GHG Protocol Agricultural Guidance

A sector-specific GHG accounting and reporting protocol for Ethiopia

Table of Contents

[Part 1: GENERAL INFORMATION 4](#_Toc427405264)

[Chapter 1: Introduction 5](#_Toc427405265)

[1.1 Climate Resilient Green Economy (CRGE) and the GHG Protocol Agricultural Guidance 5](#_Toc427405266)

[1.2 Agriculture Sector Context in Ethiopia 7](#_Toc427405268)

[1.3 Who should use this Guidance? 8](#_Toc427405269)

[1.4 The Development of this Guidance 9](#_Toc427405270)

[1.5 What does this Guidance not do? 10](#_Toc427405271)

[Chapter 2: GHG Reduction goals 12](#_Toc427405273)

[2.1 Overview of GHG Accounting goals 12](#_Toc427405274)

[Chapter 3.Principles 17](#_Toc427405275)

[3.1 Overview of principles 17](#_Toc427405276)

[Chapter 4. Overview of agricultural emission sources 19](#_Toc427405278)

[4.1 Overview of on-farm and supply chain emissions 19](#_Toc427405279)

[4.2 Emissions sources on farms 21](#_Toc427405280)

[Part 2: DEVELOPING ENTITY-LEVEL INVENTORIES 27](#_Toc427405285)

[Chapter 5 :Setting Inventory Boundaries 27](#_Toc427405286)

[5.1 Setting organizational boundaries 27](#_Toc427405287)

[5.2 Setting operational boundaries 28](#_Toc427405288)

[Chapter 6: Tracking Performance over Time 29](#_Toc427405289)

[6.1 Setting and recalculating base periods 29](#_Toc427405290)

[6.2 Using performance metrics 33](#_Toc427405293)

[Chapter 7: Reporting GHG Data 36](#_Toc427405295)

[7.1 Required information 36](#_Toc427405296)

[7.2 Minimum, best practice, recommendations for reporting agricultural GHG fluxes 36](#_Toc427405297)

[7.3 Additional information that may be reported 39](#_Toc427405298)

[7.4 Agricultural offset and renewable energy projects 40](#_Toc427405299)

**List of Tables**

[Table 1. GHG emissions reduction goals served by including agricultural emissions in entity-level inventories 14](#_Toc427405324)

[Table 2. Examples of agricultural practices that reduce GHG emissions, while improving other aspects of farm performance 15](#_Toc427405325)

[Table 3. Examples of when an individual year may not serve as a representative base period 30](#_Toc427405326)

[Table 4. Advantages and disadvantages of common performance metrics 35](#_Toc427405327)

[Table 5. Schematic illustrating the requirements and minimum, best practice recommendations for disaggregating GHG flux data in inventories 38](#_Toc427405328)

**List of Figures**

[Figure 1. Ethiopia’s GHG emissions profile in 2010 (Figures in Mt CO2e). 6](#_Toc429049812)

[Figure 2. Emission sources associated with agriculture 20](#_Toc429049813)

[Figure 3 Carbon pools in agriculture 24](#_Toc429049814)

[Figure 4. Typical patterns of the importance of different sources to overall GHG fluxes from select farming systems. 25](#_Toc429049815)

[Figure 5. The ‘Scopes’ framework for categorizing the GHG emissions from different sources 28](#_Toc429049816)

[Figure 6. The concept of rolling base periods 31](#_Toc429049817)

[Figure 7. Recalculating base period inventories for structural changes. 32](#_Toc429049818)

# Part 1: GENERAL INFORMATION

# Chapter 1. Introduction

|  |
| --- |
| This chapter:* Introduces Ethiopia’s Climate Resilient Green Economy (CRGE) and how this Guidance is intended to help support its implementation
* Describes how and why this Guidance was developed, and for whom.
* Describes what guidance is (and is not) provided in this publication.
 |

## 1.1 Climate Resilient Green Economy (CRGE) and the GHG Protocol Agricultural Guidance

Agriculture accounts for around 40% of the GDP and 85% of total employment in Ethiopia, and it is the main source of income for the overwhelming majority of the population. It correspondingly assumes great importance within the Climate-Resilient Green Economy (CRGE) initiative, which was established by the Government of Ethiopia in 2011 to protect the country from the adverse effects of climate change and to build a green economy that will help realize its ambition of reaching middle income status before 2025.

The CRGE initiative follows a sectoral approach and has so far identified and prioritized more than 60 initiatives, which could help the country achieve its development goals while limiting 2030 *greenhouse gas* (GHG) emissions to around today’s 150 Mt CO2e. Without the initiative, assuming Business as Usual practices, GHG emissions are projected to more than double from 150 Mt *CO2e* in 2010 to 400 Mt CO2ein 2030.

In 2010, more than 85% of Ethiopia’s GHG emissions came from the agricultural and forestry sectors. Within the agricultural sector, livestock production is the largest emissions source (65 Mt CO2e in 2010, or 40% of sectoral emissions). Crop production emitted 13Mt CO2e, or 9 % of sectoral emissions (see Figure 1).

**Figure 1**.**Ethiopia’s GHG emissions profile in 2010** (Figures in Mt CO2e).

To play its role in building a green economy, the agriculture sector is aiming at improving crop and livestock production practices for higher food security and farmer income while reducing emissions. The agriculture sector has a total abatement potential for soil- and livestock related emissions of 90 Mt CO2e, representing around 35% of the total domestic abatement potential.

To ensure the right track of building a green economy and abatement of emissions, the CRGE initiative prioritizes the setup of appropriate measuring, reporting, and verification (MRV) systems to provide proof of GHG abatement. *GHG emissions inventories* are a fundamental component of such MRV systems – they help woredas, regions, federal agencies, and private sector farms identify emissions reduction opportunities, track progress towards reduction targets and communicate this progress to key audiences, including internal agencies and external stakeholders. Realizing these benefits requires that inventories are prepared according to sector-specific and accepted best practices.

The GHG Protocol Agricultural Guidance is intended to help fulfill the need for robust MRV systems and support the CRGE initiative. It does so by outlining recommendations for compiling and reporting GHG inventories of agricultural sources at the level of individual farming entities.

1.

## 1.2 Agriculture Sector Context in Ethiopia

An enormous diversity exists across the country in terms of agro-ecologies, population densities, and road networks, resulting in varied agricultural production, although much agriculture is characterized by mixed product farming. The main crops produced are cereals (e.g. wheat, barley, millet), pulses (e.g. lentils, chick-peas), stimulants (e.g. coffee, chat, tobacco), oil seeds (e.g. linseed, fenugreek, rapeseed, groundnuts), spices and herbs (e.g. pepper, garlic, ginger), vegetables, fruits, sugarcane, and fibers (e.g. cotton). Most agricultural production takes place in the highlands, where five major crops (tef, wheat, maize, sorghum, barley, and enset) are staples. Depending on elevation, rainfall, and market access, different sets of these five crops define in large part which cropping systems prevail in any given region. This diversity in cropping systems makes Ethiopia’s agricultural and food economy particularly complex and it necessitates a regional or district approach to agricultural development and to food security.

Paralleling this agro-ecological diversity, multiple types of farms and farm operations exist in Ethiopia. This Guidance identifies three general types:

**Smallholder Farms** (Definition by CSA, Ethiopia)

There is no one definition of smallholder farms/farming that can be applied everywhere. However, there are common aspects. Smallholder agriculture is practiced by families (including one or more households), using only or mostly family labor and deriving from that work a large but variable share of their income in kind or in cash. Smallholder agriculture includes crop raising, animal husbandry, forestry and artisanal fisheries. The holdings are run by family groups, a large proportion of which are headed by women and women play important roles in production, processing and marketing activities. CSA of Ethiopia uses the private agriculture holding as a synonym for smallholder farm.

**Commercial Farms** (Definition by CSA, Ethiopia)

Commercial Farms are certified (legally established) farms owned/operated by government, private investors, and/or share-holders. They are profit-oriented, large and medium scale farms. These farms use relatively capital intensive, mechanized and market oriented farming system, as well as modern farm management practices and inputs, such as irrigation scheme, fertilizers, pesticides, etc., to attain high productivity per unit of area.

