Regional Agriculture GHG Inventory Improvement Guidance for Nine CARICOM Countries

The Bahamas, Belize, Dominica, Haiti, St. Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, Trinidad and Tobago

With the support of

GREEN CLIMATE FUND

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The Bahamas, Belize, Dominica, Haiti, St. Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines, Suriname, and Trinidad and Tobago
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Castries, Saint Lucia
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Foreword

This report is an asset and probably one of the first that gives a clear and well-structured guidance to countries in the region in improving our agriculture Green House Gas Inventory (GHGI) process.

It covers all key steps regarding data on relevant reported categories in agriculture, in line with the Inter-governmental Panel on Climate Change (IPCC) requirements, prior to the actual calculations of the GHG emissions, such as available data sources, the collection and processing of activity data, filling data gaps, quality check and assurance. Furthermore, it suggests actions to improve data collection in the region.

Data collection for agriculture GHGI is a big challenge in many of the countries in the region. Countries often rely on international data sources for their activity data, and oftentimes it is unclear and not traceable how these sources collect data. The templates provided by the Green House Gas Management Institute (GHGMI) during the data collection training for regional agriculture stakeholders, (mentioned in this report), are a great tool to not only collect local data but also to improve this data collection, to meet the requirements for a proper agriculture GHG assessment. Since countries aspire to continuously improve their GHG inventories, these templates also provide the opportunity to collect disaggregated data for an assessment at a higher level. Furthermore, this report also addresses institutional arrangements, which can be tailored according to the specific needs of the countries.

By the time the GHG inventory and data collection training started, the Ministry of Agriculture in Suriname had just completed the GHGI for agriculture as contribution to the national GHGI for the Third National Communication to the United Nations Framework Convention on Climate Change (UNFCCC). The calculations were done in the Intergovernmental Panel on Climate Change (IPCC) 2006 software tool. This software posed many challenges as it is not transparent and was managed by an external superuser which created limitations and dependency for inventory compilers. For the aforementioned trainings, Luanne Stevens, Fellow at the GHGMI, and author of this publication, developed valuable templates for GHG calculations and data collection. These templates make the several steps of the calculations transparent and understandable. In contrast to the IPCC software tool, they allow to easily detect and trace back data errors. The calculation templates have also proven their worth in the recalculations of rice cultivation related emissions in Suriname, which yielded the same results as the IPCC software tool. For the agriculture mitigation assessment in Suriname, Dr. Stevens mentored me in using these templates to project baseline scenarios in the absence of mitigation measures. She voluntarily developed additional calculation templates to project mitigation scenarios to assess the mitigation potentials of proposed mitigation actions in rice cultivation.

As I look back, I'm filled with admiration for the hard work and dedication that Dr. Stevens put into this project, often not confined to the scope of her duties only. On behalf of all the participating countries I would like to express a deep sense of gratitude to Dr. Stevens, the GHGMI and the Inter-American Institute for Cooperation on Agriculture (IICA) for the valuable contribution to building our capacity in GHG inventory and data collection.

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Executive Summary

The purpose of this Regional Agriculture GHG Inventory Improvement Guidance Report is to identify common challenges and provide recommendations on how countries in the Caribbean region could work together to improve agriculture GHG inventory reporting. The report also provides some general guidance and tools on institutional setup for GHG inventories, data collection and gap filling, quality control processes, monitoring and reporting, and capacity building.

With respect to institutional arrangements, it is difficult to provide regional guidance as this is very country specific; however, guidance is provided on the possible composition of the inventory team, as well as the roles and responsibilities of its members. An excel tool is provided to assist countries in documenting the team members and identifying the competencies required for each position.

Livestock population data, synthetic fertiliser data, manure management data and crop management data are the data sets that are identified as being on the priority list for improved data collection. Data collection of these data sets needs to be improved across the region. Example data collection templates are provided, although these templates are merely a guide and may be adapted by each country to suit its needs, or incorporated into existing data collection systems. Further guidance on data collection is provided in the materials from the Data Collection training course that was held in April-May 2022. For those countries that rely on international data sources for their inventory activity data, it must be borne in mind that these data sets must be evaluated more closely and, if possible, the underlying data sources found. This will assist in providing further insights into the data time-series, and aids the inventory compiler in understanding the quality and uncertainty associated with the data.

Gaps in data pose a challenge across the region, as data sets are not always collected annually. IPCC 2006 provides guidance on various splicing (or gap filling) techniques that can be applied to complete the time-series data. In this guidance report, the guidance provided on the use of these techniques is discussed and examples are provided to guide inventory compilers through the process.

With respect to quality assurance and quality control (QA/QC), it has been noted that only a few countries have a QA/QC plan. Therefore, guidance on how to develop a QA/QC plan is provided (based on the IPCC 2006 Guidelines) with respect to the types of QA/QC activities and when they should be completed relative to the inventory cycle. A list of Tier 1 quality checks is also provided.

For archiving and reporting, guidance is provided on Method Statements, along with a template. Method Statements are one of the ways in which countries can document all the relevant information related to inventory methods, data, QA/QC and verification for each category in the inventory.

Based on information from the National Agriculture GHG Inventory Improvement Action Plans, the main capacity building needs identified are Agriculture GHG compilation training, data collection training and QA/QC training. These plans also highlighted the need for awareness building at both the farmer and policy maker level, across the region. The sustainability of capacity building needs to be considered taken into account in the future.

The report provides some guidance of how countries can work together to address the common regional challenges faced by agriculture inventory compilers.

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Acronyms

CARICOM	Caribbean Community
CSA	Climate Smart Agriculture
COP	Conference of the Parties
CS	Country specific
DF	Default factor
EFs	Emission Factors
EJ	Expert Judgement
FAO	Food and Agriculture Organization
GCF	Green Climate Fund
GPG	Good Practice Guidance
GHG	Greenhouse Gas
IE	Incomplete estimation
IFA	International Fertilizer Association
IICA	Inter-American Institute for Cooperation on Agriculture
IPCC	Intergovernmental Panel on Climate Change
MRV	Monitoring, reporting and verification
MS	Method statement
NA	Not applicable
NE	Not estimated
NIR	National Inventory Report
NDC	Nationally Determined Contribution
ND	No data
NO	Not occurring
T1	Tier 1
T2	Tier 2
QA	Quality assurance
QC	Quality control
VS	Volatile solids

1. Introduction

The readiness project, "Strengthening the foundation for a climate responsive agricultural sector in the Caribbean" (CARICOM AgREADY 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 and 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 risk 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 the collection, monitoring, measuring, reporting, verifying (MRV), and analysing agriculture and associated activity data from the sector. This includes work with national and regional stakeholders as well as 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 prioritized agricultural value chains, with a focus on cultivating the innovative capacity of the region´s youth.

Regarding climate change mitigation, the project started with a scoping analysis of how agriculture was included in the Nationally Determined Contribution (NDC) of each country. The project also developed nine national and one regional agriculture GHG inventory improvement action plans, as well as a regional data collection framework, which were validated in different ways, including through national and regional workshops. Additionally, the development and implementation of a course on agriculture GHG inventory compilation for experts was undertaken, as well as a train-the-trainer workshop for agricultural extension officers and farmer representatives in data collection procedures, which was then replicated in each country for farmers by the participants.

This report is the Regional Agriculture GHG Inventory Improvement Guidance Report, which provides information to guide the nine countries included, but can also serve to support other countries in the region.

2. Objectives

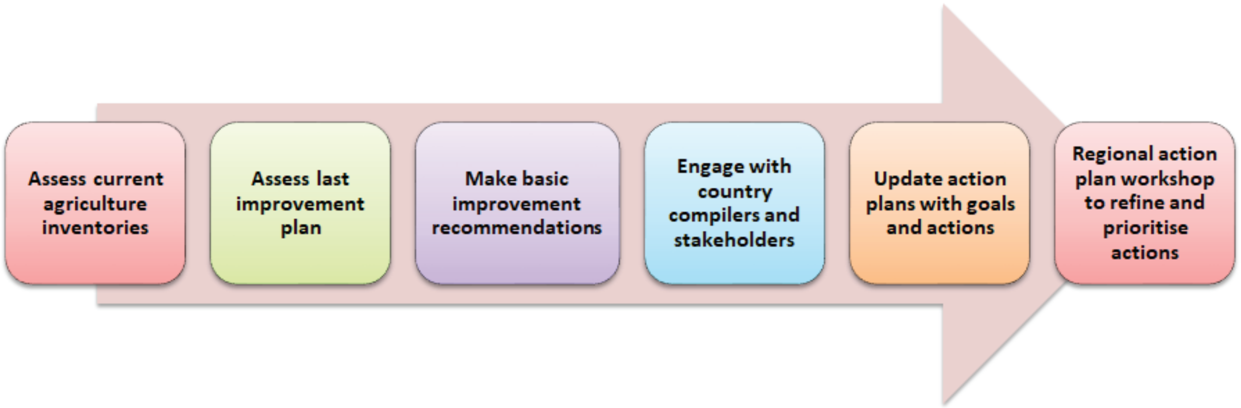
National action plans for improving agriculture GHG inventories for the nine CARICOM countries were developed, however there are often commonalities across the region. The aim of this document is to identify these commonalities and to provide recommendations on how countries can work together to improve the agriculture GHG inventories in the region. In addition, some general guidance on data collection, filling gaps in data, QA/QC processes and report writing, which countries can use as a basis to develop their own country specific plan, is presented.

3. Methodology

Firstly, the National Agriculture GHG Inventory Improvement Action Plans (NAGIIAPs) for the 9 countries were developed (Figure 1). The actions were considered under four main categories:

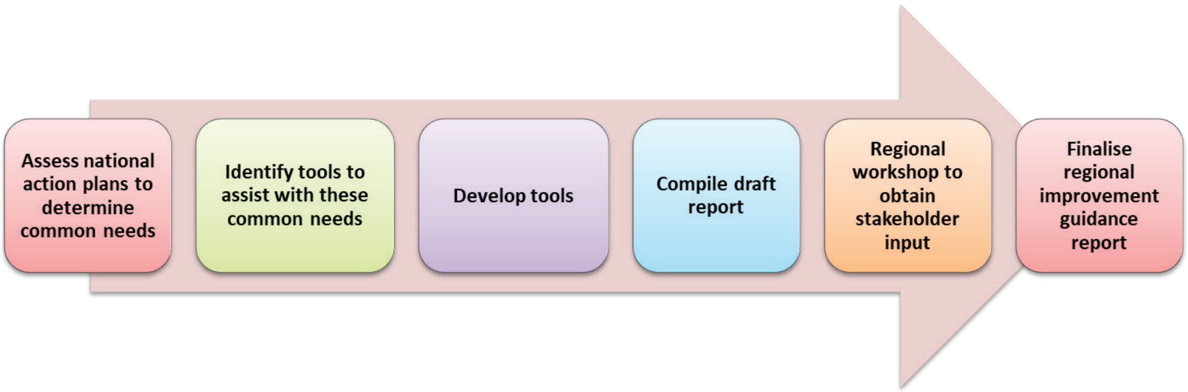
- Institutional arrangements
- Data collection
- QA/QC process
- Archiving and reporting

Figure 1: Overview of the development process for the National Agriculture GHG Inventory Improvement Action Plans



The starting point of the Regional Agriculture GHG Inventory Improvement Guidance Report process (Figure 2) was the assessment of these national action plans to determine the common needs across the region. Based on these challenges, some recommendations were made in terms of what may be needed to move forward. Tools that could assist countries in dealing with these common challenges were identified and developed, and then presented in this Regional Agriculture GHG Inventory Improvement Guidance Report.

