GMT Holding Farm S/A

GHG Inventory Management Plan

January 30, 2024

REVISION HISTORY

Version Number	Date	Reporting Period	Comments	Revised by
1.0	2023-03-30	2021-01-01-2021-12-31	Initial version developed for the 2021 GHG Inventory	External
2.0	2023-12-12	2022-01-01-2022-12-31	Updated for 2022 GHG Inventory	External
2.1	2024-01-30	2022-01-01-2022-12-31	Updated post validation by GMT	External

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1. INTRODUCTION

This document serves as the Inventory Management Plan (IMP) for GMT Holding Farm's S/A (GMT) greenhouse gas (GHG) inventory (GHG Inventory). The IMP functions alongside the GHG Inventory and provides the steps to develop and manage GMT's corporate GHG inventory including setting boundaries, data collection, and quantification methodologies. The IMP is intended to be a live document that evolves alongside the GHG inventory.

1.1. BACKGROUND

A corporate GHG inventory is an important tool for companies to measure and manage their GHG emissions. A GHG inventory identifies emission sources within an organization's boundaries and reports the GHG emissions associated with those sources within a specified period in accordance with standard GHG accounting principles.

1.2. GHG ACCOUNTING STANDARD

The Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard[1] (GHG Protocol), is a globally accepted GHG accounting standard developed in partnership between the World Resources Institute (WRI) and World Business Council for Sustainable Development (WBCSD). The GHG Protocol sets standards and guidance for organizations preparing a GHG inventory and provides a common approach for GHG accounting and reporting for organizations across the globe.

GMT's GHG Inventory was developed in accordance with the GHG Protocol. Additional guidance or methodologies used in the development of the GHG Inventory are referenced throughout the IMP.

2. DEVELOPMENT OF GHG INVENTORY

2.1. GHG ACCOUNTING PRINCIPLES

The GHG Protocol identifies five generally accepted principles to guide GHG accounting and reporting. Table 1 describes the GHG accounting principles identified by the GHG Protocol.

Table 1 - Generally accepted GHG accounting principles

GHG Accounting Principle	Description
Relevance	Ensure the GHG inventory is reflective the GHG emissions of the company and serves the needs of internal and external users of the inventory.
Completeness	Account for all GHG emission sources within the stated inventory boundaries. Any exclusions from the reported GHG inventory should be disclosed and justified.
Accuracy	Ensure the GHG inventory is sufficiently accurate to allow users to make decisions and undertake reasonable effort to reduce uncertainty in the reported information.
Consistency	Apply a consistent approach to emissions quantification to make meaningful comparison over time. Disclose any changes in methodologies, data, boundaries, or other relevant factor.
Transparency	Disclose sufficient and appropriate information including references to methodologies, and data sources used.

2.2. INVENTORY DEVELOPMENT PROCESS

Per the GHG Protocol, a systematic approach to developing a GHG inventory should be followed. This includes setting boundaries, gathering data, and quantifying emissions. Figure 1 provides an overview of the typical process used to develop a GHG inventory. A detailed description of each step listed in Figure 1 and how the process was applied for the development of GMT's GHG Inventory is provided in the following sections.