**Out-grower Scheme Farm** (Definition by UN-FAO)

An out-grower scheme is a contractual partnership between growers or landholders and a company for the production of commercial forest products. Out-grower schemes or partnerships vary considerably in the extent to which inputs, costs, risks and benefits are shared between growers/landholders and companies. Partnerships may be short or long-term and may offer growers only financial benefits or a wider range of benefits. Also, growers may act individually or as a group in partnership with a company, and use private or communal land. Out-grower schemes are usually prescribed in formal contracts. Within this definition out-grower schemes may include joint ventures and contract tree farming. Differences between these arrangements are largely in responsibility for farm operation, resource ownership and control, and the financial remuneration to growers.

## 1.3 Who should use this Guidance?

This guidance is to be used by public and private sector entities. Public sector users include the Bureau of Agriculture at the woreda and regional levels, as well as the Ministry of Agriculture. Private sector users include large, medium and small farms engaged in livestock and/or crop production. Users can include the following types of entities:

* Smallholder Farmers (not expected to directly account for nor report their GHG emissions)
* Woreda Agriculture Office (account and report GHG emissions from smallholder farms under its jurisdiction)
* Ministry of Agriculture (responsible for collecting GHG emissions reports from woreda agricultural offices and producing sector level report)
* [State] Agriculture Large Scale Company and associated out-grower scheme farms
* [Private] Agriculture Large Scale Company and associated out-grower scheme farms

## 1.4 The Development of this Guidance

In 2010, the GHG Protocol launched a three-year process to develop the Global Agricultural Guidance. That Global Guidance was the output of a deliberative stakeholder process and road testing in multiple sectors and countries. It is largely intended for large scale agricultural operations.

Because of the preponderance of smallholder farms in Ethiopia, the Global Guidance is not fully suited to the needs of MRV in the Ethiopian agricultural sector. Therefore, as part of the ‘The national MRV Project’ (Box 1), WRI partnered with Echnoserve to form a technical working group (TWG) that would customize the guidance to the local context. Members of the TWG were drawn from the Ministry of Agriculture (MoA), Ethiopian Agricultural Research Institute (EIAR), and Climate Science Centre (CSC) of the Addis Ababa University. This, Ethiopic-specific, adaptation of the guidance is based on the following activities of the TWG:

* TWG meetings to review and adapt the *accounting* and reporting methodologies in the Global Guidance
* Comparative analysis of GHG emissions calculation methodologies and identification of those most suitable for Ethiopia
* Pilot testing of a draft of the guidance before making it fully operational.

The pilot testing process involved piloting the guidance in a total of 11 smallholder, commercial and out-grower scheme farms to develop GHG inventories.

Annex 1 shows the results of this piloting process.

Box 1: The National MRV Project

“The National MRV Project” aims to support the establishment of an MRV system in Ethiopia. The objective of the project is to develop an MRV system with the necessary building blocks, including methods for measuring, reporting and tracking GHG emissions reductions/enhanced *carbon sequestration* in sectors and track performance towards the Climate Resilient Green Economy (CRGE) strategy. The principles of collaboration are based on the “Capacity Building to Monitor and Track Mitigation Activities in Ethiopia” program. The project will be achieved through a series of activities that build on the technical capacity of key institutions and personnel to manage key datasets and monitor and report GHG emissions. The pilot will be carried out via the development of methodologies, and piloting of the methodologies in select sectors. WRI partnered with staff at MEF and other ministries to carry out the work, which concluded in August 2015.The project outcome is to see the Ethiopian government and key private sector stakeholders are being able to measure and report greenhouse gas emissions associated with policies, goals and key sectors.

## 1.5 What does this Guidance not do?

This Guidance is focused on entity-level or geographically bounded accounting and reporting issues. It does not:

* Provide accounting methods for the CO2emissions from the production and combustion of commercial biofuels. While the CH4 and N2O emissions from biofuel combustion should be reported in inventories, consensus on the accounting methodologies for CO2emissions has not yet materialized and requires the analysis of complex life cycle and indirect Land Use Change (iLUC; see below) issues that are beyond the scope of the Corporate Standard and this publication.
* Provide accounting methods for *indirect Land Use Change* (iLUC). iLUC occurs when an existing crop is diverted for another purpose, such as transportation fuel production, and replacement crops are then grown on formerly non-agricultural lands. An example of iLUC is when sugarcane is diverted from sugar to biofuel production, causing forests to be cleared for additional sugarcane production. Accounting for such iLUC impacts requires a project-based approach to determine what the GHG fluxes would have been in the absence of the market intervention.
* Provide guidance on the selection and deployment of GHG mitigation practices on farms. Individual mitigation measures will have a range of co-benefits and costs that would need to be evaluated at the field level in designing a corporate GHG reduction strategy (see Chapter 2.1for examples of co-benefits), including trade-offs between the emissions of different GHGs.
* Recommend sector-specific GHG performance metrics. To have most relevance, metrics that are used to assess performance against that of other businesses, as well as industry averages and best practices, should be developed through close sectoral cooperation. While this Guidance does not recommend specific metrics, it does outline accounting procedures relevant to understanding what and how emissions sources should be included in metrics (e.g., through the use of boundary approaches; Chapter 5).
* State value positions on miscellaneous sustainability issues such as large versus small agriculture, GMOs, or food miles.
* Provide guidance on the selection and deployment of GHG mitigation practices on farms.

# Chapter 2. GHG Reduction goals

The development of a GHG inventory can be a significant undertaking. Entities should therefore have clearly defined goals for managing their *GHG fluxes* and understand how inventories will allow them to meet those goals. Entities generally want their GHG inventories to be capable of serving multiple goals. It therefore makes sense to design the inventory process from the outset to provide information for a variety of different users and uses – both current and future.

|  |
| --- |
| This chapter:* Reviews the various goals that GHG emissions inventories can help entities meet
* Enumerates the potential economic and environmental benefits from a range of GHG reduction measures
 |

## 2.1 Overview of GHG Accounting goals

Entities along agricultural supply chains can have diverse reasons for developing inventories and managing the GHG emissions from agriculture. Many of these drivers are common to both producers and their downstream buyers, and these drivers generally involve (Table 1):

* Understanding the operational and reputational risks and opportunities associated with agricultural emissions
* Identifying GHG reduction opportunities, setting reduction targets, and tracking performance
* Reporting to stakeholders, including civil society and internal management
* Supply chain engagement and management.

Entity-level inventories can also help policy makers plan and implement policies that aim to reduce emissions at the farm level.

The primary business benefits to executing a GHG inventory and/or reduction plan are direct cost reductions, increased productivity, and meeting the requirements of downstream buyers. For instance, conservation tillage and cover cropping can help to reduce fertilizer and fuel costs (Table 2).

**Producers**

Many of the GHG reduction measures that can be implemented on farms have other, positive impacts on the productivity and environmental status of farming systems. These benefits can include (Table 2):

* Increased productivity
* Reduced erosion and land degradation
* Reduced phosphorous (P) and nitrogen (N) runoff
* Improved water quality and retention
* Control of air pollutants (e.g, ammonia and hydrogen sulphide)
* Increased soil fertility
* Reduced energy costs

While a farm management practice is seldom adopted for its effects on GHG emissions alone, these co-benefits are often instrumental in driving the adoption of practices that do reduce emissions. The ability to maintain or increase productivity is often the overriding factor. Entity-level inventories are useful in identifying practices that both reduce emissions and increase productivity or yield other co-benefits.

Because agro-ecosystems are inherently complex, management practices that reduce emissions and yield other co-benefits should not be selected in isolation of each other, but rather selected using a whole-farm or systems approach. This ensures that interactions between the carbon (C) and N cycles on farms, as well as trade-offs between the emissions of different GHGs are taken into account, and that mitigation practices can be more effectively integrated into individual farming systems.

**Policy makers**

The spectrum of policy options to reduce agricultural GHG emissions is extremely broad and includes technical and business advice to build capacity in GHG management best practices; reporting programs to monitor patterns of emissions at the entity-level; regulatory controls, such as prohibitions on certain types of land use change or controls on the intensity and timing of field operations; and incentives, such as payments for emissions reductions or assistance with investments in less GHG-intensive technologies.

Accurate emissions data is crucial to ensuring that policy makers can properly plan, implement and track the impacts of such policies. Much of these data are required at the farm-level. For example, if farm-level emissions have been over-estimated, regulatory controls will force farmers to bear unnecessary adjustment costs and the GHG emissions reductions will be less than anticipated. Equally, if farm-level emissions have been under-estimated, farmers may receive insufficient credit for reducing emissions, leading to reduced rewards under any payment scheme.