Figure 2: Process for developing the Regional Agriculture GHG Inventory Improvement Guidance Report



4. Institutional Arrangements

All nine countries assessed are still setting up and developing their institutional arrangements. In some cases, the agriculture inventory compilation occurs in the Ministry of Agriculture or Ministry of Environment while in other cases it may be a consultant or someone from a research institute or university. None of the countries has a formal process in place for data collection, but rather, the agriculture compiler is responsible for collecting the data from the various data sources. The common data sources are the Ministries of Agriculture, statistics departments or bureaus, customs agents and FAOSTAT.

Institutional arrangements are context specific and will need to be decided by the country; however, Figure 3 shows the basic composition of an inventory team. In the Caribbean region, as with many developing countries, resources and capacity are limited, leading to one person performing more than one task. It is important that all countries create institutional arrangement diagrams to incorporate into their inventory reports to show the flow of information between the institutions, from data sources to the organisation or Ministry designated to prepare the GHG inventory. Table 1 provides some ***guidance on the responsibilities of the various team members,*** and a ***template*** is provided in Excel (see Appendix A). The specific responsibilities of the agriculture compiler are provided in Table 2.

Figure 3: General components of a National GHG Inventory team

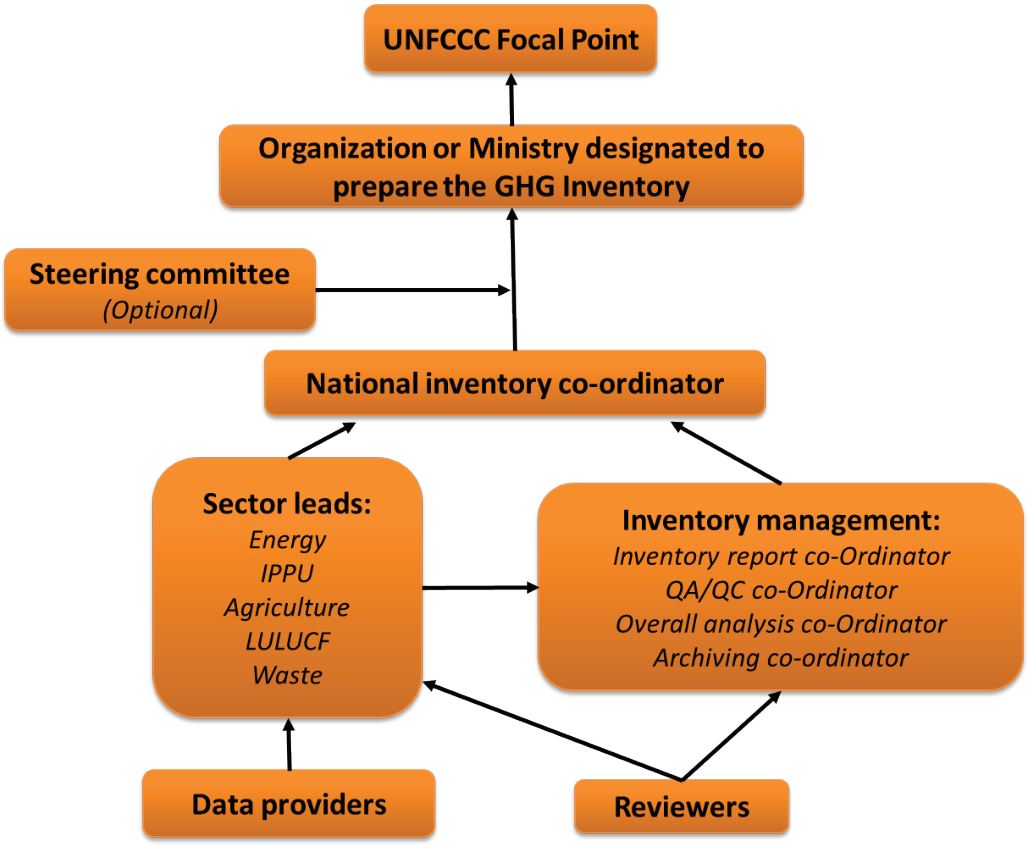


Table 1: General guidance on roles and responsibilities of the GHG inventory team member[1]

Entity	Responsibilities
Designated Organisation/ Ministry for Inventory Preparation	• Management of submissions and their consistency with other related submissions; • Development of legal and contractual infrastructure (review of structure and implementation); • Executive engagement with stakeholders (including data providers and users); • Ensuring participation of relevant stakeholders; • Management of contracts and delivery of GHG Inventory; • Prioritising and facilitating improvements (through new agreements and/or research); • Submission of the National Inventory Report/ BUR/NC to the UNFCCC focal point, who will submit to the UNFCCC.
National Inventory Coordinator	• Manage and support the National GHG Inventory team schedule and budget in order to develop the inventory in a timely and efficient manner by: – Preparing a detailed work plan for producing the National GHG Inventory, including interim deliverables and specific outputs, in close consultation with sectoral leads; – Establishing internal processes and schedules to ensure that the national inventory team produces accurate emission estimates; – Developing Terms of Reference documents and contracts with consultants to support inventory cross-cutting tasks and report compilation; – Overseeing sector leads/consultants handling the report compilation, both at the individual sector level as well as compilation from all sectors, to ensure incorporation of the inventory into the NC and BUR for submission to the UNFCCC. • Identify, assign and oversee national inventory sector leads by: • Assisting sector leads to prepare and implement sector-specific work plans; – Assisting sector experts to obtain activity data from data suppliers where necessary; – Communicating uncertainty analysis plan and procedures to team members and sector leads; • Assign cross-cutting roles and responsibilities, including those for Quality Assurance/Quality Control (QA/QC), archiving, key category analysis (KCA), uncertainty analysis and compilation of the inventory section of the NC and/or BUR. – For all project activities coordinate with cross-cutting leads to convey responsibilities to sector leads, consultants, national agencies and institutions, as well as relevant international organisations; – Manage QA processes and inventory review periods (if applicable) with support from the QA/QC Coordinator: ° QA includes review procedures conducted by personnel not involved in the inventory development process; ° Coordinate the response to comments received from QA (external) reviews of the sector GHG estimates and update the inventory if necessary; ° QA/QC of the data before submission & QA/QC of reports; • Provide technical support to the Designated Organisation or Ministry with stakeholder engagement and setting up data supply agreements (designing specifications and timetables); • Maintain MoU/MoAs between Designated Organisation or Ministry responsible for GHG Inventory preparation and data providers; • Maintain and implement a national GHG inventory improvement plan; • Prepare the submission for the UNFCCC; • Obtain all necessary government approvals for the National Inventory Report (NIR), BUR or NC before submission; • Foster and establish links with related national projects and other regional or international programmes, as appropriate.
Steering committee (optional)	• Provide input for improvement planning; • Respond to requests to review high-level data and assumptions.
Sector leads	• Review the IPCC Guidelines *for National Greenhouse Gas Inventories* and *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories.* – Understand the GHG categories that are sources in the relevant sector; – At a minimum, understand the Tier 1 methodologies, data needs, and other requirements for developing GHG estimates for the sector, and become familiar with those for Tier 2; • Collaborate with the National Inventory Coordinator to manage the sector budget and develop a sector-specific work plan and schedule that coincides with deliverables acknowledged in the overall National Inventory Schedule; • Develop and implement a 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 the national inventory; • Gather data and conduct technical engagements with data providers; • Consider potential improvements identified in the previous inventory for this sector and assess whether to implement improvements based on the contribution to overall national emissions (by conducting a Key Category Analysis) and availability of resources; • In consultation with the QA/QC coordinator, convene a sector working group to review calculations and perform initial Quality Assurance/Quality Control (QA/QC): – 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); • Coordinate the response to comments received from QA (external) reviews of the sector GHG estimates and update the inventory, if necessary; • Review the final sector GHG estimates and the narrative describing the assumptions, methodologies, and results; • Ensure consistency of data; • Coordinate with lead compilers of other sectors to ensure no double counting or losses; • Oversee the development of the uncertainty analysis for the sector; • Identify and document any improvements needed for subsequent inventories, related to activity data, emission factors, methodologies, or other components for developing the estimates; • Assist in determining the key categories in the sector; • Coordinate with the Archives Manager and ensure all relevant data and documents are archived; • Ensure all relevant information is incorporated into the MRV system.

1 Adapted from EPA Toolkit for Building National GHG Inventory Systems

Entity	Responsibilities
QA/QC Coordinator	• Clarify and communicate QA/QC responsibilities to National GHG Inventory team members; • Develop QA/QC checklists appropriate to roles on the inventory team; • Distribute QA/QC checklist to appropriate inventory team members and set deadlines for completion; • Ensure the timely and accurate completion of QA/QC checklists and related activities by checking in with team members; • Ensure all uncertainty analysis has been completed and included in QA/QC lists; • Collect completed QA/QC checklists and forms; • Review completed QA/QC checklists and forms for completeness and accuracy; • Deliver documentation of QA/QC activities to the National Inventory Coordinator and archive coordinator; • Coordinate external reviews of the inventory document and ensure that comments are incorporated into the inventory.
Document Manager	• Obtain all sector reports from lead compilers and compile the overall National Inventory Report, BUR or NC; • Complete the overall Key Category Analysis; • Incorporate all the introductory information (institutional arrangements, inventory preparation, QA/QC plan, data archiving, etc) by liaising and obtaining information from the various section managers; • Complete all the overall trends (graphs, tables and text); • Complete all the Appendices; – Collect uncertainty data from sector leads and complete overall uncertainty analysis; • Have the Inventory report edited; • Perform document QA/QC checks; • Ensure document is produced in a timely manner.
Archive Manager	• Communicate archiving system plan, procedures and responsibilities to other staff; • Determine archiving tasks and assign tasks to staff; • Create a checklist of archiving procedures for team members to follow; • Ensure that the archive procedures are carried out effectively; • Serve as the keeper of the permanent archive and respond to future requests to view archive materials.

Table 2: Agriculture lead compiler responsibilities[2]

Agriculture lead responsibilities	Sub-tasks
• 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.*	• Understand the GHG categories that are sources in the agriculture sector. • At a 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.
• 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.	
• Develop and implement an agriculture sector-specific plan for archiving all relevant information and materials, in coordination with the Archive Coordinator and adhering to any existing archiving guidance materials for your national inventory.	
• 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 residues 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.	
• Oversee the establishment of arrangements between agriculture sector data collectors and data suppliers.	• Collaborate with the Inventory Coordinator to record the institutional arrangements for the agriculture sector. • 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). • 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

2 Adapted from EPA Toolkit for Building National GHG Inventory Systems

Agriculture lead responsibilities	Sub-tasks
• 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.	
• 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	
• Oversee development of GHG estimates from all categories in the agriculture sector.	• Determine the most appropriate IPCC methodology to be used to estimate GHGs for each category in accordance with decision trees. • Oversee choice and/or development of emission factors. • 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. • Ensure consistency of data between enteric and manure management (e.g., livestock populations and characterisation). • Ensure consistency between nitrogen quantities in Manure Management and Agricultural Soil Management. • Coordinate with the Waste sector to ensure that assumptions on application of sewage sludge and nitrogen content are consistent. • 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 who are developing the estimates.
• In consultation with the QA/QC Coordinator, convene agriculture sector working group to review calculations and perform initial Quality Assurance/Quality Control (QA/QC), in consultation with QA/QC Coordinator.	• 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.). • 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 in estimate development). • Ensure that QA/QC procedures are consistent with the general and sector-specific procedures, which you should be able to obtain from the Inventory Coordinator.
• Coordinate the response to comments received from QA (external) reviews of the agriculture sector GHG estimates and update the inventory, if necessary.	
• Review the final agriculture sector GHG estimates and the narrative describing the assumptions, methodologies, and results.	
• Oversee the development of the uncertainty analysis for the agriculture sector.	
• Identify any improvements needed for subsequent inventories relating 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 prioritisation in the overall inventory improvement plan.	

