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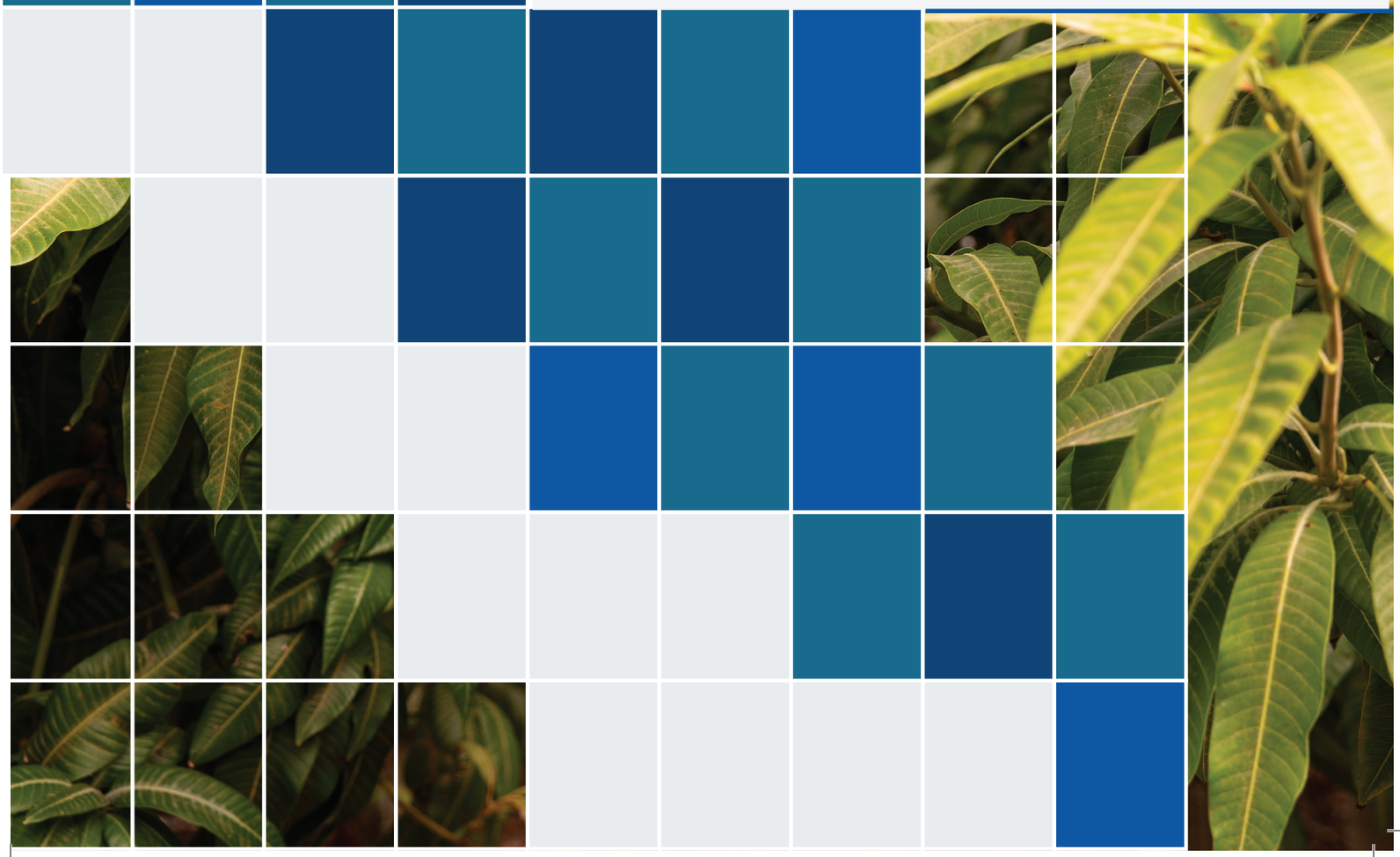
Enhancing Mitigation Ambition in Caribbean Agriculture: Opportunities and Challenges



Enhancing Mitigation Ambition in Caribbean Agriculture: Opportunities and Challenges

Prepared by:
Greenhouse Gas Management Institute and
the Caribbean MRV Hub
Under the IICA GCF CARICOM AgREADY Project
With the support of

GREEN
CLIMATE
FUND

Inter-American Institute for Cooperation on Agriculture (IICA), 2023

This publication is also available in electronic (PDF) format from the Institute's web site: http://www.iica.int.

Editors: Kelly Witkowski, Chaney St. Martin, and Shanna Prevost
Proofreader: Catalina Ann Saraceno
Layout: Kathryn Duncan
Cover design: Kathryn Duncan

Stevens, Luanne
Enhancing Mitigation Ambition in Caribbean Agriculture: Opportunities and Challenges/ Castries, Saint Lucia : IICA, 2023
66 p.; 21x16 cm.

ISBN: 978-92-9273-042-0

1. agricultural sector 2. climate change mitigation 3. greenhouse gas emissions 4. carbon footprint 5. climate change adaptation 6. CARICOM 7. Caribe 8. NDC I. IICA II. Title

AGRIS P01
DEWEY 363.737

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Castries, Saint Lucia
2023

Acknowledgement

This work was funded by the Green Climate Fund through the Readiness Project titled "Strengthening the Foundation for a Climate Responsive Agriculture sector in the Caribbean" (GCF CARICOM AgREADY, in short) with The Bahamas - The Ministry of Environment and Housing as the lead National Designated Authority (NDA) and the Inter-American Institute for Cooperation on Agriculture (IICA) as the delivery partner.

Contents

Acronyms

AWD	Alternative Wetting and Drying
BAU	Business As Usual
BUR	Biennial Update Report
CAFOS	Concentrated Animal Feeding Operations
CARICOM	Caribbean Community and Common Market
CNA	Capacity needs assessments
CSA	Climate-Smart Agriculture
FAO	Food and Agriculture Organisation
FOLU	Forestry and Other Land Use
GDP	Gross Domestic Product
GCF	Green Climate Fund
GRA	Global Research Alliance
GHG	Greenhouse Gas
IICA	Inter-American Institute for Cooperation on Agriculture
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPNS	Integrated Plant Nutrient System
LEDs	Low Emission Development Strategy
LRG	Livestock Research Group of the Global Research Alliance
LULUCF	Land Use, Land Use Change and Forestry
MRV	Monitoring, Reporting and Verification
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NAMA	Nationally Appropriate Mitigation Actions
NC	National Communication
NDC	Nationally Determined Contribution
NIR	National Inventory Report
NUE	Nitrogen Use Efficiency
PU	Prilled Urea
RA	Regenerative Agriculture
REDD+	Reducing Emissions from Deforestation and Forest Degradation as well as the sustainable management of forests and the conservation and enhancement of forest carbon stocks
SAI	Sustainable Agriculture Initiative
SDG	Sustainable Development Goals
SIDS	Small Island Developing States
SKN	Saint Kitts and Nevis
SVG	Saint Vincent and Grenadines
SWP	Soil Water Potential
UNFCCC	United Nations Framework Convention on Climate Change

Foreword

Given the high level of vulnerability of the Caribbean and its very low contribution to global greenhouse gas emissions, mitigation in the context of the region can be a challenging topic to broach, even more so in the agriculture sector. However, the majority of mitigation measures that can be taken in agriculture can provide additional benefits beyond the greenhouse gas reduction itself—such as helping to build resilience, enhance efficiency, increase competitiveness, reduce input costs, improve soil health and so on.

As the latest IPCC reports make abundantly clear, there is a very significant risk we will cross the threshold of 1.5° C temperature rise that all countries agreed to in 2015. This will result in more damaging impacts on food production and food security. All possible contributions are needed. Agriculture, together with land use change and deforestation is responsible for approximately 17% of emissions in the Caribbean, more if the emissions from the farm to fork are considered.

Many of the adaptation measures linked to agriculture that were set in countries' climate action plans, Nationally Determined Contributions (NDC), or National Adaptation Plans (NAP) can also potentially contribute to mitigation goals. As the CARICOM AgREADY Project seeks to support increased engagement of the agriculture sector in national and international climate processes, and to provide insights that can help guide the sector to increase its ambition in the future, we wanted to dig in more to those climate instruments to help different stakeholders understand the current state of the art, and the key entry points for action across countries—where there are possibilities for increasing ambition—both from a resilience building and mitigation perspective. As the NDCs are iterative instruments that need to be updated every five years, this analysis provides information on different options for agriculture to play a greater role, and the barriers that need to be overcome to make this happen.

To complement this analysis, we also examined the state of the agriculture greenhouse gas inventories in the nine project countries, developed national action plans, a regional agriculture GHG improvement plan and a regional data collection framework to help guide improve and strengthen the inventories in the future, as they are key tools for helping to understand existing emissions sources, trends and identify key areas for investment and action. This was accompanied by training on the agricultural GHG inventories and a train-the-trainers course on data collection to support inventory development for technicians in the region.

We are confident that this analysis will provide useful information for technicians and decision makers at the national and regional level, for Ministries of Agriculture and Environment, and for donors and other organisations working to address climate change in agriculture in the region by helping to highlight where opportunities exist for the sector to increase its ambition, and where the investment of time and resources could add greatest value for the people and countries of the region.

Kelly Witkowski
Agriculture Climate Action and Sustainability Program Manager, IICA

1 Introduction

The "Strengthening the foundation for a climate responsive agricultural sector in the Caribbean" (CARICOM AgREADY project) readiness project, financed by the Green Climate Fund, targets nine countries in the CARICOM region with the Ministry of Environment and Housing of The Bahamas as the lead National Designated Authority (NDA) and the Inter-American Institute for Cooperation on Agriculture (IICA) as the delivery partner.

The AgREADY project seeks to raise the profile of the agriculture sector in GCF's climate financing prioritisation processes by implementing an evidence-based and intersectoral strategy for developing and rebranding Caribbean agriculture as "low emissions", to enhance market opportunities and attract private sector investments. The project logic is premised on a vision of developing "a climate responsive agriculture sector in the Caribbean that supports food security, livelihoods and uses natural resources sustainably" by addressing barriers of ineffective mechanisms and engagement with agricultural experts and stakeholders in GCF climate programming processes, policy gaps, and limited or fragmented data/information to inform climate risks planning, programming, and action in the sector.

The project, covering The Bahamas, Belize, Dominica, Haiti, St. Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago, includes specific objectives and activities related to:

- Improving the enabling conditions to design, implement and evaluate options for enhanced climate data collection action in the agriculture sector by strengthening policies, capacities, frameworks, methods, and institutional arrangements for collecting, monitoring, measuring, reporting, verifying (MRV), and analysing agriculture and associated activity data from the sector. This includes work with national and regional stakeholders and data keepers to improve agriculture data collection across the board and across the countries listed.
- Increasing the number of projects identified for development and investment in a pipeline of evidenced-based and bankable projects aligned with regional and national priorities as informed by climate risk assessments of the agriculture sector.
- Disseminating best practices for institutional capacity building, coordination, and pipeline development of more robust proposals for building climate resilience along prioritised agricultural value chains, with a focus on cultivating the innovative capacity of the region's youth.

The project's primary focus was on adaptation; however, different aspects linked to mitigation were also covered. This includes this analysis which details the current status of agricultural mitigation efforts included in the NDC from the nine countries covered in the project, and a synthesis across the region.

1.1 Background

1.1.1 NDCs and the agriculture sector

There are many options for including additional agricultural contributions in an enhanced Nationally Determined Contribution (NDC), and, depending on national circumstances and priorities, countries may choose to:[1]

- Strengthen the implementation of existing agricultural climate policies and targets,
- Add specific policies and actions to build resilience and enhance adaptation,
- Add specific policies and actions to reduce emissions,
- Incorporate additional agriculture-sector action into an emissions reduction target, and/or
- Include additional information to improve understanding of agricultural emissions.

Multiple benefits may arise from including the agriculture sector in NDCs:

- Ensuring food and nutrition security in the face of climate change,
- Increased awareness of the needs and priorities for climate action in the sector,
- Greater support for building resilience, especially for small-scale and vulnerable farmers,
- Mitigation through reduced emissions or enhanced sequestration from the agriculture sector,
- Progress to achieve sustainable development objectives, and
- Attracting technical and financial resources for the agriculture sector.

Although many countries include the agriculture sector in their NDCs,[2] the primary focus to date has been on adaptation given the importance of the sector for the region's food security. Some of the response measures included in the current NDCs could also contribute to the mitigation of greenhouse gases (GHGs). However, there are typically data gaps limiting the extent of agricultural emissions that may be included, thus many of the adaptation/mitigation synergies possible are not fully leveraged. Advantages to incorporating agriculture mitigation can include enhanced efficiencies and, therefore an increase in the competitiveness of production, an opening up of new market opportunities for sustainably produced and climate-smart products, and improved health associated with low-emission diets.

Globally, mitigation actions in the NDCs for the agriculture sector are generally limited to "on farm" activities, meaning they include the activities included under the agriculture sector in the Intergovernmental Panel on Climate Change (IPCC) Guidelines for greenhouse gas inventories, and do not extend to the complete value chains of farm products. Emission reductions in the processing, packaging, transportation and marketing areas of the value chain have a greater impact on emissions in other sectors (e.g. energy sector), however altering the supply and demand can impact agriculture emissions through changes in agriculture land area or crop types. There is also little focus in NDCs on reducing emissions across the food supply chain (such as shifting consumers to lower emission diets, reducing food loss and waste, etc.).[3] Up to 37% of global emissions are attributed to the world's food systems[4] and of

1 Ross, K. et al., 2019, NDC Enhancement: Opportunities in Agriculture. Working paper, Washington, DC: WRI. Available online at: https://oxfamilibrary.openrepository.com/bitstream/handle/10546/620922/dp-ndc-enhancement-opportunities-agriculture-011219-en.pdf?sequence=1&isAllowed=y

2 Witkowski, K., Medina, D. and Garcia, M. Intended Nationally Determined Contributions in the Caribbean: Where does agriculture fit? IICA, 2016; Crumpler, K., Gagliardi, G., Meybeck, A., Federici, S., Lieuw, T., Bloise, M., Slivinska, V., Buto, O., Salvatore, M., Holmes, I., Wolf, J. and Bernoux, M. 2020. Regional analysis of the nationally determined contributions in the Caribbean – Gaps and opportunities in the agriculture sectors – Synthesis. Rome, FAO. https://doi.org/10.4060/ca7337en

3 WWF, 2020. Enhancing NDCs for Food Systems: Recommendations for decision-makers.

4 Crippa, M., Solazzo, E., Guizzardi, D. et al. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat Food* 2, 198–209 (2021). https://doi.org/10.1038/s43016-021-00225-9; Mbow, C., C. Rosenzweig, L.G. Barioni, T.G. Benton, M. Herrero, M. Krishnapillai, E. Liwenga, P. Pradhan, M.G. Rivera-Ferre, T. Sapkota, F.N. Tubiello, Y. Xu, 2019: Food Security. In: Climate Change and Land: an IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems [P.R. Shukla, J. Skea, E. Calvo Buendia, V. Masson-Delmotte, H.-O. Pörtner, D.C. Roberts, P. Zhai, R. Slade, S. Connors, R. van Diemen, M. Ferrat, E. Haughey, S. Luz, S. Neogi, M. Pathak, J. Petzold, J. Portugal Pereira, P. Vyas, E. Huntley, K. Kissick, M. Belkacemi, J. Malley, (eds.)].

this 5–10% comes from beyond the farm gate[5] (10–14% from on farm agriculture emissions[6] and 5–14% from land use change[7]), therefore these actions on supply and demand can be considered and enhanced in future NDCs.

Another gap is the general lack of available information to enable the identification of the financial requirements to implement activities in the agriculture sector. Lastly, the agriculture elements of NDCs generally lack detail regarding how their targets will be achieved and specificity in terms of the policy environment necessary to advance agricultural climate action.

1.1.2 Agriculture in the Caribbean

Agriculture across the nine Caribbean countries assessed contributes on average 7.4% to the gross domestic product (GDP), but there is high variability in the proportion of GDP agriculture represents among Caribbean countries (in Dominica agriculture represents 19% of GDP while in Trinidad, agriculture is just 1% of GDP).[8] The region is home to 38 million inhabitants of which 4.5 million have livelihoods supported by agriculture.[9] Of the countries included in this report, only Belize and Haiti produce more than 50% of the food they consume, with other countries being more heavily reliant on food imports.[10] The region is highly susceptible to climate change-related damages and disasters, including floods, hurricanes, drought, among other increased climate change risks that threaten the agriculture sector.

1.2 Objectives and Scope of Work

This mitigation scoping study assesses the current status of agricultural mitigation efforts included in the NDC submissions from the nine countries covered in the CARICOM AgREADY Project. The agriculture sector as defined in the IPCC Guidelines[11] was the primary focus of this report, however some additional contributions of agriculture to other sector emissions were also highlighted. This study identifies the barriers and opportunities that exist for enhancing efforts to reduce emissions within the agriculture sector in each of these countries and then provides a regional analysis.

Stakeholder engagement with national entities relevant to the NDC from many of the nine countries was conducted throughout the process of developing this report in collaboration with the team working to evaluate other aspects of the NDCs. Stakeholders sometimes identified actions linked to agricultural value-chain emissions, such as plants for the processing of agricultural products or the transportation emissions related to import or export of agricultural products, or solar power for pumping and irrigation systems or paired with poultry barns. These activities will reduce overall, economy-wide emissions but will be reflected in sectors other than the agriculture sector (e.g., energy) in the GHG inventories. The report identifies these agricultural value chain emission sources but as they are not reducing emissions in the agriculture sector (as defined by IPCC sectors), the report does not provide detailed recommendations to mitigate these emission sources.

In press.

5 These are emissions which are associated with upstream activities such as manufacture of fertilisers, and downstream activities such as food processing, transport and retail, and food consumption.

6 These are emissions from agricultural production as defined to be the activities included under agriculture in the IPCC Guidelines (enteric fermentation, manure management, managed soils, rice cultivation).

7 These are emissions from land use change related to croplands as defined by the FOLU sector in the IPCC Guidelines (emissions associated with land converted to croplands).

8 FAO and Caribbean Development Bank (CDB), 2019.

9 FAOb, n.d.

10 Ibid. Crumpler *et al., 2020.*

11 Includes emissions from livestock (enteric fermentation and manure management) and aggregated and non-CO_2 emission sources on land (biomass burning, lime and urea application, direct and indirect N_2O from managed soil, indirect N_2O from managed manure and CH_4 emissions from rice cultivation).

1.3 Methodology

Each of the nine countries' most recent NDCs at the time of writing this report (table 1) was evaluated and documented in an excel sheet to identify each country's general national mitigation objectives, and possible additional opportunities to mitigate emissions arising from national adaptation-related goals for the agriculture sector that are identified within-country NDCs but are not yet identified as such.

Table 1: Country NDCs assessed in this report

Country	NDC	UNFCCC submission date
The Bahamas	First NDC (2015)	31/10/2016
Belize	First NDC (updated submission) (2021)	01/09/2021
Dominica	First NDC (2015)	21/09/2016
Haiti	First NDC (2015) First NDC (Draft updated version: 2021 v1 03 Nov 2021 MDE January 2022)	31/07/2017
Saint Kitts and Nevis	First NDC (Updated submission) (2021)	25/10/2021
Saint Lucia	First NDC (Updated submission) (2021)	27/01/2021
Saint Vincent and Grenadines	First NDC (2015)	29/06/2016
Suriname	Second NDC (2020)	09/12/2019
Trinidad and Tobago	First NDC	22/02/2018

In addition to the NDCs, country-level information was also gathered from National Communications to the UNFCCC (NCs), Biennial Update Reports to the UNFCCC (BURs), approved Green Climate Fund (GCF) proposals, National GHG Inventory Reports (NIRs), national climate change policy documents, and other scientific literature relevant to opportunities for achieving emission reductions within relevant national agriculture sectors. The GHG inventory data for the analyses were taken from the documents listed in table 2.

Table 2: Source and year of GHG inventory data utilised for the analysis.

Country	Inventory document	Latest inventory year
The Bahamas	Department of Environmental Planning, 2021, The Bahama's Third National Greenhouse Gas Inventory: GHG removals 2001–2018 (Draft).	2018
Belize	Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, 2020. Belize's Fourth National Greenhouse Gas Inventory Report.	2017
Dominica	Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020, Third National Communication.	2017
Haiti	Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, 2013. Coopération Technique FEM/PNUE/GFL-2328-2724-4867.	2000
Saint Kitts and Nevis	Ministry of Environment and Cooperatives, 2022, St. Kitts and Nevis National Inventory Report.	2018
Saint Lucia	Government of Saint Lucia, 2021, Saint Lucia's First Biennial Update Report.	2018
Saint Vincent and Grenadines	Ministry of Health, Wellness and the Environment, 2015, Second National Communication on Climate Change.	2004
Suriname	Office of the President of the Republic of Suriname, 2016, Second National Communication.	2008
Trinidad and Tobago	Ministry of Planning and Development, 2021, Trinidad and Tobago's First Biennial Update Report.	2018

The NDCs and other documents were assessed for each of these broad objectives through the sub-headings provided below:

- National mitigation objectives
  - Key mitigation targets
  - Primary GHG emitting sectors
  - Sectors targeted for emission reductions
  - GHGs covered
- National mitigation objectives for agriculture
  - Emission sources identified
  - Targeted goals
  - Actions specified
  - Specified timeline for implementation (if applicable)
  - Co-benefits of mitigation actions
- Agricultural adaptation goals with potential mitigation benefits
  - Targeted goals
  - Actions specified
  - Case study examples

The complete excel sheet containing the analysis is included as Appendix A: Complete NDC Scoping Study Data Collection & Analysis.

For each country, the report identifies the barriers presented within reviewed documents that are presently or anticipated to impede the implementation of agricultural mitigation objectives.

Lastly, for each country, opportunities for emission reductions are identified based upon the sources of emissions present within the country and the state of implementation of mitigation actions to address these emission sources. Due to considerable overlap between the mitigation opportunities for the nine countries evaluated, these opportunities are consolidated into one list of potential options for enhanced ambition in agriculture for the region and discussed in section 3.4. The opportunities pertinent to each country and any country-specific guidance are included within that country's section.

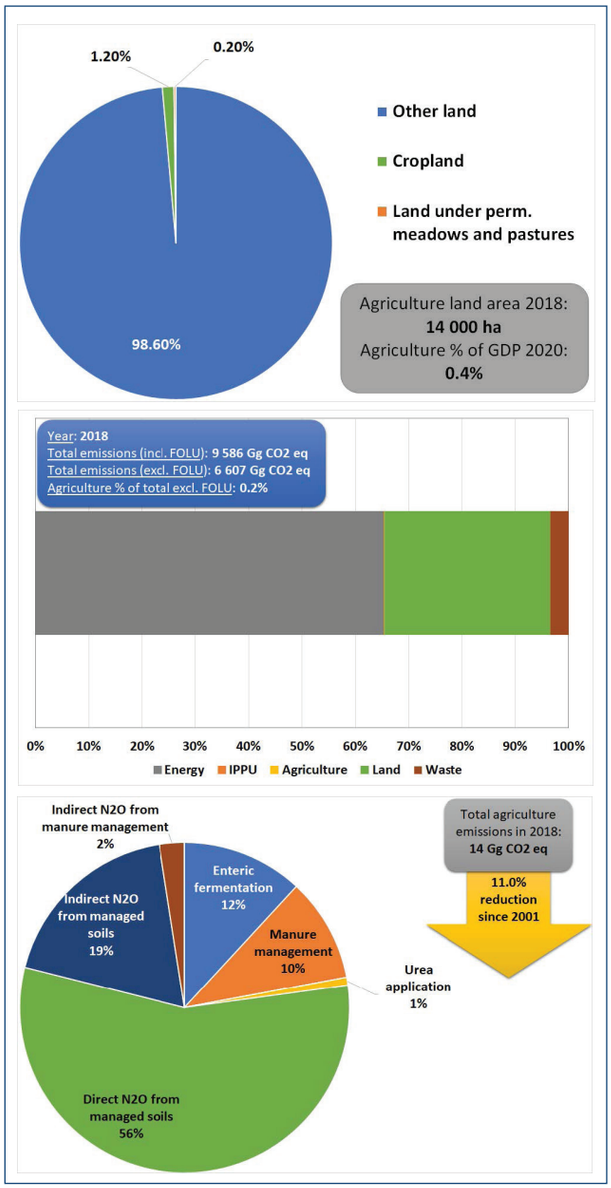
2 National Level Agriculture GHG Emission and NDC Profiles

In this section, the report examines each country's agriculture sector and provides an overview of the agriculture emissions profile to obtain an understanding of where the mitigation potentials lie. It also examines the mitigation goals relevant to agricultural activities in the NDCs.

