National Action Plan for Agriculture GHG Inventory Improvement

The Bahamas
2022

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

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Acronyms

AFOLU	Agriculture, Forestry and Other Land Use
BUR	Biennial Update Report
CBIT	Capacity Building for Increased Transparency
DEPP	Department of Environmental Planning and Protection
FAOSTAT	The Food and Agriculture Organization Corporate Statistical Database
GCF	Green Climate Fund
GEF	Global Environment Facility
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
IICA	Inter-American Institute for Cooperation on Agriculture
MRV	Monitoring, Reporting and Verification
NC	National Communication
NCCC	National Climate Change Committee
NDC	Nationally Determined Contribution
NGHGI	National Greenhouse Gas Inventory
NIR	National (GHG) Inventory Report
QA/QC	Quality Assurance/ Quality Control
UNFCCC	United Nations Framework Convention on Climate Change

1. Introduction

The GCF-Readiness Project titled "Strengthening the foundation for a climate responsive agricultural sector in the Caribbean" (GCF CARICOM AgREADY, in short) is funded through a Grant Agreement with the Green Climate Fund (GCF) with The Ministry of Environment and Housing, The Bahamas as the lead National Designated Authority (NDA) and the Inter-American Institute of Cooperation on Agriculture (IICA) as the delivery partner.

The AgREADY project seeks to raise the profile of the agricultural sector in GCF's climate financing prioritisation processes by positing an evidence-based and inter-sectoral argument that seats Caribbean agriculture as "low-emissions" and part of the solution for addressing climate change. The project logic is premised on a vision of developing "a climate responsive agricultural 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 IICA-GCF Readiness project targets nine countries (The Bahamas, Belize, Dominica, Haiti, St. Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago) in the CARICOM sub-region, with specific activities related to the following objectives:

- To improve the enabling conditions to design, implement and evaluate options for enhanced climate action in the agricultural sector by strengthening policies, capacities, frameworks, methods and institutional arrangements for collecting, monitoring, measuring, reporting, verifying (MRV) and analysing agricultural and associated activity data from the sector.
- To increase 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.
- To disseminate 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.

2. Context

To date, the Commonwealth of The Bahamas has submitted two National Communications (NC) and their first Nationally Determined Contribution (NDC). The third NC and the first Biennial Update Report (BUR1) (with GHG reference year 2018 and an updated time series) are expected to be completed during 2021/2022. Submission of an updated NDC is also anticipated in 2022. The National Greenhouse Gas Inventories cover the reference year 1994 in The Bahamas' first NC submitted in 2001, and reference year 2000 in its second NC submitted in 2014.

In previous GHG Inventories, the key sector of GHG emissions in The Bahamas was identified as the energy sector with electricity generation and transport as the top categories[1]. In its most recent assessment, however, the AFOLU (primarily land use change) and energy sectors dominate total national GHG emissions in The Bahamas, contributing 47.7% and 47.1%, respectively, to total emissions in 2018.[2]

According to the country's draft National Inventory Report of 2021, the agriculture sector in The Bahamas represents about 2.3% of the national GDP including small-scale farming of food crops, limited livestock production throughout the islands, and more significantly, poultry egg and broiler production, and soil enrichment from fertilizers. This sector's emissions are attributed primarily to the importation of nitrogen-based fertilizers (direct N_2O emissions) accounting for 56.1% of sector emissions in 2018, followed by indirect N_2O emissions to managed soils from leaching and atmospheric volatilization from fertilizers and managed animal waste, accounting for 18%, livestock enteric fermentation (11.9%) and manure management (10.2%), and lastly indirect N_2O emissions from manure management and urea application (jointly 3%).