5. Data Sources and Data Collection Procedures

5.1 Priority Emission Sub-categories in Agriculture across the Region

The priority emission sub-categories for the various countries are shown in Table 3. Enteric fermentation emissions are in the top three sub-categories for all nine countries, and Direct N_2O emissions are important in six of the nine countries. If there are direct N_2O emissions there will also be indirect N_2O emissions, however, the indirect emissions are a portion of direct emissions and are therefore smaller. With lower emissions, the indirect emissions are therefore less important and are not always included in the top-three sub-category emission list. Biomass burning is not estimated for all countries, but is also shown to be important in four of the nine countries. Rice cultivation is obviously only present for those countries which have rice cultivation.

Table 3: Top three emitting sub-categories in Agriculture for each country

	The Bahamas	Belize	Dominica	Haiti	St Kitts & Nevis	Saint Lucia	St Vincent & the Grenadines	Suriname	Trinidad and Tobago
Enteric fermentation	3	1	2	1	1	2	3	3	1
Manure management									
Biomass burning		3	1					2	2
Lime application			3						
Urea application									3
Direct N_2O from MS	1	2		2	2	1	1		
Indirect N_2O from MS	2				3	3	2		
Indirect N_2O from MM									
Rice cultivation				3				1	

It is noted that the calculation for enteric fermentation is easier than that for Direct N_2O, and is often the reason why it is the first sub-category that countries include in the emission estimates. Direct N_2O emissions require more input data, which includes nitrogen inputs from:

- Synthetic fertilisers
- Organic fertilisers (which include managed manure inputs)
- Crop residues
- Urine and dung
- Mineral soils
- Organic soils

The details of what is included in the Direct N_2O emissions are not always reported, but it appears that, in most cases, synthetic fertiliser, managed manure as well as urine and dung inputs are included, with crop residues only being included for a few countries due to a lack of data. Inputs from mineral and organics soils ae not included for any of the countries as these require soil data information from the LULUCF sector. It is noteworthy that none of the countries has included soil carbon in their LULUCF calculation estimates due to a lack of data and knowledge on the methodology for incorporating soil carbon data.

5.2 Data Sources for the Agriculture Sub-categories across the Region

The sources of data for the agriculture GHG inventories were assessed through the National GHG Inventory reports, as well as stakeholder consultations, and the results are shown in Table 4.

Livestock: For livestock population data, Dominica and St Kitts and Nevis rely solely on FAO data[3], while Suriname, St. Vincent and the Grenadines and Belize have country specific data for almost all livestock categories. The other countries have a mix of FAO and country specific data. Saint Lucia possesses country specific data prior to 2010; the FAO data is used as surrogate data to estimate the amounts and trends in the livestock population from 2010 onwards.

Using surrogate data is the only way to fill in the gaps in the time series. Inconsistent time series is the reason why most countries use FAO data instead of country specific data. Limited data makes it difficult to fill the gaps, but if there is several years of country data, then the various IPCC ***gap filling techniques*** can be considered (***guidance*** provided in Appendix C). That way, country specific data is still used.

Nitrogen inputs: In terms of nitrogen inputs, half of the countries rely on FAO data for synthetic nitrogen input data, while the rest have country specific data, which is most often obtained from customs data. In several cases, the country-specific nitrogen fertiliser data is not disaggregated enough to separate out the urea data and, in these cases, countries rely on FAO data. FAO data is not available for all countries; therefore, this input dataset is often not available at all, and urea CO_2 emissions are not estimated. Fertiliser data can also be obtained from IFASTAT (https://www.ifastat.org/), which is the data from the International Fertilizer Association (IFA). This could be an alternate data source to consider.

Lime application: Lime application data is not available on the FAOSTAT website; therefore, if the country does not have data, then the CO_2 emissions from lime application are not estimated. This is the sub-category that is the most incomplete across the region, but it is also understood that lime application is not large in the Caribbean, so it is not expected to have large emissions.

Crop residue: Crop residue input amounts are not often known by the farmers, so country specific data is not available. However, crop residue input data can be estimated by combining crop area and residue management data with some IPCC default values. Not all the inventory reports document the details of how crop residue input data is determined, but Belize and Suriname have county specific crop area data and are able to estimate the crop residue inputs. Saint Lucia and Trinidad & Tobago apply crop area and yield data from FAO data.

Rice Cultivation: Similarly, for rice cultivation, the crop area data is the activity data, and this is either obtained from FAO or country specific data.

All countries, except Belize, apply a Tier 1 method for estimating emissions from all sub-categories (Table 5). Belize applies a Tier 2 method for biomass burning as they have a county specific emission factor for crop residue burning.

3 https://www.fao.org/faostat/en/#home

Table 4: Data sources for the various data in each country4

	The Bahamas	Belize	Dominica	Haiti	St Kitts & Nevis	Saint Lucia	St Vincent & the Grenadines	Suriname	Trinidad and Tobago
Cattle population	FAO	CS	FAO	CS/FAO	FAO	CS/FAO	CS	CS	FAO
Buffalo population	NE	CS	FAO	NA	NO	NA	NA	CS	FAO
Sheep/goat population	CS	CS	FAO	CS	FAO	CS/FAO	CS	CS	CS
Swine population	FAO	CS	FAO	CS	FAO	CS/FAO	CS	CS	CS
Horse/mule/ass population	CS	FAO	FAO	CS/FAO	ND/FAO	NE/FAO	CS	CS	NA
Poultry population	FAO	CS	FAO	CS	FAO	CS/FAO	CS	CS	FAO
Manure management data	EJ	EJ	EJ	CS	CS	EJ	EJ	EJ	DF
Lime application	NE	CS	CS	ND	NE	EJ	ND	NO	ND
Urea application	CS	CS	NA	CS	CS	ND	ND	FAO	FAO
Synthetic N fertiliser application	CS	CS	FAO/ CS	CS	FAO	CS	CS	FAO	ND
Crop residue data	NE	CS	NA	EJ	NE	FAO	NE	CS	FAO
Rice cultivation data	NE	CS	FAO	CS/FAO	NO	NA	NO	CS	FAO

FAO = Food and Agriculture Organization; NA = Not applicable; CS = Country specific; EJ = Expert judgement; ND = No data, NO = Not occurring; NE = Not estimated.

Table 5: Tier method applied to estimate the sub-category emissions for the 9 countries[5]

	The Bahamas	Belize	Dominica	Haiti	St Kitts & Nevis	Saint Lucia	St Vincent & the Grenadines	Suriname	Trinidad and Tobago
Enteric fermentation	T1	T1	T1	T1	T1	T1	T1	T1	T1
Manure management (CH_4)	T1	T1	T1	T1	T1	T1	T1	T1	T1
Manure management (N_2O)	T1	T1	NE	T1	T1	T1	T1	T1	NE
Biomass burning	NE	T2	NE	T1	T1	T1	T1	T1	T1
Lime application (CO_2)	NE	T1	T1	NE	NE	NE	NE	NO	NE
Urea application (CO_2)	T1	T1	NE	T1	T1	NE	NE	T1	T1
Direct N_2O from MS	T1	T1	T1	T1	T1	T1	T1	T1	NE
Indirect N_2O from MS	T1	T1	T1	NE	T1	T1	T1	T1	T1
Indirect N_2O from MM	T1	T1	T1	T1	T1	T1	T1	T1	NE
Rice cultivation	NE	T1	T1	T1	NO	NO	NO	T1	T1

T1 = Tier 1; T2 = Tier 2; NE = Not estimated; NO = Not occurring.

4 Country National Agriculture GHG Inventory Improvement Action Plans

5 Country National Agriculture GHG Inventory Improvement Action Plans

5.3 Priority Data Collection Requirements

5.3.1 Livestock Population Data

The inventory improvement assessment shows that the two data sets that most countries indicate need improvement are livestock population data and nitrogen fertiliser data. This is no surprise since enteric fermentation and direct N_2O from managed soils are the dominant emitting categories in the region. Livestock population data are the key activity data for enteric fermentation calculations, but it is important to note that this activity data set also impacts the following sub-categories:

- Manure management – through the amount of manure produced
- Direct N_2O from managed soils – through the managed manure inputs, as well as through the amount of nitrogen added to the soil in the form of urine and dung
- Indirect N_2O from managed manure – this is linked to direct N_2O from manure management as it is a fraction thereof)
- Indirect N_2O from managed soils – this is linked to the direct N_2O emissions as it is a fraction thereof)

This highlights the importance of this data set. Accurate estimates of livestock populations affect a large portion of the agriculture emissions inventory.

Since about half of the countries rely on FAO data for livestock populations, it would be important to do a comparison of the FAO data wherever country specific data is available. A quick assessment comparing FAO data to the country census data, which is very limited) shows that if the data in FAOSTAT indicates official data, then it generally matches up with the country specific census data. This is the case for Belize 2009 census data for cattle, pigs and sheep[6], and Saint Lucia's 1996 and 2007[7] census data for pigs, sheep and goats. For the cattle in Saint Lucia, the FAO data indicates that it is unofficial, and the FAO data is approximately double that provided in the country census. Poultry data is also indicated to be unofficial in FAOSTAT and is again overestimated according to the country data. Dominica, on the other hand, conducted a census in 1995[8] and the FAOSTAT data indicates that the cattle numbers are more than four times what was provided in the census data; however, it is noted that the data is not listed as official in the FAOSTAT database. The FAO pig and sheep numbers are overestimated by 30% and 128%, respectively, while goat numbers are underestimated by 11%. The Dominica data needs to be assessed in more detail.

The annual goat, sheep and rabbit data from the Central Statistics Office in Trinidad & Tobago for the years 2016 to 2019[9] were compared to FAOSTAT. The FAO indicates that 2016 data is official, and the population numbers do not exactly match the CSO data, but are close. For the other years, FAO has made estimates, and a comparison of these years to CSO data shows that the FAO data does not indicate the annual variation provided by the CSO data. FAO data shows small variations, whereas the CSO data annual variation is greater. This, again, shows the importance of country specific data as it takes into account events that are occurring on the ground.

6 Ministry of Agriculture, Forestry, Fisheries, the Environment, Sustainable Development and Immigration, 2020. Belize's Fourth National Greenhouse Gas Inventory Report.

7 Government of Saint Lucia, 2007, 2007 Saint Lucia Census of Agriculture: Portrait of the main findings, Ministry of Agriculture, Forestry and Fisheries. Found at: https://www.govt.lc/media.govt.lc/www/resources/publications/2007AgricultureCensus.pdf

8 Government of Dominica, 2012. Dominica Second National Communications on Climate Change.

9 Central Statistics Office, 2018. Small Ruminants Bulletin, July - September 2018, Republic of Trinidad and Tobago, Ministry of Planning and Development. https://cso.gov.tt/wp-content/uploads/2020/01/Small-Ruminants-July-September-2018.pdf

Suriname livestock population data[10], which is annual data between 1990 and 2018, matches that provided by FAO; it is indicated as official data in the FAO database. Having additional census data to compare to FAO would allow the trends in the FAO data to be assessed more closely; it is also important to ensure variations on the ground, such as those due to natural disasters, are reflected in the livestock population data.

5.3.2 *Synthetic Nitrogen Fertiliser Data*

For direct N_2O emissions, most countries indicate that nitrogen fertiliser data needs to be collected. Several countries rely on FAO data, therefore, in-country data needs to be obtained to validate this data. When using the FAO data, compilers must try to understand where this data is coming from in order to assess its quality. As mentioned above, the IFA data could also be used as a comparison point.

With respect to inventory compilers, it is also evident that there can be confusion on how to use the FAO data correctly, particularly the data disaggregated by fertiliser type. A detailed guidance document on how to use the disaggregated fertiliser data in the inventory should be developed in the future to guide the inventory compilers through the process and reasoning. This would also include the Urea data.

