectors. ERF has three components:</p> <ul style="list-style-type: none"> ➤ Entities (e.g. farmers) earn carbon credits for emissions reductions and can resell credits in private market ➤ Government purchases emissions reductions at lowest cost through reverse auctions (1 buyer, multiple sellers) 	<p>ERF contracted 189 million tCO₂e at a cost of \$2.23 billion (Nov 2017)</p> <p>139 million tonnes of carbon to be stored in vegetation and soil</p> <p>Projected to contribute 65 Mt CO₂-e of abatement to 2020, and 240 Mt CO₂-e over the period 2021 to 2030</p>	<p>Technology transfer</p> <ul style="list-style-type: none"> ➤ Government-supported farmer training and advisory services (AusIndustry) support farmers with application requirements and help identify emissions reduction opportunities. <p>Reduced emissions from land clearing (savanna burning) was a low-hanging fruit and thus had widespread uptake as it increased grazing species composition and supported aboriginal methods.</p> <p>Finance</p> <ul style="list-style-type: none"> ➤ 2014 the Government allocated A\$2.55 billion to the Emissions Reduction Fund to purchase credits ➤ 2019 Allocated additional A\$2 billion to the fund, to be renamed “climate solutions fund” and to provide funds for 10-years <p>GHG accounting and standards</p> <ul style="list-style-type: none"> ➤ To define eligible activities, benchmark studies were conducted to identify activities that were not common practice. Activities with adverse impacts on food security, water, employment, biodiversity or the environment were excluded. ➤ 34 GHG quantification methodologies ➤ Independent Emissions Reduction Assurance Committee (ERAC) reviews methodologies every five years. ➤ Government applies 20% discount and withholds credits for a 25-year permanence option. A 100-year permanence option is also provided, with no discounts. ➤ More rigorous additionality tests only for projects that create a large number of credits. ➤ Recommendation has been made that scheme participants submit a plan for maintaining permanence of carbon, especially in light of fire risk.

<p>➤ A cap-and-trade compliance scheme for large emitters that creates a secondary market for C credits</p> <p>http://www.environment.gov.au/climate-change/government/emissions-reduction-fund/about</p> <p>http://climatechangeauthority.gov.au/review-emissions-reduction-fund</p> <p>http://www.environment.gov.au/system/files/resources/128ae060-ac07-4874-857e-dced2ca22347/files/australias-emissions-projections-2018.pdf</p> <p>http://www.cleanenergyregulator.gov.au/ERF/Choosing-a-project-type/Opportunities-for-the-land-sector/Agricultural-methods</p>		<p>➤ Need for transparency and governance of carbon aggregators to manage risk of unscrupulous behavior.</p> <p>Methods reflect trade-offs in complexity, integrity/robustness and scale, and thus requires pragmatism.</p> <p>➤ Policy support and alignment</p> <p>➤ Carbon Credits Act 2011 established the Carbon Farming Initiative.</p> <p>➤ Department of the Environment and Energy develops methods; Clean Energy Regulator manage the ERF.</p> <p>➤ The Carbon Farming Futures program began in 2012 and ran through June 2017. The Australian Government invested more than \$AUS 139 million in 200 projects, involving 350 organizations with more than 530 farm trial sites.</p> <p>➤ Uncertainty on legal issues with land titles; consultation and consent is a barrier for uptake of savanna burning by indigenous communities.</p> <p>➤ Carbon management has been politically contentious. Policy has changed with political leadership. CFI/ERF is the only element that has remained stable. Need political will and arrangements that can be stable during political change.</p> <p>➤ Government has important role to play in assuring integrity of credits.</p> <p>➤ CFI was a politically acceptable alternative to the national carbon trading scheme and a carbon tax.</p>
<p>Alberta Carbon Offset Program</p> <p>Alberta Canada</p> <p>https://www.alberta.ca/alberta-emission-offset-system.aspx</p> <p>Emission offsets are generated by voluntary mitigation projects. Emission offsets are quantified using Alberta-approved methodologies, and are verified by a third party in accordance with the Standard for Validation, Verification and Audit.</p> <p>https://www.eralberta.ca/projects/</p>	<p>Total project value of Can\$774 million for food, fiber and bioindustries, with GHG reductions of 0.5 MtCO₂e by 2020 and 11.2 MtCO₂e by 2030</p>	<p>Technology transfer Government of Alberta takes a proactive role in investing in diverse mitigation technologies as well as in helping innovators address barriers to commercialization of technologies. Strong advisory services. Aggregators play pivotal role. Based on a 2017 survey, about one-third of Alberta farmers have participated in the Conservation Cropping Protocol. Larger acreage growers are more likely to be users of this program with almost half of those with 5000 or more acres indicating that they have used it. 2017 survey indicated participants wanted a wider choice of practices. Non-program participants cite the following barriers: onerous paperwork for value of returns; practices and equipment don't fit the program; some farming practices are excluded; lack of familiarity and understanding of the program; need to obtain landlord approvals; not agreeing with the premise of carbon credits; perception that the aggregators are taking too large a portion of the carbon credits; perception that the program is too complicated.</p>
		<p>Finance Emission offset payments based on compliance carbon offset market for large industrial emitters. Emissions Reduction Alberta invests in projects and technologies to reduce greenhouse gases. They have funded Can\$ 101 million to agriculture sector (out of a total of Can\$ 572 million for all sectors) for projects having a total value of Can\$774 million.</p> <p>2017 Survey indicated that participants believed the program needs better compensation, feeling that the compensation received is not worth the time and effort required.</p>