2.1 The Bahamas

2.1.1 Overview of agriculture GHG profile

The Bahamas' have a land area of 1,001, 000 ha with agricultural land (croplands and pastures) occupying 1.4% of this area.[12] The share of GDP from agriculture represents 0.4% in 2020 (which is down from 1.1% in 2010)[13], although small-scale, supplemental, and backyard farming are commonplace throughout the archipelago.[14] Ninety percent of the food consumed in The Bahamas is imported, and crop agriculture is focused largely on fruit. Poultry, livestock, and dairy are other key agricultural products of The Bahamas.[15]



GHG emission from Bahamian agriculture in 2018 was 14.23 Gg CO_2e, representing 0.24% of the total national emissions (excluding FOLU).[16] The most significant source of emissions is nitrous oxide (N_2O) emissions (both direct and indirect) from managed soils. This is attributed to nitrogen-based fertiliser application, as well as dung and urine inputs from livestock. Enteric fermentation is the second largest emissions source, and, based on livestock population numbers (5 dairy cows, 101 other cattle, 2,142

12 FAOSTAT data, accessed on 26/03/2022; The Bahamas Ministry of Agriculture and Natural Resources, Blue & Green Sectoral Strategy and Action Plan, Appendix 1: Current Situation Analysis Report, May 2021.

13 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

14 The Second National Communication Report of The Commonwealth of The Bahamas Under UNFCCC, 2014. The Bahamas. UNFCCC Submissions. Available: https://unfccc.int/documents/67632.

15 Ibid. The Second National Communication Report of The Commonwealth of The Bahamas Under UNFCCC, 2014.

16 Department of Environmental Planning, 2021, The Bahama's Third National Greenhouse Gas Inventory: GHG removals 2001-2018 (Draft report, Nov 2021)

sheep, 6,147 goats, 264 horses, 100 mules, 7,059 swine, and 114,000 chickens in 2018[17]), much of these emissions are from small ruminants. Poultry does not contribute to enteric fermentation emissions but was a significant contributor to manure management emissions. Agriculture emissions have decreased by 11% since 2001, although there is a fluctuation in the time series, with a peak in 2004, declining to 2013 and then increasing again.[18]

In addition to these agriculture emissions, the National Inventory Report (NIR) also indicates that there are 138.31 Gg CO_2e being emitted due to land conversions to cropland, but this is only 4.6% of the FOLU emissions. It is important to note that only biomass carbon changes were considered in the inventory. The total FOLU emissions were 2,979 Gg CO_2e in 2018, with the majority of emissions being due to the conversion of forest land to grassland.[19]

2.1.2 NDC targets

In The Bahamas' First NDC, submitted on 31 October 2016, the country established an overall emissions reduction goal of 30% compared to the business-as-usual scenario for the entire economy by 2030.[20] The NDC covers CO_2, CH_4, and N_2O and focuses on emissions reductions from the energy and forestry sectors, with agriculture mentioned in terms of adaptation (table 3).

Forest sector mitigation actions were provided, but these have not been highlighted as they do not relate specifically to agriculture. GHG emission reductions from land degradation and deforestation were indicated to have a mitigation potential of 5,661 Gg CO_2e, but it is not clear to what extent agriculture may contribute to this.

Table 3: Economy-wide and agriculture related mitigation and adaptation targets in The Bahamas' First NDC (2015)

Economy-wide target	Agriculture related mitigation target	Agriculture related adaptation goals
Reduce total GHG emissions from BAU by 30% by 2030 (conditionality not specified).	None	Formulate and implement strategies and measures that will help to enhance food security and sustainable food production.

2.1.3 Agriculture related actions

Since the analysis was conducted the Bahamas updated NDC was submitted, but still does not include mitigation actions for agriculture.

In terms of adaptation, the NDC targets the formulation and implementation of strategies to enhance food security and increase the sustainability of food production within the country. This is also relevant for mitigation as there is strong potential to conceptualise strategies that increase food security, reduce water consumption, reduce the cost of farming inputs such as fertilisers or pesticides, improve the health of humans and animals, reduce the odours resulting from animal farming operations, and increase the profitability of agricultural livelihoods within The Bahamas. These potential strategy objectives not only support improved food security and sustainability, but would also reduce emissions and could make a contribution towards future versions of The Bahamas' NDC[21].

17 Ibid. Department of Environmental Planning, 2021.

18 Ibid. Department of Environmental Planning, 2021.

19 Ibid. Department of Environmental Planning, 2021.

20 The Government of The Bahamas, 2015. Intended Nationally Determined Contribution (INDC) under the United Nations Framework Convention on Climate Change (UNFCCC). www4.UNFCCC.int. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Bahamas%20First/Bahamas_COP-22%20UNFCCC.pdf. Accessed 01 March 2022.

21 The updated NDC presented after this analysis was completed highlights five examples of adaptation actions (specific to agriculture) that can be implemented by 2030 to support the targets of adaptation strategic component: 1. Provide farmers with relevant meteorological information regularly, as well as weather forecasts, with the aim to foster climate sensitive farming; 2. Promote climate smart sustainable agriculture measures and agroforestry practices; 3. Assess climate change risk impacts on the Agriculture/Fisheries sector (productivity and food security); 4. Invest in research on climate resilient crops; 5. Establish climate monitoring systems for farms.

2.1.4 Implementation schedule

The Bahamas National Mitigation Analysis[22] (supporting the Third National Communication and First Biennial Update Report) identified three FOLU and one agriculture mitigation actions to assess in terms of their mitigation potentials. These actions were determined through a review of policies, sectoral action plans, strategies, development plans and stakeholder engagements. These are:

- FOLU: Sustainable management practices for 15% of conservation forest (191,826 ha) and forest reserves (128,865 ha) and protected forests (25,537 ha) on Abaco and Andros by 2025 (ongoing project).
- FOLU: Reestablishment & rehabilitation of 50 ha of Davis Creek, Andros Ecosystem by 2025 (ongoing project).
- FOLU: Sustainable land-use practices to result in zero emissions in the LULUCF sector by 2045 (proposed action).
- Agriculture: Sustainable agroforestry practices on Abaco, Andros and Grand Bahama by 2025 (ongoing project).

Through the integration of crop trees, ground crops, and livestock a **greater carbon storage** and a **reduction of fertiliser use could be achieved**.[23] No estimates of these agriculture related reductions were provided due to data limitations, only the FOLU sector goals were able to be modelled through this analysis. These were projected to achieve 1,324 Gg CO_2e avoided by 2030 and 2,979 Gg CO_2e avoided by 2050.[24]

2.1.5 Barriers to implementing agricultural mitigation objectives and enhancing actions

Although no barriers are identified within the First NDC, the same barriers preventing action throughout the Caribbean region are likely to present within The Bahamas and these are discussed in section 3.3.

2.1.6 Opportunities for enhanced mitigation actions in future versions of the NDC

Overall, the emissions from agriculture categories are a small percentage of national emissions (<1%) and therefore may not be a policy priority. In addition, the cost of the mitigation action in agriculture may outweigh the mitigation reduction impact with such a small sector contribution. Given this, The Bahamas can consider working together with other countries to identify technologies and practices that are working to reduce emissions or enhance sinks in the region (see section 3 for further details). Opportunities that could be considered in The Bahamas include:

- More efficient or **reduced use of synthetic fertilisers** for enhancing mitigation as well as contributing to agricultural adaptation targets.
- Poultry is the livestock type with the largest potential to reduce emissions through improved manure management. The size and scale of the poultry industry could make anaerobic digesters an economically viable option for achieving emission reductions.

More information on the concentration of animal feeding operations is needed to determine the applicability of changing animal feeding practices to reduce emissions from enteric fermentation and manure management. Lastly, there are significant tourism operations in the country that can provide a market for sustainable climate smart agricultural products to help incentivise changes.

22 Department of Environmental Planning and Protection (DEPP), Ministry of Environment and Natural Resources Government of Bahamas, 2022. National Mitigation Analysis (Draft report submitted by The Greenhouse Gas Management Institute, The Caribbean Cooperative Measurement Reporting & Verification Hub and Stockholm Environment Institute).

23 Ibid. Department of Environmental Planning and Protection (DEPP), 2022.

24 Ibid. Department of Environmental Planning and Protection (DEPP), 2022.

2.2 Belize

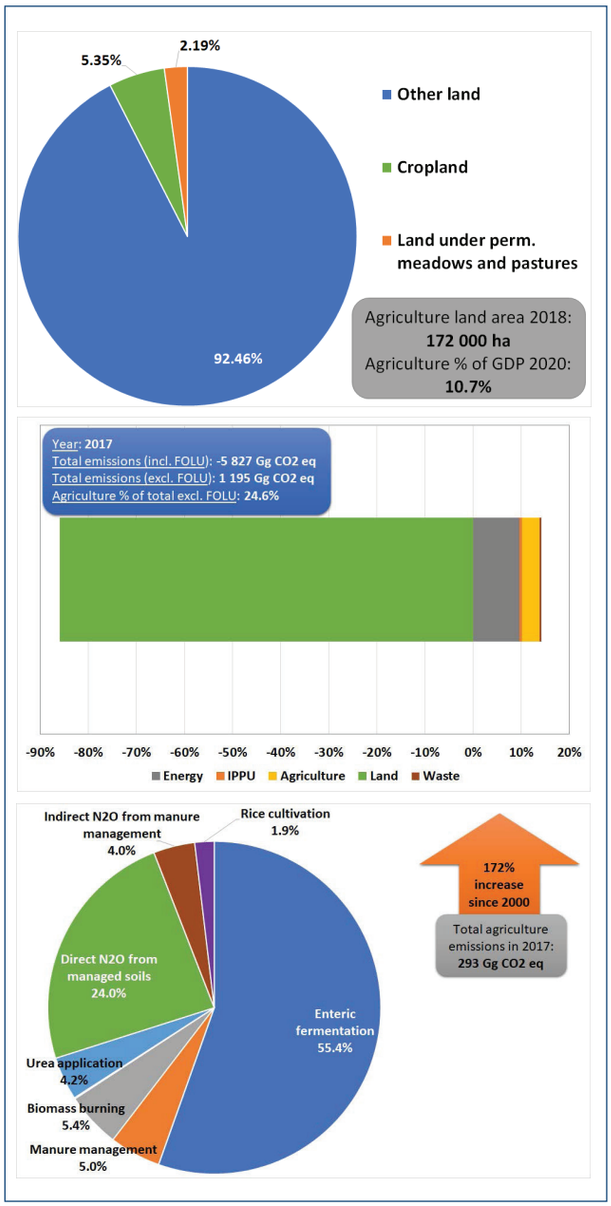
2.2.1 Overview of agriculture GHG profile

The agriculture sector, one of the mainstays of the Belizean economy, employs 12,000 farmers[25] and is comprised of large-scale commercial production destined for both domestic and international consumption, and traditional small-scale production for local consumption.[26]

Agricultural land (croplands and pastures) occupy 7.5% of the Belize land area,[27] with approximately 38,800 ha planted with sugarcane, 19,400 ha with citrus, and 19,600 ha with corn.[28] Additionally, 142,000 ha of pastures are grazed by approximately 135,400 head of cattle.[29] Seventy four percent of farms in Belize are less than 20 ha in size and farming is heavily concentrated within Toledo, Orange Walk, and Corozal districts that are home to 25%, 22%, and 21% of all farms respectively (68% total).[30]

The leading agricultural export commodities between 2011 and 2015 were sugar (23% by value), orange concentrate (21%), banana (20%), papayas (4%), and animal feed (3%). The agricultural share of GDP represents 10.7% in 2020, which is down from 11.7% in 2010.[31]

Production practices vary in the country, with some farmers employing shifting practices, and some fully mechanised while most (90%) agricultural land uses rain-fed irrigation.[32] In the mechanised systems, most crop residues are incorporated into the soil, while other residues are burned.[33] Rice is grown under three systems in Belize, namely: milpa or upland rice, rain-fed mechanised, and irrigated.



Since the 2009 livestock census, there has been a substantial increase in beef cattle (91,125 in 2009 to 126,129

25 National Climate Change Office, 2016. Belize's Third National Communication to the United Nations Framework Convention on Climate Change. Ministry of Agriculture, Fisheries, Forestry, the Environment and Sustainable Development. Belmopan, Belize. Available: Belize. National Communication (NC). NC 3. | UNFCCC

26 Ibid. National Climate Change Office, 2016.

27 FAOSTAT data, accessed on 26/03/2022

28 Ibid. Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, 2021.

29 Ibid. Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, 2021.

30 Ibid. National Climate Change Office, 2016.

31 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

32 Ibid. National Climate Change Office, 2016.

33 Ibid Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, 2021

in 2017) and pig populations (17,038 pigs in 2009 to 32,674 in 2017), with a slight decline (5%) in dairy cattle.[34] Sheep production has declined from 13,018 in 2009 to 11,434 in 2017. In Belize, the majority of animal waste is deposited by animals in the fields and left there. There are a few dairy farmers and beef feedlots where manure is managed and then applied to the field, while poultry waste is managed as litter and used for soil amelioration after it has been aged or composted.[35]

Agricultural emissions in Belize in 2017 were 293.40 Gg CO_2e (25% of total emissions excluding FOLU) with 55% coming from enteric fermentation and 24% from direct N_2O emissions from managed soils.[36] Enteric fermentation emissions have more than doubled since 1994, while direct N_2O emissions from managed soils increased by 73% over the same period. Beef cattle were the largest contributors to enteric fermentation and poultry contributed the most to manure emissions.

The Fourth National GHG Inventory report also indicates that there has been an increase in the area of forest land converted to cropland since 2010 which leads to increased CO2 emissions. Croplands were identified as a major driver of forest conversions. In 2017 it was estimated that 2,717 Gg CO2e were produced from these conversions. The FOLU sector was an overall sink of 7,270 Gg CO2e in 2017 with forest lands being the main contributor to the sink. It is noted that only biomass carbon stock changes were included in the FOLU sector contributions.

2.2.2 *NDC targets*

The updated First NDC for Belize,[37] submitted in 2021, indicates a reduction of 5,647 Gg CO2e by 2030.[38] Two mitigation and two adaptation actions for the agriculture sector were identified (table 4).

Two mitigation actions were also identified for the FOLU sector with one having links with the agriculture sector through the monitoring of agroforestry practices. This target aims to "reduce GHG emissions and increase GHG removals related to land use change totalling 2,053 kt CO_2e cumulative over the period from 2021 to 2030". This target also has implications for the forestry sector. The second target was related to mangrove conservation which does not have a direct impact on agriculture emissions.

Table 4: Economy-wide and agriculture related mitigation and adaptation targets in Belize's First (updated) NDC (2021)

Economy-wide target	Agriculture related mitigation targets	Agriculture related adaptation goals
Emission reduction of 5,647 Gg CO_2e between 2021 and 2030.	Reduce methane emissions from livestock by 10% by 2030 (conditional). Avoid emissions of at least 4.5 Gg CO_2e related to agriculturally driven land-use change by 2025 (conditional).	Reduce post-harvest losses through the implementation of the National Adaptation Strategy to Address Climate Change in the Agricultural Sector to increase the adaptive capacity of the agricultural sector (conditional). Develop and implement an enhanced early warning system for drought and extreme weather events to support farmers in planning for and responding to the impacts of climate change by 2025 (conditional).

34 Ibid, Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, 2021.

35 Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, Belize's Fourth National Greenhouse Gas Inventory Report, Belmopan, Belize, 2021. Available at: https://unfccc.int/sites/default/files/resource/Fourth%20National%20GHG%20Inventory%20rev%20Aug42020.pdf

36 Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, Belize's Fourth National Greenhouse Gas Inventory Report, Belmopan, Belize, 2021. Available at: https://unfccc.int/

37 Belize Updated Nationally Determined Contribution, 2021. NDC Partnership. Government of Belize. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Belize%20First/Belize%20Updated%20NDC.pdf

38 Belize Updated Nationally Determined Contribution, 2021. NDC Partnership. Government of Belize. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Belize%20First/Belize%20Updated%20NDC.pdf

2.2.3 *Agriculture related actions*

Belize's updated NDC identifies the following agriculture-focused mitigation actions (conditional on receiving financial and technical support):[39]

- Incorporate and monitor agroforestry practices into at least 8,000 ha of agricultural landscapes by 2030 by planting shade trees in line with the draft National Agroforestry Policy, with 4,500 ha of this being implemented by 2025 conditional on adoption, implementation and financing of the agroforestry policy,
- Improve the management of 80,000 ha of the agro-landscape through good agricultural and silvopastoral practices, including by bringing 30,500 ha under sustainable agriculture systems with biodiversity benefits and 15,000 ha in production systems under sustainable land management,
- Restore 200 ha of arable sugar land in northern Belize that has been denuded over time by use,
- Promote the reduction of agricultural GHG emissions through altering crop cultivation methods, including green mechanical harvesting in sugar cane production systems, through a public awareness campaign targeting women, youth, and local communities, and
- Promote the reduction of agricultural GHG emissions through implementing effective management that involves changing the feeding practices of livestock to include more optimal nutrient levels.

Some forestry related actions were included:

- Reduce degradation in 42,600 ha of forest within protected areas by reducing fire incidence, improving logging practices, and controlling other human disturbance by 2030, and
- Promote and monitor the stewardship of 10,000 ha of local community and Indigenous people's lands as sustainably managed landscape to serve as net carbon sinks.

Even though these are forest targets, agriculture could have an impact on the first target, as the expansion of croplands can lead to the degradation or loss of forest lands. Agriculture is, however, not specifically mentioned as a contributor to forest degradation.

Significant emission reductions can also be incentivised or achieved as co-benefits from adaptation actions (also contingent on financial and technical support) listed in the NDC:[40]

- Mobilise infrastructure investments for Climate Smart Agriculture (CSA) as set out in the National Adaptation Strategy to Address Climate Change in the Agriculture Sector including the delivery of short-term actions by 2025,
- Establish a financing facility for CSA investments through local financial institutions,
- Improve both crop and livestock husbandry practices, increase access to drought-tolerant crops and livestock breeds through a partnership with research institutions, and
- Adopt better soil and water management practices, including the use of biochar and improved (solar-powered) irrigation systems.

These adaptation actions are included within this section on mitigation actions because their implementation potentially represents significant emission reduction benefits. The actions relating to Climate Smart Agriculture (CSA) and the improvement of crop practices will benefit mitigation objectives through applying a "carbon/nutrient smart" component within the mitigation pillar of the CSA framework.[41]

39 Ibid. *Belize Updated Nationally Determined Contribution, 2021.*

40 Ibid. *Belize Updated Nationally Determined Contribution, 2021.*

41 Bhusal A., L. Khatri, B. Bhandari, L. Sherpa and G. Neupane. 2020. Climate-Smart Agriculture (CSA): Training Manual. Local Initiatives for Biodiversity,

Mitigation can be achieved through CSA crop systems that enhance CO_2 sequestration and storage, improving nutrient management which can reduce the use of fertiliser and N_2O emissions, ensuring the maintenance of existing carbon stocks (e.g., through erosion control and prevention, reduced need to convert additional land to farmland due to exhausted/barren soils), and reducing the emissions associated with rice cultivation, among other potential reductions from applying CSA practices.

Improving the animal husbandry and genetic breeds of livestock can also benefit mitigation objectives by reducing emissions associated with enteric fermentation. Soil and water management improvements through the use of biochar, which increases carbon sequestration, and solar-irrigation systems, which may reduce the use of fossil fuel combustion will also create emission reductions. Lastly, the two actions relating to raising awareness and providing education can help to spread the practices mentioned above to a larger group of farmers, enhancing the possibility of emissions reductions.

2.2.4 Implementation schedule

The updated NDC identifies goals to: "reduce methane emissions from livestock by 10% by 2030 and avoid emissions of at least 4.5 kt CO_2e related to agriculturally driven land-use change by 2025."[42]

2.2.5 Barriers to implementing agricultural mitigation objectives and enhancing actions

The cost to implement the agricultural mitigation actions stated in Belize's updated NDC is a significant obstacle. Implementing the NDC-identified mitigation actions will cost a combined USD 41,306,164; however, there is currently only $16,306,164 identified to support these actions, leaving a USD 25 million gap.[43] Both the mitigation and adaptation actions presented within the updated NDC are identified as conditional upon funding and technical support.[44]

Belize does not rely solely on FAOSTAT data for its inventory, as it makes use of country census data. Lack of disaggregated data on key livestock is a limitation for moving to a Tier 2 approach. A Tier 2 approach would allow for improved tracking of mitigation impacts. Belize utilised a Tier 2 approach for rice cultivation, so there is the will to improve the inventory detail. The limiting factor here is capacity to undertake these enhanced calculations and the ability to collect more detailed data.

In terms of enhancing some of the CSA actions to include mitigation impacts, the barrier is research and data. Research is required to quantify the impacts of CSA actions on emissions. Further, country data on the extent of CSA activities will be needed in order to assist in the quantification and tracking of the potential reductions. To see the impacts of these activities reflected in the GHG inventory, soil carbon changes must be included in the FOLU inventory. Data and technical capacity are limiting factors for its inclusion.

2.2.6 Opportunities for enhanced agriculture mitigation actions in future versions of the NDC

National emissions from rice cultivation and agricultural residue burning are quite small and therefore, it is recommended that Belize focus on the more significant emission sources present in the agriculture sector, namely enteric fermentation, livestock manure management, and direct and indirect emissions of N_2O from nitrogen inputs

Research and Development (LI-BIRD) and Ministry of Land Management, Agriculture and Cooperative (MoLMAC), Gandaki Province, Pokhara, Nepal. Available: https://cgspace.cgiar.org/bitstream/handle/10568/111199/CSA%20Training%20Manual-2020.pdf

42 Belize Updated Nationally Determined Contribution, 2021. NDC Partnership. Government of Belize. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Belize%20First/Belize%20Updated%20NDC.pdf

43 Ibid. Belize Updated Nationally Determined Contribution, 2021.

44 Ibid. Belize Updated Nationally Determined Contribution, 2021.

to agricultural fields. Section 3.4 provides further explanation of the technologies and practices that can be employed to reduce emissions from these sources. Specifically for Belize, mitigation opportunities include:

- Developing a programme to promote the domestic growth and production of higher quality forage to both reduce emissions and improve growth rates among livestock populations.
- Establishing anaerobic digesters near large (>10,000 sheep, >125,000 chickens, >2,500 swine, or >1,000 cattle)[45] and medium (3,000–9,999 sheep, 37,500–124,999 chickens, 750–2,499 swine, or 300–999 cattle)[46] animal feeding operations, potentially collecting waste from multiple animal feeding operations (if feasible) to gain economies of scale and reduce emissions more cost-effectively.
- Promote CSA activities to enhance soil carbon storage, but also implement a strategy or data collection process to monitor the CSA activities. Activities may already be occurring, but without information to track the implementation it is difficult to quantify the impacts and set targets. Further details on the contribution of CSA activities to mitigation are discussed in section 3.4.