5.3.3 *Manure Management Data*

Direct N_2O emissions do not only include synthetic fertiliser, but rather a large portion is due to animal manure applications as well as urine and dung inputs. This is not always associated with direct N_2O. As mentioned above, accurate livestock population data is one component of improving this data set; the other aspect is the manure management data. The manure management data indicates the percentage of manure that goes to the various management systems. This will impact not only manure management emissions, but also direct and indirect N_2O emissions. Often the manure management data is overlooked, and this could be a relatively easy dataset to obtain through a survey. Countries already rely on expert opinion for this dataset; however, this is usually the opinion of only a few experts. To improve this dataset, a survey could be undertaken across a wider area to cover many more farmer inputs. This would provide more accurate data and would also provide information on uncertainty. Manure management may not change every year; therefore, a survey could be done every few years instead of every year.

5.3.4 *Crop Residue Data*

Another data set that is seldom mentioned in the different country improvement plans is crop residue data. This is another form of nitrogen input into the soil that can lead to both direct and indirect N_2O emissions. The estimation of crop residue data is also not well documented in reports, making it difficult to properly assess exactly the data that is being used to determine the amount of residue applied. The amount of crop residue applied to soils can be estimated from crop area, yield and residue management data. The crop residue management data is similar to the manure management data and could be collected in a similar manner. However, the difficult data to obtain is the crop area and yield data. This is challenging for small-scale farmers since they do not keep records and often have more than one crop throughout the year. Therefore, it might be better to collect data twice a year; however, this places an extra burden on data collectors and extension services.

10 Data provided by Iwan Samoender, Climate Change Unit at the Ministry of Agriculture (LVV)

Information on crop residue management also has an impact on:

- Biomass burning emissions – the practice of burning residues leads to emissions and is the main factor contributing to biomass burning emissions in agriculture.
- Soil carbon storage – crop residue management is incorporated into the climate smart agriculture (CSA) activities. These CSA activities are included in some country NDCs as an adaptation action. However, since they also have mitigation co-benefits, this could be a way to enhance agriculture mitigation in future NDCs.

As with livestock population data, crop residue management data has multiple impacts on the GHG emission inventory for agriculture.

5.4 Suggested Actions for Data Collection in the Region

5.4.1 Data Collection Procedures for Annual Livestock Population, Crop Area and N Fertiliser Data

Suriname has annual livestock population data and crop area data that is published officially by the Ministry of Agriculture. The data is collected through the agriculture extension service and could serve as an example for other regional countries on how to collect annual livestock population and crop data. Trinidad & Tobago also collects quarterly data for some livestock and crops in order to obtain annual estimates and this is done via surveys. Nitrogen fertiliser data could also be considered for inclusion in these types of data collection systems. ***Data Collection Templates for data providers***, which were provided during the Data Collection training for farmer representatives and shown in Appendix B, can serve as a starting point to enable data providers to understand the data requirements. It would be ideal if some of these questions could be included in the current country data collection systems. Several countries already collect data from farmers via a questionnaire, either annually or quarterly. Including GHG inventory data requirements in these existing forms would yield the best results.

During stakeholder discussions it is apparent that the extension offices have training or demonstration centres. It would be useful to utilise these demonstration centres to pilot the data collection templates with the farmer before incorporating them into existing systems or rolling them out on a larger scale. Extension officers can discuss a reasonable time period to collect the data with the farmers, whether quarterly or annually. Ideally, data should be collected at the same time each year in order to be consistent. Through a pilot project, the data collection templates can be modified to address any challenges that may arise, or to determine if there is any additional data that can be included in the data collection templates.

Surveys or data collection templates may be completed manually or electronically. Electronic forms could speed up the process of transferring data from the data provider to the regional and national offices.

In addition to the process of collecting data, data flows and procedures must be put in place and tested. Data should flow from the farmer to the extension officer and on to regional and national agricultural offices. Countries would need to determine if the data would flow to statistics offices or to the Agricultural Ministries. In order to ensure that data collection does occur, policies must be put in place so that data collection for inventories is the mandate of the agriculture ministries.

It is both resource and time intensive to visit all farms to collect data. Other options may be to develop an app into which farmers can input data. The app could be developed from the piloted data collection templates to guide the user through the data collection process. Training centres may also be used to train farmers in how to input the data. There are various agricultural apps in use and should be examined to determine whether existing systems can be added before developing an entirely new system. The development of an app could be a regional project.

The concept of using drones for data collection was raised during the regional workshop. Dominica and Saint Lucia both indicated that their country had participants participating in a training workshop hosted by FAO on the use of drones[11]. Due to the expense and coverage, this is not likely to be a sustainable and national data source for inventory data, but the data could be used to augment other datasets. It could provide access and livestock counts in remote areas, which could support the data collection from agricultural services. Drones can be used to monitor specific studies and monitor GHG emissions, soil moisture and nitrogen content. They could be used on a project basis to monitor an area before and after an adaptation/mitigation action has been implemented, thus monitoring the impacts of various actions.

The problem with collecting data, whether through the extension officers or the app, is that there needs to be an incentive or perceived benefit to farmers. Farmers need to be engaged through workshops to understand what the incentives might be. If farmers register to collect data, they could receive additional information on aspects such as weather, links to markets, training sessions, technology innovations, financing, relief funds or service provisions. It could be of interest to have the app show them what their carbon footprint or emissions are, and how it changes over time. This information could assist them in reaching other markets (low emission markets) if they are interested in contributing to the environment by reducing emissions.

Data collection could also be done through an alternate process to extension officers. In The Bahamas, for example, a farm registration system is being established in which farmers must register in order to receive grants or funds, such as disaster relief funds. This system may not be able to collect a lot of detailed data, but it could be used to collect crop area data and livestock population data.

5.4.2 Manure Management and Crop Residue Management Data

Collecting management data yearly is useful for tracking the impacts of changes in management; however, if this type of data cannot be incorporated into annual data collection processes, it can be collected in census data. Management is less likely to change yearly; therefore, collecting this type of data at intervals would still provide useful information. It is recommended that census data be collected at least every 10 years, preferably every 7 years. This type of data also lends itself to a project-based study. Sometimes funding is available on a project basis; therefore, a project could be initiated through which a survey is conducted across various regions to determine the use of the manure management system. This would be a static number but would still be better than no data or expert opinion.

5.4.3 Tier 2 Emission Factor Data

Most of the countries are not ready to proceed to Tier 2 as the focus should be obtaining good, sustainable activity data for Tier 1. Suriname has annual livestock and crop data and is the only country that could consider moving to Tier 2. The Tier 2 approach requires a greater disaggregation of the livestock data and therefore the enhanced categories need to be defined first, and then considered for inclusion in the agriculture extension programme. However, there is no point in having disaggregated data if there are no emission factors to accompany these disaggregated categories. This means that

11 Discussions with Winston Doboulay (Ministry of Agriculture, Saint Lucia) at the Regional Action Plan Workshop, July 2022

starting to develop a system to collect more disaggregated population data must be accompanied by a plan to collect more detailed data to estimate country specific emission factors.

There are numerous data requirements for estimating Tier 2 enteric fermentation emission factors. It is unlikely that all the background information for Tier 2 emission factors will be collected on an annual basis; however, a more project-based approach could be applied in the interim. In this case, the key livestock should be selected, beef cattle in the case of Suriname, and then a project established to collect the relevant Tier 2 information from a representative farm or organisation. The study could be carried out through an agricultural research organisation or through a university. This data could then be used to calculate a country specific emission factor for that category of livestock. Since the background data is not being collected annually, the emission factor would not vary annually. However, it may be more representative than the Latin America IPCC default value that is being applied by all countries. This will also provide insights into the data requirements; a sensitivity analysis could be conducted to determine which required data is most important. This will then provide the focus for future research or data collection processes, so that new data requirements can be slowly introduced into the annual data collection system. This type of project can be utilised as an example for future studies and could include other livestock types and other countries.

5.4.4 Regional Database

It would be useful to establish a central repository for agriculture data that can be used as reference for the region. Currently the IPCC 2006 Guidelines provide a lot of default data, but this is for the Latin America region in general, so developing a database of factors for the Caribbean would be useful. This data may be compared with the IPCC default values, but may provide more accuracy for the region. This could contain information such as livestock weights, milk production, feed intake, digestibility factors, manure management practices, nitrogen application rates, etc. Quality control processes will need to be put in place to ensure data incorporated into the database is of good quality. It is suggested that a quality control guidance document be drawn up to indicate what the rules are for determining good quality data.

5.4.5 Regional Data Collection Framework

A ***Regional Data Collection Framework*** has been drawn up and is presented in a separate report.

5.5 Data Processing

In many cases, countries may have data for a year and often the FAO data is chosen over the country data because of the consistent time series. The IPCC guidelines provide some methods, called splicing techniques, which can be used to fill data gaps or extend the time series. Countries need to consider these techniques and determine if they are appropriate for filling gaps in their data. This would allow the sparse country data to be incorporated. ***Guidance on the use of the IPCC splicing (or gap filling) techniques*** are provided in Appendix C. ***Examples*** are also given to guide compilers through the process.

6. Quality Control and Verification Procedures

All countries have some form of quality control, but only a few have actually developed a QA/QC plan. In the future, all countries are encouraged to develop a QA/QC plan to follow during the inventory cycle and guidance. In this section, ***guidance is provided on how to develop a QA/QC plan*** and what should be included. Quality control checks and procedures that are specific to the agriculture sector are also discussed.

6.1 Guidance on Developing a QA/QC Plan[12]

A QA/QC plan should contain the following details:

- Introduction
- Roles and responsibilities
- QA/QC objectives
- QA/QC process and timeframes
- QC procedures (general and specific QC checks)
- QA procedures
- Verification procedures
- Documenting and arching procedures

6.1.1 Introduction

This section is an introductory paragraph to the QA/QC plan and should include a few sentences on the importance of the QA/QC process.

6.1.2 Roles and Responsibilities of QA/QC Team

This section should describe the roles and responsibilities of the organisations or team members involved in the inventory QA/QC process. The responsibilities are therefore related to QA/QC activities. The roles and responsibilities are likely to be specific to each country and should take into account the institutional arrangements, composition of the inventory compilation team and the QA/QC process. Table 6 provides some examples of the type of roles and responsibilities that could be considered.