**Ethiopia’s Context:**

To play its role in building green economy, the agriculture sector is aiming at improving crop and livestock production practices for higher food security and farmer income while reducing emissions. The agriculture sector has a total abatement potential for soil- and livestock related emissions of 90 Mt CO2e, representing around 35% of the total domestic abatement potential. In the CRGE strategy, Ethiopia chose to follow the green path as business as usual practice will dramatically increase the GHG emission with the current rate of economic growth. Moreover, as many of the GHG reduction measures that can be implemented on small scale farms have other co-benefits; these co-benefits will also bring about economic and environmental benefits. Some of the co-benefits include reducing erosion and land degradation, increasing productivity, improving water quality and retention, reducing P and N runoff and increasing soil fertility.

Table 1. GHG emissions reduction goals served by including agricultural emissions in entity-level inventories

|  |  |
| --- | --- |
| **Goal** | **Examples** |
| Track and reduce GHG impacts | Identify emissions hot spots and reduction opportunities, and prioritize GHG reduction efforts  |
| Set GHG reduction targets |
| Measure and report GHG performance over time |
| Develop performance benchmarks and assess performance against industry averages and competitors |
| Understand operational and reputational risks and opportunities associated with agricultural GHG fluxes | Identify climate-related risks (e.g., determine whether agricultural or processing facility would be subject to government regulations, such as a cap and trade scheme or other reporting scheme) |
| Understand economic and environmental benefits of managing emissions (see Table 2‑2 for examples) |
| Enhance market opportunities (e.g., access niche markets with potential price premiums) |
| Guide investment and procurement decisions (e.g., to purchase relatively less GHG-intensive goods ) |
| Report to stakeholders | Meet needs of stakeholders through public disclosure of GHG fluxes and of progress towards GHG reduction targets  |
| Participate in voluntary reporting programs to disclose GHG related information to stakeholder groups  |
| Report to government reporting programs at the international, national, regional or local levels |
| Improve reputation and accountability through public disclosure |
| Supply chain engagement and management | Partner with entities in the value chain to achieve GHG reductions  |
| Expand GHG accountability, transparency, and management in the supply chain  |
| Enable greater transparency on entities’ efforts to engage supply chain partners  |
| Reduce energy use, costs, and risks in the supply chain and avoid future costs related to energy and emissions |

Table 2. Examples of agricultural practices that reduce GHG emissions, while improving other aspects of farm performance\*

| **Practice** | **Potential GHG benefits** | **Potential environmental co-benefits** | **Potential agronomic / business benefits**  | **Potential trade-offs or problems** |
| --- | --- | --- | --- | --- |
| **Cover crops**Non-commodity crops planted in between rows of commodity crops or during fallow periods  | * Increased soil C sequestration
* Reduced *indirect N2O emissions from soils* due to a reduction in N leaching
* Reduced emissions from fertilizer manufacture
 | * Improved soil nutrient content
* Reduced wind and water erosion
 | * Reduced fertilizer needs
* Reduced weed growth
* Reduced irrigation needs
* Supplemental livestock feed (extends grazing season, cattle weight gain)
* Increased profit
 | * Requires extra time and knowledge to manage, and some new techniques for growing commodity crops
* Requires more fuel use for crop planting
 |
| **Conservation tillage**A range of cultivation techniques (including minimum till, strip till, no-till) designed to minimize soil disturbance for seed placement, by allowing crop residue to remain on soil after planting | * Increased soil C sequestration
* Reduced indirect N2O emissions from reduction in run-off
* Reduced emissions from fertilizer manufacture
 | * Improved soil water retention and drainage
* Reduced water and wind erosion
 | * Reduced fertilizer needs
* Reduced fuel and labor costs from fewer field passes
* Improved yields
 | * Potential increase in herbicide use
* Increased pest threats in repetitive single commodity production
 |
| **Rotational or mob livestock grazing on pasture**Grazing practices that maximize plant health and diversity, while increasing the animal carrying capacity of the land | * Increased soil C sequestration
* Reduced CH4 emissions from *enteric fermentation* (due to improved feed)
 | * Increased plant cover and productivity
* Improved soil water retention and drainage
* Reduced water and wind erosion
 | * Increased herd size
* Can increase length of grazing season
* Reduced need for purchases of feed
* Pastures more able to exclude weeds / exotic species
* Potentially reduced herbicide costs
* Helps avoid burning fields as a management practice
 | Requires careful management in some areas with sensitive species |
| **Anaerobic digester**Enclosed system in which organic material such as *manure* is broken down by microorganisms under anaerobic conditions | * Reduced N2O and CH4 emissions from manure management
* Reduced emissions from fertilizer manufacture
 | * Reduced risk of accidental toxic leakages (pathogens killed)
* Reduced ammonia and VOC emissions
 | * Processed solids can be used as bedding
* Reduced need for fertilizers (as nutrient availability in the digestate is increased)
* Electricity / heat generation
 | Digester technologies can be expensive |
| **Windbreaks**Plantations usually made up of one or more rows of trees or shrubs  | Increased C sequestration in biomass and soils | * Reduced soil erosion
 | * Greater animal survival and health in livestock systems
 |  |

\*, A more extensive discussion of the advantages and disadvantages of different management practices can be found in Stockwell & Bitan (2011)

# Chapter 3. Principles

As with financial accounting and reporting principles, generally accepted GHG accounting principles are intended to ensure an inventory represents a faithful, true, and fair account of an entity’s GHG impacts.

|  |
| --- |
| This chapter:* Introduces GHG accounting and reporting principles that should guide the use of this Guidance
 |

## 3.1 Overview of principles

The following principles are intended to guide the implementation of this Guidance, particularly when its guidelines in specific issues or situations are ambiguous.

**Relevance:** The GHG inventory should appropriately reflect the GHG impacts of the entity and serve the decision-making needs of users – both internal and external to the entity.

**Completeness:** Entities should account for and report on all GHG emission sources and activities within the inventory boundary, to the extent practicable and relevant to the purpose of the inventory.

**Consistency:** Entities should use consistent methodologies to allow for meaningful performance tracking and comparison of GHG flux data over time, business units, geographies or suppliers. If there are changes to the inventory boundary that affect GHG flux estimates (e.g., inclusion of previously excluded sources, methods, data or other factors), they should be transparently documented and justified, and may warrant recalculation of flux data (see Chapter 6).

**Transparency:** Entities should address all relevant issues in a factual and coherent manner, based on a clear audit trail. Transparency relates to the degree to which information on the processes and procedures of the GHG inventory are disclosed in a clear, factual, neutral, and understandable manner based on clear documentation and archives (i.e., an audit trail). A transparent report will allow internal reviewers and external assurance providers to attest to its credibility and allow a meaningful assessment of the GHG performance of the reporting company. In ensuring transparency, specific exclusions need to be clearly identified and justified, assumptions disclosed, and appropriate references provided for the methodologies applied and the data sources used.

**Accuracy:** Entities should ensure that the quantification of GHG fluxes is systematically neither over nor under actual fluxes, as far as can be judged, and that uncertainties are reduced as far as practicable. A level of accuracy is needed that will allow users to make decisions with reasonable confidence as to the integrity of the reported information. The accuracy of GHG flux data is a particular concern for many agricultural sources. Reporting on measures taken to ensure accuracy and improve accuracy over time can help promote the credibility and enhance the transparency of inventories.

**Trade-offs between principles**

Entities may encounter trade-offs between principles when completing an inventory and should strike a balance between these principles, depending on their individual business goals.

Trade-offs will be particularly common in relation to accuracy. An entity may find that achieving the most complete inventory requires the use of less accurate data, compromising overall accuracy. Conversely, achieving the most accurate inventory may require the exclusion of activities with low accuracy, compromising overall completeness.

# Chapter 4. Overview of agricultural emission sources

Many different types of emission sources are associated with agriculture. Understanding the qualitative differences amongst these is crucial to many steps in inventory development, including calculating, reporting and undertaking the quality control of GHG flux data.

|  |
| --- |
| This chapter:* Distinguishes between two types of emissions sources – *mechanical* and *non-mechanical sources* – whose fluxes differ in fundamental ways, with important implications for GHG inventory development.
* Describes the variety and relative importance of these sources along agricultural value chains.
 |

## 4.1 Overview of on-farm and supply chain emissions

Figure 2 lists the principal emission sources on farmland, as well as those associated with upstream and downstream operations.