45 EPA, N.D. Regulatory Definitions of Large CAFOs, Medium CAFO, and Small CAFOs. Available: https://www3.epa.gov/npdes/pubs/sector_table.pdf

46 Ibid. EPA, N.D.

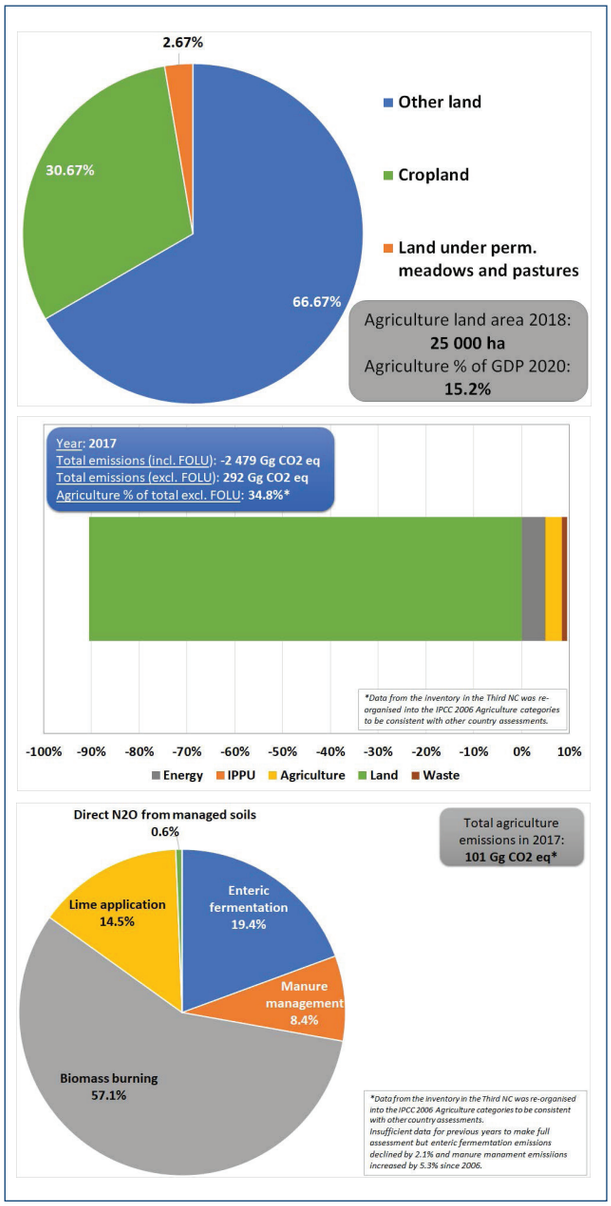
2.3 Dominica

2.3.1 Overview of agriculture GHG profile

Agriculture, Dominica's second largest sector, contributed between 11.5% and 15.2% of the country's GDP between 2010 and 2020.[47] Croplands and pastures cover 33.3% of Dominica's land area[48] with Dominica's agriculture sector featuring a mixture of both subsistence and commercial operations. Employment in the sector includes farm labour, production of inputs on a commercial scale, employment in agro-manufacturing and allied service industries.[49]

The 2011 Population and Housing Census indicated 15% of the labour force (4,236 people) were employed as skilled Agriculture, Forestry, and Fishery workers in addition to unskilled labourers.[50] The main activities occurring within the sector are:

- Crop production, at both the subsistence and commercial (export) scales. Average crop-producing farm size typically ranges from 0.5 ha to 1.0 ha of land. Popular export crops include banana, and tree crops such as citrus, coffee, cocoa, coconut, mango, and avocado, while other crops such as plantain, pineapple, watermelon, roots, and tubers are grown for domestic consumption and inter-regional trade.[51]
- Livestock (cows, goats, sheep, pigs, and chickens) are raised for domestic consumption within this sub-sector, primarily on a subsistence basis.[52] Livestock are primarily subsistence and small scale in nature, as little commercial livestock production occurs on the island. FAOSTAT data indicates there were 13,291 cattle, 4,561 pigs, 7,166 sheep, 8,735 goats and 169,150 poultry in 2017.[53] Animal products are largely imported to meet the growing demands of the population for animal protein.[54]



47 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022; O'Neill, Aaron, *2021.* Dominica: Share of economic sectors in the gross domestic product (GDP) from 2010 to 2020. *Statista, Available: https://www.statista.com/statistics/730540/share-of-economic-sectors-in-the-gdp-in-dominica/*

48 FAOSTAT data, accessed on 26/03/2022

49 Government of the Commonwealth of Dominica, 2021. Volume I: The Dominica National Agriculture Policy Context and Situation. Inter-American Institute for Cooperation on Agriculture (IICA).

50 The Commonwealth of Dominica, 2020. Population and Housing Statistics. Central Statistics Office, Ministry of Finance, Roseau (Dominica). Available: https://stats.gov.dm/wp-content/uploads/2020/04/2011-Population-and-Housing-Census.pdf

51 Ibid, Government of the Commonwealth of Dominica, 2021.

52 Ibid, Government of the Commonwealth of Dominica, 2021.

53 Ibid., Commonwealth of Dominica, 2020

54 Ibid, Government of the Commonwealth of Dominica, 2021.

- Apiculture (beekeeping) is mainly carried out on a subsistence basis, however, is becoming more commercialised.[55]

The sector's contribution to the GDP is largely attributable to the export of the products mentioned above. There has been a consistent decline in the agriculture sector's share of GDP with each major disaster resulting from climate hazards.[56] Climate risks are increasing for the agriculture sector due to shifting rainfall patterns, increased temperatures that damage crops, and increased flooding and saltwater incursions due to sea-level rise or storms.[57] Additionally, Dominica's reliance on the banana industry, which has faced intense market pressures and the brunt of damages caused by storms, has contributed to the sector's economic vulnerability.[58] Other factors which threaten Dominica's agriculture sector include:[59]

- Lack of access to appropriate and affordable finance,
- Low levels of land tenure,
- High reliance on costly imported inputs such as fertilisers and feed, and
- Rudimentary practices negatively impacting productivity.

The GHG emissions reported in Dominica's Third NC were utilised in this analysis, however it is noted that Dominica has recently updated its inventory. The updated version was not available at the time of completing this report, therefore could not be evaluated. The Department of Forestry indicated that there were notable updates to the FOLU component of the inventory.

The emissions reported in the Third NC were determined using the 1996 IPCC Guidelines, so the categories are not completely aligned with the categories for the IPCC 2006 Guidelines (which are being used in this assessment). The agriculture sector emissions included CO_2 emissions from land use change as well. Data was provided in the annex of the Third NC, and this was used to reallocate the emissions into the relevant IPCC 2006 Guidelines categories as far as possible to allow for comparison across the region. Some uncertainties were associated with the data, as the reporting units are not always clear. The analysis outputs were compared to emissions provided by FAOSTAT to check the data was in a similar range. The overall emissions were estimated to be -2,479 Gg CO_2e and 292 Gg CO_2e with and without FOLU, respectively. Agriculture is estimated to contribute 34.8% to the total (excluding FOLU) with biomass burning contributing 57% and enteric fermentation 19% of the total agricultural emissions. Croplands in the FOLU sector were estimated to be a sink of CO_2.

Agriculture emissions in the Third NC were calculated based on FAOSTAT data livestock population data which can bring about some uncertainty in the emission estimates. The cattle numbers from the country agricultural census were compared to the data in FAOSTAT and it showed that the FAOSTAT cattle population data applied in the inventory are overestimated.[60] This would lead to overestimation of the livestock related emissions. The reliance on FAOSTAT data is common in the Caribbean region and this may lead to inaccuracies in emission estimates across the region.

55 Ibid, Government of the Commonwealth of Dominica, 2021.

56 Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020, Third National Communication, 2020. Third National Communication to the United Nations Framework Convention on Climate Change of the Commonwealth of Dominica. UNFCCC Submissions. Available: https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/02487591_Dominica-NC3-1-Dominica%20TNC%20-%20Final%20(March%202020).pdf.

57 Ibid, Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020.

58 Ibid, Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020.

59 Government of the Commonwealth of Dominica, 2021. Volume II: Medium Term National Agriculture Policy (NAgriP) 2021–2030. Inter-American Institute for Cooperation on Agriculture (IICA).

60 Ibid, Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020,.

2.3.2 NDC targets

Dominica's First NDC indicates that GHG emissions will be reduced by 44.7% by 2030 in comparison to 2014.[61] This includes sectoral targets for energy industries; transport; manufacturing and construction; commercial/institutional, residential, agriculture, forestry and fishing; and solid waste. No specific agriculture mitigation targets were identified. The 8.1% reduction in emissions for commercial/institutional, residential, agriculture, forestry and fishing are related to energy consumption. The contribution of agriculture to this 8.1% reduction is not clear. The NDC also identifies several agriculture related adaptation goals (table 5), although not all these actions (e.g. early warning systems, education) would have quantifiable co-benefits for mitigation.

The revised NDC is anticipated to include greater specificity regarding agriculture sector targets.[62]

Table 5: Economy-wide and agriculture related mitigation and adaptation targets in Dominica's First NDC (2015)

Economy-wide target	Agriculture related mitigation target	Agriculture related adaptation goals
Reduce total gross greenhouse gas (GHG) emissions below 2014 levels (164.5 Gg est.) at the following reduction rates: 17.9% by 2020; 39.2% by 2025; and 44.7% by 2030 (conditional).	Reduction in (energy consumption) emissions for commercial/institutional, residential, agriculture, forestry and fishing by 8.1% by 2030.	Promotion of Food Security through Climate Resilient Agricultural/Fisheries Development to build climate resilient communities by strengthening capacity to address climate change risks to food security associated with changing precipitation patterns. Establishment of early warning systems, multi-use disaster shelters (powered by renewable energy and back up bio-diesel generators) and emergency preparedness training programmes in vulnerable communities. Design and implementation of climate change adaptation and disaster risk management education and awareness programme at all levels to be coordinated by the Department of Climate Change, Environment and Development.

2.3.3 Agriculture related actions

- The agriculture mitigation target mentioned in the NDC relates to the reduction in energy use. No specific actions were provided. No agricultural mitigation actions are specified within the NDC. In Dominica's Third National Communication several actions are identified including:[63]
  - Enhancement of soil organic carbon storage,
  - Continued use of no-till,
  - Mitigation of N2O emissions,
  - Elimination of short-lived climate pollutants,
  - Introduction of manure management practices,
  - Reduction and eventual elimination of slash and burn agricultural practices, and
  - Elimination of burning of agricultural residues, and
  - Replacement of fossil fuel energy sources for agricultural practices with biofuels and renewable energy.

It should, however, be noted that reductions due to the first two actions would be reflected in the FOLU sector, while those from the last action would impact the energy sector. The impacts of the use of biofuels and renewable energy on the agriculture sector need to be fully assessed as there can be negative consequences due to increased carbon removals or expansion of agricultural area to accommodate the needs.

61 Commonwealth of Dominica, 2015. Intended Nationally Determined Contribution (INDC) of the Commonwealth of Dominica. UNFCCC. Available: INTENDED NATIONALLY DETERMINED CONTRIBUTION (INDC) (unfccc.int)

62 Interview notes, Mr. Edgar Hunter. Interview conducted on Jan 18th, 2022.

63 Ibid., Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020,

2.3.4 *Implementation schedule*

The NDC identifies that compared to 2014 emission levels, overall emissions should be reduced by 17.9% by 2020, 39.2% by 2025, and 44.7% by 2030.[64]

2.3.5 *Barriers to implementing agricultural mitigation objectives and enhancing actions*

A major obstacle to implementing mitigation actions within the agriculture sector were the damages caused by Hurricane Maria and other damaging storms that have required that resources be dedicated to recovery instead of making improvements.[65] The impact of Hurricane Maria is likely to delay longer-lasting emission reduction improvements as efforts to rebuild will take priority over the implementation of more expensive, novel low-emissions technologies. The Third NC indicates that 45% of cattle, 65% of pigs, 50% of small ruminants, 90% of chickens, and 50% of rabbits were killed during Hurricane Maria, which had a very high economic cost to livestock farmers, though it did reduce emissions at least temporarily.

Another barrier is the limited availability of agricultural data, given that data is widely distributed across the various agricultural stakeholders at present. Centralised data management infrastructure and networks for data sharing do not presently exist.[66]

In the past budgeting for the NDC implementation has occurred on an ad hoc basis, but current NDC implementation efforts will ensure it is a part of the national budget in years to come, although external funding sources will remain necessary to implement anticipated mitigation measures in the updated NDC.[67]

2.3.6 *Opportunities for enhanced agriculture mitigation actions in future versions of the NDC*

Opportunities to reduce emissions from biomass burning, enteric fermentation and manure management, significant sources of agricultural GHG emission sources within Dominica, include:

- Anaerobic digesters to reduce emissions from livestock manure management have been piloted on a micro-scale to reduce CH_4 emissions which has the potential to be replicated in other areas.[68] This is a promising opportunity for mitigation action, although micro-scale anaerobic digesters will require substantially more administrative, financial, and technical assistance than medium or large-scale digesters. The administrative burden could be reduced if it were possible to construct larger facilities and aggregate waste from multiple animal feeding operations near each other.
- Enteric fermentation emission reductions can be reduced through various activities discussed in section 3.4.
- Reduce slash and burn activities to reduce biomass burning emissions. In addition, reduce burning of crop residues and move towards incorporating residues into the soil.
- Enhancing soil carbon storage through the promotion of CSA activities.

64 Ibid., Commonwealth of Dominica, 2015.

65 Ibid., Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020,

66 Ibid., Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020,

67 Interview notes, Mr. Edgar Hunter. Interview conducted on Jan 18th, 2022.

68 Interview notes, Dr. Al-Mario Casimir. Interview conducted on Jan 20th, 2022.

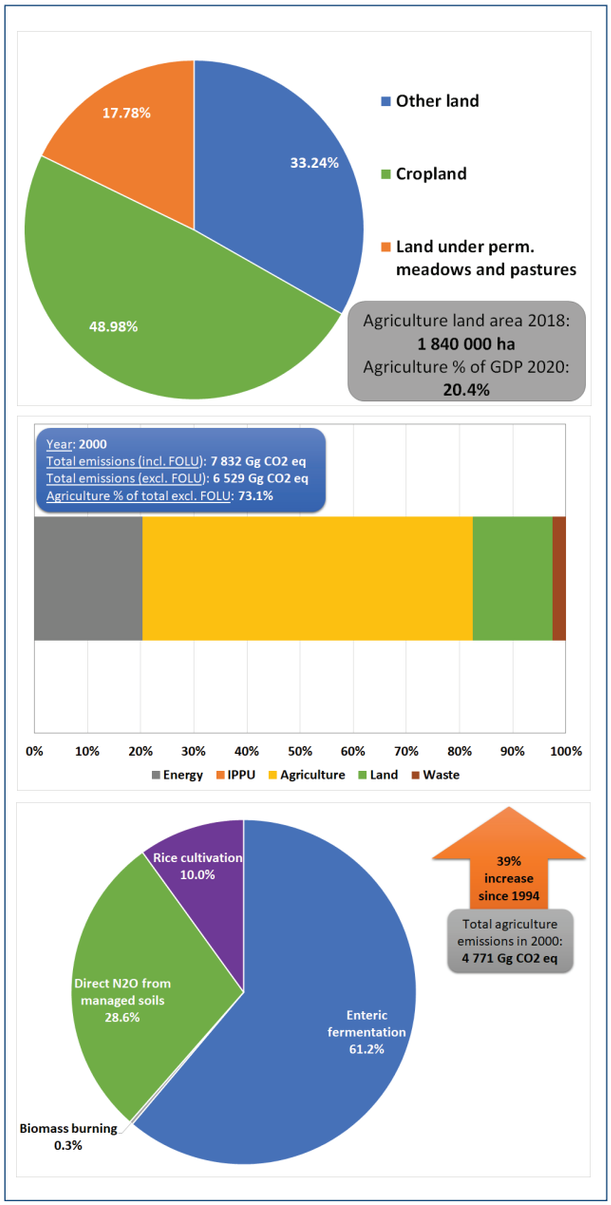
2.4 Haiti

2.4.1 Overview of agriculture GHG profile

Agriculture remains one of the main sources of revenue for rural Haitian families, contributing 50% to rural livelihoods.[69] Croplands cover 48.9% of the land area in Haiti and 17.8% is used for pastures.[70] Agriculture contributed 20.2% to the GDP in 2010 and 20.4% in 2020.[71] The economy is still dependent on subsistence agriculture and in 2005, 59.87% of the employed workforce laboured in the agriculture sector.[72] Lack of access to modern technology, disasters caused by hydro-meteorological events, and impacts of climate change is resulting in fewer people committing themselves to farming.[73]

Haiti has always faced disasters linked to climate hazards and its agriculture sector is especially vulnerable to climate impacts such as increasing floods, droughts, and changes in crop and livestock viability due to variations in temperature or rainfall patterns.[74] In recent years, an increasing number of disasters has plagued the nation, severely affecting crops and causing millions of dollars in losses in the agriculture sector.[75] The sector experiences a lack of public and private investment in agricultural infrastructure.[76] Agricultural infrastructure that could help increase the sector's resilience includes irrigation, greenhouses, water containment pools, lakes, and dams.

The GHG inventory data from Haiti's Second NC[77] was analysed in this report as the recently updated inventory for 2000–2010 was still being finalised and had not been released at the time this report was compiled.[78] Agriculture contributed 81% to the overall AFOLU emissions in



69 Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, ND. Coopération Technique FEM/PNUE/GFL-2328-2724-4867. Translated into English and provided by IICA on January 27, 2022. Original (in French) available: https://unfccc.int/documents/107014

70 FAOSTAT data, accessed on 26/03/2022

71 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

72 Ibid, Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, ND.

73 US Agency for International Development (USAID), 2016. Haiti: Economic Growth and Agricultural Development Fact Sheet. Available: https://reliefweb.int/report/haiti/haiti-economic-growth-and-agricultural-development-fact-sheet-2016

74 ND, 2019. Climate Change and Agriculture; A Perfect Storm in Farm Country. Union of Concerned Scientists. Available: https://www.ucsusa.org/resources/climate-change-and-agriculture

75 The World Bank, 2013. Agriculture in Haiti: Highly Vulnerable, Mostly Uninsured. Available: https://www.worldbank.org/en/news/feature/2013/04/03/agriculture-in-haiti-highly-vulnerable-mostly-uninsured

76 Ibid., The World Bank, 2013. The World Bank, 2013.

77 Ibid, Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, ND.

78 Mr Odre Valbrun, Ministry of Environment, Email communication on 28/03/2022

2000 and 71% towards the total country emissions (excluding FOLU). Enteric fermentation contributed 61.1% and agricultural soils contributed 28.6% to the agriculture emissions (4,771 Gg CO_2e) in 2000. It should be noted that these estimates are for the year 2000, and with emissions increasing by 39% between 1994 and 2000, further increases would be expected in the last 20 years. The baseline scenario provided in the updated NDC draft shows that overall emissions increased by 74% between 2000 and 2020.[79]

2.4.2 NDC targets

Haiti's Draft Updated First NDC identifies an economy-wide goal to reduce emissions by 6.32% using 23 unconditional measures. If funding is provided by external sources, Haiti can achieve reductions equal to 25.5% from a further 35 measures compared to the reference scenario, of which agriculture would be responsible for 6%.[80] The reference scenario projects the year 2000 emission levels to the year 2030 applying economic development historical data and forecasting using the 2006 IPCC guidelines.[81]

There were other mitigation targets for FOLU (afforestation, deforestation, forest regeneration, avoided deforestation and mangrove restoration) but agriculture may only contribute to the avoided deforestation target of 9,000 ha of deforestation avoided by 2025 and 11,000 ha by 2030 (conditional) with 10,000 ha avoided by 2025 (unconditional).

Table 6: Economy-wide and agriculture related mitigation and adaptation targets in Haiti's draft updated First NDC (2021).

Economy-wide target	Agriculture related mitigation target	Agriculture related adaptation goals
Reduction of 6.32% compared to the reference scenario (unconditional). Reduction of 25.5% compared to the reference scenario (conditional).	Improving pasture quality with legumes (10,000 ha by 2025; 20,000 ha by 2030)—conditional. Fruit tree growing (7,500 ha by 2025; 25,000 ha by 2030)—conditional.[#] Manure management (3% DM fat added to diet by 2025 and 3% by 2030)—conditional. Increase crop cover (10,000 ha by 2025; 30,000 ha by 2030)—conditional.[#] Reforestation with agroforestry: 10,000 ha by 2025 and 15,000 ha by 2030 are conditional, but there is also 3,000 ha reforested with agroforestry by 2025 that is unconditional.[#]	Strengthening the population's adaptive capacities and resilience by: developing watersheds and soil conservation; enhancing and conserving natural resources; preserving and strengthening food security; and establishing an information, education and awareness programme.

[#]*These are agriculture related actions, but emissions will be reflected in the FOLU sector.*

2.4.3 Agriculture related actions

The agricultural mitigation actions (conditional upon receiving external financial support) are related to improving pasture quality, which would reduce enteric fermentation emissions, and reducing manure management emissions. Action related to increasing carbon storage through agroforestry and planting fruit trees will impact sequestration in the FOLU sector.

Specified adaptation goals that have the potential to contribute to mitigation include:

- Cultivating crops that are resilient to climate change, which can help maintain plant growth and carbon accumulation throughout periods of drought,
- Promoting soil conservation practices which can enhance soil carbon storage,
- Farmer training, education, and awareness building, which can help reduce overapplication of fertilisers, build soil carbon,

79 République d'Haiti, Ministère de L'Environnement, 2021, Contribution Déterminée au Niveau National de la République d'Haïti. Premiere Actualisation. Translated into English and provided by IICA on January 27, 2022.

80 Ibid. Republique d'Haiti, Ministère de L'Environnement , 2021.

81 Ibid., Republique d'Haiti, Ministère de L'Environnement , 2021.

- Practicing semi-intensive livestock farming, increased forage production and silage, and improved genetics breeding programme which can reduce enteric fermentation.[82]

The Second NC also identifies practices that can contribute to mitigation:

- Genetic improvements to crops,
- Increased storage of carbon within the soil,
- Reduction of CH_4 emissions through improved management of rice field irrigation,
- Improved application of fertilisers to reduce N_2O emissions, and
- Reduced CH_4 emissions from enteric fermentation.[83]

Specific recommendations are identified for rice production including:[84]

- Modified flooding/watering regimes,
- Potential use of mineral fertilisers instead of organic fertilisers,
- Direct sowing plus mechanization to reduce CH_4 while advancing the date of harvest, and
- The use of improved genetics with hybrid varieties of rice.

Some water resource management objectives may also generate emission savings throughout the agricultural value chain such as the implementation of efficient (e.g., drip) irrigation systems and wastewater treatment.[85] These measures have the potential to reduce emissions from pumping and supplying water to agricultural fields, but these emission reductions will be reflected in the energy sector emissions and not the agriculture emissions.

2.4.4 Implementation schedule

Target completion dates in the NDC are given for 2025 and 2030 as shown in table 6, though this is contingent on external funding for implementation.

2.4.5 Barriers to implementing agricultural mitigation objectives and enhancing actions

Barriers as identified within the Second NC are:[86]

- Lack of innovation and support to identify and adopt technologies appropriate for the socio-economic and cultural context of the country.
- Lack of willingness of farmers to shift practices.
- Weak policy landscape and lack of enforcement of property rights with agrochemicals, agriculture machinery, and innovation.
- Lack of financial support and the significant funding required for implementation.

While Haiti has identified several actions for reducing emissions in the agriculture sector, and shows commitment to reducing is emissions, the one limitation is that reduction estimates are based on emissions in 2000. An updated inventory would be important for making a more accurate assessment of current emissions and forhaving an updated baseline against which it can measure and track its implemented actions. The Ministry of Environment indicates that an updated inventory has recently been completed as part of the Third NCs; however, results are still being validated,

82 Ibid., Republique d'Haiti, Ministère de l'Environnement , 2021.

83 Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, ND.

84 Ibid. Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, ND.

85 Ibid., Republique d'Haiti, Ministère de L'Environnement., 2021.

86 Ibid., Ministère de L'Environnement. Deuxième Communication Nationale sur les Changements Climatiques, ND.

therefore, could not be released for inclusion in this assessment.[87] This will go a long way in improving estimates and reduction potentials in future NDCs.

2.4.6 Opportunities for enhanced agriculture mitigation actions in future versions of the NDC

Haiti has identified numerous actions for reducing emissions from enteric fermentation, manure management, direct and indirect emissions of N_2O from agricultural fields, and rice cultivation within its First Updated NDC and Second NC. Identifying co-benefits of adaptations could enhance the contribution.

87 Mr Odre Valbrun, Ministry of Environment, e-mail communication on 28 March 2022.

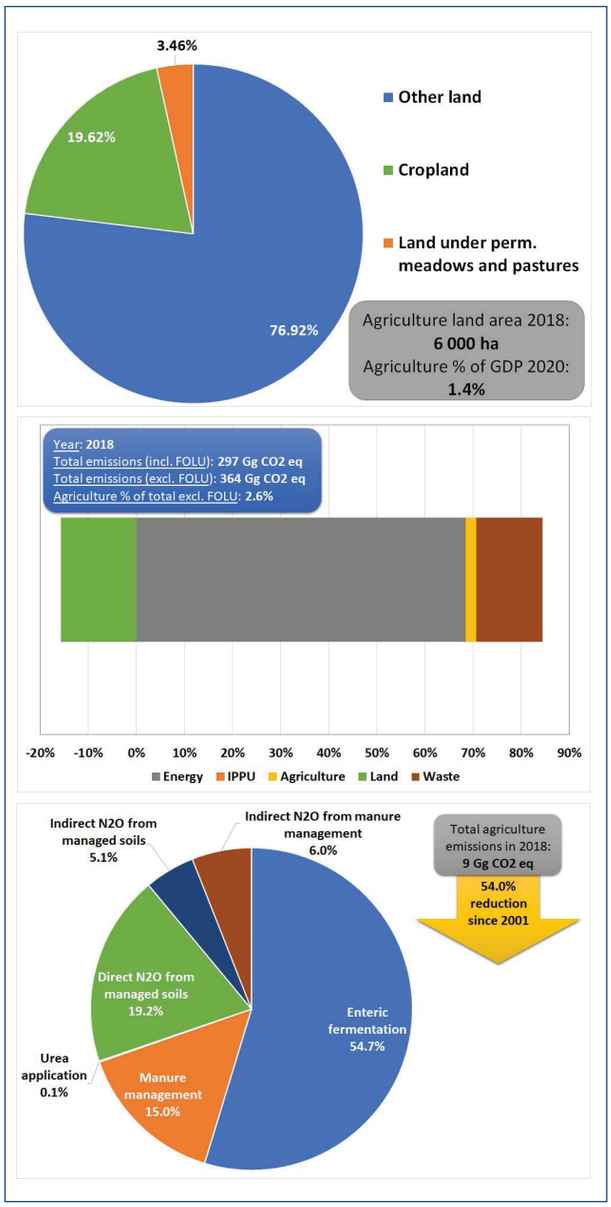
2.5 St. Kitts & Nevis

2.5.1 Overview of agriculture GHG profile

St. Kitts & Nevis' agriculture sector represented 1.4% of GDP in 2020[88] and is comprised of 1,795 farm holdings, most of which are owned by individuals or families who operate on less than one hectare of land.[89] Agriculture land covers 23% of the land area[90] and the government owns 81.5% of the total farm land, with the remainder mostly spread between the individual and family farm holders.[91] Subsistence farming supports rural livelihoods within the country and policies over the last decade have successfully increased production to support the domestic food supply.[92] In 2015 food and live animals imported were equal to USD 50.12 million and exports for the same category equalled USD 1.87 million.[93] Cotton is the primary export crop. Others crops include yams, bananas, hot pepper, vegetables (unspecified), citrus crops, breadfruit, and sugarcane.[94] Livestock production focuses on beef and poultry.[95]

The island nation faces a future of low water availability for agricultural purposes, and a higher likelihood of inconsistent rainfall due to climate change is expected to make rain-fed agriculture more challenging.[96]

Agriculture emissions in 2018 amounted to 9.5 Gg CO_2e, which represents 2.6% of total emissions (excluding FOLU).[97] Enteric fermentation contributes 54.7% of all emissions from agriculture, followed by emissions from agriculture soils and manure management with 24.2% and 20.9%, respectively.[98] There is also a small emission of 8.1 Gg CO_2e due to the conversion of land to cropland. The overall FOLU sector was a sink of 67 Gg CO_2e in 2017.