		<p>GHG accounting and standards</p> <ul style="list-style-type: none"> ➤ Ten types of offsets for agricultural producers (e.g. edible oils and reduced feed days for beef cattle, biogas), although not all have earned credits. ➤ 2012 increase in requirements for proof for crop conservation methodology, changing from ‘limited assurance’ to ‘reasonable assurance’ and creating new record-keeping requirements for seeded field size, tillage implement, annual crop, and land ownership. <p>Program participants want to simplify the program forms and paperwork, as a 2017 survey showed that respondents felt the paperwork is onerous. Methodologies are backed by scientific models of emissions that are routinely updated and verified</p> <p>Policy support and alignment Carbon Competitiveness Incentive Regulation. http://www.qp.alberta.ca/1266.cfm?page=2017_255.cfm&leg_type=Regs&isbncln=9780779800193</p>
<p>Life Beef Carbon Initiative, France, Ireland, Italy, Spain 2015-2020 https://unfccc.int/news/life-beef-carbon-toward-the-low-carbon-beef-farm</p> <p>France IDELE: http://www.interbev.fr/life-beef-carbon/?lang=en Ireland TEAGASC: https://www.teagasc.ie/animals/beef/research/beef-systems/beef-carbon/ Italy CREA: http://centroflc.entecra.it/index.php/project Spain, ASOPROVAC: https://www.asoprovac.com/11-paginas-estaticas/4437-proyecto-life-beef-carbon</p>	<p>2000 beef demonstration farms in four countries</p> <p>170 innovative farms</p> <p>Reduced carbon footprint of beef by 15% over ten years in France, Ireland, Italy and Spain.</p> <p>120,000 tCO₂e emission reductions</p>	<p>Technology transfer</p> <ul style="list-style-type: none"> ➤ Focus on awareness building. ➤ Trained 150 national and regional advisors and innovative farmers involved in the project to build a common knowledge base on carbon emissions and greenhouse gas (GHG). ➤ Created a network of 2,000 beef farms that will take part in the first carbon assessment actions operating at such a scale covering several beef farming systems. ➤ Built a network of 170 innovative farms that will test, apply and promote innovative techniques to reduce GHG emissions and increase carbon storage. <p>Mobilization building on an EU beef carbon farmers’ network, allowing exchanges between farmers and advisers in the four countries. This will include feedback from participating farmers on the acceptability and feasibility of innovative carbon reduction practices tested on their farms.</p> <p>Finance Private farmers and producer organizations, local commerce bodies.</p> <p>Carbon accounting and standards Reviewing current methodologies and building a common GHG assessment method and calculation tools.</p> <p>Policy</p> <ul style="list-style-type: none"> ➤ Built national and EU awareness about beef emissions and mitigation. ➤ Developed national Beef Carbon Action Plans (Ireland, France, Italy, Spain) showing feasibility and interest. <p>Supported national and common European platforms and partnerships to support mitigation in beef production.</p>

Annex B: MRV of CSA

B.1 General guidance on MRV of CSA

Table B1.1. Potential activity-based indicators for monitoring mitigation outcomes by production system and intervention

Production system	Intervention	Key activity-based monitoring indicators	Parameters for development at outset of program	Additional monitoring parameters to reduce uncertainty
Paddy rice	Water management	Area of rice under water-saving irrigation	Emission factors for continuous flooding and water-saving irrigation practices under different irrigation & straw management regimes	Length of growing season Irrigation volume and drainage Straw management
	Residue management	Area of rice under alternative residue practice	Residue input rates for baseline & alternative practices	Timing of incorporation Alternative use of residue
	N fertilizer application	Area under improved nutrient management practice	Average N application rate under baseline and improved practices	N application rate Application method Irrigation volumes
Grassland and livestock	Grazing and pasture management	Area of pasture under improved management	Modeled soil and biomass C stock change rates for improved practices (average over 20 years)	Stocking rates
	Animal feeding and breeding	Livestock population within a management subcategory, milk and meat off-take	Emission factors for detailed livestock subcategories Regression equation relating emission intensity to productivity parameters	Animal productivity (weight gain, milk production) Feed composition and quality
	Biogas	Biogas units installed Biogas units operational Fuel consumption per unit	Baseline fuel consumption	Biogas unit leakage rates
Agroforestry		Hectares under agroforestry	Soil and biomass C stock change factors	Number and species of trees planted
Other crops	Cover crops and residue management (avoided burning)	Area under cover cropping or avoided burning of residues	Soil C stock change factors (average over 20 years)	Specific crop residue uses
	N fertilizer application	Area under improved nutrient management practice	Average N application rate under baseline and improved practices, modelled N ₂ O emissions	N application rate Application method Irrigation volumes

Table B1.2. Potential indicators for monitoring adaptation outcomes

Production system	Example indicators of practice change	Other potential indicators of adaptation outcomes	Example indicators relevant across production systems
Paddy rice	Rice-growing area under water-saving irrigation	Water use efficiency	Food security and nutrition Number of people with reduced risk to extreme weather events Number of households affected by drought Percent rural population having access to early warning systems Target population with land use or ownership rights
Grassland and livestock	Pasture area under improved practice # of cattle of improved breeds	Annual livestock losses Yield per livestock unit	
Agroforestry	Hectares under agroforestry	Forest area as a proportion of total land area	
Other crops	Cultivated area under improved practice	Yield per ha and crop Yield variability per ha and crop	
Supply chain	% of food produced with improved storage, transportation, or processing technologies	Food losses	

B.2 Selected agriculture sector carbon market methodologies

CDM:⁸⁶

- AM0073 GHG emission reductions through multi-site manure collection and treatment in a central plant
- AM0089 Production of diesel using a mixed feedstock of gasoil and vegetable oil
- AMC0010 GHG emission reductions from manure management systems
- ACM0017 Production of biofuel
- AMS-I.H. Biodiesel production and use for energy generation in stationary applications
- AMS-III.A. Offsetting of synthetic nitrogen fertilizers by inoculant application in legumes-grass rotations on acidic soils on existing cropland
- AMS-III.R. Methane recovery in agricultural activities at household/small farm level
- AMS-III.AK. Biodiesel production and use for transport applications
- AMS-III.AU Methane emission reduction by adjusted water management practice in rice cultivation
- AMS-III.BF. Reduction of N₂O emissions from use of nitrogen use efficient (NUE) seeds that require less fertilizer application
- AMS-III.BK. Strategic feed supplementation in smallholder dairy sector to increase productivity.