12 Guidance taken from IPCC 2006 Guidelines, Volume 1, Chapter 6

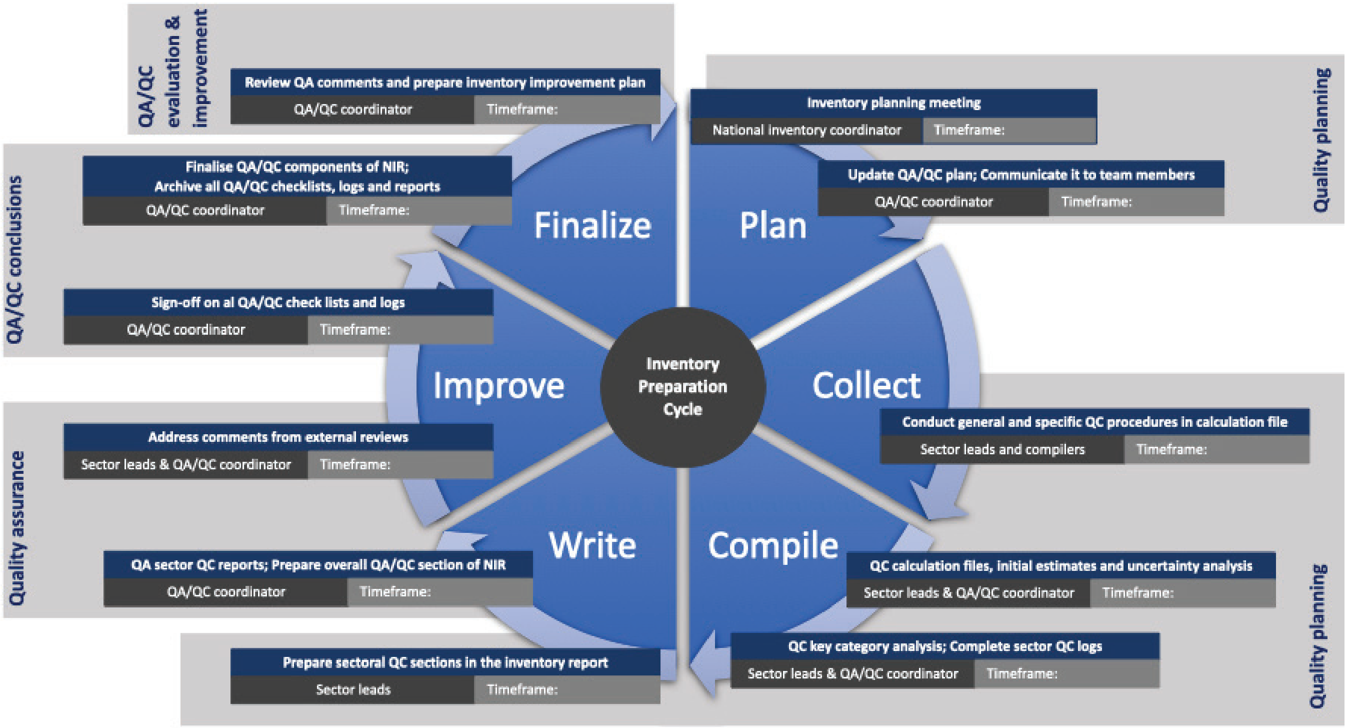
Table 6: Examples of the roles and responsibilities related to the QA/QC process

Role	Responsibility
Organisation or Ministry designated to prepare the GHG inventory	• Ensure that the overall quality checks of the NIR have been completed and that the report meets all international requirements.
National Inventory Coordinator	• Ensure that the QA/QC plan is developed and implemented. • Designate a QA/QC Coordinator who would be responsible for ensuring that the objectives of the QA/QC plan are implemented.
QA/QC Coordinator	• Understand the procedures described in Section 3 and the content of *the IPCC Good Practice Guidance* (Chapter 8, Quality Assurance and Quality Control). • Assign responsibilities for implementing and documenting QA/QC procedures for inventory team members. • Develop QA/QC checklists in keeping with roles on the inventory team. • Distribute QA/QC checklist to relevant inventory team members and set deadlines for completion. • Ensure the timely and accurate completion of QA/QC checklists and related activities by checking in with team members. • Collect completed QA/QC checklists and forms. • Review completed QA/QC checklists and forms for completeness and accuracy. • Sign off on all QA/QC checks. • Document the findings and results of the checks. Careful documentation is important for potential improvements in the inventory and for lightening the work of developers of the next inventory. • Coordinate external reviews of the inventory document and ensure that comments are incorporated into the inventory.
Sector Leads	• Complete QC checks of all input data. • Complete the QC checks in the calculation files during the compilation of the inventory. • Obtain QA review comments from the QA/QC Coordinator. • Implement changes and sign off on comments from the QA Reviewer. • Complete the sectoral QA/QC checklists and return to QA/QC Coordinator.
Inventory Report Coordinator	• Conduct document quality checks. • Complete the Document Manager QA/QC Checklist. • Send the completed document QC checklist to the QA/QC Coordinator. • Liaise with the QA/QC Coordinator during the QA review process and address all review comments.
Data Archive Manager	• Ensure that all calculation files and reports from sector leads and Coordinators have been saved/uploaded to the archiving system. • Ensure that all files are correctly labelled. • Ensure that all supporting data is labelled and archived in the archiving system. • Complete the Archive Manager checklist and submit to QA/QC Coordinator.

6.1.3 Overall QA/QC Process and Timeframes

This section is aimed at outlining the overall QA/QC process and providing timeframes for the various steps. The phases of the QA/QC process relative to the GHG Inventory Preparation Cycle are shown in Figure 4. This template could be used to assist in planning the QA/QC process. The specific timeframes and dates can be inserted or determined during the suggested inventory kick-off meeting at the beginning of every inventory update cycle.

Figure 4: QA/QC process in relation to the inventory preparation cycle.[13]



6.1.3.1 Quality Control Planning

This phase of the QA/QC process is for planning, and a meeting should be held between the National Inventory Coordinator and the inventory coordinating team to plan the work for the next inventory cycle. This section should therefore describe the purpose of the meeting, which would include activities such as:

a) Review of comments from the previous year's submission
b) Discussion on improvements for the upcoming submission
c) Setting of quality objectives and
d) Review and update of the QA/QC plan for the subsequent inventory preparation.

QA/QC Objectives

This section should outline the framework for quality, based on the inventory principles of transparency, accuracy, consistency, comparability, completeness and timeliness. The definitions of the principles (as provided in Table 7) could be included in this section. The outputs produced by the national inventory system are assessed according to these principles. In addition, it could also be indicated that the principle of continuous improvement is included.

13 Modified from Stevens et al., 2017. A National Greenhouse Gas Inventory Management System for South Africa, The Clean Air Journal, 27 (2): 44-51.

Table 7: Quality principles as defined by IPCC (2006)

Principle	Meaning
Transparency	The assumptions and methodologies used for an inventory should be clearly explained to facilitate replication and assessment of the inventory by users of the reported information. The transparency of inventories is fundamental to the success of the process for the communication and consideration of information.
Accuracy	A relative measure of the exactness of an emission or removal estimate. Estimates should be accurate in the sense that they are systematically neither over, nor under, true emissions or removals, as far as can be judged, and that uncertainties are reduced as far as practicable. Appropriate methodologies should be used, in accordance with the IPCC Good Practice Guidance, to promote accuracy in inventories.
Consistency	An inventory should be internally consistent, in all its elements, with inventories of other years. An inventory is consistent if the same methodologies are used for the base and all subsequent years, and if consistent data sets are used to estimate emissions or removals from sources or sinks. The inventory using different methodologies for different years can be considered consistent if it has been recalculated in a transparent manner, taking into account the guidance in Volume 1 on good practice in time series consistency.
Comparability	Estimates of emissions and removals reported by countries in inventories should be comparable among countries. For this purpose, countries should use the methodologies and formats agreed by the COP for estimating and reporting inventories. The allocation of different source/sink categories should follow the split of the IPCC Guidelines, at the level of its summary and sectoral tables.
Completeness	The inventory covers all sources and sinks, as well as all gases, included in the IPCC Guidelines for the full geographic coverage, in addition to other existing relevant source/sink categories that are specific to individual countries (and therefore may not be included in the IPCC Guidelines).

At this point, the objectives for ensuring transparency, accuracy, completeness, comparability and consistency should be provided. Examples of some types of objectives are provided in Table 8, but each country should define its own objectives, and may include the level of detail required by that country, i.e. high level objectives and/or detailed objectives.

Table 8: Examples of objectives that can be carried out to achieve the 5 principles

Principle	Objectives
Transparency	• Provide transparent estimates with clear and up-to-date descriptions of the methodologies, data sources and assumptions information in the NIR. • Use the notation keys as indicated in the UNFCCC guidelines. • Justify recalculations as improvements in accuracy. • Address the recommendations related to transparency provided in the review reports during the preparation of the next inventory submission. • Provide full documentation on quality checks used in the QA/QC procedures. • Present, in the NIR, a summary of the improvement of transparency compared with the previous submission.
Accuracy	• Ensure that methods, data sources and assumptions result in accurate estimates. • Ensure that all data is aggregated correctly between reporting levels. • Ensure that there are verification activities. • Ensure that there is continuous improvement and implementation of all review recommendations.
Completeness	• Report estimates for all sources and sinks and for all gases included in the IPCC guidelines, as well as for other relevant source/sink categories. • Ensure that all data is representative of the national territory. • Address the recommendations related to completeness provided in the review reports, during the preparation of the next inventory submission. • Ensure that the submission includes all calculations, methods and trend descriptions. • Ensure that the submission includes all mandatory and non-mandatory accompanying sections. • Provide information on completeness of the inventory. • Provide a summary, in the NIR, of the changes related to completeness of the inventory and the improvements of completeness from the previous submission.
Consistency	• Maintain a consistent time series of emissions and removals. • Maintain consistency in method application. • Ensure that estimates are consistent with other related datasets or include explanations of the differences between datasets. • Ensure that consistency between common data parameters. • Address the recommendations related to consistency provided in the review reports, during the preparation of the following inventory submission. • Provide information in the NIR on consistency and recalculations. • Explain the major trends and sharp increases/decreases in time series emissions in the inventory time series.
Comparability	• Use the methodologies, procedures and formats agreed upon under the UNFCCC and the Kyoto Protocol for estimating and reporting the national GHG emissions and removals by sinks. • Allocate the emissions and removals to source and sink categories in accordance with the aggregation level presented in the IPCC 2006 Guidelines and IPCC-GPG. • Ensure minimal use of 'IE' and full justification of 'NE.'

6.1.3.2 Quality Control

This is the phase in which the quality checks, which are performed by the experts during inventory calculation and compilation, are implemented. After data collection, selection of emission factors and calculation of emissions the quality is checked (units, sources, methodology, emission factors, transcription, documentation, aggregation, etc) by performing the general and specific quality checks. This section of the QA/QC plan should, therefore, describe the QC process and provide lists of the checks to be completed.

General QC Checks

Provide a list of general Tier 1 quality checks such as those listed in Table 9.

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Table 9: Example of general QC checklist[14]

QC Activity	Procedures	Task Completed		Corrective Measure Taken	
		Name/ Initials	Date	Supporting Documents (List Document Name)	Date
Data Gathering, Input, and Handling Checks					
Ensure that the criteria/ assumptions used to select relevant emission factors and activity data are documented.	• Using category information, cross check emission factor and activity data descriptions to ensure they are properly archived and recorded.				
Check for transcription errors in data inputs and references	• Using the Methodologies/Data Documentation document, ensure that all bibliographical data that is referenced is properly cited. • From each category, cross check a sample of input data (measurements/parameters used in calculations) for transcription errors. • To minimise transcription errors, use electronic data wherever possible. • Check to ensure that the spreadsheet features used minimise user and data entry errors. (Example, using cell protection so fixed data cannot be changed, automatic tables to be used for common values used/required for calculations.)				
Check that GHG emissions/ removals are correctly calculated.	• Reproduce a representative sample of GHG emissions/removals calculations. • If the Party has used any models for its GHG emissions/removals calculations, select/mimic these with abbreviated calculations to help judge their accuracy.				
Ensure/check that the units used for GHG emissions/ removals and parameters are correctly documented and that the appropriate conversion factors are used.	• Ensure that all units have been correctly carried through from beginning to end of the calculations. • Check that the conversion factors chosen are correct. • For both the methodologies/data documentation document and calculation sheets, ensure that all units are properly labelled. • Check that the temporal and spatial adjustment factors are used correctly.				
Check the integrity of the database files.	• Confirm that the Party has represented the appropriate data processing steps in its database. • Ensure that the Party has correctly represented all relevant data relationships in its database. • Ensure that all data fields have been properly labelled. • Check/Ensure that the Party has archived database/model/ operation documentation.				
Check for consistency in data between categories.	• Using the chosen/identified activity data and constants selected by the Party, ensure that all parameters common to multiple categories are consistent in their values when used for GHG emission/removal calculations.				
Check that the movement of inventory data amongst processing steps is correct.	• Ensure that the emissions/removals data reported has been correctly aggregated between lower and higher reporting levels. • Check that the Party's GHG emissions/removals data has been correctly transcribed between different intermediate products.				