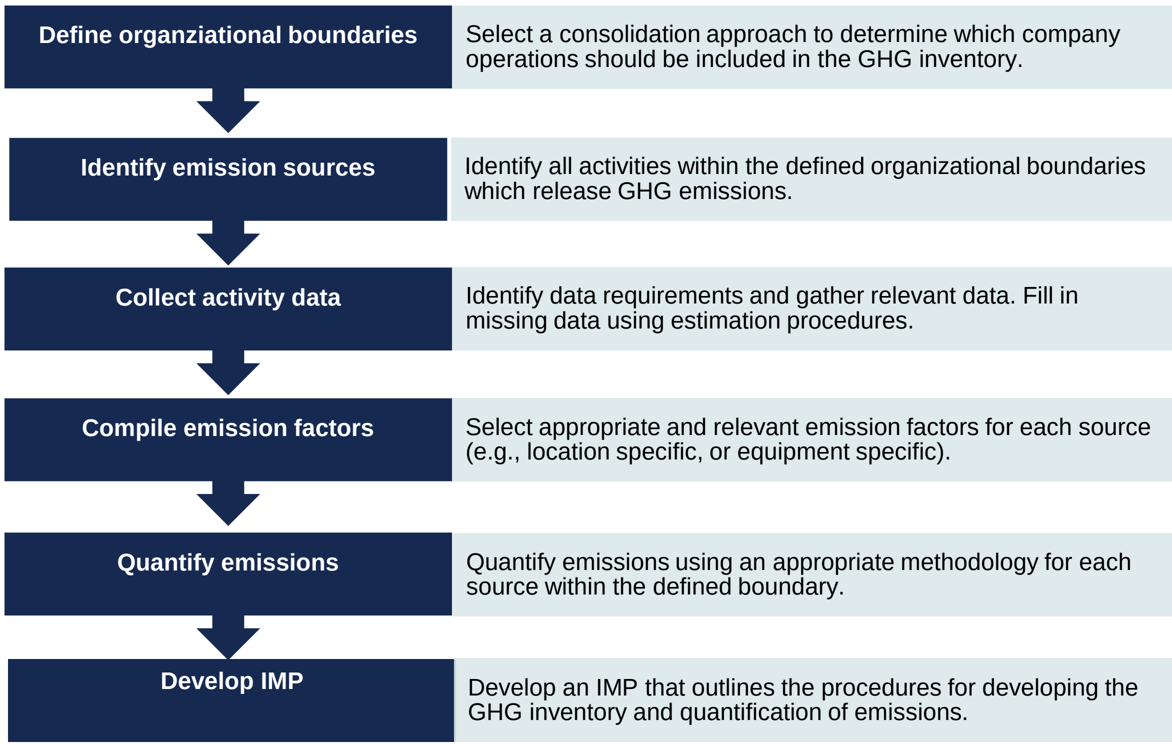

Figure 1 - GHG inventory development process

3. ORGANIZATIONAL BOUNDARY

3.1. CONSOLIDATION APPROACH

Defining the organizational boundary is a key step in corporate GHG accounting. This step determines which operations are included in a company's organizational boundary and how emissions from each operation are consolidated by the reporting company. The GHG Protocol presents two distinct approaches for consolidating organizational boundaries: the equity share approach or the control approach (defined as either operational or financial control).

GMT's organizational boundary is consolidated using the operational control approach for this GHG Inventory. Under the operational control approach, a company is required to account for 100 percent of the GHG emissions from operations over which it has the authority to introduce and implement operating decisions and is not required to account for GHG emissions from operations in which it owns an interest but over which it has no operational control.

3.2. REPORTING PERIOD

The GHG Inventory covers the period from January 1, 2022, to December 31, 2022.

3.3. COMPANY INFORMATION

GMT Holding Farm S/A is an agricultural company which operates agricultural land in Brazil. The company information is provided in Table 2.

Table 2 - Company information

IMP Component	Details
Company name	GMT Holding Farm S/A
Corporate address	Avenida Barão Homem de Melo, 4554, 10° floor, Belo Horizonte, BR-MG, 30494-270, BR
Inventory contact	Raquel Gouveia
Inventory contact information	raquel@montesantotavares.com.br

3.4. GMT'S OPERATIONS

The organizational chart for GMT is provided in Appendix A. The company's subsidiaries are agricultural operations, primarily involved in the cultivation and harvesting of coffee. Table 3 provides a list of all subsidiaries within GMT's organizational boundary for the reporting period. It was determined that GMT has operational control over all subsidiaries listed in Table 3 and thus all operations listed in Table 3 should be included within the GHG inventory.

Table 3 – Operations within GMT's organizational boundary

FACILITY NAME	OPERATIONS	LOCATION	DATE OF ACQUISITION
Fazenda Sequoia Bahia LTDA	Coffee production and processing	Zona Rural de Barreiras-BA, CEP 47819-899	2013
Riviera Coffee Agro LTDA	Coffee production	Zona Rural de Minas Novas-MG, CEP 39650-000	2020
Fazenda Bela Vista Agronegocios LTDA	Coffee production	Not operational during the reporting period	NA
Primavera Agronegocios LTDA	Coffee production and processing	Zona Rural de Angelândia-MG, CEP 39.685-000	2010
Atlantica Agropecuaria LTDA	Coffee production	Zona Rural de Pirapora-MG, CEP 39.270-970	2008
Fazenda Matilde Agronegocios LTDA	Coffee production	Zona Rural de Capelinha-MG, CEP 39680-000	2010
Atlantica Participacoes LTDA	Holding company with aircraft asset	No longer under operational control as of December 16, 2022.	NA