VCS:⁸⁷

- VM0017 Adoption of Sustainable Agricultural Land Management
- VM0021 Soil Carbon Quantification Methodology
- VM0022 Quantifying N₂O Emission Reductions in Agricultural Crops through Nitrogen Fertilizer Rate Reduction
- VM0026 Methodology for Sustainable Grassland Management
- VM0032 Methodology for the Adoption of Sustainable Grasslands through Adjustment of Fire and Grazing
- VM0009 Methodology for Avoided Ecosystem Conversion
- VM0041 Methodology for the Reduction of Enteric Methane Emissions from Ruminants through the use of 100% Natural Feed Supplement

CAR⁸⁸

⁸⁶ See <https://cdm.unfccc.int/methodologies/index.html>

⁸⁷ See <https://verra.org/methodologies/>

⁸⁸ See <http://www.climateactionreserve.org/how/protocols/>

- Mexico Livestock Protocol (biogas)

Gold Standard:⁸⁹

- Gold Standard Low Tillage Methodology
- Smallholder Dairy Methodology.

Annex C: The Transformative Carbon Asset Facility (TCAF)

The World Bank's Transformative Carbon Asset Facility (TCAF) is an innovative facility that provides results-based carbon finance through emission reduction transactions for verified emission reductions (VERs) from changes in policies and programs with transformative impact and sustainable development benefits. TCAF will purchase VERs and aim for recognition of those VERs under Article 6 of the Paris Agreement. TCAF also aims to stimulate the establishment of regulatory frameworks for carbon pricing and to disseminate the knowledge gained in the development of the facility and the implementation of programs.

TCAF results-based finance flows to operations are in line with the TCAF Core Parameters.⁹⁰ These include criteria for portfolio selection, and methodological and operational guidelines. Working with national policy makers, TCAF helps shape domestic policies to reach meaningful scale (i.e. at least 1 MtCO₂e per year) and demonstrate transformative sustainable development impact. In particular, TCAF seeks to assist developing countries to implement market-based pricing and sector-wide mitigation measures. These programs generate mitigation outcomes that are likely to be compliant in future international regimes. TCAF buys a portion of the mitigation outcomes generated by the programs. The remaining mitigation outcomes can be used by the host country towards achieving their NDC targets. Contributors to TCAF may use the mitigation outcomes for their own compliance, support climate finance objectives through cancellation, or allow host countries to use the mitigation outcomes towards their NDC targets. TCAF's efforts will inform the international process established under Article 6 of the Paris Agreement to develop standards and agreements for future carbon crediting instruments and transfer of mitigation assets.

Portfolio selection criteria:

- **Coherence with national mitigation aims:** Programs should be consistent with the host country's NDC and aligned with domestic policy objectives and priorities.
- **Support increased domestic ambition:** Programs should enable a host country to increase its mitigation target or enhance the implementation of mitigation policies and actions beyond what it would achieve with its own efforts.
- **Programs that achieve a transformative impact:** Programs should be able to become self-sustaining or ensure sustainability of emission reductions after TCAF support ends.
- **Promote sustainable development and comply with environmental and social safeguard standards:** Programs should promote the sustainable development goals (SDGs) and follow World Bank environmental and social standards.
- **Environmental integrity:** Programs shall generate emission reductions with strong environmental integrity as defined by the framework and principles of the UNFCCC, including robust MRV and avoiding double counting.
- **Distortionary effects:** Programs should avoid distortionary effects on the sector and on GHG mitigation incentives.
- **Baselines:** Programs should establish a robust baseline to measure program performance
- **Readiness for implementation:** Programs should be ready for implementation after ERPA signature.

TCAF's methodological and operational parameters guide how the facility and programs shall meet these criteria, and are discussed in relation to CSA programs in Chapter 3 of this report.

⁸⁹ See <https://www.goldstandard.org/content/methodologies>

⁹⁰ TCAF (2018) Core Parameters for TCAF Operations.
(https://tcaf.worldbank.org/sites/tcaf/files/TCAF_Core%20parameters_July%202018.pdf)

Annex D: Pricing policies and results-based carbon finance

Carbon pricing policies can support achievement of the goals of the Paris Agreement. Carbon pricing policies may be explicit or implicit. Explicit carbon pricing includes carbon taxes, emissions trading, carbon credits, and results-based climate finance using a carbon metric. Implicit carbon pricing indirectly creates a price on carbon through policies that target the agricultural practices that result in GHG emissions. Results-based carbon finance may provide direct or indirect support for carbon pricing. Direct support for explicit carbon pricing consists of crediting emission reductions from domestic carbon pricing schemes. Indirect support could include contributions to creating or enhancing enabling conditions for implementation of domestic carbon pricing policies, such as knowledge management and capacity building. Table D.1 presents selected types of agricultural pricing policy relevant for promoting CSA. **Pricing policies, such as input subsidies and input or output taxes, may have a role to play in incentivizing uptake of CSA practices, but will not address institutional or capacity constraints.** Therefore, it may be important for results-based carbon finance programs to identify how ex post results-based payments can be complementary to domestic and international financing sources, including World Bank investments.