1 The Government of The Bahamas, 2021. The Bahamas Draft National Inventory Report.

2 The Government of The Bahamas, 2021.

3. Objectives and Methodology

The objective of this initiative was to develop a National Action Plan to improve the agriculture GHG inventory by:

a) Assessing the status of the national agriculture GHG inventory
b) Identifying areas for improvement
c) Developing actions for taking the improvement plan forward
d) Prioritising the actions

A review of The Bahamas' latest available agriculture GHG inventory was completed to identify current institutional arrangements, data sources, data collection procedures, quality control and verification procedures, and tools utilised for inventory compilation. Any improvement plans suggested in the inventory reports or BURs and NCs were extracted and assessed. This information was used as a basis for discussions with national experts to determine what improvements are required to improve the agriculture GHG inventory compilation process in each country and improve agriculture emission estimates in the future. The synthesis of the results was framed in accordance with current situations and opportunities to improve institutional arrangements, data sources, collection, quality control and verification procedures, and MRV and archiving.

4. Assessment of Current Status and Opportunities for Improvement

4.1 Institutional arrangements

4.1.1 Current situation

The Bahamas National Climate Change Committee (NCCC) provides strategic-level guidance on climate change-related activities, policies, and plans, including the preparation of National Communications (NC), Biennial Update Reports (BUR), National Greenhouse Gas Inventory Reports (NIR), among others. The NCCC is chaired and led by the Department of Environmental Planning and Protection (DEPP), which also maintains the day-to-day national climate change portfolio[3].

The DEPP, apart from its role as the chair of the NCCC, is also the UNFCCC and Global Environmental Facility (GEF) operational focal point and coordinates the preparation and presentation of all reporting requirements to the UNFCCC. The technical aspects of the preparation of its most recent NIR for its first Biennial Update Report submission were led by regional consultants from the Caribbean Cooperative MRV Hub in a collaborative fashion with national experts to build national capacity. This included both GHG inventory data collection, estimation, compilation, and quality control and assurance throughout the inventory compilation period. The country is, however, committed to institutionalising these functions in-house through a phased approach coupled with building capacity through doing.

The Bahamas decided to use the opportunity of the NC3/BUR1 reporting cycle to move from a decentralised project-based system to a centralised project-based system. To achieve this goal, the country prioritised the enhancement of the technical and institutional capacity of the local team. This was achieved through capacity-building activities conducted by the different consultant teams during their identified tasks for the relevant reporting requirements. An example of this approach can be seen through the Greenhouse Gas Inventory (GHGI) compilation process where technical aspects led by regional consultants in a collaborative fashion with national experts simultaneously underwent targeted training. These activities included both GHG inventory compilation training and hands-on participation in data collection, and a UNFCCC quality assurance review during inventory compilation.

4.1.2 Opportunities for improvement

At present, the institutional and legal arrangements for coordinating timely GHG inventory reports were noted as a limiting factor in this reporting cycle. However, efforts have been made to identify the roles and responsibilities of coordinating entity, data providers, and sector experts, the country identified that continued effort to maintain these arrangements will be necessary.

For the GHG inventory to be sustainable, appropriate institutional, procedural, and legal arrangements and documentation are needed to facilitate a coordinated approach in subsequent reporting cycles. The country underwent a voluntary quality assurance exercise by the UNFCCC in January 2022, which further assessed institutional and technical needs from the GHG inventory management, producing a list of inventory improvements, with the need for addressing the issue of institutionalising the GHG inventory reporting cycle, persons involved, and data collection processes identified as being the priority.

3 The Government of The Bahamas, 2021.

There is an agricultural representative on the NCCC, but there is no national GHG inventory compiler for the agriculture sector, thus a national agriculture compiler could be incorporated as part of the GHG inventory team. This role could be housed under the Ministry of Agriculture. During the NC3/BUR1 process, some inventory compilation training was provided, but further training would be needed for the agriculture inventory compiler to support the person as they transition to completing the inventory themselves.

Table 1 shows the identified actions to improve the institutional arrangements for the agriculture GHG inventory compilation process.

Table 1: Potential actions to improve the institutional arrangements for the agriculture GHG inventory compilation process.

Goal	Actions
National agriculture GHG inventory compiler in the Ministry of Agriculture	Develop a set of roles and responsibilities for the Agriculture GHG Inventory compiler.[4]
	Identify a staff member to take on this role.
	Identify training opportunities to train the inventory compiler.
	Provide the inventory compiler with sufficient time to attend these training sessions.
Formalised institutional arrangements for data collection in the agriculture sector	Identify key data providers of agricultural GHG inventory data (see section 1.2)
	Draft a set of data requirements from the various identified organisations (including details on what, how often, what format, etc).
	Draft MoUs or data agreements, attach the data requirements, and formalise the data collection process with each data provider.