4. IDENTIFICATION OF EMISSION SOURCES

The GHG Protocol defines three scopes for GHG emissions which delineate direct and indirect emission sources. The three scopes are defined as follows:

- Scope 1 emissions: direct emissions from sources owned or controlled by the company
- Scope 2 emissions: indirect emissions from the generation of purchased energy such as grid electricity and other similarly distributed energy types such as steam, hot water, and chilled water
- Scope 3 emissions: all other indirect emissions which occur as a consequence of the company's activities but from sources not owned or operated by the company

The GHG Protocol requires the inclusion of all Scope 1 and Scope 2 emissions in a GHG inventory because an organization has control over these activities. Reporting of scope 3 emissions is currently optional under the GHG Protocol Corporate Standard. Organizations are however encouraged to quantify Scope 3 emissions sources that are material or significant to their business activities, and more organizations are beginning to include scope 3 emissions in their GHG inventory to better understand the full GHG impact to their operations. Scope 3 sources may in some cases represent the majority of an organization's GHG emissions and as such may present additional emissions reduction opportunities.

As previously noted, all operations identified in Table 3 were within GMT's operational control for the reporting period. Table 4 identifies the direct (Scope 1) and indirect (Scope 2) sources of GHG emissions from GMT's activities. Scope 3 indirect emissions have not been quantified as part of this scope of work and are therefore not included in this GHG Inventory.

Table 4 - GHG emission sources identified from GMT's activities

Emissions source	Activity	Applicable	Description
Direct (Scope 1) emission sources			
Fuel Use	Fuel use in mobile equipment	Yes	Combustion of fuels to generate mechanical energy in mobile equipment. This includes on-road equipment such as pickup trucks and light vehicles, as well as off-road equipment such as tractors, and aircraft
	Fuel use in stationary equipment	Yes	Combustion of fuels to generate useful energy such as heat in stationary equipment including compressors and generators.
Refrigeration or air conditioning	Fugitive emissions from refrigeration, air conditioning, and industrial gases	Yes	Emissions from leakage of refrigerants from on-site cooling and refrigeration units.
Soil management	Direct Nitrous Oxide (N_2O) emissions from nitrogen inputs to soil	Yes	Release of nitrous oxide from enhanced nitrification and denitrification of soil due to an increase in available nitrogen from the application of nitrogen-based fertilizers.

	Indirect N_2O emissions from atmospheric deposition or leaching/run-off	Yes	Along with the direct nitrous oxide emissions mentioned above, this gas is released through two indirect pathways: through volatilization and subsequent redeposition, and through leaching and runoff.
	CO_2 emissions from application of urea	Yes	Release of CO_2 fixed during the industrial production of urea through application to soil.
	CO_2 emissions from liming	Yes	Release of CO_2 fixed during the industrial production of lime through application to soil.
	N_2O emission from crop or other biomass residue inputs to soil	No	Release of N_2O from the decomposition of waste biomass materials added to soil. Materials primarily consist of branches and leaves gathered from pruning of perennial plants
Open burning of crop residue	CH_4 and N_2O emissions from open burning of crop residue	No	Both methane and nitrous oxide are produced from the combustion of crop residues on-site.
Waste treatment	Composting of agriculture waste or other organic material	Yes	Methane, nitrous oxide and biogenic carbon dioxide are released when organic material is transformed through biological activity.
Wastewater treatment	Emissions from treatment of wastewater	Yes	Processing and treatment of wastewater generated from facility operations in on-site treatment systems.
Land Use	Biogenic CO_2 emissions from soil carbon due to land management practices	Yes	Soil management practices (tillage, input level of organic matter, etc.) result in a flux in the soil's carbon stock, depending on multiple factors (climate, soil texture, crop type, etc.)
Land Use Conversion	Biogenic CO_2 emissions from soil carbon lost during the land use conversion process	No	Emissions from losses in carbon stock from biomass removal due to conversion of grassland and forest to cropland during the reporting period.
Indirect (Scope 2) emission sources			
Purchased Electricity	Indirect emissions from purchased electricity	Yes	Upstream emissions from the generation of electricity purchased for consumption at facility operations.

4.1. LIST OF GHGS

As required by best practice in corporate GHG accounting per the GHG Protocol, all seven Kyoto Protocol greenhouse gases should be included where applicable and material. The GHG inventory accounts for both biogenic and anthropogenic GHG emissions. Per the GHG Protocol, biogenic CO_2 emissions, which occur from the release of biologically sequestered carbon, shall be quantified but reported separately from the GHG emissions per scope.