Table D.1. Types of carbon pricing policies relevant to CSA

	Implicit carbon pricing	Explicit carbon pricing
Direct support	<ul style="list-style-type: none"> • Reform of agricultural or product standards • Taxes and tariffs on inputs or outputs • Subsidies for production inputs • Payments for environmental services • Agri-environment schemes 	<ul style="list-style-type: none"> • Agricultural carbon offset programs • Regulations for aligning offset and ETS allowance prices
Indirect support	<ul style="list-style-type: none"> • Design of product standards or industry benchmarks • Development of MRV systems • Evidence-based policy development • Demonstration of mechanisms for scale up 	<ul style="list-style-type: none"> • Development of agricultural offset methodologies • Institutional arrangements and registries for offset and ETS linkages • Development of financing mechanisms

The potential types of programs in agriculture are very diverse. Section 5.2.2 presented an example of a program involving direct support for implicit carbon pricing. The blueprints in this annex illustrate examples of how results-based carbon finance can support effective upscaling of other types of pricing policy in the CSA context:

- Indirect support to implicit carbon pricing policy (Section D.1)
- Direct support to explicit carbon pricing (Section D.2), and
- Indirect support explicit carbon pricing (Section D.3).

Table D.2 summarizes each of these examples in relation to the common requirements of results-based carbon finance described in Chapters 3 and 4.

Table D.2. Summary of CSA program blueprints

Blueprint	Direct support to implicit carbon pricing policy	Indirect support to implicit carbon pricing policy	Direct support to explicit carbon pricing policy	Indirect support to explicit carbon pricing policy
Example shown	Punjab SMART project (Section 5.2.2)	Kenya Dairy NAMA (Section D.1)	Floor price option contract (Section D.2)	Promoting agricultural offsets in an emerging ETS (Section D.3)
Pricing policy	Government subsidies to change relative prices of high- and low-emitting fertilizer products	Private sector financing of dairy advisory services	Regulations for offset eligibility for compliance with ETS	Establishing the infrastructure for inclusion of agricultural offsets in an ETS
National policy coherence	Fertilizer efficiency is prioritized in NDC, but no specific targets set.	Dairy NAMA is listed in national climate change action plan, which aligns with NDC	Agriculture is included in NDC targets and agriculture offsets are eligible in emerging ETS	ETS is a key part of the national mitigation strategy. Agriculture is included in the NDC targets.
Support increased ambition	Support development of specific targets for fertilizer production and use measures	Demonstrate proof of concept for scaling up & feasibility of Article 6 mechanisms	Reduce project development risks	Demonstrating feasibility of agriculture inclusion in ETS offset program
Lasting impact	Increasing domestic commitment to non-carbon pricing policies	Crowding-in private investment	Demonstration & replication effects in domestic ETS	Support for implementation of domestic carbon pricing measures
Potential links with World Bank and other finance	PforR program pilots upscaling of public-funded e-subsidy, ERPA payments reward increased ambition	Investment Project Financing (IPF) builds capacities, ERPA payments provide incentives for enhanced performance	Investment Project Financing (IPF) demonstrates technologies & develops methodologies, ERPA reduces project developer ETS price risks	Investment Project Financing (IPF) demonstrates technologies & develops methodologies, and ERPA payments incentivize demonstration projects
Baselines, crediting and additionality	Policy-specific BAU scenario and crediting thresholds	Sector-specific BAU, crediting thresholds based on GHG inventory trend	BAU, crediting based on approved protocols + two-level additionality assessment	BAU, crediting based on approved protocols + two-level additionality assessment
Sustainable development benefits	Number of poor farmers enrolled Increased agricultural yields Increased farm profits	Increased agricultural yields Increased incomes for women	Increased agricultural yields Reduced land degradation	Reduced environmental pollution Improved food safety Agri-business profitability Higher incomes for women
GHG measurement	Methodologies available under existing standards adopted with modifications or new methodology proposed	Methodologies available under existing standards adopted with modifications	Apply nationally approved or eligible offset methodologies and comply with ETS regulation on offset use	Methodology development and institutional capacity development included in program

D.1 Blueprint for indirect support to implicit carbon pricing policy

Adoption of CSA practices often requires several interventions to create an enabling environment. Access to production inputs, credit for investments and operational costs, advisory services and output markets are all necessary to enable farmers to adopt and profit from practice changes. Policy makers have several tools to support this enabling environment, including:

- Targeted subsidies for production inputs that increase productivity and reduce GHG emissions;
- Subsidized agricultural credit tied to adoption of GHG mitigation measures with sustainable development benefits and certification schemes;
- Public extension services and contracted extension services;
- Regulatory and financial support for farmer organizations.

In many countries the private sector – represented by individual farmers, cooperatives and agri-food businesses – are the major drivers of agriculture production. To illustrate how carbon finance might provide indirect support to implicit pricing policies, the following case study presents an outline of a public-private partnership to incentivize the private sector to finance extension services and provide access to finance and inputs, while strengthening market linkages. The case study is based on Kenya's Dairy NAMA, an initiative developed by Kenya's State Department of Livestock and stakeholders in the dairy sector with support from CCAFS.⁹¹

Agriculture sector background: Kenya's dairy sector contributes about 14% of agricultural GDP and 3.5% of total GDP. With population growth, urbanization and rising incomes, demand for dairy products is growing rapidly. About 1.8 million farming households – or 35% of rural households – produce milk, and women play a major role in dairy production throughout the country. About 70% of milk is produced on smallholder farms, and milk sales contribute significantly to farm incomes (including income for rural women) and household nutrition. Most milk is sold to informal markets, but the formal sector – led by cooperatives and private processing companies – accounts for about 16% of marketed milk and is growing. Average dairy cow productivity is low, due to poor feeding, low-productivity breeds and poor animal health, resulting in high production costs and slim profit margins for many farmers. Low productivity is associated with high GHG emission intensity per liter of milk produced and research has shown that as productivity increases, the GHG intensity of milk production decreases. Dairy cows currently contribute about 25% of Kenya's GHG emissions from livestock. Addressing productivity constraints requires on-farm investments (e.g. fodder production, more productive breeds, animal housing), access to inputs (e.g. feed, veterinary services) and advisory services to increase the efficiency of dairy production. Because women often don't own land or cattle, increasing productivity and formal sector marketing also requires that gender issues at farm and cooperative levels are addressed.