4.2 Data sources and data collection procedures

4.2.1 Current situation

The Bahamas does not currently have formal arrangements for data collection from its public agencies, and no framework exists for reporting or obtaining access to data.

Data collection for the current inventory was done by regional consultants in close collaboration with national sector experts to validate the source of the data, and the accuracy of the values to the extent possible. Data quality and availability from national sources remain a challenge for estimating emissions and removals for the current GHG inventory. For the agriculture data, national sources of data were prioritised where possible, using data for some livestock categories and fertilizer use from annual customs reports. All other data were obtained from FAOSTAT.

The priority emission sub-categories, in order, for The Bahamas are (a) direct N_2O from managed soils, (b) indirect N_2O from managed soil, and (c) enteric fermentation.

4 General guidance provided in Appendix A on Roles and Responsibilities.

Table 2: Data sources for Bahamas agriculture GHG inventory activity data.

Activity data	Data source
Livestock population numbers	
Cattle[5]	FAOSTAT (cattle, meat)
Buffalo	NE*
Sheep/goats	Customs Annual Reports
Swine	FAOSTAT (pigs, meat)
Horses/mules/asses	Customs Annual Reports
Poultry[6]	FAOSTAT
Manure management data	Expert judgement for management types
Lime consumption	NE
Urea consumption	Customs Annual Reports
N fertilizer consumption	Customs Annual Reports
Crop residue data	NE
Rice cultivation area and data	NE
**not estimated*	

Table 3: Categories included in the Bahamas agriculture GHG inventory and the tier-level approach.

Category	E/NE/NO	Tier 1/Tier 2
3A1 Enteric fermentation	E	Tier 1
3A2 Manure management CH_4	E	Tier 1
3A2 Manure management N_2O	E	Tier 1
3C1 Biomass burning	NE	Tier 1
3C3 Lime application (CO_2)	NE	Tier 1
3C3 Urea application (CO_2)	E	Tier 1
3C4 Direct N_2O from managed soils	E	Tier 1
3C5 Indirect N_2O from managed soils	E	Tier 1
3C6 Indirect N_2O from manure management	E	Tier 1
3C7 Rice cultivation	NE	Tier 1

E = Estimated; NE = Not estimated; NO = Not occurring

4.2.2 Opportunities for improvement

Data quality and availability were identified as the main challenges throughout the development of the inventory. Livestock data is very limited and not readily available on an annual basis. There is a need to work with customs import reports and agriculture field officers to collect and validate livestock data periodically. Furthermore, there is a need for support to validate the assumptions of national data in the customs reports for live animals and fertilizer use to better understand how it corresponds to actual usage.

For livestock, although a small sector in the country, conducting a livestock survey, including livestock manure management practices on an annual basis, aligns with the National Agricultural Census cycle. Even though the agriculture census is supposed to be conducted every 10 years, the last census was done in 1994. The barriers to conducting the agriculture census every 10 years need to be understood and actions put in place to overcome this to enable better data availability.

5 Cattle production is not a large industry in the Bahamas, therefore values for meat production were used, which represents the majority of the industry according to expert judgement. Future data validation of this sector was prioritized.

6 Poultry livestock includes eggs and laying hens, however further assessments should prioritize obtaining national figures for broiler production, which has an established industry.

Another opportunity noted through consultation with the Department of Agriculture was utilising the annual farmer registration process that guides the distribution of subsidies to incentivise data collection on a more regular basis.

Table 4 shows the identified actions to improve the data and data collection process for the agriculture GHG inventory compilation.

Table 4: Potential actions to improve the data collection and data collection process for the agriculture GHG inventory compilation process.