88 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

89 St. Kitts & Nevis, 2016. St. Kitts Strategy & Action Plan for Agriculture (2017-2021). Government of Saint Kitts & Nevis. Basseterre, St Kitts & Nevis

90 FAOSTAT data, accessed on 26/03/2022

91 Ibid. St. Kitts & Nevis, 2016.

92 Droiterre Inc. and Associates, Legal & Environmental Consultants. The Second National Communications Report of St Christopher and Nevis under the United Nations Framework Convention on Climate Change (UNFCCC) 2015. UNFCCC Submission. Available: https://unfccc.int/sites/default/files/resource/Knanc2.pdf.

93 St. Kitts & Nevis, 2016.

94 Ibid. Droiterre Inc and Associates, 2015.

95 Ibid. Droiterre Inc and Associates, 2015.

96 Ibid. Droiterre Inc and Associates, 2015.

97 Ministry of Environment and Cooperatives, 2022, St. Kitts and Nevis National Inventory Report (Draft of 8 February 2022).

98 Ibid. Ministry of Environment and Cooperatives, 2022.

GHG emissions from agriculture show some oscillations for individual years, but there has been a decline of 54% since 2001.[99] The 2018 decline is reflected in beef, mutton, goat, and pork over this period (table 7), while only eggs show an increasing trend. While the overall emissions of the agricultural sector of St. Kitts & Nevis are small, the domestic production of cows and pigs are the most significant sources of emissions and could be targeted for reduction within the sector. Chickens and pigs are also the largest contributors to manure management-related emissions.

Table 7. Production volume (metric tonnes) of livestock commodities, 2005–2015

Commodity	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Beef	85.6	60.2	90.4	108	104.5	97.9	77.58	61.45	50.9	56.4
Mutton	8.9	9.7	8.6	11	10.3	11.9	12.29	5.6	7.4	7.2
Goat	11.3	12.1	14.6	12.6	11.7	9.7	7.81	3.3	4.7	5.5
Pork	68.8	73.9	74.6	71.8	50.8	59.7	60.4	45.6	46.7	65.48
Chicken	-	-	-	-	-	1.8	1.74	1.36	0.85	1.56
Eggs ('000)	3222	3269	3321	3354	3892	4013	4429	-	-	-

Source: St. Kitts & Nevis, 2016. St. Kitts Strategy & Action Plan for Agriculture (2017–2021). Government of Saint Kitts & Nevis. Basseterre, St. Kitts & Nevis.

2.5.2 NDC targets

The St. Kitts and Nevis NDC targets adaptation objectives for the agriculture sector (table 8) but does not specify any agriculture related mitigation targets. This is due to a lack of data. Much of the FOLU sector emissions were calculated based on international data sets and default values so there was high uncertainty, making it difficult to set targets for this sector.

Table 8: Economy-wide and agriculture related mitigation and adaptation targets in Saint Kitts and Nevis First Updated NDC (2021).

Economy-wide target	Agriculture related mitigation actions	Agriculture related adaptation goals
Reducing economy-wide CO_2 emissions by 61% (124 Gg CO_2e) by 2030, compared to the base year 2010 (conditional).	No agriculture mitigation targets.	Expand SMART aquaponics and aquaculture systems. Develop alternative livelihoods and training and diversify away from at-risk crops. Introduce drought resistance technologies and species in animal husbandry.

2.5.3 Agriculture related actions

No mitigation actions for agriculture were included in the NDC as there are no mitigation targets. The adaptation efforts in the NDC relate to expanding aquaculture systems, diversifying away from at-risk crops and introducing drought resistant technologies and species.[100] The identified adaptation targets and pilot projects within the updated NDC (see next section) can potentially connect to mitigation opportunities while fulfilling their primary goals to build resilience. For instance, drought-tolerant crops can reduce the need for irrigation (which typically results in GHG emissions from pumping water to fields), and agroforestry or intercropping can be utilised to provide some shade to reduce the heat for at-risk crops while also sequestering additional carbon in the soil and biomass. The emission reductions for these two actions would be reflected in the energy and FOLU sector, respectively. If animal species are being evaluated for drought tolerance, it would be possible to include the level of methane generation as an additional criterion for prioritization.

99 Ministry of Environment and Cooperatives, 2022, St. Kitts and Nevis National Inventory Report (Draft of 8 February 2022).

100 St. Kitts and Nevis, 2021. Updated Nationally Determined Contribution. UNFCCC. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saint%20Kitts%20and%20Nevis%20First/St.%20Kitts%20and%20Nevis%20Revised%20NDC_Updated.pdf

2.5.4 *Implementation schedule*

No implementation schedule has been identified. Three pilot projects have been implemented towards the adaptation goals, focusing on the application of organic mulch, forage banking to feed livestock during drought, and the use of shade houses.[101] No implementation schedules are provided.

2.5.5 *Barriers to implementing agricultural mitigation objectives and enhancing actions*

The NDC identifies significant barriers to including actions in the AFOLU sector and thus achieving emissions reduction synergies, including:[102]

- A lack of data within the AFOLU sector makes it challenging to set goals.
- A lack of funding to implement the identified adaptation targets is apparent, given that less than 50% of the identified actions within the National Climate Change Adaptation Strategy have been implemented or integrated into annual operational plans.
- Technical capacity to implement adaptation actions is also inadequate.

Many of these barriers also apply for setting and reaching any mitigation objectives. Additional regional barriers are identified in section 3.3.

2.5.6 *Opportunities for enhanced agriculture mitigation actions in future versions of the NDC*

The most likely opportunities for mitigation actions in St. Kitts and Nevis relate to enteric fermentation and livestock manure management to address emissions from cow and pig farming, though as these emission sources are not large it may represent a challenge to find measures where the emission reductions outweigh the costs.

Still, agricultural practices can be improved, and St. Kitts & Nevis could build expertise to effect emission reductions within its national boundaries or in collaboration with a nearby country. Section 3.4 provides further details on actions that may be considered to reduce emissions from St. Kitts & Nevis' agriculture sector.

101 Ibid. St. Kitts and Nevis, 2021.

102 Ibid. St. Kitts and Nevis, 2021.

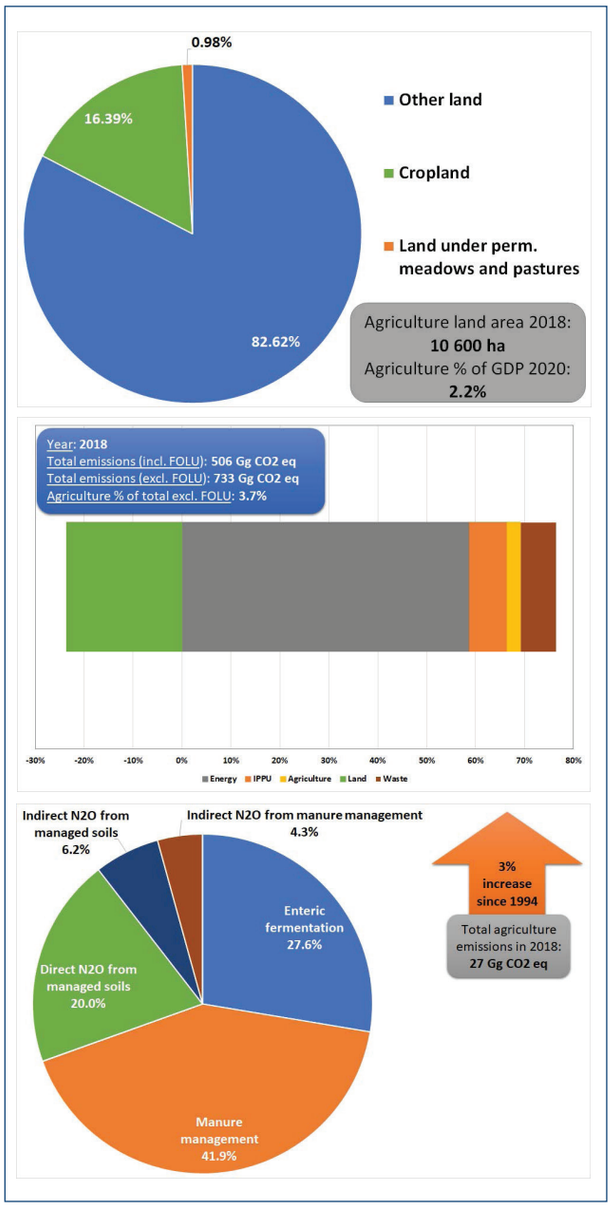
2.6 Saint Lucia

2.6.1 *Overview of agriculture GHG profile*

The agriculture sector's contribution to Saint Lucia's economy has been declining since 2000,[103] contributing 2.7% to the GDP in 2010 and 2.2% in 2020.[104] Factors such as the abandonment of farmlands, loss of prime agricultural lands to physical development, and extreme weather events contributed to this reduction.[105] Agricultural land constitutes 17.4% of the land area of Saint Lucia.[106] The agriculture sector remains sensitive to climate change and the impacts of increased temperatures, precipitation variability, drought, land degradation, and storm events.[107] The sector is expected to remain small but important due to its contributions to employment (9.9% in 2019) and food security.[108]

Saint Lucia produced an estimated 506 Gg CO_2e (including FOLU) in 2018.[109] The agriculture sector, whose emissions have only increased by 3% since 1994, contributed 27 Gg CO_2e, which is 3.7% of the total emissions (excluding FOLU). Enteric fermentation accounted for 27.6% of the agriculture emissions, while manure management contributed 46.2%.[110] Direct and indirect N_2O from soils contributed 26.2%. Land conversions to croplands contribute to a sink of 2 Gg CO_2e emissions and this makes up 1% of the total AFOLU emissions.

The FOLU sector was estimated to be a sink of 227 Gg CO_2e in 2018 and showed an increase in sequestration over time. There was a reduction in banana production in recent years and this land was converted to forest land which resulted in increased carbon sinks.[111]



103 Government of Saint Lucia, 2017. Third National Communication on Climate Change for Saint Lucia. UNFCCC Submissions. Available: https://www4.unfccc.int/sites/SubmissionsStaging/NationalReports/Documents/104538_Saint%20Lucia-NC3-1-THIRD%20NATIONAL%20COMMUNICATION%20_%20SAINT%20LUCIA%202017.pdf.

104 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

105 Ibid., Government of Saint Lucia, 2017.

106 FAOSTAT data, accessed on 26/03/2022

107 Government of Saint Lucia, 2021, Saint Lucia's First Biennial Update Report. UNFCCC Submissions. Available: https://unfccc.int/sites/default/files/resource/Saint%20Lucia%20BUR.pdf

108 Ibid., Government of Saint Lucia, 2021.

109 Ibid., Government of Saint Lucia, 2021; Department of Sustainable Development, 2020. Saint Lucia National Inventory Report. Available: https://unfccc.int/sites/default/files/resource/Saint%20Lucia%202020%20GhG%20Inventory%20revised%20Dec%202021.pdf.

110 Ibid., Government of Saint Lucia, 2021.

111 Ibid. Department of Sustainable Development, 2020.

In the FOLU sector, which includes a cropland component, only biomass and dead organic matter were included and the changes in the soil organic carbon pool were not estimated due to a lack of data.

2.6.2 NDC targets

The Updated NDC identifies an economy-wide emission reduction of 7% compared to 2010 emission levels by 2030, focusing specifically on the electricity generation and transportation.[112] No agricultural mitigation actions were identified, while adaptation in agriculture was mentioned (table 9). Saint Lucia is exploring a REDD+ programme, but has not yet included forest-related mitigation activities into its NDC.

Table 9: Economy-wide and agriculture related mitigation and adaptation targets in Saint Lucia's First Updated NDC (2021).

Economy-wide target	Agriculture related mitigation targets	Agriculture related adaptation goals
Reduction of 7% (37 Gg CO2e) Greenhouse Gas (GHG) emissions in the energy sector relative to 2010, by 2030.	No agriculture mitigation targets.	Saint Lucia has committed to prioritising cross-sectoral and sectoral adaptation measures for eight key sectors/ thematic areas, including agriculture. Developing and implementing better practices in agricultural production.

2.6.3 Agriculture related actions

Mitigation co-benefits to adaptation actions are recognised in the NDC,[113] and some of these reductions will be reflected in other sector emissions besides agriculture:

- Carbon sequestration by developing and implementing better practices in agricultural production (FOLU sector).
- Reduced emissions from implementing fuel efficient technologies for aquaculture and fishing operations (energy sector).
- Pig farms' wastewater and manure management: Piloting solutions to reduce water pollution under a changing climate (waste sector but will also have implications for agriculture if manure management is changed).
- Increased resilience for adaptation to climate change vulnerabilities in agriculture.
- Reduced emissions from implementing resilient ecosystem activities to better manage the available ecosystem services and resources.

The Third National Communication and the first BUR identify further agriculture sector mitigation actions targeted for implementation including:[114]

- Capacity building with farmers,
- Expansion of extension services targeting agroforestry practices,
- Use of anaerobic digesters, and
- Conversion of 2,500 ha of agricultural land to agroforestry.

112 Government of Saint Lucia, 2021. Saint Lucia's Updated Nationally Determined Contribution communicated to the United Nations Framework Convention on Climate Change (UNFCCC). UNFCCC. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saint%20Lucia%20First/Saint%20Lucia%20First%20NDC%20(Updated%20submission).pdf.

113 Ibid., Government of Saint Lucia, 2021.

114 Government of Saint Lucia, 2017. Third National Communication on Climate Change for Saint Lucia. Ministry of Education, Innovation, Gender Relations & Sustainable Development; Department of Sustainable Development. UNFCCC. Available: THIRD NATIONAL COMMUNICATION _ SAINT LUCIA 2017.pdf (unfccc.int); Department of Sustainable Development, 2020. Saint Lucia National Inventory Report. UNFCCC Biennial Update Report (BUR1). Available: https://unfccc.int/sites/default/files/resource/Saint%20Lucia%202020%20GhG%20Inventory%20revised%20Dec%202021.pdf.

2.6.4 *Implementation schedule*

The mitigation actions mentioned within the NDC, the Third NC, and the first BUR are indicated to be implemented by 2030.[115] Saint Lucia has already started to implement these actions.[116]

2.6.5 *Barriers to implementing agricultural mitigation objectives and enhancing actions*

Data gaps were identified within all sectors other than energy, including the agriculture sector.[117] These include:

- High upfront labour demands disincentivise implementation of novel practices like agroforestry.[118]
- Costs and benefits for the agriculture sector GHG targets and adaptation policies have not yet been calculated.[119]
- Current limited capacity for MRV. The country is seeking to rectify this by preparing an MRV Portal to incorporate information from all sectors supported by a GCF Readiness Proposal for 2022.[120]

While adaptation was indicated to be key to reducing risks and impacts of climate change, lack of ambition in mitigating climate change at the global level may limit efforts in Saint Lucia, including inability of coastal ecosystems to adapt to increased rates and extent of sea level rise; insufficient financial resources to implement required adaptation strategies; and lack of effective or affordable technologies to provide coastal protection from impending sea level rise and extreme events.

2.6.6 *Opportunities for enhanced agriculture mitigation actions in future versions of the NDC*

Overall, the emissions from Saint Lucia's agriculture sector are small and are divided largely amongst three sources, namely enteric fermentation, livestock manure management, and managed soils (direct and indirect N_2O). It may, therefore, be challenging to find actions where emission reductions outweigh the mitigation implementation costs. Saint Lucia has initiated several efforts that provide a solid path forward for mitigation actions to be included within the future versions of its NDC, including:

- Promotion of agroforestry to sequester CO_2 (emission reductions to be reflected in FOLU sector),
- Use of biodigesters to reduce emissions from livestock manure management, and
- Use of solar energy to reduce emissions relating to irrigation (emission reductions to be reflected in energy sector).

Each of these actions critically involves other co-benefits for farmers choosing to shift practices, which can facilitate the implementation process. The focus could be put on emphasizing the emission reduction co-benefits to practices which enhance resilience and productivity considering the small emissions in Saint Lucia. Implementing improved farming practices, or CSA activities, as part of the adaptation actions can also lead to enhanced soil sequestration in croplands. This is a mitigation action that would enhance the sink capacity of the FOLU sector, thereby contributing to reduced overall emissions. These are the types of activities which could be taken advantage of.

115 Ibid., Government of Saint Lucia, 2021; Ibid. Government of Saint Lucia, 2017; Ibid., Department of Sustainable Development, 2020.

116 Ibid., Government of Saint Lucia, 2021.

117 Ibid., Government of Saint Lucia, 2021.

118 Ibid., Government of Saint Lucia, 2017.

119 Interview conducted with Kurt Prospere by IICA consultant team, 2022.

120 Interview conducted with Kurt Prospere by IICA consultant team, 2022.

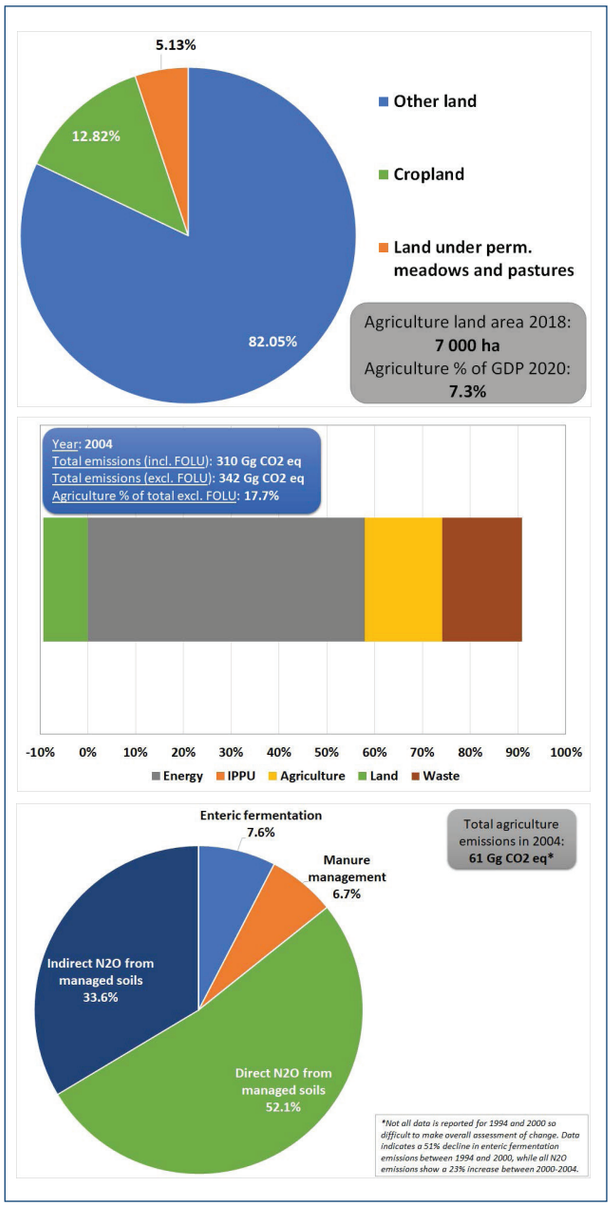
2.7 Saint Vincent and the Grenadines

2.7.1 Overview of agriculture GHG profile

Saint Vincent and the Grenadines' agriculture sector largely consists of subsistence farming, mostly on mainland St. Vincent with some farming practices on the larger Grenadine islets. The agriculture land area (croplands and pastures) covers 17.9% of the total land area.[121] The major crops produced are sugar, cotton, arrowroot, and bananas.[122] Animals such as sheep, goats, cows, and pigs are raised by farmers in small family holdings.[123] Most livestock products are sold in the domestic market and mostly traditional non-mechanised agricultural methods are used within the sector.[124]

The agriculture sector made an average GDP contribution of ~6.1% between 2013–2017,[125] and contributed 6.1% in 2010 and 7.3% in 2020.[126] Between 2013 and 2017 approximately 11.4 % of the labour force was engaged in agriculture.[127] Saint Vincent & the Grenadines was a net exporter but is now a net importer of food crops.[128]

Saint Vincent and the Grenadines' agriculture sector is vulnerable to soil erosion, fragmentation of farmlands, loss of farmlands due to development, and outbreaks of plant diseases.[129] Irrigation infrastructure, roads, and farms are repeatedly damaged or destroyed by floodwaters, siltation, and high winds caused by storms.[130] Other climate risks impacting the region are also likely to be relevant to the agriculture sector of Saint Vincent and the Grenadines, such as saltwater incursions due to sea-level rise, increased storm severity, drought, flooding, and increased temperatures that can damage crops.



121 FAOSTAT data, accessed on 26/03/2022

122 Ministry of Health, Wellness and the Environment, 2015, Second National Communication on Climate Change, Government of Saint Vincent & the Grenadines. Available: https://unfccc.int/resource/docs/natc/vctnc2.pdf.

123 Ibid, Ministry of Health, Wellness and the Environment, 2015.

124 Ibid, Ministry of Health, Wellness and the Environment, 2015.

125 Caribbean Climate Smart Agriculture Forum, Saint Vincent & The Grenadines: Climate Change and Agriculture: Policies, strategies and actions, 2017.

126 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

127 Ibid., Caribbean Climate Smart Agriculture Forum, 2017.

128 Ibid., Ministry of Health, Wellness and the Environment, 2015.

129 Ibid, Ministry of Health, Wellness and the Environment, 2015.

130 Ibid, Ministry of Health, Wellness and the Environment, 2015.

In 2004, agriculture accounted for 17.7% (61 Gg CO_2e) of Saint Vincent and The Grenadine's total GHG emissions (excluding FOLU).[131] The major sources of emissions for the sector are N_2O from managed soils (application of nitrogen fertilisers and manure to agricultural fields), enteric fermentation and manure management. Direct N_2O from soils contributes 52.1% (32 Gg CO_2e) to total agriculture emissions, indirect N_2O from soils contributes 33.6% (21 Gg CO_2e) and enteric fermentation 7.6% (5 Gg CO_2e). The FOLU sector was a net sink of 37 Gg CO_2e in 2004, but only biomass data was included in the estimates. In addition, the inventory utilised FAO data, which is focused on forest land, with forest plantations covering less than 0.8% of the land area. Carbon changes in croplands were not included.

2.7.2 NDC targets

The First NDC for Saint Vincent and the Grenadines identifies a goal to reduce overall GHG emissions by 22% by 2025 compared to 2010 emission levels.[132] The mitigation targets are related to the energy, transport and forestry sectors. Regarding agriculture, the NDC identifies adaptation projects in agriculture and indicates the need to support small-scale farmers with production technologies and agri-business management and to improve agricultural practices and pest and disease management. The NDC also identifies policy initiatives that are needed to address climate change and food security (table 10).[133]

Table 10: Economy-wide and agriculture related mitigation and adaptation targets in Saint Vincent and the Grenadines First NDC (2015).

Economy-wide target	Agriculture related mitigation targets	Agriculture related adaptation goals
Reduction in greenhouse gas (GHG) emissions of 22% compared to its business as usual (BAU) scenario by 2025 (unconditional).	No agriculture mitigation targets.	Improve agricultural practices, pest and disease management. Improve agriculture policies/strategies.