Non-mechanical sources occur exclusively on farmland. Their fluxes are determined by complex interactions with environmental conditions and they are often connected by complex patterns of N and C flows through farms. Non-mechanical sources emit CO2, CH4 and N2O (or precursors of these GHGs) and through quite different routes. CO2 fluxes are mostly controlled by uptake through plant photosynthesis and releases via respiration, decomposition and the combustion of organic matter. In turn, N2O emissions result from *nitrification* and *denitrification* (see Box 2), and CH4emissions result from methanogenesis under anaerobic conditions in soils and manure storage, enteric fermentation, and the incomplete combustion of organic matter.

Mechanical sources exist throughout the value chain and are combustion sources or industrial processes that consume fuels, chemical feedstock or electricity. Mechanical sources also include refrigeration and air-conditioning equipment. They emit any of the seven *Kyoto GHGs* and their emissions are wholly determined by the properties of the source equipment and material inputs (e.g., fuel composition). Examples of mechanical sources include harvesting or irrigation equipment, and fertilizer production processes.

Figure 2.Emission sources associated with agriculture

Upstream

On the farm

Downstream

**Mechanical**

* Mobile machinery (e.g., tilling, sowing, harvesting, and transport and fishing vessels): CO2, CH4, and N2O
* Stationary machinery (e.g., milling and irrigation equipment): CO2, CH4, and N2O

**Non-mechanical**

* Drainage and tillage of soils: CO2, CH4, and N2O
* Addition of synthetic fertilizers, livestock waste, and crop residues to soils: CO2, CH4, and N2O
* Addition of urea and lime to soils: CO2
* Enteric fermentation: CH4
* Manure management: CH4  and N2O
* *Land-use change*: CO2, CH4, and N2O
* Open burning of savannahs and of crop residues left on fields: CO2, CH4, and N2O
* Managed woodland (e.g., tree strips, *timberbelts*, etc.): CO2
* Composting of organic wastes: CH4
* Oxidation of horticultural growing media (e.g., peat): CO2

Many different sources potentially exist downstream. Some important sources are:

* Product processing and packaging
* Product transport
* Disposal of agricultural wastes (e.g., manure) and waste food by end-consumers

Many different sources potentially exist upstream. Some important sources are:

* Fertilizer production
* Pesticide and other agrochemical production
* Feed production (if entity does not make its own feed)
* Extraction and processing of lime
* Production of plastics used, for example, in mulching, polytunnels, row cover, silage wrap, etc.
* Production of other inputs (e.g., farm machinery, greenhouses, fuels, etc.)
* Transport of raw materials

This figure does not provide an exhaustive list of emission sources. This is a generalized depiction of the agricultural supply chain. Whether individual sources are located upstream, on the farm, or downstream will depend on the entity concerned. Also, this figure does not connote reporting requirements for emission sources, merely the types of sources commonly associated with farming. Subsequent sections of this Guidance outline whether individual sources should be reported in entity-level GHG inventories.

## 4.2 Emissions sources on farms

### Non-mechanical sources

The most important non-mechanical sources are:

**Enteric fermentation (CH4)**

CH4is produced in herbivores as a by-product of enteric fermentation, whereby carbohydrates are broken down by bacteria in the digestive tract. The amount of CH4that is produced depends on:

* The type of digestive tract. *Ruminant* livestock have an expansive chamber, the rumen, which fosters extensive enteric fermentation and high CH4 emissions. The main ruminant livestock in Ethiopia are cattle.
* Quantity and type of feed. Generally, the higher the feed intake, the higher the CH4emissions. The extent of CH4production is also affected by feed composition and type (e.g., forage versus grains).
* Age and size of livestock. Feed intake is positively related to animal size, growth rate, and production (e.g., milk production, wool growth, or pregnancy).

**Manure management (CH4 and N2O)**

*Manure* management releases both CH4 and N2O, although the emissions of these GHGs are influenced by different factors.

CH4 is emitted during the storage and treatment of manure under anaerobic conditions. The main factors affecting CH4emissions are the amount of manure produced and the portion of the manure that decomposes an aerobically. The former depends on the rate of waste production per animal and the number of animals, and the latter on how the manure is managed. In Ethiopia most livestock manure is managed as a solid on pastures and ranges; a smaller fraction is burned as a fuel.

N2Ois emitted either directly or indirectly from stored or treated manures (see Box2). N2O emissions are influenced by:

* The N and C content of the manure, and on the duration of storage and type of treatment.
* Temperature and time - comparatively simple forms of organic N, such as urea (mammals) and uric acid (poultry) tend to lead to indirect N2Oemissions more quickly.
* The extent of leaching and run-off of N from treatment units.

**Soil amendments and soil management (N2O)**

Direct and indirect emissions of N2Oalso occur from soils following increases in available N from:

* Synthetic N fertilizers and organic fertilizers (e.g., animal manure, compost, sewage sludge, and rendering waste).
* Urine and dung that is deposited onto pastures, ranges and paddocks by grazing animals.
* Incorporation of crop residues into soils and N-fixation by legumes. (Note: crop residue management and legume growing can reduce field fertilizer requirements and ultimately reduce overall soil N2O emissions.)
* *N mineralisation* associated with the loss of soil organic matter and caused by changes in land use or soil management, such as the drainage or management of organic soils (i.e. histosols).

|  |
| --- |
| Box 2. Indirect and direct N2Oemissions from soilsN2O emissions on farms are controlled by the supply of available N. Increases in available N, through the addition of fertilizers or animal wastes to soils, or from the storage and treatment of manure, stimulate denitrification and nitrification processes, which lead to N2O emissions. The actual N2O emissions may occur directly from the site of manure storage or fertilizer application, or they may occur indirectly, via leaching and *volatilization*. Volatilized N is ultimately deposited onto soils or onto the surface of lakes and other water bodies, where N2O emissions then occur. Leached N leads to N2O emissions in the groundwater below the farm or in ditches, rivers, estuaries, etc., that eventually receive the leachate. While indirect N2O emissions may occur off the farm, they are accounted for in the same way as direct N2O emissions in this Guidance. https://encrypted-tbn1.gstatic.com/images?q=tbn:ANd9GcSZylJt3c5F4vPu0m_hhEyc3dFQuBTIxMNCUv2Ph4kFv7OO5SA0CQ= Enhancement of denitrification and nitrification processes from increase in available N |

Water body (river, estuary, etc)

N2O precursors

**Soil liming**

Liming is used to reduce soil acidity and improve plant growth. When added to soils, carbonate limes such as limestone (CaCO3) or dolomite (CaMg(CO3)2) dissolve and may release bicarbonate (2HCO3-), which then evolves into CO2.Whether CO2 is emitted and the amount of emissions depends on soil factors, climate regime, and the type of lime applied(i.e., limestone or dolomite, fine or course textured). Non-carbonate limes, such as oxides (e.g., CaO) and hydroxides of lime, do not result in CO2 emissions on farms, but their production causesCO2emissions from the breakdown of carbonate raw materials.

**Carbon pools**

The agricultural sector differs profoundly from industrial sectors in the importance of *C pools*, which may act either as sources or sinks of CO2during agricultural land use or LUC. These pools are of four main types (Figure 3):

* Above-ground and below-ground biomass (e.g., trees, crops and roots).
* *Dead organic matter* (DOM) in or on soils (i.e., decaying wood and leaf litter).
* Soil organic matter. This category includes all non-living biomass that is too fine to be recognized as dead organic matter.
* Harvested products. Generally, this pool is short-lived in the agricultural sector as crop products are rapidly consumed following harvesting. *Harvested wood products* (HWPs) are a potential exception.

It is possible to disaggregate these pools further. For instance, the DOM and biomass pools can be subdivided into understory vegetation, standing dead tree, down dead tree, and litter pools, etc. This level of disaggregation may be useful depending on data availability and the intended accuracy of the inventory.

*Carbon stocks* represent the quantity of C stored in pools. It may take C stocks decades to reach equilibrium following a change in farm management. Ultimately, for agricultural land as a whole to sequester C, the sum of all stock increases must exceed the sum of all stock decreases (i.e., the sum of all C gains through CO2 *fixation* must exceed the sum of all C losses through CO2andCH4emissions and harvested products).