Policy alignment and support for increased ambition: The dairy sector is one of 13 value chains prioritized in Kenya's Agriculture Sector Growth and Transformation Strategy. The sector is deregulated, with public services limited to provision of vaccination, and national policy supports private provision of extension services and other inputs, including finance. Kenya's NDC supports agricultural mitigation in line with the Kenya Climate Smart Agriculture Implementation Framework (KCSAIF). KCSAIF supports actions that increase the efficiency of livestock production and reduce the GHG intensity of production. The State Department for Livestock has proposed a Dairy NAMA as one of three agricultural mitigation measures listed in the National Climate Change Action Plan. The Dairy NAMA's development goal is to transform Kenya's dairy sector to a low-emission and climate resilient development pathway while improving the livelihoods of male and female dairy producers. Implementation of the Dairy NAMA is subject to international support.

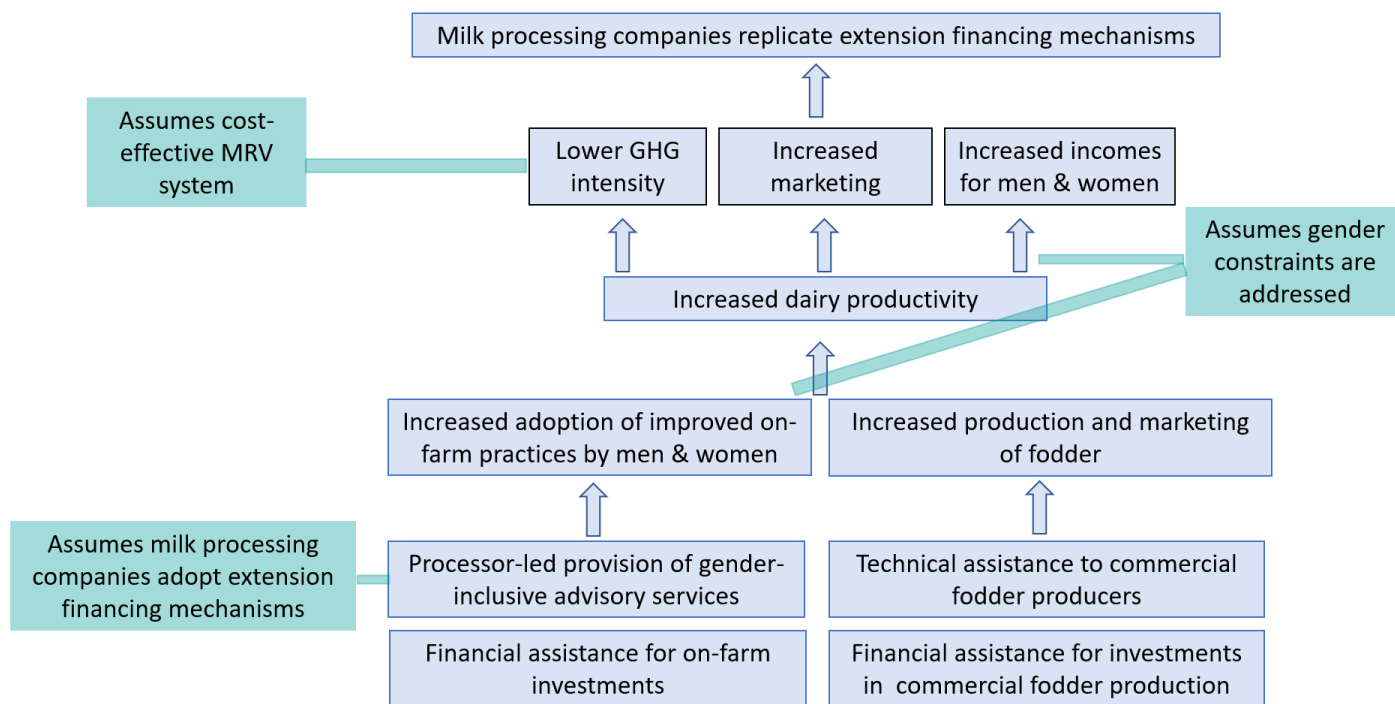
Sustainable development benefits: Most on-farm interventions that increase dairy productivity also increase farming system resilience to climate risks. Strengthening access to inputs, advisory support and finance also increases the adaptive capacity of households. Addressing women's constraints to control of income from milk sold to the formal sector would also benefit women's empowerment and household welfare.