GHGs should be quantified for each gas released. Total GHG emissions are quantified by converting each individual GHG to a standardized unit of measure, carbon dioxide equivalent (CO_2e) based on the global warming potential (GWP) of each GHG. Global warming potentials (GWPs) are factors describing the radiative forcing impact of one unit of a specific greenhouse gas (e.g., methane) relative to one unit of carbon dioxide. GWPs are used in GHG accounting to convert individual GHGs to a single standardized unit, CO_2e. The 100-year GWPs without climate-carbon feedbacks were applied to all emissions data in this GHG Inventory in order to calculate total emissions in tonnes carbon dioxide equivalent (tCO_2e). Global warming potential values were sourced from the Intergovernmental Panel on Climate Change's (IPCC) Fifth Assessment Report[2] (AR5), as currently recommended under the GHG Protocol. Exceptionally, for isobutane the 100-year GWP without climate-carbon feedbacks was sourced from the IPCC's Sixth Assessment Report[3]. The Kyoto Protocol GHGs applicable to GMT's operations during the reporting period and their respective GWPs are listed in Table 5.

Table 5 - Kyoto Protocol GHGs and GWPs

GHG	Chemical Formula	100-year GWP	Applicability to GMT
Carbon Dioxide	CO_2	1	Applicable and included
Methane	CH_4	28	Applicable and included
Nitrous Oxide	N_2O	265	Applicable and included
HFC-134a (1,1,1,2-Tetrafluoroethane)	$C_2H_2F_4$	1300	Applicable and included
R-600a (isobutane)	C_4H_{10} or $(CH_3)_2CH\ CH_3$ or $(CH_3)_2CHCH_3$	3	Applicable and included. AR6 used as GWP for isobutane not provided in AR5.
Perfluorocarbons (PFCs)	Various	As listed in AR5	Not applicable
Nitrogen trifluoride	NF_3	16,100	Not applicable
Sulphur hexafluoride	SF_6	23,500	Not applicable

5. ACTIVITY DATA

For each emission source identified, activity data is required for the calculation of emissions. Activity data refers to the data that is associated with the occurrence of the activity during company operations and tracks factors such as frequency, location, time of occurrence and other characteristics specific to the activity. The GHG Protocol recommends implementation of a data acquisition management system for required GHG inventory data. Figure 2 identifies the typical process to gather required activity data.

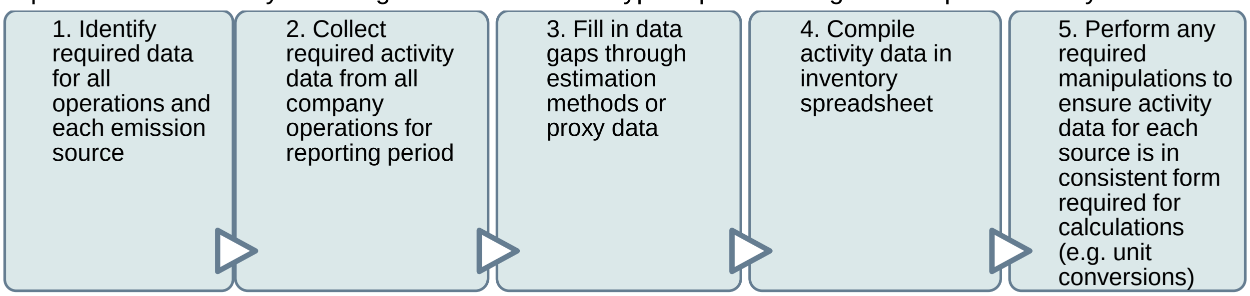

Figure 2 - Data collection process

5.1. GMT'S ACTIVITY DATA

Activity data required from GMT for each emission source identified in Table 4 was identified and is summarized in Table 6. All data is required for the full reporting period and all company operations where the source applicable. Where possible, data should be disaggregated by business unit or facility for ease of calculation and increased oversight of data collection.