14 Adopted from US EPA Toolkit, https://www.epa.gov/ghgemissions/toolkit-building-national-ghg-inventory-systems#qa

QC Activity	Procedures	Task Completed		Corrective Measure Taken	
		Name/ Initials	Date	Supporting Documents (List Document Name)	Date
Data Documentation					
Review archiving procedures and internal documentation.	• Check/ensure that relevant stakeholders have provided detailed documents to support their GHG emission/reduction calculations. Use these documents to duplicate calculations. • Ensure that all primary data sources are referenced. • Check that the Party has archived and stored the following information to facilitate the review process: inventory data/records and the accompanying supporting data. • Check that data archiving procedures of key stakeholders involved in the preparation of the Party's GHG inventory have been followed?				
Calculation Checks					
Check methodological and data changes that may result in recalculations.	• Ensure mathematical correctness, produce a representative sample of emission calculations. • Ensure that the Party has been consistent in its chosen methodology for emission calculations throughout the relevant time series. • Check for temporal consistency in time series input data for each category.				
Check time series consistency.	• Ensure that the effects of mitigation activities undertaken by the Party have been appropriately reflected in time series calculations. • Check methodological and data changes that may result in recalculations. • Check for temporal consistency in time series input data for each category. • Ensure that the Party has been consistent in its chosen methodology for emission calculations throughout the relevant time series.				
Check completeness	• Confirm that the Party has reported emission estimates for all categories and all relevant years in the time series (baseline to most recent inventory). • Confirm that the Party has covered entire categories and not just sub-categories. • If 'Other' type categories have been used, provide a clear definition and explanation. • If the Party has any incomplete category emission estimates due to data gaps, provide relevant documentation and a qualitative evaluation of the importance of the category to the overall national emissions.				
Trend checks	• Ensure that there are no unusual/unexplained trends noticed for parameters (activity data, conversion factors) over the relevant time series. • Check the value of implied emission factors (aggregate emissions/removals divided by activity data) across time series. Are changes in emissions or removals being captured? • Compare current emission estimates for each category using current estimates and previously reported estimates. Explain any differences in estimates or expected trends in the relevant categories. If discrepancies are noticed, check to ensure there were no data input/calculation errors in previous year estimates.				

Sector-specific QC checks

Provide a list of specific quality checks for each sector. Table 10 shows some examples of specific checks for the agriculture sector.

Table 10: Examples of specific checks for the agriculture sector

Quality control check	Details
Livestock activity data	Review livestock data collection methods, in particular checking that livestock subspecies data were collected and aggregated correctly. The data should be cross-checked with previous years.
Livestock population data	Ensure that the same population data has been used throughout, i.e., same population data used in the calculation of enteric fermentation emissions and direct N_2O from soil emissions.
Enteric Emission Factors	Check that the appropriate emission factors have been selected for each livestock category and sub-category by looking at the background data for the development of the emission factors
Manure management	Check that all manure has been accounted for (i.e., manure management usage fractions should total 1). Manure management system allocation should be reviewed on a regular basis to determine if changes in the livestock industry are being captured.
Manure management emissions	Ensure that all manure management emissions are allocated to the correct category (e.g., pasture, range and paddock data is allocated to the Direct N_2O emissions from soils)
Manure management emission factors	If using the Tier 1 method, the inventory compiler should evaluate how well the default VS excretion rates, Bo values, and manure management practices represent the defined animal population and manure characteristics of the country. This should be done by reviewing the background information from Tables 10A-4 to 10A-9. If using the Tier 2 method, the inventory agency should cross-check the country-specific parameters (e.g., volatile solids (VS) excretion rates, Bo, and MCF) against the IPCC defaults.
Volatile solids (VS)	For all animals, on a gross basis, VS rates should be consistent with the feed intake of the animal (i.e., waste energy should not exceed intake energy) (Tier 2).
Nitrogen excretion rates	The nitrogen excretion rates, whether default or country-specific values, should be consistent with feed intake data as determined through animal nutrition analyses.
Crop statistics	National crop production statistics should be compared to FAO crop production statistics
Crop residue data	Ensure all crop residues are accounted for (i.e., all crop residue usage fractions should add up to 1)
Fertiliser data	National fertiliser data should be compared to FAO and IFA statistics
Biomass burning	Ensure that there is no double counting of emissions lost due to burning between the Agriculture and LULUCF inventory

6.1.3.3 Quality assurance procedures

Quality Assurance, as defined in the *IPCC Good Practice Guidanc*e, comprises a "planned system of review procedures conducted by personnel not directly involved in the inventory compilation and development process." The quality assurance process may include expert review (such as UNFCCC Review), government review, general public review (such as a public commenting process or industry reviews) and/or validation workshops. These reviews present an opportunity to uncover technical issues related to the application of methodologies, selection of activity data, or the development and choice of emission factors. The expert and public reviews of the draft NIR offer a broader range of researchers and practitioners in government, industry and academia, as well as the general public, the opportunity to contribute to the final NIR. The comments received during these processes are reviewed and, as appropriate, incorporated into the Inventory Report or reflected in the inventory estimates. The results of the QA activities and procedures are documented and described in the QA/QC sub-chapter from the NIR. This section should describe the procedures for this QA process for the country. It is useful to draw up a flow diagram illustration of the process.

6.1.3.4 QA/QC Conclusions

This phase is where all the QA/QC checklists are approved, and archives are prepared. The process for completing these tasks should be described in this section.

6.1.3.5 QA/QC Evaluation and Improvement

The final project evaluation takes place at the next year's inventory planning meeting.

6.1.4 Reporting, Documenting and Archiving

The final section of the QA/QC plan should describe the steps for reporting and archiving, so it should describe the MRV system utilized by the country.

7. MRV and Archiving

Countries across the region do not have well developed MRV systems, although some countries have started to develop such systems. The archiving and documentation of the inventory is critical for the transparency required by UNFCCC. It is also very important for the sustainability of the system. If an inventory is well documented, and all the associated documents and calculation files are archived, it is easy for a new staff member to pick up from the previous compiler and complete the inventory without any major delays or changes. If information is not documented, the compiler has to start from scratch again to rebuild the inventory and find all the data sources. This can lead to inconsistencies in the inventory, not to mention a waste of resources.

Saint Lucia has a system through which they completed ***method statements*** for each category[15] (example template shown in Table 11) which describes the methods, recalculations, assumptions and QA/QC processes carried out during the estimation of the various category emissions. These method statements were then filed as part of the archiving system. This is one way to archive methods.

Table 11: Example of a method statement template

Method Title	
[A short title which uniquely identifies the method statement, for example, manure management]	**MS #** *[insert unique reference number]*
Relevant Categories, source names (List)	
[List the relevant IPCC categories and subcategories that are covered by this method statement]	
Relevant Gases (List)	
[List the relevant gases that are covered by this method statement]	
Relevant fuels, activities (List)	
[List here the relevant fuels and activities that are covered by this method statement, such as nitrogen excretion in manure, manure management systems and livestock populations.]	
Background	
[Include a brief background which helps the reader to understand the scope of the categories and activities.]	
Data sources (list)	
[Include a list of data source references. A short description about how the referenced information is used may be included.]	
Method approach (text)	
[Include text on how the estimates are calculated. Describe the basic calculation, sequence of calculations and how data sources are used. Provide a clear picture of the approach used. Do not include tables of emission factors or activity data, unless necessary to provide transparency. *Where methods are simple, the method statement can be very short. It only needs to reference the key data sources and basic calculation and assumptions. Methods should be described in more detail where methods are more complex than just the basic IPCC default equations or EFs, where assumptions are applied, or where there are a number of options to choose from (e.g., in IPCC default EFs).]*	
Method Changes (Y/N)	
[Yes/No to indicate whether the method has changed in this latest submission.]	
Assumptions & observations (list)	

15 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.

[List the assumptions made in the calculations that have an impact on the estimates. This could include assumptions about changes to emission factors and activity data, or the representativeness of emission factors or activity used. Explain how these assumptions have been made, for example, expert judgement or based on evidence (which should be referenced).]
Recalculation (yes/no)
[Yes/No statement on whether recalculations have been done for the current submission.]
Recalculation justification & summary of change
[Describe the recalculations and their impacts. Include justification of why they were undertaken and how they have improved the quality of the GHG inventory.]
Improvements (list completed and planned)
[Include text on improvements undertaken in the last inventory cycle and planned improvements for the next cycle.]
QA/QC processes
[Include information on the sector-specific QA/QC applied for this method. Include a description of QA/QC for the sector/category and ensure that this represents the comprehensive QA/QC that is actually undertaken.]
Time series consistency issues (list)
[State whether the time series is considered consistent or not. Where there is some discontinuity to the input data and work is needed to ensure that time series consistency highlights these efforts here.]
Uncertainties (describe key uncertainties)
[Describe the key uncertainties that arise for this method. Include text on how the uncertainty information has been derived or collected (measurement error, expert judgement, statistics, etc). Explain why uncertainties are particularly high or low and for which gases/fuels etc.]
Verification
[Describe any verification procedures that were undertaken for this category]

Countries such as Trinidad and Tobago are also now moving towards online MRV systems where all documents, data, contacts, tools and agreements related to the inventory are kept. These online portals can be protected through passwords and can also have a component that allows for the display of the inventory data. Some online systems have a page that is visible to the public, thereby allowing the public to see visual outputs of the national GHG inventory.

8. Awareness and Capacity Building

There is still a need for capacity building in the region[16] with the main needs identified from the National Action Plans and the Regional Action Plan Workshop as follows:

- Training on the compilation of the agriculture inventory As part of the GCF AgREADY project, a ***course*** was conducted in March and April 2022 ***for agricultural experts***. The slides and recording from these training sessions are available[17] as a start.
- Data collection training for both inventory compilers and data providers
  - The expert compilation course mentioned above also covered data requirement for agriculture compilation.
  - In addition, as part of the GCF AgREADY project, a ***data collection training course was held for farmer representatives***. The slides, materials, recordings and templates from this course are also available[18] upon request.
- Gap filling
  - Appendix C provides some guidance on gap filling techniques
- QA/QC process

Funding may need to be sought in order to continue with capacity building. Regional funding could be sought to create an inventory training programme in which the costs are shared between the countries.

During the Regional Action Plan Workshop, some ideas were put forward on how to make capacity building sustainable. These ideas included:

- Training-for-the-trainers programme.
- Creation of training packages and manuals that may be used for continuity.
- Platform for storage and sharing of regional training materials and videos
- Development of courses for the University so that students can be trained in inventory compilation.
- Drafting of a Standard Operating Procedures manual on data collection and reporting that is easy to follow by new personnel.
- Creating peer review networks
- Mandatory refresher courses.
- Creation of networks with structural interactions and consultations.
- Training centres within the Agriculture Ministries.

Another aspect mentioned in the National Improvement Action Plans was the need to build awareness among data providers and policy makers. Some of the materials provided during the Data Collection training for farmer representatives included general presentations on climate change and its impact on agriculture, as well as the basics of data collection and its importance. Two 1-page handouts on livestock data and cropland data were provided. All these materials could be used to build awareness.