Goal	Actions
Improved frequency of agriculture census	Assess the barriers to completing an agricultural census every 10 years.
	Develop an action plan for ensuring an agriculture census occurs every 10 years.
Agriculture GHG inventory data included in the agriculture census	Engage with the Department of Statistics to discuss the questions included in the agriculture census.
	Identify a few critical questions relevant to the verification of agriculture GHG inventory data that could be added to the agricultural census data collection template.
Improved data collection procedures	Utilise the training material[7] from the IICA-GCF Readiness Project to set up training courses at extension officer training centres to teach farmers/extension officers about climate change and GHG inventory data requirements.
	Prepare short surveys, which can be given out during these training sessions, to determine what would incentivise farmers to collect data.
	Hold a stakeholder workshop to identify the best way to collect the data, i.e., what can be collected through the farm registry, extension officers, the Department of Statistics, or via the use of apps.
	Pilot the provided data collection templates[8] at a few sites to understand the issues on the ground and to adapt the templates for local purposes (focusing on what key data can be collected such as crop management, livestock, manure management, and fertiliser use).
	Adapt the data collection templates to collect appropriate country-specific data and then either produce manual or electronic data collection templates or develop the template into an app.
	Perform scoping study for financing from national activities/projects and/or regional projects to finance data collection efforts, app, and administration
	Develop a data collection roadmap (also building on information from the CBIT project).
	Implement the roadmap.
Improved inter-island communication	Identify Ministry of Agriculture personnel from Family Island/ agricultural producing islands.
	Ensure that stakeholder consultations, training, and expert meetings involve experts from all Family Islands.

**Focus for the Bahamas should be on livestock population data, manure management, and crop management data.*

7 See Appendix B on training material pamphlet from train the trainer training.

8 See Appendix C on example data collection template.

4.3 Quality control and verification procedures

4.3.1 Current situation

Quality control measures were undertaken initially by the inventory compiler, and secondarily internally reviewed by the MRV Hub GHG accounting experts who were not directly involved with compilation as a quality control check for each sector inventory. These quality control steps included checking:[9]

- assumptions and criteria for the selection of activity data and emission factors are documented.
- transcription errors in data input and reference.
- correct calculation of emissions and removals.
- parameters and emission and removal units are correctly recorded, and appropriate conversion factors are used.
- estimates are complete, all categories and all years from the base year (2001) to the current inventory year (2018).

In terms of quality assurance, national sector experts were involved in data collection and understanding sector-specific assumptions for methods. Other line Ministry representatives and experts from non-governmental organizations and academia reviewed emissions estimates and methodological assumptions.

4.3.2 Opportunities for improvements

At present, The Bahamas does not have a fully appointed inventory compilation team with roles for implementing QA / QC procedures. Establishing persons responsible for the compilation, quality control of estimates, and further quality assurance is necessary to put in place before the next inventory cycle. QA procedures also need to be developed to assess the accuracy of final reports.

Table 5 shows the identified actions to improve the quality assurance and quality control procedures for the agriculture GHG inventory compilation.

Table 5: Potential actions to improve the quality assurance and quality control for the agriculture GHG inventory compilation process.

Goal	Actions
Improved QC of agriculture inventory	Develop a list of specific QC checks for the agriculture sector inventory (both for the calculation file and the report).
	Identify a quality controller for the agriculture GHG inventory (this may be the compiler for another sector if resources are limited).
	Identify training opportunities to train the inventory quality controller.
	Provide the inventory quality controller with sufficient time to attend these training sessions.
Improved QA of agriculture inventory	Develop a bilateral agreement with another Caribbean country so that the agriculture compiler from that country can review The Bahamas' agriculture inventory and vice-versa.

9 The Government of The Bahamas, 2021.

4.4 MRV and archiving

4.4.1 Current situation

The Bahamas faces challenges in this process due to limited human, technical and institutional capacity within its local teams. To overcome these obstacles for previous reporting, The Bahamas engaged regional and international consultants to conduct the relevant planning and preparation activities to meet its reporting obligations.

Analysis of historical information revealed a lack of documented and archived datasets (inclusive of methodologies and expert judgement) from previous reporting events, which hindered the opportunity to improve reporting through the latest NC3/BUR1 reporting cycle. Previous reports were conducted using a decentralised, project based MRV system.