Table 6 – Required Data Associated with Different Emission Sources within GMT's operations

Emissions source	Data Requirement	Data status
General	– List of facilities including location, date of acquisition and mean daily temperatures	– Climate zone was determined based on IPCC 2019 as discussed in section 7.
Fuel combustion (mobile and stationary)	– List of fuels consumed – Quantity of each fuel consumed per facility by equipment type – Fuel characteristics (e.g., biofuel content)	– Data was available, however, not broken down by equipment type. – GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 value was used as a proxy and prorated based on the 343 days Atlântca Agro

Emissions source	Data Requirement	Data status
		was under GMTs operational control in 2022. – GMT confirmed by email on December 21, 2023 that wood was used for stationary combustion at the Primavera facility. – GMT confirmed by email on January 9, 2024 that the wood used is eucalyptus.
Soil management – nitrogen application	– List of nitrogen-based fertilizers consumed at each facility – Quantity of each fertilizer consumed per facility – Area and method of application – Fertilizer types (e.g., organic) and characteristics (e.g., nitrogen content)	– Data available was complete. – GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 value was used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.
Soil management – urea fertilizer	– List of urea fertilizers consumed at each facility – Quantity of each fertilizer consumed per facility – Area and method of application – Fertilizer types (e.g., organic) and characteristics (e.g., nitrogen content)	– Data available was complete.
Soil management – lime application	– List of lime amendments consumed at each facility – Quantity of each lime amendment consumed per facility – Area and method of application	– Data available was complete.
Soil management – crop residue	– Quantity of crop residue generated from each crop type at each facility – Residue management process Residue characteristics (e.g., carbon content)	– There are no emissions associated with crop residue in the current reporting period as there was no residue, confirmed by email on 10/31/23.

Emissions source	Data Requirement	Data status
Soil management – soil carbon	– Area cultivated at each facility – Land management activities including tillage practices, land use, and residue input to soil – Soil characteristics to classify soil types	– Climate and soil type determined based on IPCC methodology and Brazilian soil map as discussed in Section 7.4.6 – GMT confirmed that there was no tillage in the reporting period by email on 10/31/23.
Wastewater treatment	– Quantity of wastewater generated and treated on-site at each facility and type of treatment – Type of treatment technology used	– Wastewater data was calculated and provided by GMT for the reporting period. – GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 value was used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.
Waste treatment - composting	– Quantity of organic waste composted at each facility	– Data available was complete
Refrigerants	– Type of refrigerant per unit – New units: capacity and charge quantity – Disposed units: capacity and recovered quantity – Existing units: Top-up quantity	– Quantity of refrigerants leakage was estimated based on literature as discussed in Section 7.8. – GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 value was used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

Emissions source	Data Requirement	Data status
Purchased Electricity	– Quantity of electricity purchased from the grid per facility – Information on market-based instruments (MBIs) purchased where applicable, including quantity of electricity purchased under MBI, generation technology of purchased MBIs, supplier-specific emission factors (if available)	– Data provided was complete. – GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 value was used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

6. EMISSION FACTORS

An emission factor is a ratio which relates the quantity of an atmospheric pollutant to an activity which releases that pollutant. Typically, an emission factor is an average rate of emissions released from an activity determined through research. In GHG inventories, emission factors are used to calculate emissions from a company's activities in lieu of direct measurement. While the use of emission factors in GHG inventories is common practice, accuracy in GHG emissions requires the use of appropriate and representative emission factors. Emission factors may vary by factors such as geography and technology and it is recommended that the most representative available emission factors be used in a GHG inventory.

Emissions factors used in GMT's GHG Inventory were sourced from reputable third-party organizations, typically government reports. Emission factors for each source are provided in Section 7. Emission factors should be reviewed for each reporting period and updated as necessary.

7. QUANTIFICATION METHODOLOGY

For each GHG emissions source, the emissions are quantified in metric tonnes (t) by multiplying an appropriate emission factor (EF), by the activity factor of that GHG source (for e.g., by the litres of fuel consumed), as shown in Equation 1.

Equation 1 – General calculation for GHG emissions

$$GHG\ emissions\ per\ activity\ (tGHG) = EF\ \left(\frac{tGHG}{activity\ unit}\right) \times\ Activity\ quantity\ (unit\ of\ activity)$$

Where:

– *GHG* is the quantity of GHG released from the activity in tonnes
– *EF* is the emission factor for the release of GHG from that activity per unit of activity

– *Activity quantity* is the total quantity of the activity for which emissions are being quantified undertaken by the company during the reporting period, measured in the units for which emission factors are available (e.g., litres of fuel)

Where possible, emissions for each of the individual GHGs from the seven GHGs required under the GHG protocol released from an activity were quantified. The total GHGs from each activity were converted to a standardized unit, CO_2e as shown in Equation 2. The global warming potentials (GWP) used in Equation 2 for each GHG applicable to GMT are provided in Section 4.1.