Transformational change: Figure illustrates the theory of change behind the Component 1 of the Dairy NAMA, which aims to increase on-farm dairy productivity through private sector investment in gender-inclusive extension services and fodder supply. The component proposes interventions to incentivize and strengthen capacities of milk processing

⁹¹ <http://www.kilimo.go.ke/wp-content/uploads/2018/03/NAMA-Kenya-Dairy-NAMA-GCF-concept-NoteJanuary-2017-1.pdf>

companies to deliver extension services to their suppliers, and create links with input and credit providers so that farmers can make on-farm investments and access farming inputs. Three critical areas of dairy development to address are: (1) sustainable financing mechanisms for advisory services, (2) gender constraints to women's engagement in formal milk markets, and (3) cost-effective systems for tracking non-carbon benefits and quantifying GHG emission reductions. Kenya's milk processing companies have their own approaches to financing extension services. Some companies contract private advisory service providers from their annual operation budget. Others are interested to enhance their extension services by levying an 'extension fee' equivalent to about 1% of the farm gate milk price, which is then used to pay extension service providers. The lasting impact of the program will depend on milk processing companies adopting policies and mechanisms that provide sufficient and sustainable financing for gender-inclusive extension services to farmers; upscaled impact would depend on milk processing companies replicating the financing and extension delivery mechanisms developed in the program (**indicators of transformational change**).

Figure D.1. Theory of change for increased on-farm dairy productivity

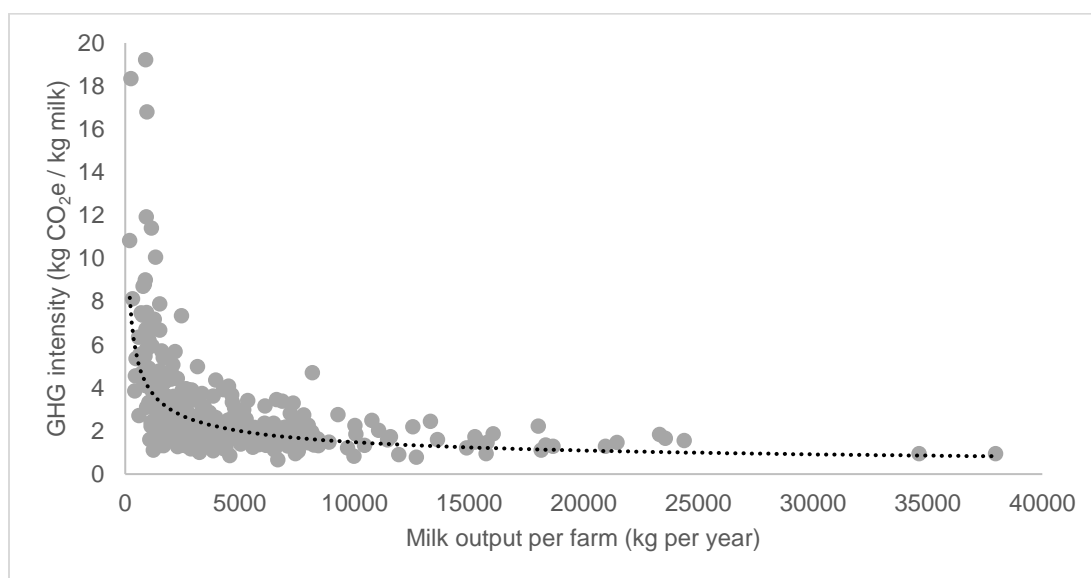


Up-front finance from international sources will be needed to strengthen the capacities of extension service providers for gender-inclusive services and to support commercial banks to provide concessional loans to dairy farmers and commercial fodder producers. A results-based carbon finance program would therefore have to be aligned with other sources of international finance. The program could have transformational impacts through:

- **Leveraging private sector investment:** Incentivizing milk processing companies to increase the number of farmers receiving advisory services, and to access finance and fodder resources.
- **Carbon pricing:** Support to dairy processors to price extension services that increase productivity and reduce GHG emission intensity.
- **Scale:** The Dairy NAMA feasibility study indicates a mitigation potential of 4 million tCO₂e over 5 years if 153,000 households are engaged
- **Sustainability:** Technologies to increase productivity are known (**technology sustainability**). Investment by dairy processors and financial institutions is driven by commercial incentives (**policy and financing sustainability**).

Mitigation potential, baselines and crediting options: The dairy NAMA proposes to use a voluntary carbon market methodology to quantify emission reductions from increased dairy productivity.⁹² In the methodology, baseline surveys establish the relationship between milk yields and GHG intensity (Figure D.2). As milk yield increases, GHG intensity decreases, and emission reductions are calculated based on the difference between producing a given level of milk output at the baseline and with-project GHG intensities. Monitoring can be low-cost because once the GHG intensity-milk yield relationship has been established, milk yield is the main parameter that needs to be monitored. Kenya's GHG inventory shows a gradual decrease in GHG emission intensity over time. The carbon finance program could decide to credit only emission reductions associated with decrease in emission intensity below the trend shown in the national inventory, or to make emission reduction purchases conditional on meeting more ambitious targets for productivity increases and numbers of farmers enrolled in milk processing companies' extension services.

Figure D.2: Relationship between milk output and GHG intensity on smallholder farms in Central Kenya⁹³



D.2 Blueprint for indirect support to explicit carbon pricing policy

Several countries are developing carbon markets as part of their climate response strategies. Agriculture is generally not a sector covered in emission trading schemes (ETS), but agriculture has been eligible as a source of offsets in some schemes. Historically, there have been relatively few agriculture projects in CDM and international voluntary carbon markets in developing countries. Most agriculture CDM projects were limited to biogas generation. Given the limited experience with carbon finance projects in the agriculture sector, engagement of the agriculture sector with the emerging domestic ETS will require significant efforts in terms of policy, institutional capacity, regulation, finance, awareness and replication of agriculture offsets to be eligible for ETS schemes. The support to identification of feasible categories of activities for scaling up mitigation, development of methodologies, piloting of demonstration of projects and programs, and technical capacities for implementation, monitoring and verification are expected to be priorities for countries that intend to use market mechanisms to achieve climate change mitigation objectives. This blueprint highlights the scope to integrate results-based finance with World Bank Group financing for promoting CSA activities in a country with an ETS (e.g. Hubei Smart and Sustainable Agricultural Project in China approved in May 2020). Implementation of the Hebei Project is expected over the next five-year period. Therefore, a generic example of an

⁹² FAO and ILRI (2016) Smallholder Dairy Methodology (<http://www.fao.org/3/a-i6260e.pdf>)

⁹³ Wilkes, A. et al. (2020). Variation in the carbon footprint of milk production on smallholder dairy farms in central Kenya. *Journal of Cleaner Production*, p.121780.