16 Regional Action Plan Workshop Report, 2022

17 Available on request from Luanne Stevens at: luanne@jacali.net

18 Available on request from Luanne Stevens at: luanne@jacali.net

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Central Statistics Office, 2018. Small Ruminants Bulletin, July - September 2018, Republic of Trinidad and Tobago, Ministry of Planning and Development. https://cso.gov.tt/wp-content/uploads/2020/01/Small-Ruminants-July-September-2018.pdf

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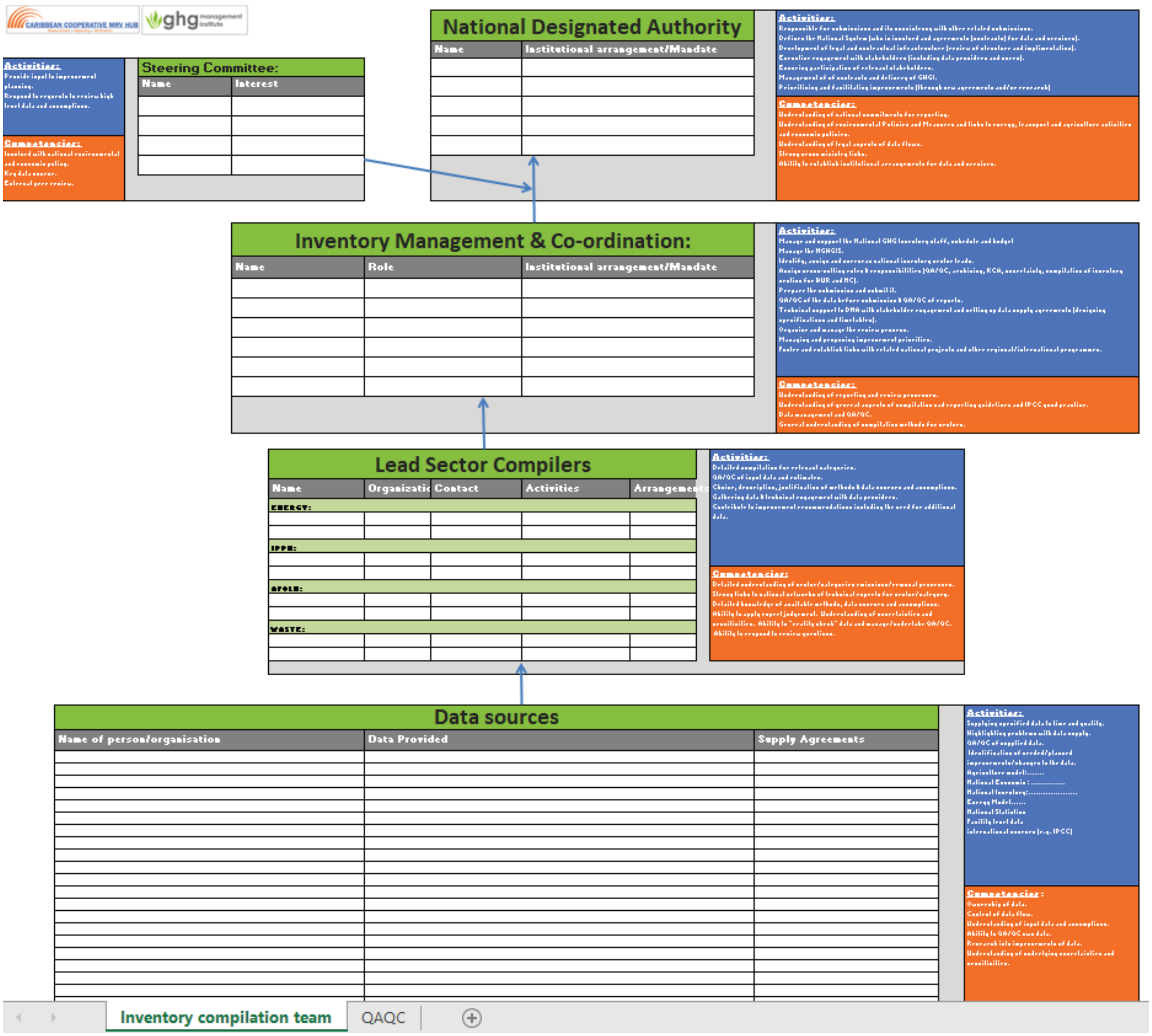
U.S. EPA, 2022, U.S. EPA Toolkit for Building National GHG Inventory Systems. Found at: https://www.epa.gov/ghgemissions/toolkit-building-national-ghg-inventory-systems

Appendix A: Inventory Compilation Team Template



Appendix B: Data Collection Templates (example for Dairy Cows)

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 (Head)	Typical average animal mass (TAM) (kg)	Daily feed intake (kg dry matter/ head/day)	Average milk production (kg milk/head/yr)	Milk fat content (%)	Manure management (% 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:

Appendix C: Technical Guidance on Addressing Data Gaps

In a GHG inventory, it is important to have a time series as this provides information on historical emission trends and tracks the efforts of strategies to reduce national level emissions. A time series should be consistent in that it should be calculated using the same methods and data in all years; otherwise, it reflects changes in methodology and not changes due to emission reductions.

Recalculations in an inventory may be due to:

- methodological changes which usually occur due to the development of a new or different data set. It may be because there has been a change in the tier level.
- methodological refinements which occur when the same tier is used but a different data source or disaggregation is applied.

It is good practice to change or refine a calculation when:

- available data has changed
- the previous method is not consistent with IPCC guidelines
- the category has become a key category
- the previous method is insufficient to reflect mitigation activities in a transparent manner
- the capacity for inventory preparation has increased
- new inventory methods have become available and
- errors are corrected.

There are two types of data gaps:

- periodic data: when the data available is less frequent than annual data and when the data is only available for a few years in the time-series;
- changes and gaps in data availability: when the methodology changes (i.e., the tier level) and there is no data for the new method in previous years. There is a chance that the data is not available as government priorities have changed and the data is no longer collected.

In these cases, different **splicing techniques** may be applied to **combine or join data to fill these gaps**.

C.1 Selecting an appropriate splicing technique

The choice of a splicing technique (Table C.1) involves expert judgement but is dependent on the availability of data, adequacy and availability of surrogate data and the number of years of missing data.

Table C.1: Summary of splicing techniques19

Approach	Applicability	Comment
Overlap	Data necessary to apply both the previously used and the new method must be available for at least one year, preferably more.	• Most reliable when the overlap between two or more sets of annual estimates can be assessed. • If the trends observed using the previously used and new methods are inconsistent, this approach is not good practice.
Surrogate data	Emission factors, activity data or other estimation parameters used in the new method are strongly correlated with other well-known and more readily available indicative data	• Multiple indicative data sets (singly or in combination) should be tested in order to determine the most strongly correlated. • Should not be done for long periods.
Interpolation	Data needed for recalculation using the new method is available for intermittent years during the time series.	• Estimates can be linearly interpolated for the periods when the new method cannot be applied. • The method is not applicable in the case of large annual fluctuations.
Trend extrapolation	Data for the new method is not collected annually and is not available at the beginning or the end of the time series.	• Most reliable if the trend over time is constant. • Should not be used if the trend is changing (in this case, the surrogate method may be more appropriate). • Should not be done for long periods.
Other techniques	The standard alternatives are not valid when technical conditions are changing throughout the time series.	• Document customized approaches thoroughly. • Compare results with standard techniques.

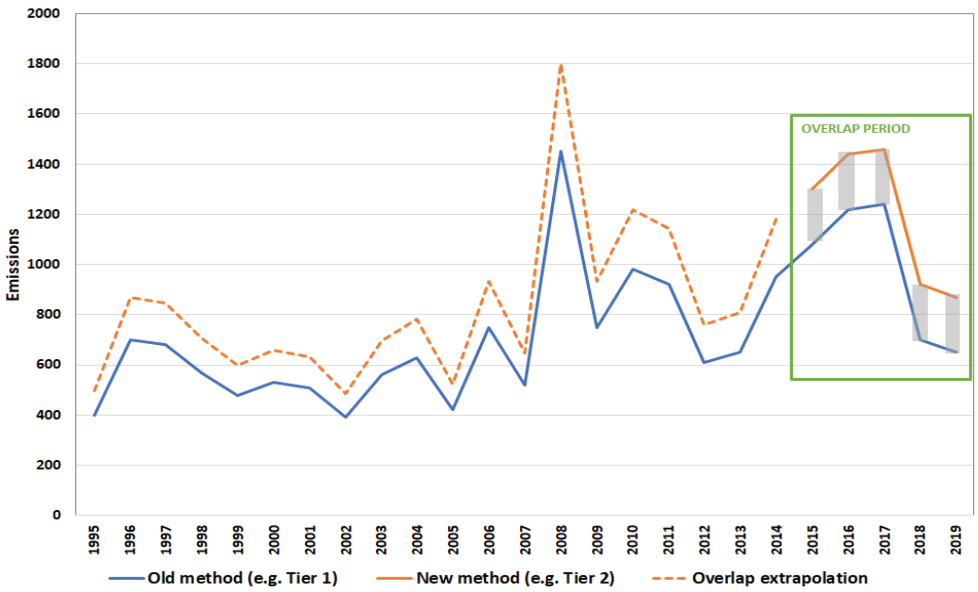
Splicing techniques

C.1.1.1. Overlap method

The **overlap technique is often used when a new method is introduced** but data is not available to apply the new method to the earlier years in the time series. The **time series** of the new method is therefore **extended based on the relationship observed between the two methods during the overlap period**. It is preferable that there is more than one year of overlap data. The assumption is that there is a **consistent relationship** between the results of the previous and the new methods (see grey blocks in Figure C.1). If there is an inconsistent relationship, i.e. the new method does not show the same trends as the old method during the overlap period and the grey bars in Figure C.1 show a high degree of variability, then it is not good practice to use this method.

19 IPCC, 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The National Greenhouse Gas Inventories Programme, Eggleston H S, Buenida L, Miwa K, Ngara T, and Tanabe K, eds; Institute for Global Environmental Strategies (IGES). Hayama, Kanagawa, Japan.

Figure C.1: Example of overlap technique with consistent relationship



The methodology for calculating the data in the years prior to the overlap period shown in Figure C.1 is described in Box C.1.

BOX C.1: Example of overlap method

Consider an example where the old method and the new method provide the following emissions (t CO_2e):

2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**	
Old method	980	920	610	650	950	1080	1220	1240	700	650
New method						1300	1440	1460	920	870

To calculate the new emission value for 2014, use the following equation:

$$New\ emission\ estimate\ for\ 2014 = x*(A*B)$$

where *x* is the old emission estimate and A and B are factors described below

Step 1: Calculate factor B, which is the sum of the new method estimate divided by the old estimate for the overlap period (2015 to 2019) (B):

$$B = \sum_{i=m}^{n} \frac{y_i}{x_i} = \left(\frac{1300}{1080} + \frac{1440}{1220} + \frac{1460}{1240} + \frac{920}{700} + \frac{870}{650} \right) = 6.21$$

Step 2: Calculate factor A as follows: take the last year of the overlap period, subtract the first year of the overlap period, add 1 and invert (A):

$$A = \frac{1}{(2019 - 2015 + 1)} = 0.2$$

Step 3: Multiply the old emission estimate in 2014 by factor AB:

$$New\ emission\ estimate\ for\ 2014 = 950*(0.2*6.21) = 950*1.24 = 1\,178$$

Now calculate the emission estimates for the previous years (2010 to 2013) using the same equation:

$$New\ emission\ estimate\ for\ 2013 = 650*(0.2*6.21) = 650*1.24 = 806.0$$
$$New\ emission\ estimate\ for\ 2012 = 610*(0.2*6.21) = 610*1.24 = 756.4$$
$$New\ emission\ estimate\ for\ 2011 = 920*(0.2*6.21) = 920*1.24 = 1\,140.8$$
$$New\ emission\ estimate\ for\ 2010 = 980*(0.2*6.21) = 980*1.24 = 1\,215.2$$

C.1.1.2. Surrogate method

The **surrogate method relates emissions or removals to underlying activity or other indicative data**[20]. For example, this method may be used when you have emissions data for livestock for some years and meat production data for a full time series. The production data could then be used to estimate emissions for the missing years. In this method, the emission data is related to the activity data or other indicative data set, and it best explains the time variation in the category. The **data relationship may not be consistent but does show similar trends** and is related to the activity data or emissions.