Equation 2 – Conversion of GHG emissions to standardized unit (CO_2e)

$$Total\ emissions\ per\ activity\ (tCO_2e) = \sum_{i=1}^{n} GHG_i(t) \times GWP_i$$

Where:

– *GHGi* is the quantity of *GHGi* released from the activity in tonnes
– *GWPi* is the GWP of *GHGi* as provided in Table 5
– n is the number of GHGs released from the activity

The following sections provide detailed calculation methodologies for each emission source identified in GMT's operations. The activity data from GMT's operations used in the calculations for each emission source is also identified with any assumptions made about the data.

7.1. SOURCE SPECIFIC QUANTIFICATION METHODOLOGIES

The following sections provide detailed calculation methodologies for each emission source identified in GMT's operations. Emissions were quantified in accordance with the methodologies specified in the Guidelines for National Greenhouse Gas Inventories (IPCC 2006 Guidelines)[4] developed by the Intergovernmental Panel on Climate Change (IPCC). The 2006 Guidelines were used as the primary quantification methodology in combination with the 2019 refinement (IPCC 2019 Refinement)[5]. The IPCC Guidelines provide quantification methodologies for emission sources by sector in three tiers which vary based on the availability of data. In general, moving to higher tiers improves the accuracy of the inventory and reduces uncertainty, but the complexity and resources required for conducting inventories also increase for higher tiers.

Tier 1 methods are designed to be the simplest and use default parameters and emission factors. Country-specific activity data are needed, but for Tier 1 there are often globally available sources of activity data estimates (e.g., deforestation rates, agricultural production statistics, global land cover maps, fertilizer use, livestock population data, etc.), although these data are usually spatially coarse. Tier 2 can use the same methodological approach as Tier 1 but applies emission factors and parameters that are based on country- or region-specific data, for the most important land-use or livestock categories. Country-defined emission factors are more appropriate for the climatic regions, land-use systems and livestock categories in that country. Higher temporal and spatial resolution and more disaggregated activity data are typically used in Tier 2 to correspond with country-defined coefficients for specific regions and specialized land-use or livestock categories. Tier 3 is the highest tier and specifies the use of country-specific methods involving process modelling and/or detailed measurement. At Tier 3, higher order methods are used, including models and inventory measurement systems, repeated over time, and driven by high-resolution activity data. Tier 3 systems may include comprehensive field sampling repeated at regular time intervals and/or GIS-based systems of age, class/production data, soils data, and land-use and management activity data, integrating several types of monitoring.

For this GHG Inventory, Tier 2, country specific methodologies were used where possible. The sources for any Tier 2 methodologies used in this GHG Inventory are specified for each emission source if applicable. If Tier 2 methodologies were not available or could not be used due to data limitations, the Tier 1 methodology specified in the IPCC 2006 Guidelines and the IPCC 2019 Refinement was used. The choice between Tier 2 and Tier 1 was based on the availability of data for each emission source.

The activity data from GMT operations used in the calculations for each emission source is also identified with any assumptions made about the data.

7.2. MOBILE FUEL COMBUSTION

Fuel combustion emissions are generated from the combustion of fuel for the purpose of generating useful energy such as heat. During combustion, the carbon in the fuel reacts with oxygen and CO_2 is released as a by-product. Trace amounts of CH_4 and N_2O are also released as by-products of combustion. Combustion emissions are calculated as shown in Equation 3, based on the quantity of fuel and the emission factors for the fuel consumed. Equation 3 is based on Equation 3.2.1, Volume 2 of the 2006 IPCC Guidelines[6] which calculates emissions for fuel consumed for road transport. For this GHG Inventory this equation was applied to emissions for off-road transport and air transport. Equation 4 shows the calculation of CH_4 and N_2O emissions for fuels consumed in on-road and off-road vehicles respectively. This equation was based on Equations 3.2.4 and Equation 3.3.2 from Volume 2 of the 2006 IPCC Guidelines [6] which provide the Tier 2 methodology for on-road and off-road transport respectively.

At GMT facilities, mobile equipment includes pickup trucks, tractors, light vehicles, and aircraft.

Equation 3 – CO_2 emissions from combustion of fuels for on-road and off-road mobile equipment

$$Fuel\ Combustion\ CO_2\ emissions\ = \sum_a [Fuel_a \times EF_a]$$

Where:
- $Fuel_a$ is the quantity of fuel a (in mass, volume, or energy) consumed during the reporting period.
- EF_a is the CO_2 emission factor for fuel a, provided in Table 7.
- a is the type of fuel (e.g., diesel, gasoline, etc.)