Increasing sinks through reforestation, afforestation, reduced deforestation and reduced degradation are mentioned as a mitigation activity for the FOLU sector. Croplands are not indicated to be a major driver of forest change and forest plantations are minimal, so agriculture and forestry are not expected to have a significant contribution to these targets.

2.7.3 Agriculture related actions

The First NDC for Saint Vincent and the Grenadines does not specify any particular mitigation actions for the sector, however several adaptation actions are included in other national policy documents. The Second NC[134] identifies a host of adaptation objectives with the potential to reduce emissions including:

- Implement agroforestry practices,
- Implement soil conservation measures,
- Use retaining walls to support hillside agriculture and reduce erosion,
- Improve the genetics of crops for drought and temperature tolerance,
- Promote alternative crops that are expected to favour emerging climate conditions,
- Diversify crop composition on farms by growing trees and vegetables or roots, and
- Implement adaptations to support livestock (provision of shade, enhanced nutrition and feeding, and breeding programmes for heat tolerance).[135]

131 Ibid, Ministry of Health, Wellness and the Environment, 2015.

132 Saint Vincent and the Grenadines, 2015. Saint Vincent and the Grenadines Intended Nationally Determined Contribution. UNFCCC. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Saint%20Vincent%20and%20the%20Grenadines%20First/Saint%20Vincent%20and%20the%20Grenadines_NDC.pdf.

133 Ibid. St. Vincent & the Grenadines, 2015.

134 Ibid. Ministry of Health, Wellness and the Environment, 2015.

135 Ibid. Ministry of Health, Wellness and the Environment, 2015.

Although adaptation is the focus on these actions, they have the potential to sequester carbon, increase biomass accumulation in crops, increase storage of carbon through tree crops, and reduce enteric fermentation through enhanced livestock nutrition and programmes to improve livestock breeding.

2.7.4 Implementation schedule

No implementation schedule is identified for specific mitigation actions. The only timeline identified is the economy-wide goal to achieve a 22% reduction of 2010 emissions by 2025.[136]

2.7.5 Barriers to implementing agricultural mitigation objectives and enhancing actions

Several factors that may inhibit mitigation action in the sector include:

- A decline in the agriculture sector due to unfavourable trade regimes that have restricted exports, particularly for the banana industry.[137]
- The need for investment in resilience due to factors such as heavy reliance on the rainy season with limited implementation of irrigation on farms[138] and the high vulnerability of livestock production to temperature increases brought on by climate change.[139]
- Economic impacts from the 2021 volcanic eruption which forced the evacuation of 16,000–20,000 residents, covered the land in ash, and damaged property.[140]

In addition, the lack of data and capacity to quantify co-benefits of adaptation actions are also barriers to further inclusion of actions in agricultural adaptation. Further barriers that were identified as common across the nine countries are discussed in section 3.3.

2.7.6 Opportunities for enhanced agriculture mitigation actions in future versions of the NDC

As a small island nation with limited opportunities for large-scale emission reductions actions within its agriculture sector, Saint Vincent and the Grenadines can focus on adaptation measures with mitigation synergies identified within the Second NC, such as:

- Agroforestry, soil conservation and crop diversification which can enhance carbon sinks.
- Building more resilient livestock populations through improved feeding and breeding programmes which could lead to reduced enteric fermentation and manure management emissions.

Section 3.4 provides details of the technologies and practices that can be employed to reduce emissions from managed soils and livestock within Saint Vincent and the Grenadines' agriculture sector.

136 Ibid. St. Vincent & the Grenadines, 2015.

137 Ibid. St. Vincent & the Grenadines, 2015.

138 Ibid. Ministry of Health, Wellness and the Environment, 2015.

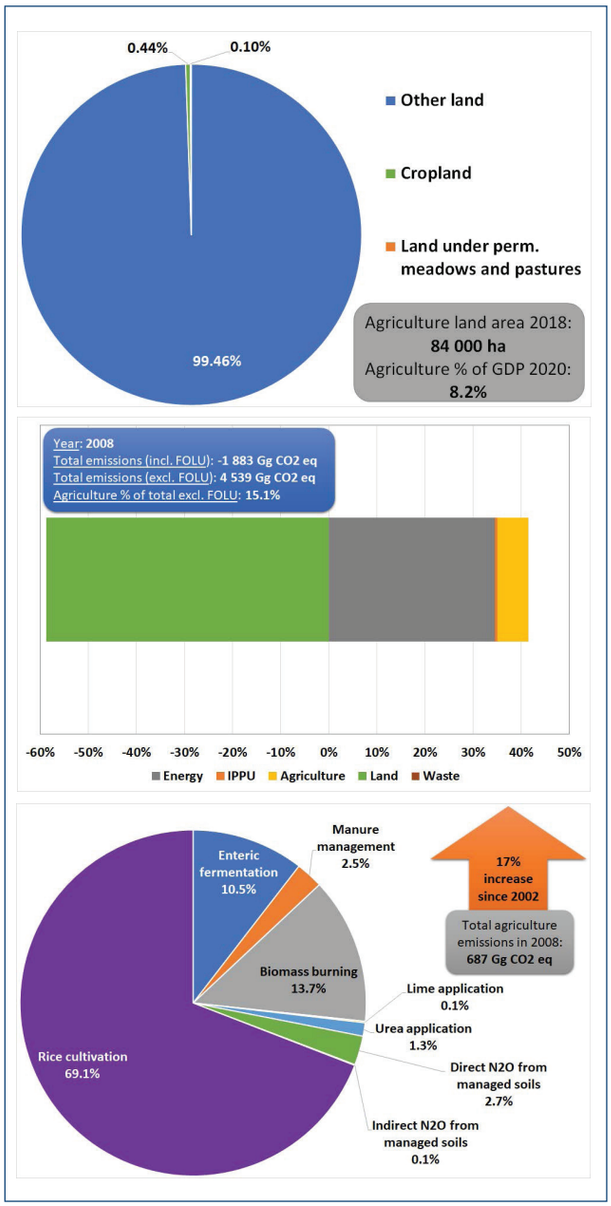
139 Ibid. Ministry of Health, Wellness and the Environment, 2015.

140 Smithsonian Institute, 2022. Soufriere St. Vincent. Smithsonian Institution, Global Volcanism Program. Available: https://volcano.si.edu/volcano.cfm?vn=360150&bgvn=1&snum=w_indies

2.8 Suriname

2.8.1 *Overview of agriculture GHG profile*

Suriname's agriculture sector contributed an estimated 8.2% to GDP (2020)[141] and employs 17% of the active population.[142] The majority of farms are small-scale, and employment is primarily part-time.[143] Agriculture covers only 0.5% of the land area of Suriname[144] and is concentrated within the northwest portion of the country, producing rice and bananas, but fertile soils extend throughout the coastal zone and in this area, vegetables and other fruit are also produced.[145] Indigenous and Maroon tribes that inhabit the Hinterland and the Interior practice subsistence agriculture, though limited commercial agriculture also occurs in these regions.[146]



Agriculture within Suriname is vulnerable to climate change impacts as farming is largely located within the coastal plains area along the northern coast (0–4 meters above sea level).[147] The threat of coastal erosion, sea-level rise, flooding, heavy rainfall, high winds, and high temperatures during the dry seasons present challenges to farmers.[148] Rice cultivation will be threatened by saltwater incursion and vegetable crops will be at risk from flooding and siltation.[149]

Suriname was indicated to be a carbon negative country in 2008 as its forest sinks were greater than its emissions. The latest publicly available inventory data is provided in the Second NC. This data shows that agriculture emissions in Suriname were estimated to be 687 Gg CO_2e in 2008, which is 15.1% of the total emissions (excluding FOU) in Suriname.[150] These emissions result primarily from rice cultivation (69.1% of agriculture emissions), biomass

141 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

142 Food and Agriculture Organization of the United Nations, 2020. GCF Readiness & Preparatory Support Proposal. Green Climate Fund. Available: https://www.greenclimate.fund/document/improving-capacity-ministry-agriculture-suriname-build-resilience-climate-change

143 Ibid, Food and Agriculture Organization of the United Nations, 2020.

144 FAOSTAT data, accessed on 26/03/2022

145 Office of the President of the Republic of Suriname, 2016. Second National Communication to the United Nations Framework Convention on Climate Change. Paramaribo, Suriname. Available: https://unfccc.int/resource/docs/natc/surnc2.pdf

146 Ibid. Office of the President of the Republic of Suriname, 2016.

147 Ibid, Food and Agriculture Organization of the United Nations, 2020.

148 Cabinet of the President of the Republic of Suriname, 2020. Nationally Determined Contribution 2020. Paramaribo, Suriname. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Suriname%20Second/Suriname%20Second%20NDC.pdf

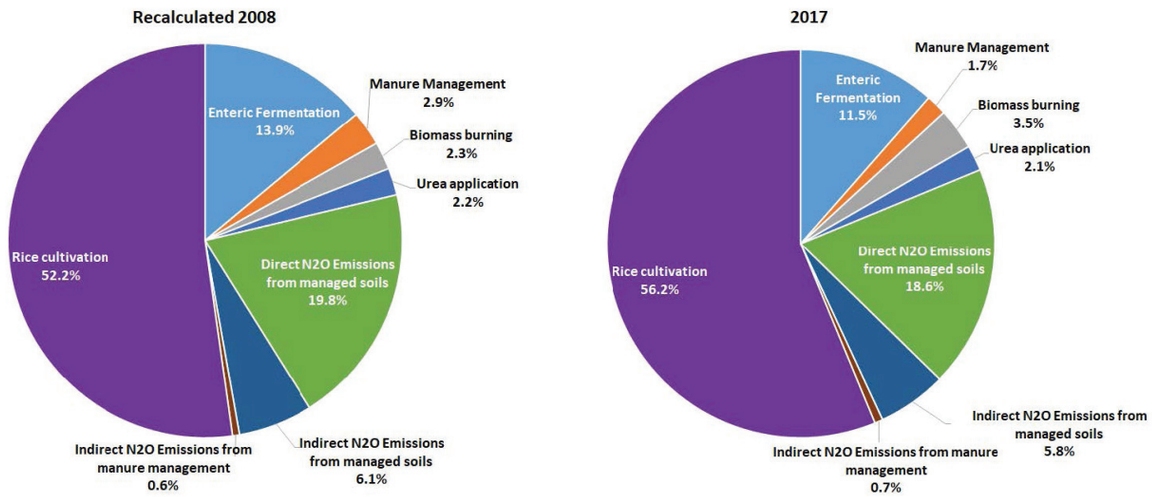
149 Ibid. Food and Agriculture Organization of the United Nations, 2020.

150 Ibid. Office of the President of the Republic of Suriname, 2016. Note: this calculation applies IPCC SAR 1996 GWP values.

burning (13.7%) and enteric fermentation (10.5%). Croplands are shown to contribute 7,241 Gg CO_2e to the carbon sink in the FOLU sector and is indicated to contribute 4% to forest degradation.[151] The changes in carbon in the FOLU sector are related to biomass and dead organic matter and do not include soil organic carbon changes.

Suriname has recently updated their inventory as part of the Third NC and the draft updated time-series for 2000 to 2017 for the agriculture sector was obtained. The recalculated 2008 data, based on country-specific livestock population and cropland data, shows rice cultivation was still the dominant emitter at 52.2% of agriculture sector emissions, but direct N_2O emissions from soils were the second highest contributor at 19.8%, followed by enteric fermentation (13.9%).[152] The total recalculated agriculture emissions for 2008 was 480 Gg CO_2e, which is much lower than the 2008 data in the Second NC that was based on FAOSTAT data. The 2017 data shows a similar pattern as the recalculated 2008 data but with a slightly increased percentage from rice cultivation and a decreased percentage from direct N_2O and enteric fermentation (figure 1). Total agriculture emissions in 2017 were estimated at 428.68 Gg CO_2e. Both rice cultivation and cattle farming are expected to grow rapidly within Suriname and are expected to become larger sources of emissions based upon government objectives targeting sectoral expansion.[153]

Figure 1: Percentage contribution from the agriculture categories from the updated draft inventory for the Third NC.



2.8.2 NDC targets

Suriname's Second NDC does not identify mitigation targets for agriculture, but rather identifies adaptation goals[154] that will contribute to:

- Enlarging the contribution of the agriculture sector to the national economy,
- Realizing and guaranteeing food security,
- Developing a sustainable agriculture sector and creating spatial conditions for it, and
- Developing the sector to become the food producer and supplier for the Caribbean.

151 Ibid. Cabinet of the President of the Republic of Suriname, 2020.

152 Ministry of Agriculture, Livestock and Fisheries, 2022, Draft agriculture GHG emissions from the Third NC, provided via email on 03/2022 by Mr Iwan Samoender of Ministry of Agriculture, Livestock and Fisheries.

153 Ibid. Office of the President of the Republic of Suriname, 2016.

154 Ibid. Cabinet of the President of the Republic of Suriname, 2020.

Specific adaptation goals are outlined in table 11. The NDC also identifies a preference for intensive and concentrated farming activities on existing or former agricultural lands to reduce land-use change conversions from forestland to cropland.[155] This would contribute to the FOLU targets and REDD+ strategy to reduce forest degradation.

Table 11: Economy-wide and agriculture related mitigation and adaptation targets in Suriname's Second NDC (2020).

Economy-wide target	Agriculture related mitigation targets	Agriculture related adaptation goals
Sectoral targets as opposed to economy-wide target: NDC describes sectoral policies and measures covering an estimated 70% of emissions from the following sectors: Forests, energy, agriculture, and transport.	No agriculture mitigation targets.	Unconditional contributions: Rehabilitation and enhancement of infrastructure such as dikes and river defences (precondition). Improvements in water resources management. Promotion of sustainable land management. Applying innovative technologies in the use of land. Introduction of a national land use planning system, to make the embedding of climate change in (agricultural) development plans possible. Strengthening capacity to implement a national research, development and innovation programme, and strengthen agricultural research.

2.8.3 Agriculture related actions

Although no mitigation actions for the sector are specified within the NDC, several adaptation options were identified:[156]

- The introduction of farming systems and techniques for rice production to reduce the occurrence of waterlogged fields, which can reduce CH4 emissions such as through the implementation of single drainage of rice fields during the planting cycle,
- Utilization of abandoned agricultural land to produce energy crops to provide fuel and reduce deforestation pressure,
- The introduction of national land-use planning,
- The trial of non-shifting and permanent agricultural systems to replace traditional farming practices, and
- Growth of programmes to support research within the national agriculture sector, and specifically create a research, development, and innovation programme.

Additionally, some adaptation actions were provided in the Second NC:[157]

- Develop research programmes and training to improve animal husbandry practices and to introduce new climate-tolerant crop species,
- Establish infrastructure to increase freshwater availability for irrigated rice cultivation,
- Plant hedgerows of trees to protect banana plantations from strong winds, and
- Direct livestock farming to abandoned farmland to help rehabilitate the land.

Each of these adaptation objectives can have emission reductions benefits through reduced enteric fermentation and soil carbon accumulation, potentially reduced emissions from pumping water for irrigation, and through carbon sequestration in hedgerow trees, while accomplishing the goal of building resilience to stabilise the food system within the agriculture sector of Suriname.

155 Ibid. Cabinet of the President of the Republic of Suriname, 2020.

156 Ibid. Cabinet of the President of the Republic of Suriname, 2020.

157 Ibid. Office of the President of the Republic of Suriname, 2016.

A GCF Readiness & Preparatory Support Proposal identifies that improving the capacity of the Ministry of Agriculture to build resilience must be achieved to address climate change risks and vulnerabilities.[158] Part of this project is to set up a Climate Change Unit to manage the climate related activities.

2.8.4 *Implementation schedule*

The introduction of national land-use planning by the MAAHF and the project targeting growth in agricultural research are two-year projects from 2020 to 2022.[159] The trial of non-shifting and permanent agricultural systems to replace traditional farming practices is a four-year project from 2020 to 2024.[160]

No other actions have implementation schedules identified within the reviewed documents.

2.8.5 *Barriers to implementing agricultural mitigation objectives and enhancing actions*

A GCF Readiness & Preparatory Support Proposal identifies the following barriers that are hampering the government's ability to increase agricultural resilience and could also be relevant for acting to reduce emissions within the sector:[161]

- Lack of institutional capacity, data, and information systems:
  - There is a lack of institutional capacity, data, and information to allow the Ministry of Agriculture to complete effective and detailed vulnerability assessments for specific adaptation options to be selected for specific crops and to allow for the design of policies to address adaptation needs.
  - Critical to the implementation of the climate change adaptation policies and plans in Suriname is a robust system for the collection, assimilation, and translation of data (agriculture and climate data) into formats that can be used to implement actions.
- Limited technical capacity and awareness:
  - There is limited technical capacity and knowledge of the detailed impacts of climate change on the agriculture and fisheries sectors in the country. What limited knowledge exists is in the institutions responsible for agriculture.
  - Farmers also lack information on the impacts of climate change and the necessary adaptation measures which need to be put in place.
- Lack of financing to address adaptation needs:
  - There is a need for financing and investment to address climate change concerns in the agricultural sector and build resilience.

2.8.6 *Opportunities for enhanced agriculture mitigation actions in future versions of the NDC*

Mitigation actions addressing emissions from rice cultivation, livestock manure management, enteric fermentation, and N inputs to agricultural fields must be carried out. In addition, there is potential to increase soil carbon stocks through CSA activities. See section 3.4 for a detailed explanation of the technologies and practices that can be employed to reduce emissions from these sources within Suriname's agriculture sector.

158 Ibid. Food and Agriculture Organization of the United Nations, 2020.

159 Ibid. Cabinet of the President of the Republic of Suriname, 2020.

160 Ibid. Cabinet of the President of the Republic of Suriname, 2020.

161 Ibid. Food and Agriculture Organization of the United Nations, 2020.

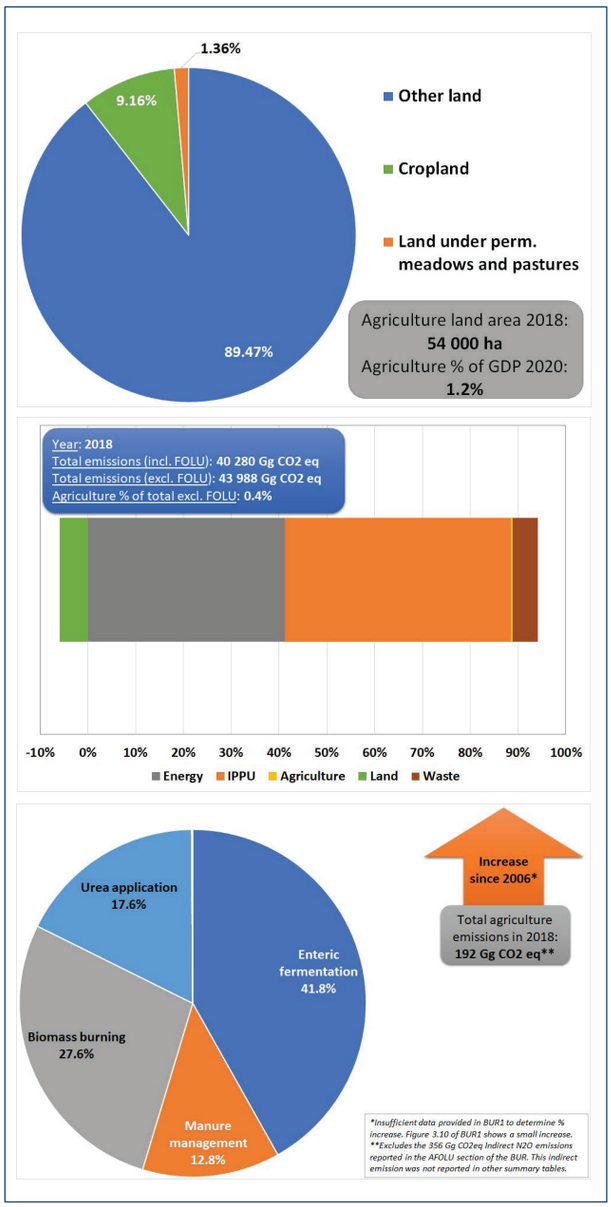
2.9 Trinidad and Tobago

2.9.1 Overview of agriculture GHG profile

Trinidad & Tobago's agriculture sector employs 3.5% of the labour force (2011)[162] and contributed 0.5% to GDP in 2018,[163] which increased to 1.2% in 2020.[164] The agriculture land area is 10.5% of the total land area,[165] and supports the production of products such as vegetables, root crops, fruit, rice, chicken, pork, milk and beef.[166]

Trinidad & Tobago's agriculture sector is threatened by climate change and increasing biophysical impacts, including lower precipitation, higher temperatures, soil aridity, and salinization of soils and groundwater from coastal inundation.[167] The installation of irrigation systems to address these climate risks to farming activities is already occurring at significant expense to farmers, and uptake is limited amongst resource poor subsistence farmers.[168] Agricultural production in the central and southern parts of Trinidad faces high vulnerability to climate change while the northern parts and Tobago are not as severe.[169]

The agriculture sector was estimated to produce 192 Gg CO_2-eq in 2018,[170] which is only 0.4% of the total country GHG emissions (excluding FOLU). The largest source of agricultural emissions is indicated to be enteric fermentation (41.8% of agriculture emissions), biomass burning and urea application. There is, however, a discrepancy in the reported emissions in the First BUR in that under the AFOLU sector description, there is mention of 356 Gg CO_2-eq emissions from indirect N_2O from managed soils. This estimate is not included in the numbers above as it was not mentioned in the summary tables. If the emission is included, then it would be the



162 Government of the Republic of Trinidad and Tobago, 2021. Third National Communication of the Republic of Trinidad and Tobago to The United Nations Framework Convention on Climate Change. Ministry of Planning and Development. Port of Spain, Trinidad and Tobago. Available: https://unfccc.int/documents/416026

163 GCF Readiness Proposal, 2019. Improving the Monitoring system for climate change impacts on the agriculture sector in Trinidad and Tobago. Green Climate Fund. Available: https://www.greenclimate.fund/document/strategic-frameworks-support-trinidad-and-tobago-through-fao

164 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

165 FAOSTAT data, accessed on 26/03/2022

166 Ibid. Government of the Republic of Trinidad and Tobago, 2021.

167 Ibid. Government of the Republic of Trinidad and Tobago, 2021.

168 Ibid. GCF Readiness Proposal, 2019.

169 Ibid. Government of the Republic of Trinidad and Tobago, 2021.

170 Ministry of Planning and Development, 2021. Trinidad and Tobago's First Biennial Update Report. Available at: https://unfccc.int/sites/default/files/resource/FIRST_%20BUR_TRINIDAD_AND_TOBAGO.pdf

largest source of emissions in the agriculture sector. The FOLU sector is estimated to be a sink of 2,708 Gg CO_2e due to carbon storage in forest land biomass.

2.9.2 NDC targets

The Government of Trinidad & Tobago has developed and submitted its First NDC to the UNFCCC. It indicates an economy-wide emission reduction of 30% by 2030 compared to the BAU scenario (Table 12). The NDC does not include the agriculture sector within its identified objectives as the sector emissions are overshadowed by emissions from the energy sector.[171] Mitigation actions are centred around the energy sector.

Table 12: Economy-wide and agriculture related mitigation and adaptation targets in Trinidad and Tobago's First NDC (2018).

Economy-wide target	Agriculture related mitigation target	Agriculture related adaptation goals
30% reduction in GHG emissions by 31 December 2030 in the public transportation sector compared to a business as usual (BAU) scenario (reference year 2013) (unconditional). Additional GHG reduction of 15% below BAU emission levels by December 31, 2030 (conditional).	No agriculture mitigation targets.	No agriculture adaptation goals.

2.9.3 Agriculture-related actions

No mitigation or adaptation actions were identified for agriculture.

2.9.4 Implementation schedule

No actions were identified; therefore, no implementation schedules were provided.

2.9.5 Barriers to implementing agricultural mitigation objectives and enhancing actions

As identified within the Third NC, Trinidad & Tobago has:

- A low level of MRV capacity in the AFOLU sector,
- Limited data availability, particularly in the AFOLU sector. The agriculture sector largely relies upon FAOSTAT data to develop its GHG emission estimates and has identified improved agricultural data as an objective for future GHG inventories,[172]
- Agricultural policies that do not acknowledge climate change or identify climate actions,[173]
- Low awareness of the NDC—its goals and its purpose—amongst farmers, extension officers, and government workers impacts the collection of data, the implementation of mitigation or adaptation actions, fundraising, and many other factors.[174]

These factors present an obstacle to incorporating the agriculture sector within the country's NDC goals. The greatest obstacle is, however, the small contribution that agriculture makes to the overall emissions, which means the country will focus more on the sectors with the most significant emissions.