Soil carbon pools

Both organic and inorganic forms of C exist and are found in soils. However, agriculture typically has a larger impact on organic C pools, which are found in organic and mineral soils.

* Organic C pools in organic soils. Organic soils (e.g., those in peat and muck) have a high percentage of organic matter by mass and develop under the poorly drained conditions of wetlands when inputs of organic matter exceed losses of C from anaerobic decomposition. The drainage of organic soils to prepare land for agriculture leads to CO2 emissions - emission rates vary by climate, with drainage under warmer conditions leading to faster decomposition rates. CO2 emissions are also influenced by drainage depth, liming, and the fertility and consistency of the organic substrate.
* Organic C pools in mineral soils. All soils that are not organic soils are classified as mineral soils.They typically have relatively low amounts of organic matter, occur under moderate to well drained conditions, and predominate in most ecosystems, except wetlands. The organic C stocks of mineral soils can change if the net balance between C inputs and C losses from the soil is altered. C inputs can occur through the incorporation of biomass residues into soils after harvesting and fires, or through the direct additions of C in organic amendments. C losses are largely controlled by decomposition and are influenced by changes in moisture and temperature, soil properties and soil disturbance.

Figure 3 Carbon pools in agriculture



### Mechanical sources

The following categories of mechanical sources exist on farms:

* Stationary and mobile combustion sources. Stationary combustion sources are devices such as boilers, furnaces, and electric generators and are used to power a wide range of equipment, such as milling and irrigation equipment. Mobile combustion sources are vehicles and mobile equipment, such as tractors, combine harvesters, and trucks. The CO2 emissions from all combustion sources are primarily determined by the C content of the fuel used. In contrast, the CH4 and N2O emissions are primarily determined by the combustion and emissions control technologies present.
* Purchased electricity. Grid electricity in Ethiopia is derived from hydropower sources. This means that the emissions associated with an entity’s consumption of electricity will effectively be zero.

### Relative importance of different on-farm sources

At the farm scale, the relative importance of different emission sources and GHGs will vary widely depending on the type of farm, management practices and natural factors at play. These factors include farm topography; soil microbial density and ecology; soil temperature, moisture, organic content and composition; crop or livestock type; and land and waste management practices. Few studies have looked at the relative contribution of different sources to the whole-farm inventories of different farming systems using a consistent set of methods. It is therefore difficult to accurately predict the relative importance of different sources for a given farm. Nonetheless, certain broad patterns can be expected (e.g., Figure 4).

Figure 4. Typical patterns of the importance of different sources to overall GHG fluxes from select farming systems.

|  |  |
| --- | --- |
| **Emission source** | **Type of system** |
| **Sheep** | **Beef** | **Dairy (pasture)** | **Arable crop** | **Horticulture** |
| Enteric fermentation |  |  |  |  |  |
| Deposition or application of fertilizer and/or wastes to soils |  |  |  |  |  |
| Crop residue burning |  |  |  |  |  |
| Manure management |  |  |  |  |  |
| Fuel use |  |  |  |  |  |
| Soil CO2 |  |  |  |  |  |

Key:

|  |  |
| --- | --- |
|  | Small contribution |
|  | Medium contribution |
|  | Large contribution |

Notes:

1. The actual emissions profile of a farm may (and in many cases will) deviate from the pattern in this figure, depending on the soil, climate and management conditions concerned.
2. Figure based on expert opinion of the Technical Working Group.

Notes:

1. The actual emissions profile of a farm may (and in many cases will) deviate from the pattern in this figure, depending on the soil, climate and management conditions concerned.
2. Figure based on expert opinion of the Technical Working Group.

# Part 2: DEVELOPING ENTITY-LEVEL INVENTORIES

**A note on terminology in GHG Protocol publications**

The GHG Protocol uses specific terms to connote reporting requirements and recommendations. The term “shall” is used to indicate what is required for a GHG inventory to conform to a given Standard. The term “should” is used to indicate a recommendation, but not a requirement. The term “may” is used to indicate an option that is permissible or allowable.

# Chapter 5. Setting Inventory Boundaries

|  |
| --- |
| This chapter:* Describes approaches for setting organizational boundaries to determine which business operations should be included in an inventory
* Describes approaches for setting operational boundaries that define whether and how emissions sources associated with these operations should be reported in inventories.
 |

## 5.1 Setting organizational boundaries

*Organizational boundaries* determine which operations should be included in an inventory. Three ‘consolidation’ approaches can be used to set organizational boundaries:

1. *Operational control*. An entity accounts for 100% of the GHG fluxes to/from an operation over which it has the authority to introduce and implement its own operating policies.
2. *Financial control*. An entity accounts for 100% of the fluxes to/from an operation over which it has the ability to direct financial and operating policies with a view to gaining economic benefits.
3. *Equity-share approach*. An entity accounts for the fluxes to/from an operation according to its share of equity (or percentage of economic interest) in that operation.

**In the Ethiopian case, it is highly recommended to use Operational Control as it is the simplest form to apply.**

Various criteria can be used by entities to determine if they exert operational control of an operation. For instance, operational control would be held if:

The operation is operated by the reporting entity, whether for itself or under a contractual obligation to other owners or participants in the operation.

The operation is operated by a joint venture (or equivalent), in respect of which the reporting entity has the ability to determine management and board-level decisions of the joint venture.

The reporting entity holds an operating license.

The reporting entity sets environmental, health and safety policies.

## 5.2 Setting operational boundaries

Having set organizational boundaries using any one of the consolidation approaches, entities should then set *operational boundaries* for each of their sources. These boundaries define whether an emission source is *direct* (i.e., is controlled or owned by the reporting entity) or *indirect* (i.e., owned or controlled by another entity, but a portion of whose emissions are a consequence of the activities of the reporting entity). Emission sources are further classified by *scope* (Figure 5):

* *Scope 1*: All direct sources
* *Scope 2*: Consumption of purchased heat, steam and electricity (an indirect source)
* *Scope 3*: All other indirect sources

All scope 1 and 2 sources shall be reported in an inventory. Scope 3 sources are optional.

Figure 5. The ‘Scopes’ framework for categorizing the GHG emissions from different sources



# Chapter 6. Tracking Performance over Time

Agricultural activities and environmental conditions that influence GHG fluxes frequently change. These changes will make meaningful comparisons of ‘like with like’, and therefore tracking performance over time, more difficult.

|  |
| --- |
| This chapter:* Describes the concept of base reporting periods, which help ensure inventories can be compared to a representative point in the past, allowing meaningful and consistent comparisons of performance over time.
* Details considerations in setting *base periods* and recalculating base period data to ensure historical comparisons are meaningful.
* Describes various types of performance metrics that can help entities track their GHG performance.
 |

## 6.1 Setting and recalculating base periods

The base period is the period in history against which an organization’s climate impact is tracked over time[[1]](#footnote-1). All entities must establish a base period. Base periods should be based on the Ethiopian calendar.

### What time period should the base period represent?

Entities should use as a base period the earliest relevant point in time for which they have verifiable data. Critically, the base period should be representative of an entity’s climate impact.

**Base periods shall not be less than one year**

The base period should not be an individual *crop year* or production season (for livestock) that is less than one year. Otherwise, the effects of seasonal management activities may not be reflected in the base period. For instance, tillage practices, winter cover crops and double cropping systems can cause emissions outside of the growing season. Also, the length of crop years and production seasons will vary between regions, potentially compromising the comparability of data from different facilities owned by the reporting entity.

**Multi-year base periods are recommended**

Often times, individual years will not serve as representative base periods (see Table 3 for examples). In such cases, entities should average GHG flux data from multiple, consecutive years to form a more representative base period. In general, this Guidance recommends at least a three-year base period, which is often sufficient to smooth over inter-annual variability. If a base year has already been set for non-agricultural emissions, then a multi-year base period can be centered on that year.

Many calculation methodologies (e.g., Tier 1 IPCC methodologies) do not capture the effects of climate or environmental change on GHG fluxes. Instead, they only pick up changes in activity data (e.g., number of hectares farmed, number of cattle raised, amount of fertilizer used, etc.). As a result, if management practices in an individual year are representative, it may be appropriate to select that year as the base period.