For the most current GHG inventory, the documentation and archiving of emissions estimates, worksheets, activity data, expert judgement, and assumptions were completed by the inventory compilers and shared with DEPP through a Dropbox folder, organized and used throughout all stages of the GHG inventory cycle. This was done to ensure transparency and national ownership of data and reports, and promote continuity of inventory preparation for subsequent cycles.

4.4.2 Opportunities for improvements

The country has already stated its commitment to establishing its climate MRV system as identified in its work in its MRV Assessment and Roadmap.[10] Suggestions would include setting up a system with appropriate administrative capacity with a focus on main data source providers that are involved in multiple reporting sectors.

For a system to be implemented sustainably, the appropriate institutional, procedural, and legal arrangements with clear reporting and documentation requirements would also be required. This activity was also identified in the Capacity Building for Increased Transparency (CBIT)[11] project, which intends to expand more on MRV systems and their foundation.

No actions were identified for MRV systems since this is being addressed under the CBIT project.

10 The Government of The Bahamas, 2022. The Bahamas Draft MRV Assessment.

11 *Building The Bahamas capacity in transparency for climate change mitigation and adaptation.*

5. Overall action plan for improving The Bahamas' agriculture sector GHG Inventory

Goal	Task	Responsibility	Priority (L/M/H)#	Timeline (S/M/L)*
National agriculture GHG inventory compiler in the Ministry of Agriculture	Develop a set of roles and responsibilities for the agriculture GHG inventory compiler[12]	DEPP	H	M
	Identify a staff member to take on this role.	DEPP/Ministry of Agriculture	H	M
	Identify training opportunities to capacitate the inventory compiler.	DEPP	H	M
	Provide the inventory compiler with sufficient time to attend these training sessions.	DEPP/ Ministry of Agriculture	H	M
Formalised institutional arrangements for data collection in the agriculture sector	Identify key data providers of agricultural GHG inventory data (see section 1.2).	Dept. of Agriculture/ DEPP	**H**	**S**
	Draft a set of data requirements from the various identified organisations (including details on what, how often, what format, etc).	DEPP/Ministry of Agriculture	H	S-M
	Draft MoUs or data agreements, attach the data requirements, and formalise the data collection process with each data provider.	DEPP/Ministry of Agriculture	H	M-L
Agriculture GHG inventory data included in the agriculture census	Engage with the Department of Statistics to discuss the questions included in the agriculture census.[13]	Dept. of Agriculture	L	L
	Identify a few critical questions relevant to the verification of agriculture GHG inventory data that could be added to the agricultural census data collection template.	Dept. of Agriculture	L	L
Improved data collection procedures	Utilise the training material[14] from the IICA-GCF project to set up training courses at extension officer training centres to teach farmers/extension officers about climate change and GHG inventory data requirements.	DEPP/Ministry of Agriculture Dept. of Agri. /Min of Agriculture	H	M-L (may take 2-4 years). We can begin with the current staff complement
	Prepare short surveys, which can be given out during these training sessions, to determine what would incentivise farmers to collect data.	DEPP/Ministry of Agriculture	H	M-L (may take 2-4 years)
	Hold a stakeholder workshop to identify the best way to collect the data, i.e., what can be collected through the farm registry, through extension officers, the Department of Statistics, or via the use of apps.	DEPP/Ministry of Agriculture	H	M-L (may take 2-4 years)
	Pilot the provided data collection templates[15] at a few sites to understand the issues on the ground and to adapt the templates for local purposes (focusing on what key data can be collected such as crop management, livestock, manure management, and fertilizer use).	Ministry of Agriculture	M	L
	Adapt the data collection templates to collect appropriate country-specific data and then either produce manual or electronic data collection templates or develop the template into an app.	DEPP/Ministry of Agriculture	H	M-L
	Perform scoping study for financing from national activities/ projects and/or regional projects to finance data collection efforts, app, and administration.	DEPP/Dept. of Agriculture	M	M
	Develop a data collection roadmap (also building on information from the CBIT project).	DEPP/Dept. of Agriculture	H	M