171 Trinidad and Tobago, 2014. Intended Nationally Determined Contribution (iNDC) under the United Nations Framework Convention on Climate Change. Available: https://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Trinidad%20and%20Tobago%20First/Trinidad%20and%20Tobago%20Final%20INDC.pdfhttps://www4.unfccc.int/sites/ndcstaging/PublishedDocuments/Trinidad%20and%20Tobago%20First/Trinidad%20and%20Tobago%20Final%20INDC.pdf

172 Ibid. Government of the Republic of Trinidad and Tobago, 2021.

173 Ibid. Government of the Republic of Trinidad and Tobago, 2021.

174 Interview notes, Rosemary Lall and Sarah Prince (UNDP). Conducted by the IICA consultant team, 23 February 2022.

Further barriers for including agriculture targets were acknowledged by the Government of Trinidad & Tobago and these include:[175]

- Lack of information on climate impacts on specific commodities,
- Limited knowledge and application of climate-resilient practices,
- Insufficient technical capacity amongst stakeholders to employ data and plan for forthcoming climate changes,
- Outdated technology and low levels of mechanization,
- Lack of infrastructure to control exposure to changing climate conditions (e.g., greenhouses),
- Absence of agricultural insurance,
- Overuse and misuse of chemical fertilisers and pesticides, and
- Absence of official safety standards and facilities for testing residual pesticide/chemical levels.

The cost of infrastructure for irrigation is prohibitive and some farmers have been forced to reduce the amount of land under cultivation, which ultimately reduces domestic food security.[176]

2.9.6 Opportunities for enhanced agriculture mitigation actions in future versions of the NDC

Trinidad & Tobago can reduce emissions within its agriculture sector by targeting crop and livestock production. The most significant emission sources are fertiliser applied to agricultural fields, enteric fermentation, and manure management. Rice cultivation occurs within Trinidad & Tobago; however, emissions are shown to be very small (0.2 Gg CO_2e) compared to the rest of the agriculture sector, so this category receives little attention. Improving the emission data for rice cultivation could assist in providing a more accurate assessment of rice cultivation contribution and assist in assessing the feasibility of emission reduction options for this category.

Section 3.3 provides further details on the technologies and practices that can be employed to reduce emissions from enteric fermentation and manure management.

175 Ibid. GCF Readiness Proposal, 2019; Ibid. Government of the Republic of Trinidad and Tobago, 2021. Ibid. GCF Readiness Proposal, 2019.

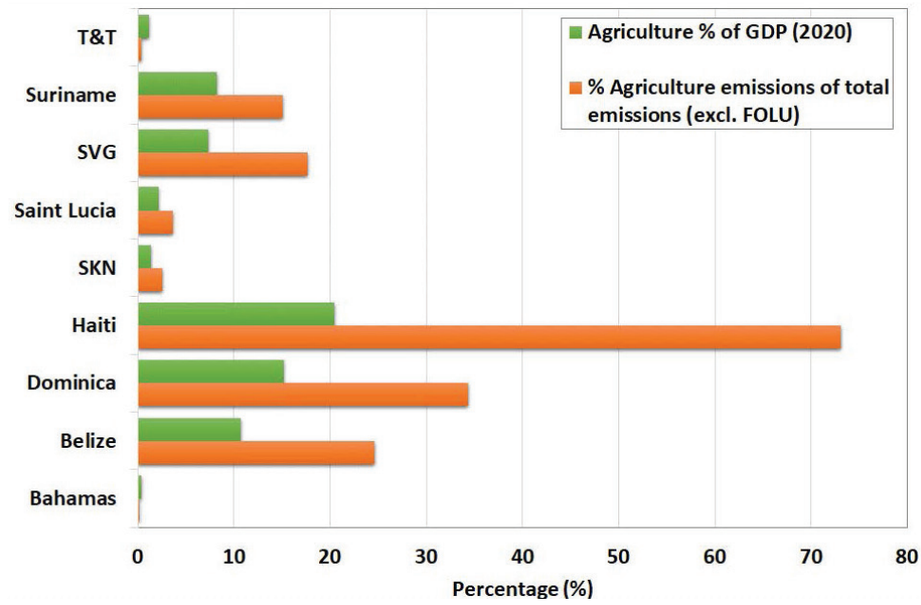
176 Ibid. GCF Readiness Proposal, 2019.

3 Regional Opportunities & Outlook

3.1 Agriculture emissions profile across the region

The nine countries evaluated through this report provide information on factors that can influence mitigation actions within the agriculture sector throughout the Caribbean region. This includes a heavy reliance on food imports across countries, and public policy goals to reduce this through the promotion of domestic food production. The agricultural contribution to the GDP is <10% in six of the nine countries (figure 2).[177] The three remaining countries, namely Haiti, Dominica and Belize, have agricultural contributions to GDP of between 10% and 20%. Although agriculture does not represent a high percentage of GDP for most countries evaluated (average of 7.4% across the countries), it does provide a livelihood in many rural communities across the region. All countries' agricultural practices face future damages and increased risk due to climate change, which has the potential to destabilise livelihoods and reduce the domestic supply of food. Encouraging action along the entire risk continuum —from sustainable development, to mitigation, to enhancing resilience to risk transfer mechanisms to address residual risk—is critical for the sector.

Figure 2: The agriculture contribution to the GDP and the total country GHG emissions (excluding FOLU) across the 9 countries.[178]



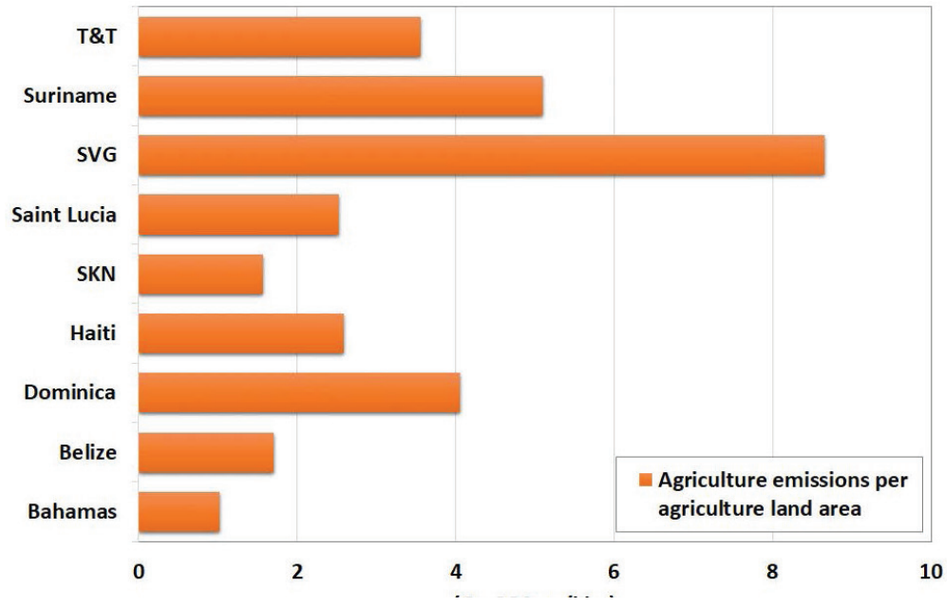
Across the nine countries, agriculture (which does not include FOLU) represents 9.5% of the total economy-wide gross emissions (excluding FOLU). The large total emissions from Trinidad and Tobago (43,988 Gg CO_2e excluding FOLU) skews the outputs. If Trinidad and Tobago is excluded then agriculture accounts for 28.9% of economy-wide emissions (excluding FOLU) across the remaining eight countries, so there is potential for mitigation and enhanced agriculture action in future NDCs.

177 World Bank, World Indicators, http://wdi.worldbank.org/table/4.2, accessed on 26/03/2022

178 Note that the inventory data is from the latest available inventory for each country (Bahamas – 2018, Belize – 2017, Dominica – 2017, Haiti – 2000, Saint Lucia – 2018, SVG – 2004, SKN – 2018, T&T – 2018)

Besides the higher agriculture contribution to GDP, Haiti, Dominica and Belize also have the largest percentage of their total emissions (excluding FOLU) coming from agriculture (figure 2),[179] which shows the coupling between the economy and the emissions. Economic growth needs to decouple from negative environmental consequences to create a pathway for green growth. Suriname and Saint Vincent and the Grenadines have the highest agricultural emissions per agriculture land area[180] (figure 3).

Figure 3: Agriculture emissions per area of agricultural land (Gg CO_2 eq).[181]



Across the nine countries, the existing mitigation opportunities largely result from four primary sources of emissions: direct and indirect N_2O from managed soils, enteric fermentation and manure management. Direct N_2O (which then influences indirect N_2O) from managed soils is the dominant source across the region, followed by enteric fermentation and manure management (figure 4). Belize, Haiti, St. Kitts and Nevis all have enteric fermentation as their dominant category, while it is the second largest category for Dominica and Saint Lucia. N_2O emissions from soils are the dominant emissions in The Bahamas and Saint Vincent and the Grenadines, while it is the second largest for Belize, Haiti, Suriname and Saint Kitts and Nevis. Rice cultivation is the dominant emitter in Suriname.

There is also potential to enhance carbon sinks by improving land management practices that lead to increased soil carbon. These activities are included under adaptation actions, but if the impacts of the actions on soil carbon storage were quantified then there may be further opportunity to include these reductions in the NDC targets.

Similarities in emission profiles across the countries offer the potential for regional collaboration to reduce emissions. Countries with similar agriculture emission profiles, such as Belize, Haiti, and St. Kitts and Nevis (figure 5) could collaborate to address emissions. Regional collaboration could include capacity-building education to address the barriers that exist across many countries including:

- Limited technical capacity within the agencies developing inventories, NCs, BURs and NDCs,

179 Note that all the emission estimates referred to in this section are from the latest publicly available inventory for each country and the years of these inventories differ (Bahamas – 2018, Belize – 2017, Dominica – 2017, Haiti – 2000, Saint Lucia – 2018, SVG – 2004, SKN – 2018, Suriname – 2008, T&T – 2018).

180 FAOSTAT data, accessed on 26/03/2022

181 For this analysis the updated 2017 data for Suriname was used.

- Limited data collection capabilities and over-reliance on FAOSTAT data,
- Limited technical capacity and data to include soil carbon in inventories, and
- Outreach barriers to reaching farmers to promote the co-innovation necessary to change agricultural practices.

Countries with similar profiles could also meet to share experiences and learn from each other to enhance the learning process.

Figure 4: Contribution of the various agricultural categories to emissions across the 9 countries.

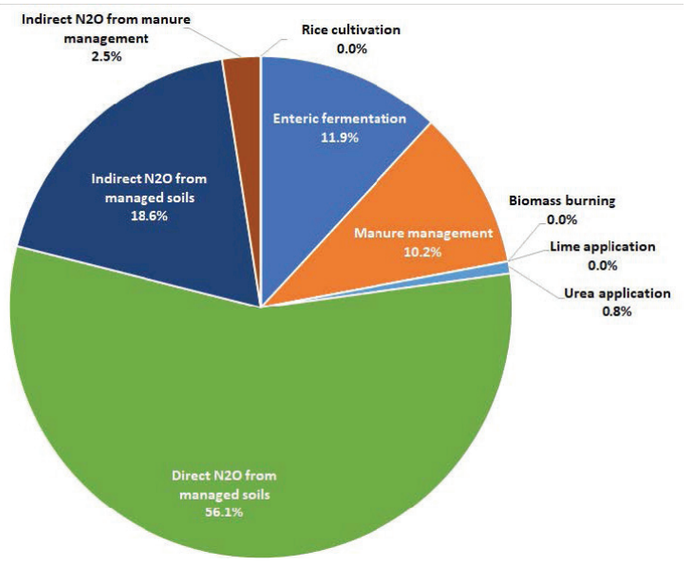
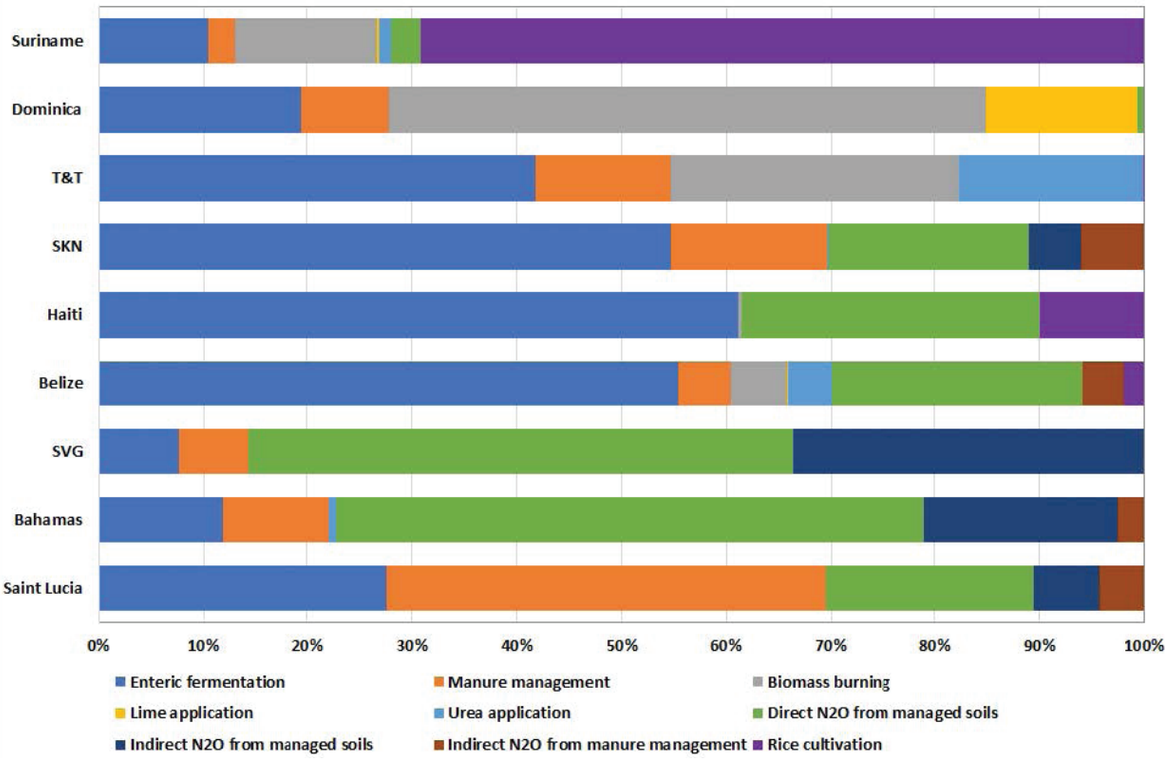


Figure 5: National emission profiles across the 9 Caribbean countries.



3.2 NDC analysis across the nine countries

Agriculture does not play a significant role in mitigation goals of the NDCs across the nine countries. Only Belize, Haiti and Dominica included agriculture mitigation, one country (Trinidad and Tobago) did not include any agricultural targets or goals, and the rest of the countries included adaptation activities (table 13). Dominica included a mitigation action relating to energy efficiency in the agriculture sector, so this would contribute to energy sector reductions. This analysis of the NDCs and related documents shows that building resilience and supporting food security are clearly the primary climate-related goals for the sector. This is to be expected given the contribution of the agricultural sector to the national emissions profile. These resilience and improved food security strategies have potential to include emissions reductions as an additional variable or co-benefit to consider when prioritizing adaptation options. Many of the NDCs from the nine countries emphasise the use of Climate-Smart Agriculture as a primary strategy to implement adaptation measures to reinforce domestic food supply and stabilise their respective agriculture sectors, while also opening up the possibility for mitigation when the measures do not have trade-offs with food security. Countries have an opportunity to prioritise the deployment of resilient and low-emissions agricultural practices while promoting agriculture sector growth.

With some mitigation actions and several adaptation actions across the region, it indicates that there is opportunity and perhaps political will for mitigation action if technical and financial resources are provided.

Table 13: Agriculture-related mitigation and adaptation actions included in the nine countries' NDCs.

NDC agriculture-related actions	Bahamas	Belize	Dominica	Haiti	SKN	Saint Lucia	SVG	Suriname	T&T
Mitigation									
Reduce methane emissions from livestock through a change in diets and feeding practices.		*		*					
Reduce manure management emissions.				*					
Avoid emissions related to agriculturally driven land-use change.		*							
Increase carbon sequestration through growth of perennial tree crops.[#]				*					
Increase soil carbon sequestration.[#]				*					
Reduced energy emissions from agriculture and fisheries.			*						
Adaptation									
Formulate and implement strategies and measures that will help to enhance food security and sustainable food production.	*						*		
Reduce post-harvest losses.		*							
Develop and implement an enhanced early warning system for drought and extreme weather events.		*	*						
Strengthen adaptive capacity and promote food security through climate- resilient agricultural actions.			*	*					
Improve and implement climate change adaptation and disaster risk management programmes (including education and awareness).			*	*			*		
Develop alternative livelihoods and training and diversify away from at-risk crops.					*				
Introduce drought-resistant technologies and species in animal husbandry.					*				
Prioritise cross-sectoral and sectoral adaptation measures in agriculture.						*			
Promotion of sustainable land management.								*	
Apply innovative technologies in the use of land.								*	
Improve agriculture policies and strategies and their implementation, with increased inclusion of climate change.							*	*	
Strengthen capacity to implement research, development and innovation programmes, and strengthen agricultural research.								*	

[#]*These are actions implemented in agriculture, but the emissions will be reflected in the FOLU sector.*

A notable target mentioned in Belize's NDC is the reduction of post-harvest losses. Reducing post-harvest losses can have a substantial impact on agriculture production as it means that more product from the same agricultural area and input would be reaching the consumer. In other words, instead of expanding agriculture to produce more product, losses could be reduced to produce more product at the end of the value chain. This would have an impact on agricultural production and its emissions. Harvest losses can occur throughout the value chain, such as during:

- Harvesting and handling at harvest,
- Drying, transport and distribution,
- Storage,
- Primary processing,
- Packaging,
- Selling and distribution, and
- Consumer waste.

Reducing post-harvest losses is particularly important in island nations as it is expensive to import extra food. In Trinidad and Tobago, the critical loss points for cassava, for example, are field harvesting, packaging and retail marketing.[182] There are many solutions to post-harvest losses, such as putting grains in bags or putting delicate produce in rigid crates or reducing the distance between farmers and their market. Several actions are also low-cost and may just require awareness raising to enable implementation. Reducing post-harvest losses is an action which could be considered by countries in the Caribbean to enhance agricultures contribution in NDCs. This may require an assessment of the losses along the value chain of key products in each region before actions can be developed.

3.3 Barriers preventing enhanced agricultural ambition in NDCs

Several barriers preventing action throughout the Caribbean region were identified:

- Limited technical capacity to develop GHG inventories and run mitigation scenarios,
- Limited agricultural data availability and overreliance on the FAOSTAT database which leads to uncertainty in emissions and difficulties in developing targets,
- Lack of data and technical capacity to include soil carbon in inventories,
- Loss of data and lack of documentation and archiving of inventory data making emission tracking difficult,
- Low emission contribution from the agriculture sector, therefore limited emission reduction potentials,
- Limited financial resources to facilitate the transition to new technologies, new practices, or new types of crop production,
- Outreach barriers to reaching farmers and providing educational resources to implement practice changes in line with future national policy objectives, and
- Compounding social inequities (such as poverty, lack of healthcare, disease, disability, limited access to political structures) conflate other barriers and can make it more difficult to address the root causes that climate actions ideally seek to address.

The document review and consultation with various stakeholders across the region indicated that two of the most significant barriers to further inclusion of agriculture in NDCs in the region are a lack of data and over-reliance on FAOSTAT data. All countries except Suriname, Belize and Saint Vincent and The Grenadines utilise FAOSTAT data for livestock population data. The FAOSTAT data for the region has, on occasion, been shown to provide inaccurate data for specific countries,[183] leading to over- or under-estimates of the emissions in agriculture. A full comparative

182 FAO, 2018. Food loss analysis: causes and solutions: Cassava supply chain in Trinidad and Tobago. https://www.fao.org/3/I9945EN/i9945en.pdf

183 Ibid, Ministry of Environment, Rural Modernisation and Kalinago Upliftment, 2020.

assessment of the FAOSTAT data does, however, need to be completed in order to determine the overall accuracy of the data at the country level. Without good data, countries are not able to accurately assess the contribution of agriculture to the overall emissions and are, therefore, not able to set accurate targets or track changes.

Another challenge across the region is the lack of capacity. There is a need to engage with farmers and extension officers to enhance awareness and to build capacity around data requirements for climate change reporting. Capacity amongst government officials can also be improved to better understand data needs (what is required), data utilization (how to process and apply data for decision making), data collection (tools to facilitate collection), and quality control and assurance procedures. Improving the frequency of agricultural census data is critical to understanding trends over time and thus enable projections for future emissions and possible emission reduction targets. These improvements would allow countries in the region to be more accurate in their assessment of the emissions from the agriculture sector and enable them to set reduction targets.

Tracking changes in emissions is vital for reporting on progress toward meeting emission targets. Systems for tracking changes in emissions are lacking in the region. The GHG inventory can be used to track changes over time; however, many of the mitigation actions may only be reflected in National Inventories that employ IPCC Tier 2 or Tier 3 methodologies. For example, a default Tier 1 emission factor for enteric fermentation would remain constant across the years and would not reflect the impacts of a policy which led to changes in livestock forage or dietary amendments. However, if a Tier 2 approach is applied, the emission factor is determined from feed intake data and would, therefore, fluctuate with changes in diet. All nine countries apply a Tier 1 approach, with a few minor exceptions, such as rice cultivation in Belize, which uses a Tier 2 approach, making it difficult for the inventories to reflect changes due to any mitigation or adaptation actions implemented. If the mitigation actions are implemented before the inventory MRV system can apply these more granular methodologies it is advisable to include a note with the National Inventory identifying any programmatic progress so that they may be acknowledged and accounted for.

3.4 Opportunities for agricultural emission mitigation

Across the nine countries evaluated, there are four emission sources that are consistently identified: direct and indirect N_2O from managed soils, enteric fermentation and manure management (see section 3.1 above). This section provides suggested mitigation options that could be applied; however, these all need to be evaluated in terms of their economic and social feasibility. It would also be useful to have disaggregated country-level data for emission sources within the agriculture sector in order to complete such an evaluation before selecting an appropriate set of mitigation actions to match the country's circumstances.

3.4.1 Enteric fermentation

The best practice to reduce emissions from enteric fermentation as identified by the *Livestock Research Group (LRG) of the Global Research Alliance (GRA) and the Sustainable Agriculture Initiative (SAI) Best Practices Guidelines (2014)* is to select and apply appropriate animal genetics through breeding and reproduction. Within each species of animal, a broad diversity of genetics exists with significant variability in terms of "resource efficiency, vulnerability to disease or stress, and adaptability to different climates."[184] Programmes that target breeding for the integration of climate-appropriate genetics that match the resource availability, likely interaction with disease and stress, and other climate-influenced factors (rainfall patterns, wind, flooding, etc.) can reduce emissions and offer other benefits for the livestock populations as well. Improved breeding can lead to increased productivity which can improve the livelihoods and

184 GRA, 2014. Livestock Research Group (LRG) of the Global Research Alliance (GRA) and the Sustainable Agriculture Initiative (SAI) Best Practices Guidelines (2014). New Zealand Agricultural Greenhouse Gas Research Centre. Available: https://globalresearchalliance.org/wp-content/uploads/2014/12/LRG-SAI-Livestock-Mitigation_web2.pdf

resilience of livestock producers and decrease pressure on land expansion for animal feed and fodder.[185] This can benefit smallholders by reducing pressure on land and increasing the quality and price of livestock products. This may be one area where countries can partner together to reduce the costs of the genetic research.

Improving the quality of forage is another best practice identified with the potential to reduce emissions intensity by 30% when comparing low-quality to high-quality forage.[186] High-quality forage improves digestibility and also increases animal growth. Low-quality feeds include straw, crop residues, or dry fodder, while higher quality forage (millet, sorghum, and corn) often has coarser straws compared to lower quality slender straw forage (rice, wheat, barley).[187] Programmes and policies to promote the import and/or domestic production of higher quality forage for livestock could reduce emissions and improve growth rates among livestock populations. Fodder rich in micronutrients can assist livestock to maintain their nutrient balance and avoid the effects of heat stress.[188] Any country that seeks to increase the domestic supply of high-quality forage would need to ensure the species of forage were matched to the soil characteristics, water availability, and temperature ranges of their prospective planting locations.

Other dietary improvements and/or substitutions can provide emission reduction and other benefits for livestock farming as well. The enteric fermentation processes of livestock can be altered by changing the composition of animal diets. For instance, feeding corn or legume silages, starch or soya decreases methane production compared to grass silages."[189] The entire supply chain should be considered when assessing the GHG emission reductions that might occur from a targeted adjustment in livestock diet, comparing the options for imported livestock feed. A coordinated programme to engage growers in supplying the identified feedstocks for improving diet could be considered, provided the crops match the soil characteristics.