Equation 4 – CH_4 and N_2O emissions from combustion of fuels in on-road and off-road mobile equipment

$$Fuel\ combustion\ CH_4 and\ N_2O\ emissions\ = \sum_{a,b} \left[Fuel_{a,b} \times EF_{a,b}\right]$$

Where:
- $Fuel_a$ is the quantity of fuel a (in mass, volume, or energy) consumed during the reporting period.
- EF_a is the CH_4 or N_2O emission factor for fuel a, provided in Table 7 in mass of GHG per fuel unit.
- a is the type of fuel (e.g., diesel, gasoline, etc.)

– *b* is the vehicle or equipment type

The 2006 IPCC guidelines also include a parameter for emission control technology in calculation of mobile fuel use emissions which may impact N_2O emissions from on-road vehicles. This parameter was excluded from Equation 4 as no information on emission control technology was available for GMT's operations.

EMISSION FACTORS AND PARAMETERS

As all facilities within GMT's operational boundary are located in Brazil, emission factors for fuels specific to Brazil were used from Fatores de Emissao, Section 3.1, Table 3, Programa Brasileiro GHG Protocol, 2023[7] provides emission factors in kilograms (kg) of CO_2, CH_4 and N_2O per liter (L) of fuel. Emission factors are listed in Table 7.

Table 7 – Mobile Fuel combustion emission factors

Fuel	Emission Factors		
	CO_2 (kg/L)	CH_4 (kg/L)	N_2O (kg/L)
Diesel – mobile	2.603	0.000139	0.000139
Aviation Kerosene	2.517	0	0.00007

ACTIVITY DATA

Activity data for mobile fuel combustion emissions is the volume of each fuel consumed per equipment type. During the reporting period, GMT used diesel for the operation of mobile equipment and aviation kerosene for the operation of aircraft. Quantities of fuel used during the reporting period per facility were collected by GMT. No missing data for fuel quantities were identified.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of fuel combustion emissions.

– The emission factors are for combustion of diesel in on-road vehicles. The aggregated fuel usage data provided by GMT comprises diesel used in tractors, trucks, and light vehicles. However, emission factors for off-road vehicles were not available for Brazil, as such on-road emission factors were used as a proxy.

– GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 values were used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

7.3. STATIONARY COMBUSTION

Fuel combustion emissions are generated from the combustion of fuel for the purpose of generating useful energy such as heat. During combustion, the carbon in the fuel reacts with oxygen and CO^2 is released as a by-product. Trace amounts of CH^4 and N^2O are also released as by-products of combustion. Combustion emissions are calculated as shown in Equation 5 based on the quantity of fuel and the emission factors for the fuel consumed. Equation 5 is based on Equation 2.3 from Volume 2 of the 2006 IPCC Guidelines.

Equation 5 - Stationary fuel combustion emissions

$$Stationary\ emissions = \sum_a Fuel_a \times EF_{GHG,a}$$

Where:

- Stationary emissions are the emissions from the fuel in mass of CO_2, CH_4, or N_2O
- $Fuel_a$ is the quantity of fuel a (in mass, volume, or energy) consumed during the reporting period
- $EF_{GHG,\,a}$ is the CO_2, CH_4 or N_2O emission factor for fuel a, provided in Table 8 in mass of GHG per fuel unit
- a is the type of fuel (e.g., diesel, gasoline, etc.)
- The IPCC 2006 guidelines also include a parameter for the type of technology. This parameter was excluded from Equation 5 as emission factors per technology type were not available for stationary fuel combustion.

EMISSION FACTORS AND PARAMETERS

As all facilities GMT's operational boundary are located in Brazil, appropriate emission factors for Brazil were used in Table 8. Data was sourced from the Ferramenta de calculo PBGHG 2023. Emission factors for each fuel are listed in Table 8.

Table 8 – Stationary fuel combustion emission factors

Fuel	Emission Factors (kg/tonne)		
	Biogenic CO_2	CH_4	N_2O
Wood – stationary	1,451	3.893724	0.05191632

ACTIVITY DATA

Activity data required for Equation 5 includes the volume of each fuel consumed per equipment type. During the reporting period, GMT used wood for operation of stationary equipment. Quantities of wood used during the reporting period per facility were estimated by GMT.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of stationary fuel combustion emissions for GMT:

- GMT confirmed the quantity of wood used in the wood-fired boiler at Primavera by email on December 21, 2023.
- GMT confirmed that the wood used in the wood-fired boiler at Primavera is eucalyptus by email on January 9, 2024.