12 General guidance provided in Appendix A on Roles and Responsibilities.

13 The next agricultural census is not currently planned and may be a long-term action.

14 See Appendix B on training material pamphlet from train the trainer training.

15 See Appendix C on example data collection template.

Goal	Task	Responsibility	Priority (L/M/H)[#]	Timeline (S/M/L)[*]
Improved interisland communication	Identify Ministry of Agriculture personnel from Family Island / agricultural producing islands.	Dept. of Agriculture / The Bahamas Agriculture and Marine Science Institute (BAMSI)[16]	H	L
	Ensure that stakeholder consultations, training, and expert meetings involve experts from all Family Islands.[17]	DEPP / Dept. of Agriculture	H	L
	Hire and place extension officers on all islands.	Dept. of Agriculture	H	M (2-4 years)
	Capacity building for officers through "train the trainer" programs for extension officers in GHG inventory data collection.	Dept. of Agriculture / BAMSI and add BAIC	H	M (2-4 years)
	Improve interisland reporting of farmer registration forms for annual agricultural data.	Dept. of Agriculture	H	M (2-4 years)
Improved QC of agriculture inventory	Develop a list of specific QC checks for the agriculture sector inventory (both for the calculation file and the report).	DEPP	M	S
	Identify a quality controller for the agriculture GHG inventory (this may be the compiler for another sector if resources are limited).	DEPP	M	L
	Identify training opportunities to capacitate the inventory quality controller.	DEPP	M	M
	Provide the inventory quality controller with sufficient time to attend these training sessions.	DEPP	M	M-L
Improved QA of agriculture inventory	Develop a bilateral agreement with another Caribbean country so that the agriculture compiler from that country can review The Bahamas' agriculture inventory and vice versa.	DEPP / Dept. of Agriculture	L	S

[#] *L = Low, M = Medium, H = High*

[*] *S = Short term (within 1 year), M = Medium term (completed within 2 years), L = Long term (completed within 4 years)*

16 BAMSI provides support for identifying Agriculture extension officers for islands with Ministry of Agriculture and Local Government could potentially provide host office space for additional family island extension staff.

17 Currently, extension officers in the Bahamas include (3-6) officers on Grand Bahama, Abaco (1), Eleuthera (3), Exuma (1), Long Island (2), Cat Island (1), and New Providence (3). All other Islands have Family Island Administrators who collect farmer registration forms from farmers and send to Dept. of Agriculture. Training these existing extension officers through "Train the Trainers" programs for data collection is a useful start while more officer positions are being established.

6. References

The Government of The Bahamas. 2021. *The Bahamas Draft National Inventory Report.*
The Government of The Bahamas. 2022. *The Bahamas Draft MRV Assessment.*

Appendix A: Agriculture Inventory Compiler Responsibilities[12]