IBRD/IDA agriculture project is presented to illustrate the support to explicit carbon price implemented with results-based finance.

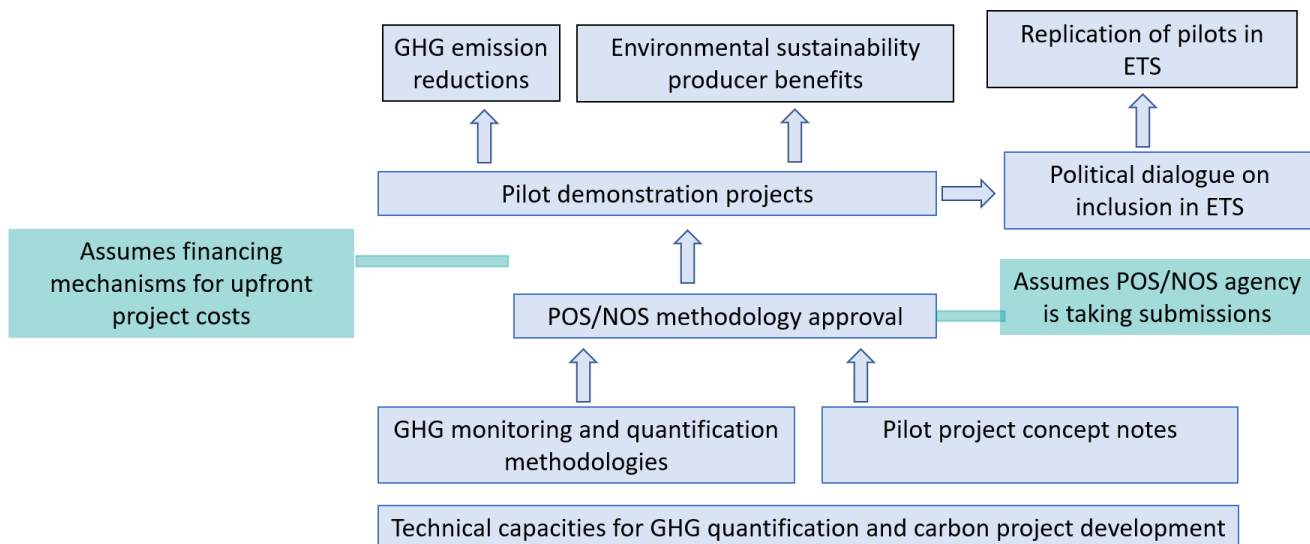
Agriculture sector background: The project is located in a region of the country where agriculture makes a significant contribution to the economy and to rural employment while also contributing to significant GHG emissions. Some agricultural practices have a large environmental footprint (e.g. intensive livestock production), contributing to high GHG emissions and adverse impacts on water quality. Fertilizer application rates are high contributing significant GHG and pollution of water bodies. There is a growing concern for food safety with more pesticide use and long and complex food chains.

The project aims to enhance national capacity to assess and monitor the quality and safety of agri-food products and environmental risks and establish green and sustainable agriculture standards to help mainstream climate smart and green agricultural practices. The project also proposes to create institutional capacity and infrastructure for including agricultural offsets in the national emissions trading system. The project components focus on agri-food risk management, demonstration of smart and sustainable agricultural practices and knowledge management.

Policy alignment and support for increased ambition: The host country has ambitious policy goals for agricultural development, including agricultural sustainability. National climate change plans aim to decrease total GHG emissions by about 20%. A pilot ETS was established in 2015 and was designed to address industrial emissions from power generation, cement, chemicals, metallurgy and manufacturing industries. The ETS allows regulated firms to use offsets to meet up to 10% of their targets. However, in the pilot phase, only renewable energy projects were eligible to supply offsets. As the ETS is scaled up, establishing the preconditions for the inclusion of CSA offsets and demonstrating the creditability of offsets generated by CSA would create incentives for the private sector to invest in CSA and generate offsets as a by-product, and/or purchase offsets from CSA as a cost-effective and creditable option to meet the target. This is supported by the economic analysis of the IBRD project, which found that some CSA interventions were only profitable if carbon benefits were valued. The provincial or national government is expected to develop a policy and institutional framework required to generate agricultural carbon offsets eligible for trade in the ETS, including approval of offset methodologies and protocols for monitoring, reporting and verification (MRV) of GHG emissions and removals agricultural activities with a focus on major value chains; and develop capacity to generate agricultural carbon offsets eligible for emissions trading at provincial and national levels.

Transformational change and sustainable development contributions: D.3 illustrates the theory of change of the program. Eligible offsets must comply with the offset methodologies and protocols for monitoring, reporting and verification (MRV) approved by Provincial or National Offset Standard (POS/NOS) recognized by national government. As a new project category, it is assumed that inclusion of agriculture offsets in the ETS would require evidence of GHG mitigation and positive sustainable development benefits assessed through pilot demonstration projects. Since POS/NOS crediting is ex post, upfront costs for project developers and implementation agencies will need to be covered through innovative financing agreements, such as loans using an ERPA as collateral. The feasibility of such arrangements can also be demonstrated by implementing in the pilot demonstration projects.