Table 3.Examples of when an individual year may not serve as a representative base period

|  |  |
| --- | --- |
| **Why is the selected base period atypical?** | **Examples** |
| Changes in environmental conditions occur that are beyond the control of the entity and that cause the base period inventory to depart significantly from typical GHG flux profiles  | During a single growing season, a drought increases irrigation and therefore fuel use requirements |
| A typical or episodic changes in farming practices  | Coppiced woodland is returned to crop production |
| Forest is cleared for agricultural production  |
| Agricultural activities vary cyclically over a set period of years, such that activities (and corresponding GHG fluxes) in one year differ from those in other years within the same cycle | A multi-year multiple crop rotation  |
| Coppicing of short-rotation woody crops (e.g., a row of willows that is harvested every three years) |
| Rotational applications of lime |

**Rolling base periods may be useful**.

Long-term environmental trends, such as changes in precipitation and temperature that accompany climate change, can affect agricultural GHG fluxes. The more widely separated the base period is from the current reporting period, the more likely it is that at least some of the difference in GHG fluxes between the two periods is due to these trends. Therefore, entities may use a *rolling base period* to help minimize the influence of these long-term trends and ensure that inventories are more useful as a basis for tracking the impacts of management practices. Using a rolling base period involves moving the base period forward with each reporting period (Figure 6).

One disadvantage to rolling base periods is that they do not allow reduction targets to be expressed as a percentage reduction relative to a fixed point in the past, which is the most common form of expressing reduction targets.

Figure 6.The concept of rolling base periods

After rolling of base period

Before rolling of base period

Amount of GHG flux

Current reporting period

Base period

### When should the base period inventory be recalculated?

**Changes that trigger base period recalculations**

To ensure consistent tracking of GHG fluxes over time, the base period inventory shall be recalculated when changes occur to the inventory boundaries or inventory development process that would significantly impact the base year inventory. These changes include:

* Structural changes that transfer the ownership or control of operations from one entity to another as long as those operations existed in the base period of the reporting entity. Examples: mergers, acquisitions, and divestments (see Figure 7).
* Changes in calculation methodologies. Example: the use of improved *emission factors*.
* The discovery of errors that are significant on their own or collectively. Example: the discovery of errors in activity data.

In determining whether changes are significant entities should set significance thresholds (i.e., changes are cumulatively significant if they cause a change that exceeds x% of the base period inventory). The GHG Protocol does not define significance thresholds, although many GHG reporting programs do. However, once defined, a significance threshold should be applied consistently over time.

Figure 7. Recalculating base period inventories for structural changes.

Here, the reporting entity acquires a business at the beginning of year 3. The emissions from that business during year 3 are reflected in the reporting entity’s inventory for that year, but the inventories for the base period and year 2 are recalculated to include the acquired business’s emissions during those two years.

## Changes that do not trigger recalculations

* Organic growth or decline. Organic growth and decline is defined as increases or decreases in production output, changes in product mix, or closures and openings of operating units that are owned or controlled by the reporting entity. For instance, an egg producer would experience organic growth if it increased production, perhaps by building a new facility, but it would not experience organic growth if it bought out a pre-existing facility. Changes in the amount of land leased by an entity are also considered organic change and do not trigger recalculations, even if that action substantially increases production levels.
* The acquisition (or in sourcing) of an operation that did not exist in the base period of the reporting entity.
* Operational changes, such as switching from a feedlot to a rotational grazing operation, assuming both operations are owned or controlled by the reporting company.

## 6.2 Using performance metrics

### What are GHG performance metrics?

GHG performance metric scan be used to:

* Evaluate performance over time (e.g., compare figures from different years, identify trends in data, and show performance in relation to targets and base periods).
* Improve comparability between different sizes of operations by normalizing figures (e.g., by assessing the impact of differently sized operations on the same scale).

This Guidance does not require the reporting of performance metrics.

**Many types of performance metrics exist**

Some examples of performance metrics are:

Productivity and efficiency ratios: These express the value or achievement of an entity divided by its GHG impact. Increasing efficiency ratios therefore reflect a positive performance improvement. Examples of productivity/efficiency ratios include resource productivity ratios (e.g., sales per GHG) and process eco-efficiency ratios (e.g., production volume per amount of GHG).

Intensity ratios: Intensity (or ‘normalized’) ratios express GHG impact per unit of physical activity or unit of economic output. A physical intensity ratio is suitable when aggregating or comparing across businesses that have similar products. In turn, an economic intensity ratio is suitable when aggregating or comparing across businesses that produce different products. A declining intensity ratio reflects a positive performance improvement. Examples of intensity ratios include product intensity (e.g., tonnes of emissions per unit of sold livestock or crops generated) and sales intensity (e.g., emissions per sales).

Percentages: A percentage indicator is a ratio between two similar variables (with the same physical unit in the numerator and the denominator). Examples of percentages that can be meaningful in performance reports include current GHG fluxes expressed as a percentage of base year GHG fluxes.

In selecting a performance metric, entities should consider which metrics best capture the benefits and impacts of their business (e.g., its operations, its products, and its effects on the marketplace), as well as its intended application.

**The use of multiple performance metrics is recommended**

Entities might find it useful to track performance using more than one metric. This is because individual metrics might exclude certain sources, such as those associated with by-products or co-products (see below) or those not directly connected to the production system. For the same reason, performance metrics should always be reported alongside data on the absolute GHG fluxes to/from a farm. The following scenarios show the importance of using additional ratio indicators (or absolute GHG flux data) to track performance at the whole farm level:

* Production intensification (e.g., an increased use of fertilizers and/or feed) might boost yields and result in a net reduction in GHG intensity per unit of agricultural output (provided the inputs are not excessive), but could also increase emissions on a per ha basis.
* Increasing the feed conversion efficiency of cattle can reduce emissions per product, but can lead to greater overall emissions (and emissions per ha) if any spare feed is diverted to new livestock.

Table 4describes various trade-offs associated with different types of metrics commonly used in the agricultural sector.

**Contextual information should always be provided**

Importantly, the inherent diversity of agricultural practices, as well as the influence of environmental factors on GHG fluxes, will affect the comparability of metrics, both within and across businesses. For example:

* Intensity ratios will often be higher for self-replacing livestock herds than non-replacement herds. This is because self-replacing herds contain younger stock that emit enteric CH4 and produce N2O from urine depositions for a longer period of time before contributing to farm products.
* Adverse weather conditions can lower realized crop yields, causing inter-annual variation in intensity ratios, independent of any changes in farming practices. (Note: in such cases, entities may find it useful to normalize and report emissions by expected yield, in addition to actual yield).

Without adequate context on the farming system, environmental effects, and the emissions sources that have been studied, performance metrics are not useful for assessing performance. Such context should be provided in reports to aid the reliable interpretation of performance metrics. .

Table 4 Advantages and disadvantages of common performance metrics

|  |  |  |
| --- | --- | --- |
| **Metric** | **Advantages** | **Disadvantages** |
| GHG flux per unit land area (e.g., flux / ha) | * Useful to entities that define policies or that manage large amounts of land (e.g., government agencies)
* Reflective of the overall level of GHG fluxes on farms
 | * Fails to consider efficiency of farm production
 |
| GHG flux per unit product (e.g., flux / tonne beef) | * Better allows for comparisons within the same industry
* Better able to represent the effects of mitigation measures that have a relatively small GHG impact, but that nonetheless improve productivity
* Performance data are frequently sought by buyers on a per-product basis
 | * Calculation may be complicated by the variety of products that come from farms and the different allocation methods used to assign GHG fluxes (see below)
* Does not consider product value
* Does not reflect the overall climate impact of farms (which would vary depending on the volume of products produced)
 |
| GHG flux per unit of farm input (e.g., flux / MJ metabolisable energy intake) | * Provides an understanding of the effects of feed type and amount on animal systems, or of the efficiency of nutrient use in cropping systems
 | * Calculation may be complicated by the need to allocate GHG fluxes
 |
| GHG flux per unit of quality content in final product (e.g., per unit of fat, protein or metabolisable energy content) | * Considers a fundamental objective of most agricultural production – to provide food energy
 | * Calculation may be complicated by the need to allocate GHG fluxes
 |

# Chapter 7: Reporting GHG Data

Fundamentally, a credible inventory provides information that is complete, accurate, consistent and transparent, while meeting the decision-making needs of both internal management and external stakeholders.