1. Review the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* and previous IPCC Guidelines, if applicable, such as *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.*
    a. Understand the GHG categories that are sources in the agriculture sector.
    b. At minimum understand the tier 1 methodologies, data needs, and other requirements for developing GHG estimates for the agriculture sector and become familiar with those for tier 2.
2. Collaborate with the inventory coordinator to manage the agriculture sector budget and develop an agriculture sector-specific work plan and schedule that coincides with deliverables acknowledged in the overall National Inventory Schedule.
3. Develop and implement an agriculture sector-specific plan for archiving all relevant information and materials, in coordination with the archiving coordinator and adhering to any existing archiving guidance materials for your national inventory.
4. Identify the types of agricultural practices in your country that are relevant to the production of GHG emissions (e.g., crop production, livestock management, burning of agricultural waste or grasslands), contact national, regional, and local experts to determine if the necessary data is readily available, and establish institutional arrangements for collecting activity data.
5. Oversee the establishment of arrangements between agriculture sector data collectors and data suppliers.
    a. Collaborate with the inventory coordinator to record the institutional arrangements for the agriculture sector.
    b. If required, develop agreements such as Memoranda of Cooperation (MOC) with necessary organisations (e.g., Ministry of Agriculture, universities) to assist with activities required by the agriculture sector lead (e.g. data collection, generating GHG estimates).
    c. Develop Scopes of Work (SOW) to engage contractors, and/or sector experts. Manage the work being carried out under these contracts to ensure it is meeting the requirements and needs of your GHG inventory sector.
6. Contact federal agencies/ministries or non-governmental organisations to inquire about the existence of satellite imagery data for categories such as agriculture residue burning. Ensure this is done in coordination with the LULUCF sector, which also requires access to imagery.
7. Consider potential improvements identified in the previous inventory for this sector. Assess whether to implement improvements based on the contribution to overall national emissions (by conducting a key category analysis) and availability of resources.
8. Oversee the development of GHG estimates from all categories in the agriculture sector.
    a. Determine the most appropriate IPCC methodology to be used to estimate GHGs for each category in accordance with decision trees.
    b. Oversee choice and/or development of emission factors.
    c. Coordinate with the LULUCF sector lead to determine emission calculations and activity data adjustments for complex categories such as agricultural soil management and manure management.
    d. Ensure consistency of data between enteric and manure management (e.g., livestock populations and characterisation).
    e. Ensure consistency between nitrogen quantities in manure management and agricultural soil management.

12 Adapted from EPA Toolkit for Building National GHG Inventory Systems.

f. Coordinate with the waste sector to ensure assumptions on the application of sewage sludge and nitrogen content are consistent.
g. Document all data collection arrangements, methodologies, activity data, emission factors, and assumptions, including the use of expert judgment, in coordination with contractors and other technical experts that are developing the estimates.

9. In consultation with the QA/QC coordinator, convene an agriculture sector working group to review calculations and perform initial Quality Assurance/Quality Control (QA/QC), consulting QA/QC coordinator.
    a. QA includes review procedures conducted by personnel not involved in the inventory development process (e.g., experts not involved with estimate development, the public, other relevant agencies, non-governmental organisations, universities, etc.).
    b. QC includes routine reviews implemented by the inventory development team to measure and control the quality of the inventory as it is prepared (e.g., sector leads and supporting experts involved with estimate development).
    c. Ensure that QA/QC procedures are consistent with the general and sector-specific procedures, which may be obtained from the inventory coordinator.
10. Coordinate the response to comments received from QA (external) reviews of the agriculture sector GHG estimates and update the inventory if necessary.
11. Review the final agriculture sector GHG estimates and the narrative describing the assumptions, methodologies, and results.
12. Oversee the development of uncertainty analysis for the agriculture sector.
13. Identify any improvements needed for subsequent inventories, related to activity data, emission factors, methodologies, or other components of developing the estimates. Document these improvements in the relevant tables, and discuss them with the inventory coordinator for prioritization in the overall inventory improvement plan.

Appendix B: Sample handouts for Data Collection Training

DATA COLLECTION ON LIVESTOCK FARMS FOR GREENHOUSE GAS EMISSION MONITORING

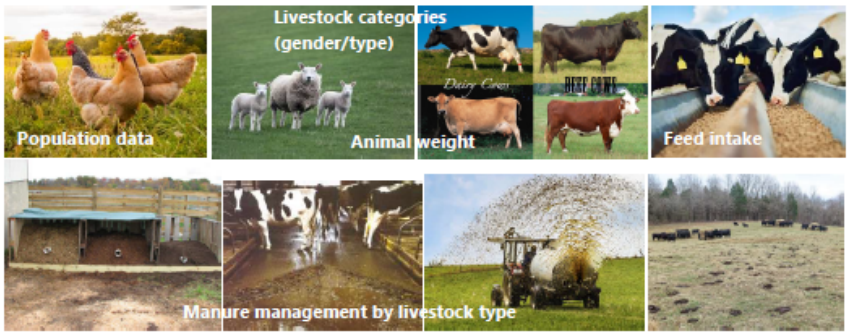
How do livestock impact greenhouse gas emissions?

Livestock release greenhouse gases into the atmosphere through the digestive process and through manure management.

Why do we need to collect livestock data?