In the simplified form, the estimate will be related to a single year of data (as can be seen in Figure C.2): however, it can be related to data from multiple years, and this might give a more accurate estimate[21]. The methodology for the simplified method is described, using an example, in Box C.2.

BOX C.2: Example of the simple surrogate method

Consider an example where you have emissions from cattle (Gg CH_4) and you have meat (beef) production data (t):

	2010	2011	2012	2013	2014	2015	2016	2017	2018	**2019**	
Meat production			1952	1890	1606	1607	1483	1338	1610	1594	1726
1891											
Cattle emissions						62	61	52	60	61	68
72											

To calculate the emissions for 2010 to 2012 the simplified method is as follows:

$$Cattle\ emissions\ for\ 2012 = y_t*(s_0/s_t)$$

Where:

y_t = emissions in 2013
s_0 = meat production in 2012
s_t = meat production in 2013

Therefore, cattle emissions for 2012 = 62 * (1606/1607) = 61.97 Gg CH_4

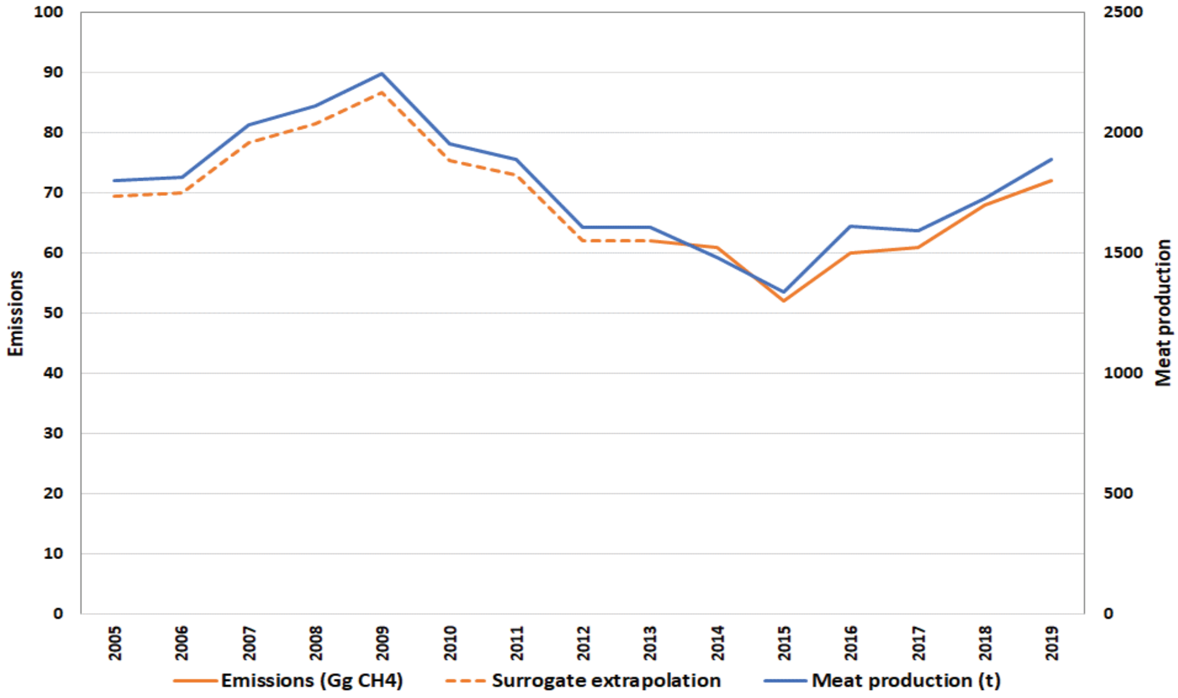
Now calculate emissions for 2011 and 2010 where y_t = emissions in next year, s_0 = meat production in that year and s_t = meat production in the following year:

Cattle emissions in 2011 = 61.97 * (1890/1606) = 72.84 Gg CH_4
Cattle emissions in 2010 = 72.84 * (1952/1890) = 75.23 Gg CH_4

20 Ibid. IPCC, 2006

21 Ibid. IPCC, 2006

Figure C.2: Example of the simple surrogate method



C.1.1.3. Interpolation

In some cases, there may be **data missing intermittently in the time series**, for example, data is probably only collected every few years, so the data in between is missing. In these cases, estimates for the intermediate years in the time series can be developed by **interpolating** between the detailed estimates. **If information on the general trends or underlying parameters is available, then it is preferable to use the surrogate method**. This technique is appropriate if the overall trend appears stable. For categories that have volatile emission trends, interpolation will not be based on good practice, and surrogate data is a better option. It is also good practice to compare interpolated estimates with surrogate data as a QA/QC check. Box C.3 provides a guided example of how to fill a gap using interpolation, and the results are shown in Figure C.3.

BOX C.3: Example of interpolation

Consider an example where there is emission data (t CO_2e) for the years 2005 to 2008, and 2012 to 2015 but no data was collected in 2009–2011:

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	**2015**
Emissions		136	141	148	144				155	156	164

161

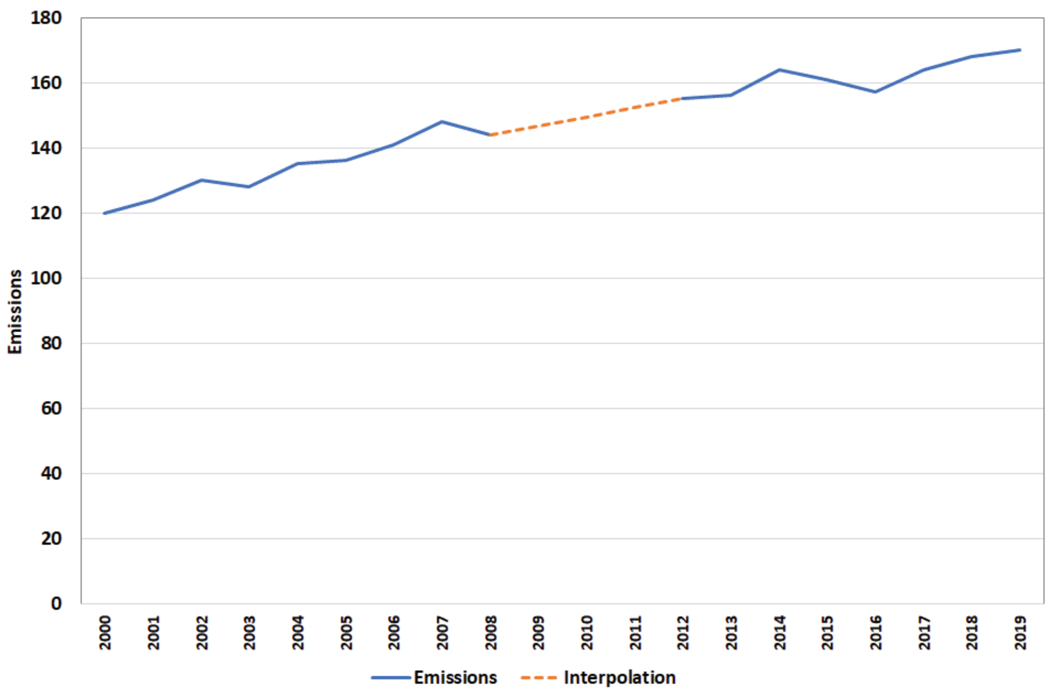
The interpolation method may be used to estimate the emissions for the missing years by assuming a constant annual growth in emissions from 2008 to 2012.

Step 1: Calculate the average annual growth rate by subtracting the emission value for the year before the gap from the emission value in the year after the gap, and dividing this by the number of years in between, for example:

Avg. annual growth in emissions between 2008 and 2012 = (155 – 144)/4 = 2.75

Step 2: Add the average annual growth rate to the emission for the previous year to obtain the emission for that year:

Figure C.3: Example of interpolation method

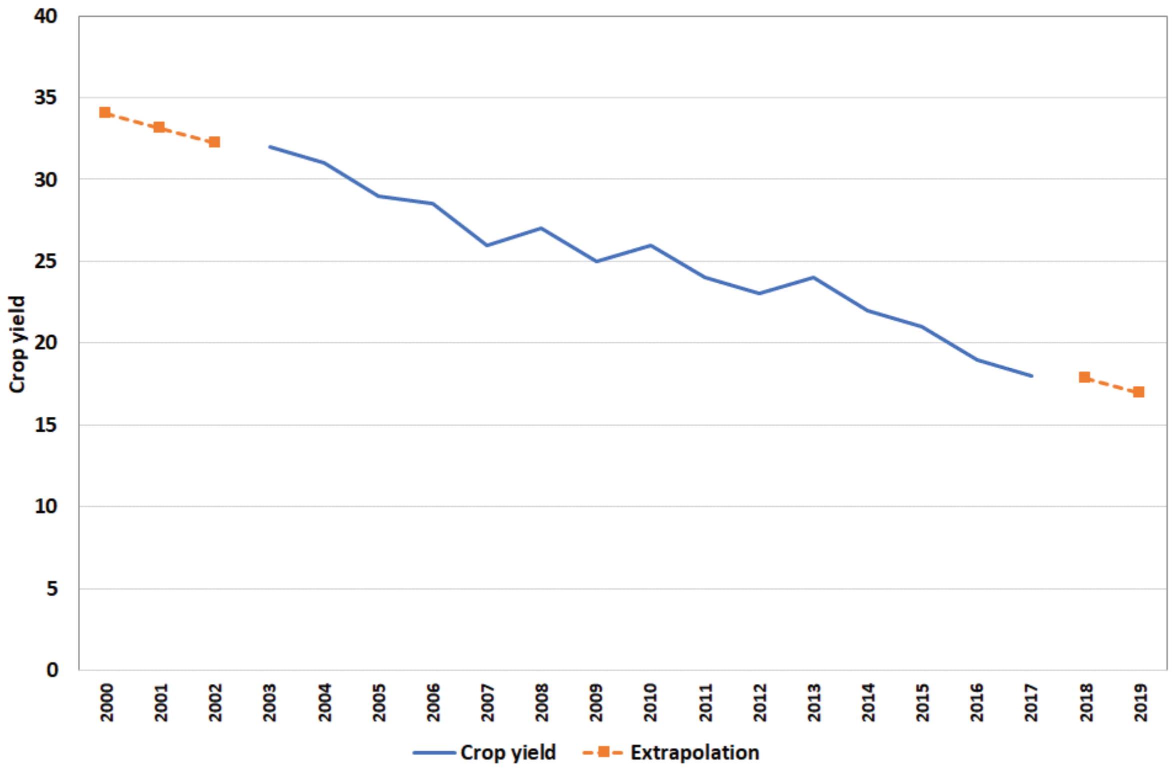


C.1.1.4. Trend extrapolation

If estimates have not been prepared for the base year or the most recent year in the inventory an extrapolation can be made from the closest detailed estimates[22]. Trend extrapolation is conceptually similar to interpolation, but less is known about the actual trend. Extrapolation can be conducted either forward, to more recent years, or backwards to the base year (Figure C.4). An extrapolation assumes that the observed trend in emissions (or activity data) for the available data remains constant over the period of extrapolation. The trend extrapolation should, therefore, not be used if the change in trend is highly variable over the time series. In this case, it would be more appropriate to use surrogate data to estimate the data for the missing years. Extrapolation should also not be used over long periods of time. In many cases the extrapolated data is a temporary measure and is often replaced once data becomes available.

The most basic extrapolation is the linear extrapolation, but non-linear extrapolation can also be used. Countries using non-linear extrapolation should provide clear documentation for the choice and explain why it is more appropriate than the linear extrapolation.

Figure C.4: Example of a linear extrapolation both forwards and backwards



22 Ibid. IPCC, 2006

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