For both forage quality and dietary improvements, changing the type of feed for livestock is likely to impact GHG emissions more significantly through a reduction in enteric fermentation than by avoiding transportation from other countries through the encouragement of domestic feed production. Therefore, emphasis should be placed on sourcing higher quality forage and feed that can reduce CH_4 production.

3.4.2 Livestock manure management

Collection and storage of manure within designated facilities is another action recommended by the *Livestock Research Group (LRG)*. The collection and storage of manure allow for many solutions to be implemented to reduce the emissions associated with manure management and provide other human and animal health benefits, in addition to making the nutrients from manure available for other agricultural purposes. "Dry" systems where manure is dried out before being stored can also reduce emissions.

Manure storage areas should take temperature and aeration into account in their design and functionality as these two factors can impact the production of CH_4 and N_2O produced from anaerobic digestion. Lower temperatures reduce the amount of CH_4 and ammonia (NH_3) produced while aeration of solid and liquid manure can decrease CH_4

185 Ross, K. et al., 2019. NDC Enhancement: Opportunities in Agriculture. Working paper, Washington, DC: WRI. Available online at: https://oxfamilibrary.openrepository.com/bitstream/handle/10546/620922/dp-ndc-enhancement-opportunities-agriculture-011219-en.pdf?sequence=1&isAllowed=y

186 It is important to remember that the source of any feed must incorporate any emissions associated with the production of the forage to properly account for the emissions from implemented changes in practices. A 30% reduction would represent the best-case scenario.

187 Ibid. GRA, 2014.

188 Ibid, Ross, K. et al., 2019.

189 Ibid. GRA, 2014.

and N_2O emissions.[190] Programmes to design appropriately sized manure storage structures, education for livestock farmers aimed at the promotion of manure management systems, and financing to assist farmers in implementing the systems would help to reduce agricultural emissions.

Anaerobic digesters could be appropriate for medium- to large-scale animal operations, or areas where animal feeding is concentrated within an area to allow for the cost-effective transport of waste to a centralised manure management facility. Small-scale application of manure collection and storage is likely the most relevant opportunity throughout the region To ensure cost-effectiveness, countries can prioritise opportunities to establish anaerobic digesters near large (>10,000 sheep, >125,000 chickens, >2,500 swine, or >1,000 cattle)[191] and medium (3,000–9,999 sheep, 37,500–124,999 chickens, 750–2,499 swine, or 300–999 cattle)[192] animal feeding operations, potentially collecting waste from multiple animal feeding operations (if feasible) to gain economies of scale and most cost-effectively reduce emissions. Small (<3,000 sheep, <37,500 chickens, <750 swine, or <300 cattle)[193] scale application of manure management systems that use anaerobic digestion will also reduce emissions, but may require additional financial and technical support to implement. Implementing small-scale anaerobic digesters requires administrative effort to locate appropriately sized farms and farmers willing to shift their practices, technical assistance to build and maintain anaerobic digesters, and financial assistance or policy-based requirements or incentives. If implemented on a small-scale, broad application will be necessary to accomplish emission reductions of significant impact, though co-benefits might make it a more attractive option.

Countries can prioritise collection and storage of manure for medium and large-scale CAFOs or areas where livestock farming is concentrated, and waste can be transported and aggregated to a centrally located anaerobic digester facility, while encouraging and incentivizing the private sector to target small-scale anaerobic deployment.

3.4.3 Fertiliser applied to agricultural fields

High variability exists globally regarding the amount of nitrogen fertiliser applied to fields and less than half of that nitrogen is absorbed by crops.[194] The rest of the nitrogen is either released into the atmosphere or runs off into groundwater or surface waters, and can result in N_2O emissions. To reduce emissions of N_2O associated with the application of fertiliser to agricultural fields, practices can shift to increase the nitrogen use efficiency (NUE) to reduce fertiliser applied without negatively impacting crop production. High rates of efficiency can be gained with more intensive management, including assessment of nitrogen needs (e.g., through soil testing) and more frequent application of only the required amount of fertiliser throughout the growing season.[195]

Overall, NUE can be increased by adjusting agricultural guidelines to reduce the quantity of fertiliser applied to fields or by providing varying recommendations depending on the frequency of fertiliser application. Adjustments to guidelines can also increase NUE by applying fertiliser to fields during times when plant growth is likely to occur (at the beginning of and through the growing season) so that the nitrogen can be absorbed by plants and limit the amount of off-gassing or runoff.[196] Also, soil sampling can be implemented to measure the nitrogen levels in crop-producing fields to further refine and target low nitrogen areas with fertiliser while passing over high nitrogen areas

190 Ibid. GRA, 2014.

191 EPA, N.D. Regulatory Definitions of Large CAFOs, Medium CAFO, and Small CAFOs. Available: https://www3.epa.gov/npdes/pubs/sector_table.pdf

192 Ibid. EPA, N.D.

193 Ibid. EPA, N.D.

194 WRI, N.D. Course 5: Reduce Greenhouse Gas Emissions from Agricultural Production (Synthesis). World Resources Institute. WRI.org. Available: https://research.wri.org/wrr-food/course/reduce-greenhouse-gas-emissions-agricultural-production-synthesis

195 Ibid. WRI, N.D.

196 Ibid. WRI, N.D.

thereby reducing the overall amount applied. Government programmes to assist farmers in collecting soil samples for lab analysis could increase NUE.

Improved fertilization of pastures can also improve fodder productivity. This has economic and ecological benefits and can assist in buffering against increasingly frequent climate extremes.[197]

Fertilisers that incorporate nitrification inhibitors can be sourced, which helps to reduce the amount of N_2O emitted when fertiliser is applied. These fertilisers, however, tend to be more expensive and would therefore require some form of financial support to be viable.[198] Other fertiliser types to consider are slow-releasing fertilisers such as polymer-coated urea, with anhydrous ammonia fertiliser releasing more N_2O emissions than ammonium nitrate or broadcast urea (as estimated for corn-soybean rotations).[199] Slow-releasing fertilisers will release nitrogen for plant absorption over time after their application and at a rate that aligns more closely with nitrogen uptake by crops, therefore reducing N_2O emissions. Nitrogen fertiliser practice amendments are presented in table 14. Some of the activities listed in this table are encompassed in Climate-Smart Agriculture (CSA). CSA is mentioned as an adaptation action in many of the country NDCs, so these actions can be enhanced to be included as a mitigation action (see more details on CSA activities in section 3.5).

Table 14: Nitrogen fertiliser technologies and practices that can reduce N_2O emissions[200]

Technology or Management Practice	Effectiveness and Comments[201]
Right N fertiliser application rate (applied at the economically optimum rate): N fertiliser refers to both synthetic and organic fertilisers (such as manure).	May reduce N_2O emissions substantially where N fertiliser is applied at rates greater than the economic optimum rate.
Right N fertiliser source: N fertiliser sources include urea, anhydrous ammonia, urea ammonium nitrate, ammonium nitrate, and manure; slow-release fertilisers, such as polymer-coated urea, are not widely used because of increased costs.	Urea, urea ammonium nitrate, and polymer-coated urea can decrease N_2O emissions by 50% or more compared with anhydrous ammonia in some locations, but there is no impact in other locations.
Right N fertiliser placement: N fertiliser may be broadcast or applied in bands, applied on the surface or below the surface.	Incorporating bands of N in the soil can improve nutrient use efficiency and can reduce N_2O emissions by about 50% compared with broadcast applications in some locations.
Right N fertiliser timing: N fertiliser should be applied as close as possible to when the crop needs it.	Applying N at planting or at times of peak crop N demand can increase nutrient use efficiency and would be expected to decrease N_2O emissions, but results from field studies are mixed.
N process (nitrification and urease) inhibitors.	Can decrease N_2O emissions by 50% in dry climates, but results are mixed for humid climates.
Cover crops.	Winter cover crops can reduce N losses (for example, leaching and runoff), but may not affect N_2O emissions.
Crop selection.	Low N-demanding crops can reduce N_2O emissions by more than 50% in many places.

197 Ibid. Ross, K. et al. (2019)

198 Ibid. WRI, N.D.

199 Millar, N. et al, 2014. Management of Nitrogen Fertilizer to Reduce Nitrous Oxide (N2O) Emissions from Field Crops. MSU Extension Bulletin E3152, November 2014. Available: https://www.canr.msu.edu/uploads/resources/pdfs/management_of_nitrogen_fertiler_(e3152).pdf

200 Note: The effectiveness of many mitigation options is influenced by soil type and climate, and there are major uncertainties about the effectiveness of most mitigation strategies.

201 Note: The effectiveness of many mitigation options is influenced by soil type and climate, and there are major uncertainties about the effectiveness of most mitigation strategies.

Technology or Management Practice	Effectiveness and Comments[201]
Improved irrigation management: timing, application rate, and application method.	Reducing application rates to minimise soil wetness can reduce N_2O emissions. Subsurface drip irrigation can reduce N_2O emissions compared with overhead sprinkler irrigation because soil moisture is better regulated, but data are limited.
Reduced tillage.	A long-term no-till strategy can reduce N_2O emissions by up to 50%, but data are limited. Short-term no-till results are more mixed.

Source: Millar, N. et al, 2014. Management of Nitrogen Fertiliser to Reduce Nitrous Oxide (N_2O) Emissions from Field Crops. MSU Extension Bulletin E3152, November 2014.

3.4.4 Rice cultivation

Paddy rice cultivation involves the wetting of soils, which can lead to the formation of CH_4 emissions from the anaerobic decomposition of biological materials that are submerged. Research has been conducted to identify cultivation practices that do not negatively impact yield while reducing the amount of wetting that is required, thereby reducing emissions of CH_4. The practice of Alternative Wetting and Drying (AWD) is a researched and practiced solution to this problem capable of reducing total global warming effects of rice cultivation by 27–29% compared to continuous flooding management.[202] AWD has been shown to increase N_2O emissions which can be minimised through improved fertiliser management practices in tandem with AWD.[203]

AWD is a low-cost way to reduce emissions and reduce water consumption.[204] Nevertheless, any practice change will face implementation barriers. The practice of AWD is not ideally suited to reduce CH_4 emissions in all locations where rice is cultivated and is reliant upon many factors (such as temperature, rainfall, soil texture, rice statistics). The mapping analysis presented by Sander et al. (2017) can be adapted to other countries' contexts[205] and could apply to the Caribbean region. The use of this methodology could help to identify areas to target with mitigation programming to reduce emissions most effectively through the adoption of the AWD practice.
A study conducted by Yagi et al. (2020) produced results consistent with the findings of emission reductions from adopting AWD and further explored the application of biochar to the same rice cultivation fields. The study found that biochar applied as a soil amendment reduced CO_2e emissions by a further 20% and significantly increased rice yield by 28% on average.[206]

Another method capable of reducing GHG emissions even more effectively than AWD is called soil water potential (SWP). SWP is a more resource-intensive practice that requires significant education to effectively implement; however, when compared to AWD in farming systems it can reduce total CO_2e emissions by approximately 50%.[207] A study conducted by Islam et al. (2020) compared AWD to SWP under two different fertilization practices: the first applied a solid pelletised urea fertiliser that was broadcast over the field and the second applied a liquid (aqueous) urea fertiliser. In both scenarios, equal amounts of nitrogen were applied to the rice cultivation areas via the two

202 Islam, S.M. et al., 2022. Mitigating greenhouse gas emissions from irrigated rice cultivation through improved fertilizer and water management. Journal of Environmental Management, 307. Available: https://doi.org/10.1016/j.jenvman.2022.114520; Yagi et al., 2020. Potential and promisingness of technical options for mitigating greenhouse gas emissions from rice cultivation in Southeast Asian countries. Soil Science and Plant Nutrition (2020) Vol 66 no. 1, pp37-49. Available: https://doi.org/10.1080/00380768.2019.1683890.

203 Sander, B., Wassmann, R., Palao, L. & Nelson, A., 2017. Climate-based suitability assessment for alternate wetting and drying water management in the Philippines: a novel approach for mapping methane mitigation potential in rice production, Carbon Management, 8:4, 331-342, DOI: 10.1080/17583004.2017.1362945

204 Islam, S.F. et al., 2020. Mitigation of greenhouse gas emissions and reduced irrigation water use in rice production through water-saving irrigation scheduling, reduced tillage and fertilizer application strategies. Science of the Total Environment, 739 (2020). Available: https://doi.org/10.1016/j.scitotenv.2020.140215.

205 Ibid., Sander, Wassmann, Palao & Nelson, 2017.

206 Ibid., Yagi et al., 2020.

207 Ibid., Islam, S.F. et al, 2020.

methods. SWP was measured to reduce CO_2e emissions by 48% in the broadcast solid pellet urea trial and by 54% in the liquid urea trial. Additionally, SWP resulted in slightly lower yields than AWD in each fertiliser scenario, but the CO_2e values presented above were presented on a per-unit yield basis to account for this effect.[208]

Fertiliser practices for rice cultivation may also be targeted to achieve a reduction in N_2O emissions. The practice of urea deep placement (UDP) has been effectively shown to reduce emissions by 9% and 15%, respectively, compared to the practices of integrated plant nutrient system (IPNS) and prilled urea (PU) within AWD managed fields. UDP has also reduced emissions by 9% and 11% compared to IPNS and PU within continuous flooding managed fields.[209] These fertilization practices were not tested under SWP management regimes.

Other options include:[210]

- accelerating rice yield growth, as this can reduce the total rice paddy area and thus reduce emissions,
- removing rice straw, as adding fresh rice straw to flooded fields increases CH_4 production,
- reducing flood periods, which reduces the growth of CH_4-producing bacteria, and
- breeding rice varieties that emit less CH_4.

3.5 Carbon sequestration activities

Another widely adopted practice mentioned by many of the nine participating countries within their NDCs or other national policy documents is Climate/Smart Agriculture (CSA) or Regenerative Agriculture (RA) for crop production. CSA presents comprehensive management programmes, including guidance for nutrient, pest, disease, water, and harvesting regimes for various crop systems. CSA can support the achievement of emission reductions as well as resilience building and can lead to the enhancement of biomass and soil carbon stocks, thereby increasing carbon sequestration. Many resources support implementing CSA and various research studies have evaluated and refined CSA's impact over the last 10+ years. To learn more about CSA, the work of Bhusal et al. (2020) provides a valuable training manual detailing the application of CSA.[211] These activities can therefore be an adaptation and/or a mitigation action.

The impacts of changes in biomass and soil carbon on country emissions (or sequestration) are reflected in the FOLU sector of the GHG inventory. When assessing the country inventories, it has been noted that, in all cases, the soil organic carbon has not been estimated due to a lack of data, complexities with the calculations and difficulties with tracking land changes. A recent survey by FAO[212] showed that only a third of developing countries include soil carbon in their inventories, citing lack of data (land management, soil, land use), limited infrastructure for data collection, limited resources for inventory experts and data uncertainties as being the main reasons for its exclusion. Thus, understanding the impacts of cropland management practices on overall emissions is difficult, and any changes in these cropland management practices would not be reflected in the inventory. The FAO survey identified the following approaches (in order of importance) to overcoming challenges of including soil carbon in the inventories:

- Enhance collaboration with national and international agencies to collect data,
- Improve collaboration between inventory compilers and soil scientists,
- Conduct scientific research to collect data,

208 Ibid., Islam, S.F. et al, 2020.

209 Ibid., Islam, S.M. et al., 2022.

210 Ibid, Ross, K. et al. (2019)

211 Bhusal A., L. Khatri, B. Bhandari, L. Sherpa and G. Neupane. 2020. Climate-Smart Agriculture (CSA): Training Manual. Local Initiatives for Biodiversity, Research and Development (LI-BIRD) and Ministry of Land Management, Agriculture and Cooperative (MoLMAC), Gandaki Province, Pokhara, Nepal. Available: https://cgspace.cgiar.org/bitstream/handle/10568/111199/CSA%20Training%20Manual-2020.pdf

212 FAO & IGES. 2022. Understanding countries' status and challenges for the estimation of carbon stock changes from mineral soils in national greenhouse gas inventories: Preliminary survey findings. Rome, FAO.

- Conduct training on the IPCC methodology,
- Raise awareness of policy makers,
- Enhance international/bilateral cooperation,
- Apply for new funding, and
- Enhance training on soil carbon dynamics.

Some of these actions could be considered as part of an improvement process for the Caribbean region.

To include CSA or RA activities under mitigation in the NDCs, the impacts on carbon sequestration need to be quantified so targets can be set. A system to track the changes in management would also need to be put in place. It would be important to work directly with stakeholders or individuals who can reliably represent and speak on behalf of stakeholders to ensure the practice shifts are comprehensively recorded so the impacts of the changes can be monitored. Data (whether it be input data for the GHG inventory on CSA activities or research on the impacts of CSA on carbon sequestration), sustainable data collection systems (which would allow for tracking change over time), and technical capacity are therefore the barriers to including CSA activities as mitigation options in NDCs.

3.6 Agricultural activities to mitigate emissions in other sectors

Several activities mentioned in the NDCs across the region are part of the agriculture value chain, but reductions would be reflected in other sectors, such as:

- Reduction in energy sector emissions through the use of solar-powered water pumps, reduced transportation emissions, and more efficient agricultural-processing plants,
- Reduced energy emissions through reduced energy consumption in aquaculture and fisheries,
- Reduction in energy emissions through the use of sugarcane bagasse,
- Reduction in FOLU sector emissions by reducing conversion of forest land to cropland, restoring abandoned agricultural lands, reducing tillage and agroforestry practices to improve carbon sequestration, and
- Reduction in waste sector emissions through a reduction in post-harvest losses.

These activities would lead to reductions in economy-wide emissions and are actions which can be considered by countries not already including these actions to enhance their overall mitigation reductions. Once the main agricultural activities highlighted in this document have been considered then a more extensive analysis across the value chain can be undertaken to achieve further emission reductions.

These cross-sectoral actions present an opportunity for intersectoral collaboration which could be considered when developing policies and strategies. These collaborations do not only extend to the traditional energy, forestry and waste management ministries, but also to ministries involved in adaptation and resilience activities such as infrastructure, housing, environmental planning and health. Intersectoral collaboration can enhance economy-wide emission reductions.

3.7 Regional outlook

Considering the analysis above and the barriers to include enhanced agricultural actions in NDCs, there are additional actions that could be implemented to further address some of these regional issues:[213]

- Alignment of agricultural climate targets, policies, and actions with NAPs, NAPAs, SDGs and LEDs:
    - This can lead to increased access to resources, sharing of climate data and information, and efficient consultation processes where stakeholder engagements can be combined.

213 Ibid, Ross, K. et al. (2019)

- It can also lead to harmonised reporting and efficiency in meeting multiple reporting requirements.
- NAPs, NAPAs, SDGs and LEDS (and supporting NAMAs) are important for linkages with international support and their credibility can result in strong vertical integration. Ensuring that the NDC actions are well-aligned to these will also provide greater opportunity for their implementation.

- Strengthening Monitoring, Reporting and Verification (MRV) systems for better inventories, assessments of mitigation potentials or assessment of access to finance:
  - MRV systems are fundamental to country responses to climate change, as they enable countries to meet international reporting requirements and allow them to demonstrate their progress towards achieving the mitigation and/or adaptation goals set out in the NDC. Improving MRV systems across the region would assist countries in producing better inventory estimates on a more frequent basis, which would enable improved mitigation potential assessments to focus mitigation planning. It would also improve emission reduction tracking.
- Improvement of agricultural innovation and extension services:
  - Climate change is a key threat to smallholder food production and extension services can support smallholder farmers in navigating and addressing the effects of climate change.
  - In addition, innovative service delivery alternatives, such as field schools, provide another approach to support farmers. This may not only provide them with information on climate change but also introduce new, innovative technologies that can be implemented to reduce emissions.
  - Extension services could be trained to teach farmers about data collection processes and data collection requirements, which could in turn lead to improved data collection for GHG inventories.
  - All countries apply a Tier 1 methodology in their inventories (except biomass burning in Belize, which is Tier 2), which means IPCC default factors are applied. In addition, many countries make use of international data sets for activity data. This means that the inventories are not granular enough to detect the changes due to mitigation efforts. Improved data could lead to an application of a Tier 2 method in the inventory, which may allow for mitigation tracking through the inventory.
- Identification of policies and measures to equitably clarify land tenure and protect small-scale farmers:
  - Land tenure is an issue in the region. Farmers are not keen to invest in mitigation or adaptation actions on a piece of land that is not theirs and could be taken away. Secure land tenure is essential for safeguarding against this and will ultimately encourage landowners to look after their land and apply sustainable farming or CSA methods.
  - In the latest Special Report on Climate Change and Land,[214] the IPCC indicates that land tenure is a key dimension in land-climate interaction discussions. Efforts by land agencies to (i) regularise tenure especially for small holder farmers, (ii) support lease of agriculture lands to farmers as a means of promoting agriculture and (iii) programmes to utilise government lands for use by multiple small farmers should be explored to promote climate resilient agriculture.
- Identification or prioritization of actions that support both mitigation and adaptation:
  - Across the region agriculture adaptation and resilience is the focus as country emissions are generally small so mitigation actions are often not prioritised. By identifying and prioritizing adaptation actions that have mitigation benefits, countries can take advantage of the adaptation actions that are already included in the NDCs. Additionally, mitigation actions that also have adaptation co-benefits can help to build resilience in the sector. Adaptation actions can be assessed to determine their mitigation potential so efforts can be focused on these activities. Ultimately, these actions can be enhanced and incorporated into the mitigation

214 IPCC, 2020. Climate Change and Land, Available at: https://www.ipcc.ch/srccl/

actions in the NDCs. This process would require the identification and quantification of mitigation co-benefits of the adaptation actions.