|  |
| --- |
| This chapter:* Describes information that must be reported in an inventory.
* Outlines additional recommendations for reporting agricultural GHG fluxes.
* Provides guidance on reporting *offset* and renewable energy projects on farms.
 |

## 7.1 Required information

Companies shall publicly report the following information:

**General information on inventory boundaries and base periods**

* The approach used to set the organizational boundaries
* An outline of the operational boundaries chosen and, if scope 3 is included, a list specifying which types of scope 3 activities are covered
* The reporting period covered
* Information on the base period, including:
	+ The period chosen as the base period
	+ The rationale for choosing this period
	+ The base period recalculation policy
	+ Base period inventory totals by category (see below and Table 5)
	+ Appropriate context for any changes that trigger recalculation of the base period inventory
* Any specific exclusion of sources and/or operations from the inventory

**General GHG flux data**

* Data for all seven GHGs (CO2, CH4, N2O, SF6, PFCs, HFCs and NF3), disaggregated by GHG and reported in units of both metric tonnes and tonnes *CO2-equivalent* (CO2e)
* Total scope 1 and 2 emissions without subtractions for trades in offsets
* Data disaggregated by scope
* A reference or link to the calculation methodologies used

## 7.2 Minimum, best practice, recommendations for reporting agricultural GHG fluxes

Companies should publicly report the following information:

* For non-mechanical sources: A description of whether the calculation methodologies are IPCC Tier 1, 2, or 3.
* Scope 1 emissions disaggregated by mechanical sources, LUC (*biogenic* CO2 only), and all other non-mechanical sources (LUC is further defined in Box 3).
* Net CO2 flux data for the C stocks in above-ground and below-ground biomass, DOM and soils (in tonnes CO2).
* Where LUC results in a reduction in the size of C stocks, the CO2 emissions are reported in Scope 1.
* Otherwise, all CO2 fluxes are reported outside of the scopes in a separate category (‘Biogenic Carbon’) that has three components: (1) CO2 fluxes (emissions or removals) during land use management; (2) Sequestration during LUC; and (3) CO2 emissions from biofuel combustion.

Table 5: summarizes how GHG data should be separated within an inventory following these requirements and best practice recommendations.

Table 5.Schematic illustrating the requirements and minimum, best practice recommendations for disaggregating GHG flux data in inventories

|  |  |  |
| --- | --- | --- |
| **Category of source or sink** | **Subcategory** | **Examples** |
| **Scopes** |  |  |
|  Scope 1 | Mechanical sources  | Mobile and stationary combustion |
|  | Non-mechanical sources | Enteric fermentation, soil N2O emissions, and manure management.  |
|  | CO2 emissions from land use change  | CO2 emissions from the conversion of forests into ranchland or the conversion of wetlands into croplands |
|  Scope 2 | Purchased energy | Purchased electricity |
|  Scope 3 (optional) | All other indirect sources  | Production of agrichemicals and purchased feed |
| **Biogenic Carbon** | Land use management  | CO2 fluxes to/from C stocks in soils, above- and below-ground woody biomass, and DOM stocks, and the combustion of crop residues for non-energy purposes |
| C sequestration due to land use change  | CO2 removals by soils and biomass following afforestation or reforestation  |
| Biofuel combustion  | Combustion of biodiesel in farm machinery |
| **Additional information** | * A reference or link to the calculation methodologies used
* Description of whether these methodologies are IPCC Tier 1, 2, or 3
 |

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Box 3.** Defining land-use changeTo determine when LUC has occurred and to ensure LUC impacts are accounted for consistently across inventories, companies should use a consistent set of definitions for land use categories over time. Currently, there is no single internationally accepted standard for land use classification – different countries and international organizations have developed their own sets of definitions. Companies may find it simpler to use a country-specific classification system should their operations occur within a single country. Companies with agricultural operations in multiple countries may instead find it easier to use internationally recognized classification systems (e.g., the EU’s CORINE system). A simplified set of land use categories is shown below. LUC occurs when land is converted from one land use category to another[[2]](#footnote-2); for instance, when cropland is converted to grassland or when forests are converted to cropland. On occasion, the same area of land might be used to support multiple agricultural activities and so meet the definitions for different land-use categories. For instance, savannah woodland might be used both to graze livestock and as a source of wood fuel. In such cases, companies should categorize the land based on the agricultural activity that is economically most important.

|  |  |
| --- | --- |
| Land use category | Definition |
| Forest land | An area of high concentration of woody biomass. Typically defined on the basis of a minimum tree height and canopy cover. Forests lands include plantations, primary forests, and naturally regenerated forests with evidence of human intervention  |
| Cropland | Includes rice fields and agro-forestry systems. |
| Grassland | Managed grasslands, rangelands, pasture land. |
| Wetland | Areas of peat extraction and land that is covered or saturated by water for all or part of the year (e.g., peatlands) and that does not fall into other categories. |
| Settlements | All developed land (e.g., roads, buildings, etc.). |

 |

## 7.3 Additional information that may be reported

Besides the required and best practice reporting elements, companies may wish to report other information to enhance the transparency and relevance of their inventories. This information includes:

* Data on the size of C stocks (in metric tonnes C per unit land area)
* Biogenic CO2 flux data further subdivided by the type of C stock (e.g., DOM versus biomass stocks)
* Other GHG flux data further subdivided by the type of non-mechanical source (e.g., enteric fermentation versus manure management)
* Emissions of other GHGs (e.g., those of CFCs)
* Performance metrics
* A description of performance measured against internal or external benchmarks
* An outline of current management practices and any GHG management strategies
* Information on the uncertainty of GHG flux data

## 7.4Agriculturaloffset and renewable energy projects

Companies can generate renewable energy in many ways, including:

* Developing their own wind turbines or leasing land to wind power development firms
* Growing trees, short rotation woodland and short rotation coppice as a source of biomass fuel stock
* Installing anaerobic digesters to produce methane as fuel for electricity or heat
* Developing farm-scale micro hydroelectricity schemes (typically less than ~ 100kW)
* Using solar panels

Such projects are a potential source of offset credits. Other offset projects could be based on the reforestation or restoration of degraded lands and changes in fertilizer management.

**Accounting for renewable energy projects**

The impact of many of these projects on a company’s inventory will depend on whether any of the energy that is generated is consumed on-site by the company or sent to the grid. If the energy is consumed on-site, the project may reduce the amount of electricity or fuel consumed, resulting in a reduction in scope 1 or scope 2 emissions that will be evident when comparing inventories over time. On the other hand, if the energy is sent off-site, it shall not be used to lower scope 1 or scope 2 emissions. This is necessary to prevent double counting of the emissions benefits of that energy. This requirement extends to the calculation of performance metrics, which should not include the emissions benefits of sold energy. The GHG Protocol Guidelines for Grid-Connected Electricity Projects provide guidance on quantifying the emissions reductions from sold energy.

**Accounting for ‘avoided’ emissions**

Many renewable energy projects may have GHG impacts that extend beyond the farm gate – they may help to displace (or ‘avoid’) the emissions from fossil fuel-based electricity generation elsewhere on the grid that would have occurred in the absence of the project. Importantly, renewable energy generation projects do not always result in a physical reduction in emissions from fossil fuel consumption. For example:

* On-site renewable energy that is sold to the grid: the total emissions of a fossil-fuel plant are affected by the aggregate demand of all consumers connected to the grid, such that the sale of renewable energy may be balanced by an increased demand for electricity amongst other grid consumers, with no net change in absolute emissions from the fossil-fuel plant.
* Switching from residual fuel to wood waste produced on a farm: such switching may lead to emissions reductions from crude oil refining and waste fuel disposal, but whether these reductions are actually realized depends on the demand for fuel oil by other organizations.

In these cases, the behavior of other consumers – which is outside of the control of the reporting company –means avoided emissions do not necessarily occur. As a result, avoided emissions shall not be reported within the scopes and they shall not be used to ‘net’ emissions. However, estimates of avoided emissions may be reported as a memo item, as long as the underlying assumptions and appropriate calculation methodologies are also described. The Project Protocol provides guidance relevant for calculating avoided emissions.

**Accounting for transactions in offset credits**

Should a company sell an offset that has been generated within its organizational boundaries, it shall remove the associated emissions reductions from its corporate inventory to prevent double counting. It should also disclose the protocol used to verify the emissions reductions.