Figure D.3: Theory of change for indirect support to agriculture inclusion in ETS



A results-based carbon finance program could have transformational impacts through:

- **Leverage of policy on low cost ETS compliance for covered entities:** The ETS has an allocation volume of about 100 million tCO₂e. Offsets can be used to meet up to 10% of each firm's allocation, although some of this may be met through other POS/NOS-approved project types. Demonstrations on agricultural offsets will also have positive impacts on ETS in some other countries that allow offsets.
- **Carbon pricing:** Demonstrates a pathway to sale of agricultural carbon offsets into the national ETS.
- **Scale:** Results-based ERPA payments incentivize pilot demonstration projects to become eligible for the POS/NOS offset standards to supply offsets to meet demand from domestic and international ETS. Offsets purchased by an international carbon facility would not be used in parallel to the domestic ETS in order to avoid double counting.
- **Sustainability:** Technologies for upscaling through the ETS could be validated based on demonstrations with support from World Bank Group project financing (**technology sustainability**), and pilot demonstration project experience would contribute to dialogue on inclusion of offsets or expanding the share of agricultural offsets in the ETS (**policy sustainability**). Opportunities to demonstrate financing modalities that would support **financial sustainability** of offset projects through increased ETS demand.

Mitigation potential, baselines and crediting options and additionality: The mitigation potential of pilot agricultural offsets demonstrated through the World Bank project highlights the role of results-based finance in creating and scaling up agricultural offset supplies to meet ETS demand. Given the context involves international carbon finance and a domestic ETS, determining additionality could apply both the additionality rules of the POS/NOS standard (regulatory market mechanism layer) and additionality following an attribution approach to emission reductions achieved (finance layer), considering the contributions of the World Bank project loan financing to the program.

Sustainable development benefits: Sustainable development benefits for agriculture are expected to include environmental sustainability benefits (e.g. low soil and water pollution) and occupational health and food safety benefits (e.g. good agricultural practices in production). Producers and agri-businesses are expected to benefit financially, including women who make up most of the agricultural workforce in the country.

D.3 Blueprint for direct support to explicit carbon pricing

Where CSA activities are eligible to supply offsets in existing emission trading schemes (ETS), there may still be barriers to engaging with carbon markets. Project developers face several risks, including delivery risks, offset credit risk and market price risks. With new project types, there is a risk that the volume of verified emission reductions (VERs) may

vary from ex ante estimates due to events that affect project implementation, and due to assessment of the accuracy and credibility of emission reduction claims by third-party verifiers. For sectors such as agriculture, where verifiers have limited prior experience of new project types, these risks are particularly high. Project developers that are early movers in an ETS also face risks associated with the eligibility of credits for compliance purposes. Offsets may be reversed or invalidated by decisions of the regulatory body. Investors in new project types may demand higher risk-adjusted returns than other project developers, and the risk that future VER sales contracts do not achieve expected prices can deter investment.

Some ETS have developed arrangements to address these risks (e.g. buffer accounts to offset subsequent invalidations, invalidation insurance), and other risks can be addressed in contracts (e.g. transferring risks to buyers). However, market price risks remain. This blueprint presents a hypothetical example where carbon facility engagement reduces project developers' market price risks by providing a floor price option.

Agriculture sector background: Country X has a large area of degraded grassland, and there is considerable evidence that improved grassland management can sequester soil carbon. Improved grassland management also has benefits for biodiversity conservation, combatting desertification and strengthening ecosystem resilience in the face of a changing climate.

National policy alignment: The agriculture sector, including grasslands, is within the scope of the country's NDC. Improved grassland is an important national goal in agriculture, biodiversity and climate change policies. However, public funding is insufficient to invest in restoring all the country's degraded grasslands. The ETS in country X has been operating for some years. Agriculture offsets are eligible, but unlike the forestry sector, few agriculture projects have been developed to date, and none in grasslands.

Transformational change: The national grassland agency has undertaken preparatory work, and a grassland GHG quantification methodology has been approved for use in the ETS offset scheme. Of the two verification agencies approved to verify agriculture sector projects in the ETS offset scheme, none have prior experience with grassland or livestock management projects. Project developers perceive that this increases their delivery risks, and have estimated that a reasonable financial return on project development is only feasible if the VERs are sold above a certain price. One proposal could be for the carbon facility to negotiate an ERPA that commits to purchase a portion of the issued VERs at an agreed floor price in case there are no other buyers for the issued VERs. The conditions for such an ERPA might include conditions related to the prevailing ETS market price, project financial analysis threshold indicators, and evidence of active negotiations between the project developer and ETS participants. If the negotiated conditions are met, then the ERPA could be activated to ensure the financial viability of the project. To avoid double counting of emission reductions, the purchased VERs could be used by carbon facility's contributors towards their own commitments if the host government maintains project and transaction registries, or the purchased VERs could be registered in the domestic ETS but remain unused. A conditional ERPA with a floor price option could have transformational impacts through:

- **Leverage of finance towards national grassland restoration and climate goals:** In the absence of financially viable transactions in the domestic ETS, the ERPA would demonstrate a pathway to securing revenues for investment in line with national climate goals.
- **Carbon pricing:** The ERPA would support private sector stakeholders to engage with and support replicability in the national ETS, and could enable private sector participation in generation of offset credits for domestic ETS or for Article 6 mechanisms.
- **Scale:** Results-based ERPA payments incentivize grassland offset projects to achieve scale through replication.
- **Sustainability:** The floor-price option would only be triggered when there is no alternative demand for offset credits. The longer-term sustainability of grassland offsets would depend on cost-effective offset generation and demand for offsets incentivizing private sector participation in the offset market, leading to replication of the initial project in the domestic ETS (**financial sustainability**).