Livestock and manure management data can be used to determine the amount of greenhouse gases produced. Detailed and more frequent data collection means more accurate emission estimates. This information assists farmers and the government to identify relevant actions that can be taken to reduce these emissions. Implementing these actions will in turn reduce the negative impacts of climate change. Frequent monitoring can also be used to determine whether the implemented action is having the desired effect.

What type of data is required?



What are the benefits to understanding and reducing livestock emissions?

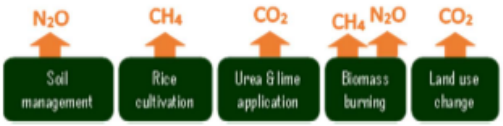
Benefits to farm businesses from improving their emissions performance may include:

- Decreasing costs and increasing productivity. Belched methane represents energy lost from the production system that might otherwise be converted to the milk, meat or fibre that generates income.
- Increasing market opportunities as supply chains and consumers become more aware of increasing demand for food and fibre produced with lower emissions.
- Improved animal health and husbandry.
- Reduction in inorganic fertiliser costs. Reducing nitrogen losses from manure means a higher concentration of nitrogen in manure being applied to soils and therefore a reduction in the requirement for inorganic nitrogen fertilisers.

DATA COLLECTION ON CROP FARMS FOR GREENHOUSE GAS EMISSION MONITORING

How does crop farming impact greenhouse gas emissions?

Crop farming leads to the release of greenhouse gases through the application of fertilisers and lime, crop residue burning, tillage and other management practices, saturated soils (such as rice paddies) and the conversion of forest land to cropland.



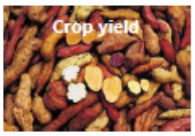
Croplands can also lead to the removal of CO_2 from the atmosphere (*carbon sequestration*) through woody crop/tree growth, increased crop cover, mulching, no tillage and reduced land conversions.

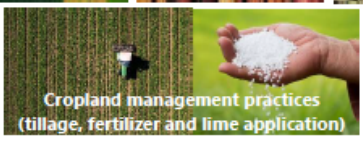
Why do we need to collect crop data?

Crop areas, harvest areas and crop management data (*activity data*) can be used to determine the amount of greenhouse gases produced. Frequent and detailed data collection means more accurate emission estimates. This information assists farmers and the government to identify relevant actions that can be taken to reduce emissions. Implementing these actions will in turn reduce the negative impacts of climate change. Monitoring can be used to determine whether the implemented action is having the desired effect.

GHG emissions = Activity data X Emission factor

What type of data is required?





What are the benefits to reducing cropland emissions and increasing carbon storage?

Benefits to farm businesses from improving their emissions performance may include:

- Improved soil fertility and sustainability through improved soil management.
- Improved productivity and increased income.
- Increasing market opportunities as supply chains and consumers become more aware of increasing demand for food and fibre produced with lower emissions.
- Reduced time, labour inputs and fuel costs due to more efficient farming.
- Improved nutritional quality of food and food security.
- Increased resilience to climate change for farmers and communities.

Appendix C: Example of Data Collection Template

LIVESTOCK DATA
Dairy cattle

YEAR	
DATE	

NOTES:

CATEGORY SPECIFIC DEFINITIONS	
High producing cows	Cows in commercial operations that have calved at least once and are used principally for milk production
Low producing cows	Cows managed with traditional methods that have calved at least once and are used principally for milk production
NOTE	Low producing, multi-purpose cows are considered under "Other cattle" as "Mature cows" and not as "Dairy cattle".

Livestock type	Livestock sub-category		Average annual population	Typical average animal mass (TAM)	Daily feed intake	Average milk production	Milk fat content	Manure management					
			(Head)	(kg)	(kg dry matter/ head/day)	(kg milk/head/yr)	(%)	(% of total manure produced by each livestock going to each manure management practice)					
Dairy cattle	TOTAL	Avg											
		High											
		Low											
	High producing cows	Avg											
		High											
		Low											
	Low producing cows	Avg											
		High											
		Low											

YEAR	
DATE	

NOTES:

Data collection template for dairy cows

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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