# Glossary

|  |  |
| --- | --- |
| Accounting (GHG accounting) | Quantification and organization of information about *GHG fluxes* based on common procedures, and correct attribution of the same to specific companies. |
| Base period | A historic period against which a company’s *GHG fluxes* are tracked over time. |
| Biogenic CO2 emissions | CO2 emissions from biological sources or materials derived from biological matter. |
| Carbon pools | Natural stores of carbon in biomass, dead organic matter, soils, or harvested products. Carbon pools both take-up and release CO2*.* |
| Carbon stocks  | The total amount of carbon stored on a plot of land at any given time in one or more *carbon pools*. |
| Carbon sequestration | The net carbon accumulation (i.e., *CO2 fixation* minus CO2 emissions) in *carbon pools*. |
| CO2-equivalent (CO2e) | The universal unit for comparing emissions of different GHGs, expressed in terms of the *global warming potential* (GWP) of one unit of CO2.  |
| Crop year | The period of time between two harvests. For many crops, this period approximates a calendar year, but for others several crop years may be possible each calendar year. |
| Dead organic matter | A *carbon pool* that includes non-living biomass in: (1) dead wood that is either standing, lying on the ground, or in the soil; and (2) litter located on or within the mineral or organic soil.  |
| Denitrification | The process whereby nitrates are reduced by bacteria and become N2O, which is then released into the atmosphere. |
| Direct GHG emissions | Emissions from sources that are owned or controlled by the reporting company. |
| Emission factor | A factor allowing *GHG fluxes* to be estimated from a unit of available activity data (e.g., tonnes of fuel consumed, tonnes of product produced). |
| Enteric fermentation | Fermentation that occurs in the digestive tracts of *ruminant* livestock species (e.g., cattle and sheep) and that releases CH4. |
| Equity share approach | An approach used to set *organizational boundaries*, wherein a company accounts for the emissions from an operation according to its share of equity (or percentage of economic interest) in that operation. |
| Financial control | An approach used to set *organizational boundaries*, wherein a company accounts for 100% of the emissions from an operation over which it has the ability to direct financial and operating policies with a view to gaining economic benefits. |
| Greenhouse gas (GHG) | A gas absorbs and emits radiation within the thermal infrared range in the atmosphere.  |
| GHG emissions inventory | A quantified list of the *GHG fluxes* from across the entire operations of the reporting entity. Such inventories include the emissions of all seven *Kyoto GHGs* (CO2, CH4, N2O, HFCs, PFCs, SF6, and NF3). |
| GHG Flux | Emissions to or removals from the atmosphere of GHGs. |
| Global warming potential (GWP) | The change in the climate system that would result from the emission of one unit of a given GHG compared to one unit of CO2. |
| Harvested wood products (HWPs) | A *carbon pool* that includes all wood material (including bark) that leaves the boundary of the reporting company. |
| Indirect GHG emissions | Emissions from sources that are owned or controlled by another company, but are nonetheless a consequence of the activities of the reporting company. |
| Indirect N2O emissions from soils | Emissions of N2O from soils as a result of leaching and *volatilization* processes that lead to the emissions being physically displaced. |
| Indirect land use change (iLUC) | A pattern of land use wherein an existing crop is diverted for another purpose and replacement crops are then grown on formerly non-agricultural lands. |
| Kyoto GHGs | The GHGs that are mandatorily reported in national GHG inventories to the United Nations Framework Convention on Climate Change (CO2, CH4, N2O, HFCs, PFCs, and SF6). |
| Land-use change | The conversion of one category of land-use (e.g., forest) into another (e.g., cropland) through fire, draining, clear felling or soil preparation. |
| Non-mechanical sources (on farms) | Either bacterial processes shaped by climatic and soil conditions (e.g., decomposition) or the burning of crop residues. See also *Mechanical sources.* |
| Manure | Effluent and bedding material collected from housed animals. |
| Mechanical sources (on farms) | Equipment or machinery operated on farms, such as mobile machinery (e.g., harvesters), stationary equipment (e.g., boilers), and refrigeration and air-conditioning equipment. See also *Non-mechanical sources*. |
| Nitrification | During nitrification, bacteria and other microorganisms oxidize the nitrogen within ammonia (NH3) to create nitrites, which are further oxidized into nitrates.  |
| Offset credits | Tradable commodities that typically represent one metric tonne of *CO2-equivalent* emissions reductions or *sequestration*. In most cases, offset credits are generated at specific projects (offset projects). |
| Organizational boundaries | The boundaries that determine the operations owned or controlled by the reporting company, depending on the consolidation approach taken (equity or control approach). |
| Operational boundaries | The boundaries that determine the *direct* and *indirect* emissions associated with operations owned or controlled by the reporting company. |
| Operational control | An approach used to set organizational boundaries, wherein accompany accounts for 100% of the emissions from an operation over which it has the authority to introduce and implement its own operating policies. |
| Product processing | The treatment of an agricultural product to change its properties with the intention of preserving it, improving its quality, or making it functionally more useful. On-farm product processing is product processing done on the farm with produce from the farm. |
| Rolling base period | Base periods that move forward in time with each reporting period. |
| Ruminants | Mammals that digest plant-based food by softening it within a first stomach (the ‘rumen’), then regurgitating the semi-digested mass (the ‘cud’) for further chewing. *Enteric fermentation* results from the microbial fermentation of food in the rumen. Examples of ruminants include cattle, goats, sheep, bison, yaks, water buffalo, and deer. |
| Scope | Defines the *operational boundaries* in relation to *direct* and *indirect* GHG emissions. |
|  Scope 1 | *Direct* GHG emissions from sources owned or controlled by the reporting company. |
|  Scope 2 | Emissions associated with the generation of electricity, heating/ cooling, or steam purchased for the reporting company’s own consumption. |
|  Scope 3 | *Indirect* emissions other than those covered in *scope 2*. |

# Bibliography

Stockwell, R. and Bitan, E. 2011.Future Friendly Farming: Seven Agricultural Practices to Sustain People and the Environment. National Wildlife Federation.(www.ncwf.org/Docs/FutureFriendlyFarming.pdf‎)

Climate Resilient Green Economy (CRGE) Strategy. Federal Democratic Republic of Ethiopia. 2011

CR Strategy Agriculture and Forestry. Climate Resilient Green Economy (CRGE) Strategy. Federal Democratic Republic of Ethiopia. 2015

Intergovernmental Panel on Climate Change. 2006. 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Prepared by the National Greenhouse Gas Inventories Programme, Eggleston H.S., Buendia L., Miwa K., Ngara T. and Tanabe K. (eds). Published: IGES, Japan.

Statistical Report on Area and Production of Crops, And Farm Management Practices. Large and Medium Scale Commercial Farms Sample Survey. 2011

Methane Emission From Agricultural Waste Report in Ethiopia. Country Resource Assessment. Global Methane Initiative. Central Statistical Agency. 2011

# List of contributors

The development of this guidance was financed by SCIP Fund which is a shared commitment by governments of UK, Norway and Denmark.

This GHG inventory was developed by the following technical workshop group with technical advice and training from World Resources Institute (WRI) and Echnoserve Consulting.

**Membersof Technical Working Group (TWG)**

Sertse Sebuh, Ministry of Agriculture (Chair of TWG)

Mezgebu Getnet, Ethiopian Institute of Agricultural Research

Million Tadesse, Ethiopian Institute of Agricultural Research

Thedros Sisay, Ethiopian Institute of Agricultural Research

Tesfaye Ertebo, Ministry of Agriculture

Zewdu Eshetu, Climate Science Centre of the Addis Ababa University

**Technical Assistance**

World Resources Institute: Stephen Russell

Echnoserve Consulting: Daniel Fikreyesus

Messay Sintayehu

1. The Corporate Standard uses the term ‘base year’ instead of ‘base period.’ The latter term is used here to avoid confusion because base periods may comprise more than one year. [↑](#footnote-ref-1)
2. This Guidance follows the ‘land-based’ approach for recognizing LUC, as opposed to an ‘activities-based’ approach. Land-based approaches assess the net emissions of select land-use categories while activity-based approaches assess the net emissions of select land-use activities. Both approaches can be used for developing national GHG inventories for the UNFCCC. [↑](#footnote-ref-2)