- Identification of support needs:
  - As a reflection of the political will to include agriculture in the NDCs, a capacity needs assessment (CNA) is needed to determine the needs within the sector. The CNA should focus on areas of finance, human resource capacity and technology needs.
- Linking to niche markets that could incentivise sustainable, lower emission sustainable products:
  - The small size of the countries in the Caribbean results in high production costs and limits the exploitation of economies of scale; therefore, high value niche products are more likely to be competitive than traditional commodity crops under such conditions.[215] There is a growing demand for organic or sustainably produced products, and this niche market could be tapped into and would incentivise farmers to manage their land sustainably and keep emissions low. Niche markets and opportunities would need to be identified and prioritised.
  - This would also link to improved innovation and agricultural extension, as this could be a way to encourage and support farmers to produce products for these niche markets.
- Targeting larger-scale mitigation activities as a region to cost-effectively reduce emissions:
  - This could address the need for the upfront capital required for some of the mitigation options mentioned above. Consider the use of Article 6.2 or 6.4 of the Paris Agreement to trade Internationally Transferred Mitigation Outcomes (ITMOs) that could be generated by a collaboratively implemented large-scale mitigation activity. The countries could share their emission reductions with regional partners based proportionally upon their contribution to the collaborative project's implementation. This could effectively help nations with limited agriculture sector mitigation actions to build experience and compensate for their GHG emissions through agricultural activities that, if addressed only within their national boundaries, may not be cost-effective.
  - The countries evaluated are likely to continue to rely upon external funding to provide financial resources to facilitate the transition to new technologies and farming practices that result in emission reductions. Large-scale mitigation activities accomplished through regional collaboration may also be an effective strategy to secure project funding and to support building national expertise

215 Tandon, 2014, Strengthening sustainable agriculture in the Caribbean: A guide for project support and guidelines for a policy framework. Available at: https://www.competecaribbean.org/wp-content/uploads/2015/02/Strengthening_Sustainable_Agriculture_in-the-Caribbean_web.pdf

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Appendix A: Data Collection Spreadsheet for NDCs

	General Agricultural Sector Info			Agricultural Mitigation		Agricultural Adaptation			
Country	**Main gases emitted**	**Main sources**	**Main agricultural Crops**	**Mitigation Actions**	**Specific Mitigation Objectives**	**Agricultural Projects & Activities**	**Adaptation**	**Additional Notes (Challenges, Gaps, Data Constraints, MRV)**	**Document Info.**
The Bahamas	CH4, N2O	Enteric Fermentation, Domestic Livestock, Direct emissions from Ag. Fields, Grazing Animals, Indirect Emissions, Leaching				**Global Fund for Coral Reefs Investment Window (GFCR)**			**GCF Case Study**
									Approved readiness proposal (GCF)
						Strengthening the foundation for a climate responsive agricultural sector in the Caribbean			**NC2**
Belize	CH4, N2O, NOx, CO	Enteric Fermentation, Manure Management, Flooded Rice Cultivation, Agricultural Soils, Agricultural Reside burning, livestock, forest fires	Sugarcane, banana, citrus, corn, marine products	Belize Agriculture Information Management System (BAIMS)	BAIMS is a web-based application that serves as a central repository for all agriculture data. It was populated from the Agriculture Census2018. This information is critical for evidence based decision making by the Ministry.	**Agriculture Project/Planned Activities:** Overall Aim: To **diversify livestock, increase access to drought resistant crops** and livestock feeds; adopt **betters oil management practices**; and provide **early warning/meteorological forecasts** and related information to be competitive in the region. **Estimated cost** for activities under this project is **BZD$26,000,000**; Specific activities can be found in **NC3 pg.150**	**Adaptation OPTION** Categories: (1)**Technological developments:** Develop new crop varieties using conventional breeding, cloning, genetic engineering (2) **Government programs and insurance:** the use of crop insurance and agricultural subsidies geared toward dealing with the effect of natural hazards on crop production yields. (3) **Change farm production practices**: farm-level decisions with respect to farm production, land use, land topography, irrigation, and the timing of operations. (4) **Farm financial management**: crop insurance and income stabilization programs	BAIMS Data are used by farmers and policy makers to analyzeag.data for proper timely decision making on the agriculture sector's contribution to the socio-economic development including GDP, national accounts and employment. Its development contributes to the MRV of key GHG emitting agricultural practices.	**NC3**
									BUR1
				Resilient Rural Belize (Be Resilient)	Strengthen small holder participation through the development of climate resilient value chains and climate resilient rural infrastructure and assets for main agricultural products			Barriers to climate change adaptation expected: Economic resources, technical knowledge, and adaptive capacity in the agriculture sector	
						Agro-ecological Farming of fruits and vegetables within the Selva Maya region (Cayo District);Funding:**$50,222USD**; Financed by **GIZ-grant**, GOB contribution &beneficiaries contribution;Year: **2015**;		Types of production systems used in Belize range from shifting cultivation practices to fully mechanized operation	
				Mitigation OPTION: Change feeding practices and quality of livestock using the proper ratio of nutrients and feeding practices and using a mixture of different feeds from several sources.		**Formulation of National Agriculture and Food Policy**; Funding:**$36,282USD**; Financed by: **FAO Grant**; Year:**2015**			
				Mitigation OPTION: Improve manure management through capture, storage,treatment and utilization of animal manures in an environmentally sustainable manner.		**Improving Livestock Sector Productivity and Climate Resilience in Belize**			
						Building the Adaptive Capacity of Sugarcane Farmers in Northern Belize			**GCF Approved project preparation on funding application**
Dominica	CH4, N2O	Enteric Fermentation (cattle, sheep), Fertilizer application to cultivated soils, excretion from grazing animals, atmospheric deposition of NH3 and NOx, leaching of agricultural soils		Enhance soil organic carbon (SOC); Mitigate NxO emissions; Eliminate Short-Lived Climate Pollutants (SLCPs); Introduce manure management; Continue no tillage; Replace fossil fuel farm energy with biofuels and RE	Reduction/Elimination of slash and burn practice	**Climate Elucidation for Adaptive Resilience in the Water Sector (D-CIEAR-Water)**		Hurricane Maria - 2017 resulted loss of livestock & reduced GHG emissions	**NC3**
					Elimination of the disposal of cuttings through burning			DOM still relies on imports for animal products to meet food demand	
								Mentions Datagaps, Data is not easily accessed and kept by many individuals rather than organizations	
								Suggestions made to improve energy sector data include development of data infrastructure and the promotion of networking for sharing data, information and knowledge on GHG inventories - Can be extended for Ag sector	
								Mention need to conduct audit of all data to undertake high quality tier 3 assessment, and systematically determine how to establish or enhance various existing data management mechanisms in order to provide what is required	**GCF Concept Note**

	General Agricultural Sector Info			Agricultural Mitigation		Agricultural Adaptation			
Country	**Main gases emitted**	**Main sources**	**Main agricultural Crops**	**Mitigation Actions**	**Specific Mitigation Objectives**	**Agricultural Projects & Activities**	**Adaptation**	**Additional Notes (Challenges, Gaps, Data Constraints, MRV)**	**Document Info.**
Haiti			Coffee, cocoa, sisal, maize, sorghum, rice, bean, banana, plantain	**NC#1** made mention of ***Mitigation techniques*** for the short & medium term(2001 - 2015) and the medium and longterm(unspecified). Short & Medium term as follows: Reduction of plowing, use of new rice cultivars emitting little CH4,Control of the use of N2 fertilizers. Medium & Long term: Carbon sequestration, hybrid crop practices to reduce CH4, reclamation of abandoned land for reduction of N2O emissions			**NC#1: Adaptation Options** were proposed based on expert judgement as follows (pg. 58) : -"Promotion of good use by farmers of products and services agriculture oriented weather", Creation of ***national system to forecast yields*** and agricultural production and risks, development of **national regionalization map** of cultures according to vocation agricultural land,development of education programs for farmers around opportunities to make the most of climate change, introduction of sustainable cultivation practices, conservation of irrigation water quality, use of new agricultural technology, development of new crop varieties w/temp resistance,	Decline in agricultural yields due to ***limited land availability due to an inheritance practice*** which causes fragmentation, ***low productivity*** caused by factors such as ***lack of maintenance of irrigation infrastructure*** and ***weak support programs for farmers***.	**NC#1**
	CH4, N2O	**Enteric Fermentation** in animals (135.69 of 158.86;**85%**); **Flooded/Irrigated rice cultivation** (22.62 of 158.86Gg; **14.24%**)		**NC#2** included ***Mitigation Options*** to reduce GHG emissions by 2020 through changing in farming practices such as: 1) Genetic improvement of crops, their efficiency in water and nutrient use 2) Carbon sequestration - Increased carbon uptake in soils, promote the creation of carbon sinks 3) Reduction of CH4emissions by managing irrigation of rice fields, 4) The use of better fertilizers and	**NC#2 - Mitigation Scenarios for Rice Production (pg.82):** 1) Modified water regimes requiring smaller quantities of water and energy for short critical periods. 2) Use of fertilizers -Minerals instead of organic fertilizers 3) Direct sowing plus mechanization to reduce CH4 while advancing date of harvest 4) Hybrid varieties of rice; **Mitigation Technologies:** 1) **Carbon Sequestration** 2) **Hybridcrops** 3) New-better				**NC#2**
						Increasing resilience of vulnerable farmers in Southern Haiti			**GCF Concept Note**

	General Agricultural Sector Info			Agricultural Mitigation		Agricultural Adaptation			
Country	Main gases emitted	Main sources	Main agricultural Crops	Mitigation Actions	Specific Mitigation Objectives	Agricultural Projects & Activities	Adaptation	Additional Notes (Challenges, Gaps, Data Constraints, MRV)	Document Info.
Saint Kitts and Nevis			Sugarcane, vegetables, root and citrus crops, cotton and breadfruit, potatoes, peppers, peanuts (St. Kitts), sea island cotton, coconut (Nevis)			Building Resiliency in the Water Supply Sector in St.Kitts and Nevis	Change of sowing and harvesting periods;	Climate change poses a risk to sector; No comprehensive assessment of key impacts and vulnerabilities has been undertaken	NC2
							Pesticide application technologies and practices;	There is need for improved information exchange among farmers and technical experts, and limited capacity to support agricultural innovation and product development for small scale farming	GCF Concept Note
							Integrated Pest Management (IPM) systems and practices;	A lack of early warning systems and access to agricultural insurance to address extreme weather events and related impacts on Ag.	National Climate Change Adaptation Strategy for SKN
							Soil management technologies and practices;	Farmers continue to use unsustainable practices that increase vulnerability (e.g. farming on steep hillsides)	
							Aquaculture and mariculture technologies.	There is a weak farm-to-market linkage, and growing reliance on imported foods	
							Integrated production & marketing system	A lack of integrated and coordinated approach to prevention and control of pests, diseases, invasive species, soil erosion and downstream pollution	
							Conduct a vulnerability assessment to identify key climate change impacts & vulnerabilities and specific adaptation measures for the Ag sector		
							Improve Ag extension services and response mechanisms for Ag risk & disaster management in small scale farming, including early warning		
							Strengthen mechanisms for application of science and tech. for climate smart solutions, including drought resistant species and use of		
							Promote ecosystem based approaches through investments in research practices for integrated pest and soil management and integrated crop-		
							Mainstream sustainable land, water and waste management into sectoral plans, including updating the St. Kitts Ag. Development Strategy		
							Explore synergies w/ other sectors to develop innovative programmes that support economic diversification and promote enhanced natural resource management including via agro-		

	General Agricultural Sector Info			Agricultural Mitigation		Agricultural Adaptation			
Country	Main gases emitted	Main sources	Main agricultural Crops	Mitigation Actions	Specific Mitigation Objectives	Agricultural Projects & Activities	Adaptation	Additional Notes (Challenges, Gaps, Data Constraints, MRV)	Document Info.
Saint Lucia	CH4, N2O **(NIR, 2015)**	Enteric Fermentation, Manure Management		Conversion 2,500 ha of additional agricultural lands to agroforestry practices by 2030.	Sustainable Agroforestry; Capacity building for farmers, extension services to enhance their knowledge &skills	**Enhanced Capacities for Disaster Risk Mitigation in Agriculture, Fisheries and Forestry (2010) - FAO funded**, to x Ag, forestry & fishery dept. & enhanced know-how of farmers and fishermen organisations to implement natural hazard risk mitigation and preparedness measures, with particular emphasis on primary and secondary impacts of hurricanes and tropical storms.	Prevention of heating stress to livestock by: Constructing simple shade structures from shade cloth, mesh fabric, tarps, canvas or sheet material for livestock, Using cooling fans in chicken farms/pens	Implementation may be affected by reluctance of farmers to change practices and adopt new systems	**NC3**
				Reforestation 2,500 ha of degraded areas by 2030	Biogas Digesters	EU Global Climate Change Alliance (EU-GCCA) Caribbean Support Project (2012-14): Implemented by CCCCC, Designed to develop capacity to design & implement climate change adaptation policies and measures by focusing on modelling, economic analysis and quantification of the costs and benefits of adaptation and mitigation options. For Saint Lucia Ag, this involved the Establishment & Expansion of Diversified,Cocoa-based Agro-Forestry Systems (Agriculture)		Additional, costly labour may be required for agroforestry	
				Improvement of watershed and flood management	Solar Dryers			Decline in Ag sector occurring due to the change in land use, characterised by the removal of productive agricultural land for high economic return development such as residential use, commercial buildings, hotels and golf courses.	
				Protection and rehabilitation 500 ha of seagrass beds, reefs, and mangroves			For fisheries & Aquaculture: incorporating uncertainty into decision-making and management process; supporting transitions to alternative species, production and post-harvest processes; supporting the development of alternative or diversified livelihoods; enhancing natural barriers, protecting fish habitats through adaptive spatial management; and incorporating climate change into transboundary water and natural resource planning across sector	Increase insurface run-off and flash flooding, inappropriate agricultural practices that use herbicides that kill ground cover and promote soil runoff; and planting systems that encourage run off instead of water retention in the topsoil and surface waters. Other characteristics include periods of severe drought and flooding, and the frequent occurrence of extreme events such as tropical storms, that pose serious challenges for the local agriculture industry	
								The BUR mentions collaboration between stakeholders including the Ministry of Agriculture to contribute to the MRV Portal; It also mentions gaps in the documentation of lessons learnt, best practices and historical/traditional knowledge within the Ag. Sector. One key aspect of the NAP 2018-28 is an annual monitoring and evaluation report. This will assist in better documentation of gaps, lessons and traditional and historical knowledge as appropriate	BUR1

	General Agricultural Sector Info			Agricultural Mitigation		Agricultural Adaptation			
Country	**Main gases emitted**	**Main sources**	**Main agricultural Crops**	**Mitigation Actions**	**Specific Mitigation Objectives**	**Agricultural Projects & Activities**	**Adaptation**	**Additional Notes (Challenges, Gaps, Data Constraints, MRV)**	**Document Info.**
Saint Vincent and the Grenadines			Sweet potato (Ipomoea batatas), dasheen (Colocasia esculenta), eddoe (Colocasia antiquorum), tannia (Xanthosoma spp.), yam (Dioscoreaspp.), cassava (Manihot esculenta), ginger (Zingiber officinale), arrowroot (Maranta arundinacea).	Implement programmes of reforestation and agro-forestry	Increase the rate of tree-planting and reforestation through collaborative programmes involving local communities and the Ministry of Agriculture, Rural Transformation, Forestry and Fisheries.		**Adaptation measures for soil and water use in agriculture include:** - ***Soil conservation measures*** to deal with run-offs,especially on hillside farming, - ***Construction of retaining walls*** to lessen the risks of landslides, - ***Increase*** the allocation of ***groundwater recharge areas*** on the islands to support the irrigation programme.	Farming technique used is deep soil tilling on slopes >30 degrees (Not conducive to mechanization); Results in frequent landslides	**NC2**
				Implement programmes for the reduction of deforestation	Promote the use of waste wood, including thinning debris, for crafts and furniture, as a means to combat deforestation. In subsequent years the programme would expand to include additional measures.		**Improved rainwater harvesting for irrigation purposes.**	Sector is heavily reliant on rainy season for planting; Most farms do not have on-farm irrigation	
							Development of stress tolerance varieties of common agricultural plants through genomics and molecular biology; Done using technical assistance from CARDI, FAO & the Taiwanese	Livestock production is vulnerable to climate change as the increased heat can affect the body temperature of the animal and consequently, their functioning.	
							Adaptive measures to control pest; **Seasonal planting of crops** that provide substrate for some pests.		
							Use of technologies by Port Health authorities to provide quarantine facilities for both import and export of biological material		
							Adapting livestock to increased heat stress by: - ***Provision of shade in pastures*** through physical structures, - ***Education of heat production through rumination*** by enhanced nutrition and feeding programme, - ***Breeding programmes*** that improve theanimals' abilities to withstand heat.		
							Identification of crops that a reproductive underemerging climatic conditions and for which there is a ready market.		
							Sensitization seminars and education about climate change		
							Adaptation measures for Hurricanes: **- Crop insurance** like WINCROP to provide start-up funds for farmers after storm damage as well as compensation for damage to crops. **- Introduction of shorter species** of Plantains (specie of bananas). **- Mix farming** using a combination of tree crops and vegetable or root crops.		

	General Agricultural Sector Info			Agricultural Mitigation		Agricultural Adaptation			
Country	Main gases emitted	Main sources	Main agricultural Crops	Mitigation Actions	Specific Mitigation Objectives	Agricultural Projects & Activities	Adaptation	Additional Notes (Challenges, Gaps, Data Constraints, MRV)	Document Info.
Suriname				Introduction of farming systems and farming techniques for rice production	single drainage of rice fields during the planting cycle.	**Improving the capacity of the Ministry of Agriculture of Suriname to build resilience to climate change in the agriculture sector; FAO**	**General:** Development and implementation of appropriate research programs, capacity building, and training required for animal husbandry (e.g. water buffaloes), crops (the introduction of new varieties including salt tolerant rice and upland rice varieties, integrated pest management) and fisheries (enhancement of competitiveness)	The GCF Readiness Proposal cites **lack of institutional capacity, data and information systems in the Ag. Sector** as one of Suriname's challenges to efficiently addressing climate change risk and vulnerabilies.	**NC2**
				Utilization of abandoned agricultural land for the production of energy crops			**RiceCultivation:** Construction of dikes, Establish infrastructure to increase fresh water availability for irrigation, Agro-eco research programs on pest management & disease control, establish an insurance fund to compensate farmers for losses in crop production due to unexpected weather hazards, research on crop rotation,		**GCF Approved Readiness Proposal**
							Banana: Planting of hedgerows of trees to protect against strong winds		
							Fruits & Veggies: Change farming systems (greenhouses and hydroponics) to cope w / varying climate change conditions; improve drainage systems to ensure efficient production & quality products; diversify crops to ensure food security under alternating climate conditions		
							Livestock: Rehabilitation of abandoned farms to guarantee food security, take measures to prevent further decline of number of productive animals (E.g. Place ban on female animal slaughter and import of beef cattle for a certain period)		
							Aquaculture and fisheries: Enhance sustainable aquaculture and fisheries management; protect fish breeding grounds, establish funds for fishermen to promote aquaculture		
Trinidad and Tobago						**Improving the monitoring system for climate change impacts on the agriculture sector in Trinidad and Tobago**			**GCF Approved Readiness Proposal**

Appendix B: Data Collection Spreadsheet for other National Policy Documents

General Overview					Mitigation				Adaptation				
Country	Key Mitigation Targets	Primary GHG Emitting Sectors	Main Reduction Target Sectors	Scope of gases covered	Emission Sources	Targets	Actions	General Mitigation Co-benefits	Target	Action	Agricultural Projects	Challenges	Document Info.
The Bahamas	Reduce GHG emissions by 30% compared to 2000 levels	Energy Sector & Forest		CO2, CH4, N2O		Not stated			Formulate and implement strategies and measures that will help enhance food security & sustainable food production				NDC#1
Belize	A 63% increase in GHG removals related to the AFOLU sector	Energy, agriculture, waste, IPPU	AFOLU, Energy	CH4, CO2	Livestock and forest fires	Reduce methane emissions from livestock by 10% by 2030 and avoid emissions of at least 4.5 KtCO2e16 related to agriculturally driven land use change by 2025	Restore 200 hectares of arable sugar land in Northern Belize that has been denuded over time		**Reduce post-harvest losses** through the implementation of the National Adaptation Strategy to Address Climate Change in the Agricultural Sector to **increase the adaptive capacity of the agricultural sector**	**Mobilize infrastructure investments for Climate Smart Agriculture (CSA)** as set out in the National Adaptation Strategy to Address Climate Change in the Agricultural Sector and including delivery of short-term actions by 2025			Updated NDC
	An increase of renewable energy projects for grid connected electricity generation						Improve the management of 80,000 hectares of the agro-landscape through good agricultural and silvopastoral practices, including by bringing 30,500hectares under sustainable agriculture systems with biodiversity benefits and15,000 hectares in production systems under sustainable land management			Establish a **financing facility for CSA investments** through local financial institutions			
	1,080 KtCO2e in avoided emissions in 2030									**Improve both crop and livestock husbandry practices**, increase access to drought tolerant crops and livestock breeds through partnerships with research institutions			
							Promote the reduced GHG emissions through **altering crop cultivation methods, including green mechanical harvesting in sugar cane production systems**, through a **public awareness** campaign targeting women, youth and local communities			**Adopt better soil and water management practices**, including the use of biochar and **improved** (solar-powered) **irrigation** systems			
									Develop and implement an enhanced **early warning system** for drought and extreme weather events to support farmers in planning for and responding to the impacts of climate change by 2025	Expand on the Belize Agriculture Informa@ on System to reach a broad awareness amongst relevant populations of hazards and best practices			
							Promote the reduced GHG emissions through implementing **effective livestock management** that involves **changing the feeding practices of livestock** to include more optimal nutrient levels			Explore crop and commodity insurance schemes and pilot insurance product including education and awareness raising campaign by 2024			
Dominica	Emissions will be reduced by 44.7% from 2014 levels			CO2, CH4, N2O, HFC		8.1% emissions reduction by 2030 in Commercial/ institutional, residential, agriculture, forestry, fishing sector	Harnessing of biomass to reduce GHG emissions		Promotion of Food Security through Climate Resilient Agricultural/ Fisheries Development				iNDC
Haiti				CH4, N2O			**Conditional Mitigation Measures**: 1) Improving pasture quality w/legumes 2) Fruit tree growing 3) Manure management 4) Crop cover (increased soil carbon)		**Updated NDC Adaptation Measures:** 1) Use and promotion of protectionist farming practices and agroforestry 2) Cultivation of species and varieties adapted and resilient to climate change 3) Implementation and application of an integrated control system against agricultural pests 4) Promotion and establishment of soil protecting and conservation structures 5) Construction of lakes and hill reservoirs for watering crops in dry periods 6) Watershed protection, management and development 7) Farmer Training, Education and Awareness. **Measures to deal w/ losses & damages due to extreme weather events:** 1) Implementation of insurance program 2) Promotion of solidarity economy program between farmers 3) Creation of compulsory declaration mechanism for farmers to allow their systematic recording.				Updated Draft NDC 2021

General Overview					Mitigation				Adaptation				
Country	Key Mitigation Targets	Primary GHG Emitting Sectors	Main Reduction Target Sectors	Scope of gases covered	Emission Sources	Targets	Actions	General Mitigation Co-benefits	Target	Action	Agricultural Projects	Challenges	Document Info.
Saint Kitts and Nevis	Reduction in 61% 2010 CO2 emissions by 2030; Target emissions: 124 GgCO2e (Approx. 129 GgCO2e reduced from 2010)	Energy	Energy	CO2	Release of carbon monoxide from residual crops			Ref: The National Climate Change Adaptation Strategy for St. Kitts and Nevis (2018)	Expand SMART aquaponics and aquaculture systems	3 pilot projects have been implemented: using organic mulch; forage banking to provide feed for livestock during dry periods; and use of shade houses to intensify production		**Lack of data** in AFOLU sector; Prevents quantifiable goals from being set;	Updated NDC
									Develop alternative livelihoods and training and diversify away from at-risk crops			AFOLU emissions were only available through an estimation based on neighboring countries; emissions estimate is **possible underestimation of real emissions**.	
									Introduce drought resistance technologies and species in animal husbandry				
												Lack of funding to implement identified adaptation actions	
												Available technical and human resources have been completely inadequate for any level of implementation of adaptation actions	
												Less than 50% of the adaptation actions identified in the National Climate Change Adaptation Strategy have been integrated into annual operational plans or have been implemented	
Saint Lucia	Reduce GHG's emissions from energy sector by 37 GgCO2e., compared to 2010 emissions,	Energy	Energy	CO2	Livestock, crop production	Not stated	Not stated	Co-benefit of reducing CO2 emission from the electricity generation and transportation sectors: There will be concomitant reductions in emissions in other gases like NMVOCs.	Not stated	Climate Resilient Agriculture Demonstration Centre (CRADE): Enabling the transformation of vulnerable groups in 3 subsistence farming communities into competitive national agribusiness leaders under a changing climate.		Energy sector is estimated to contribute 90% of emissions; **Data gaps** in other sectors added to the challenge of expanding the scope of the NDC	NDC #1 - Updated
				CH4				Reduced emissions from implementing fuel efficient technologies for aquaculture and fishing operations		Building Resilience for Adaptation to Climate Change vulnerabilities in Agriculture.			
				N2O				Reduced emissions from implementing resilient ecosystem activities to better manage the available ecosystem services and resources					
								Reduced emissions from wastewater management and introduction of renewable energy technologies in the Water sector;					
								Carbon sequestration by developing and implementing better practices in agricultural production					

General Overview					Mitigation				Adaptation				
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Saint Vincent and the Grenadines	22% reduction of GHG emissions by 2025; Base year 2010 had 407 GgCO2e	Energy	Energy	CO2, CH4, N2O, HFCs					**Support for small scale farmers** from the government, in production technologies, agri-business management, good agricultural practices and pest and disease control.; **policy initiatives** to address climate change issues, environmental protection, risk mitigation and fisheries development; and a **national plan** for dealing with food security.			Major decline in Ag. sector over last decade due to **restrictive trade regimes**	iNDC
									Enhancing the adaptive capacity of rural economies and natural resources to climate change through the **management and protection** of land based natural resources and **agricultural production systems**.				
									An innovative project which abandoned land into a model for sustainable living and farming systems in St. Vincent, young persons in local **primary and secondary schools are taught organic agriculture**, environmental art and creative land use				
Suriname	Unclear	Electricity, road transport, agriculture and forests; AFOLU contributes 40%; **Agriculture: 16.7% in 2008**	Forests, energy, agriculture, and transport	CO2, N2O, CH4	Wetland rice cultivation and animal husbandry					Identify, trial and introduce more permanent agricultural systems to replace the traditional shifting cultivation; 2020-2024, project led by Ministry of Agriculture, Animal Husbandry and Fisheries (MAAHF); Funding: Grant & Loan			NDC #2
										Define and implement a national research,development and innovation program, and strengthen agricultural research sector; Project lef be MAAHF; 2020-2022; Funding: Grant & Loan			
Trinidad and Tobago	Reduce 15% emissions by 2030 from BAU; equivalent to one hundred and three million tonnes (103,000,000) of CO2e	Power generation, transportation and industrial sectors		CO2, CH4, N2O									iNDC

Inter-American Institute for Cooperation on Agriculture

Headquarters. P.O. Box 55-2200
San Jose, Vazquez de Coronado, San Isidro
11101 - Costa Rica
Phone: (+506) 2216 0222 / Fax: (+506) 2216 0233
e-mail: iicahq@iica.int
www.iica.int