7.4. SOIL MANAGEMENT

The management of soil and application of fertilizer releases in GHG emissions through the following processes:

- Direct emissions from application of nitrogen-based fertilizers
- Direct emissions from application of crop or other biomass residue inputs
- Indirect emissions from volatilization and leaching of nitrogen (N)
- Direct emission from application of urea
- Direct emission from the application of lime

7.4.1. SOIL MANAGEMENT – DIRECT EMISSIONS FROM NITROGEN INPUTS

Application of nitrogen inputs to soil is common practice in agriculture operations to supplement soil nutrients and facilitate the growth of crops. The application of fertilizers containing nitrogen (N) releases N and nitrous oxides (NOx) as intermediary and by-products in the soil nitrification and denitrification processes. These emissions were quantified using Equation which is derived from Equation 11.1 from Volume 4 of the IPCC 2019 Refinement[8].

Equation 6 – Direct N2O emissions from application of nitrogen inputs to soil

$$Direct\ N_2O\ emissions = \sum F_i \times N_i \times\ EF_a \times \frac{Molar\ mass\ N_2O}{Molar\ mass\ N_2}$$

Where:

- *Direct N_2O emissions* is the quantity of N_2O emitted from nitrogen inputs, in mass of N_2O
- F_i is the quantity of input *i* applied during the reporting period, in mass
- N_i is the quantity of nitrogen by % mass of input *i*, based on fertilizer specifications
- EF_a is the emission factor for direct N emissions for input type *a* provided in Table in mass of N_2O-N per mass of N applied to soil
- *a* is the type of nitrogen input added to soil (e.g., urea, organic fertilizer, crop residue)
- Molar mass N_2O/molar mass N_2 is the ratio between the molar mass of N_2O and N_2 used to convert emissions of N_2O-N to N_2

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation are provided in Table . Emissions factors were sourced from the IPCC 2006 Guidelines and IPCC 2019 Refinement, in alignment with the quantification methodology used for this source. The location of each facility was used to classify each of them under the IPCC climatic zones of wet or dry to identify the appropriate emission factors.

Table 9 - Emission factors for direct N2O emissions from Nitrogen-Based Fertilizer

Parameter	Value	Source
EF_i, synthetic and organic fertilizer, dry climate (kgN_2O-N/kgN)	0.005	Table 11.1, Volume 4, IPCC 2019 Refinement [8]
EF_i, synthetic fertilizer, wet climate (kgN_2O-N/kgN)	0.016	
EF_i, organic fertilizer, wet climate (kgN_2O-N/kgN)	0.006	
Molar mass, N_2O (g/mol)	44	Section 11.2, Volume 4, IPCC 2019 Guidelines[8]
Molar mass, N_2 (g/mol)	28	

ACTIVITY DATA

Emissions were quantified using the quantity, type and characteristics of fertilizer provided, collected from GMT operations. No missing data was identified.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of direct N_2O emissions from addition of nitrogen inputs to soil:

- The climate zones for GMT's facilities were determined using figure 3A.5.1 of Chapter 3, Volume 4 of the IPCC 2019 refinement.
- Fertilizer type, including synthetic fertilizer sub-types, used to determine adequate volatilization factor (FracGASF / FracGASM). When the specific chemical composition of a fertilizer is not known, the synthetic sub-type is assumed by default as a disaggregated emission factor based on fertilizer sub-type cannot be used.
- Fertilizer type was determined based on chemical composition. "Synthetic" used where fertilizer type could not be determined and for amendments that do not include nitrogen.
- Emissions of nitrous oxide (N_2O) are calculated by converting N_2O-N to N_2O using the ratio between the molar mass of N_2O and nitrogen (N_2).
- The Fourth National Communication of Brazil (2020)[9] to the UNFCCC uses the IPCC emission factors for direct and indirect fertilizer application, therefore the same emission factors are used in this inventory.
- Direct and Indirect N_2O emissions from synthetic and organic fertilizers were estimated applying the Tier 1 methodology used in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 11.
- There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.
- GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 values were used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

7.4.2. SOIL MANAGEMENT – BIOMASS RESIDUE

As GMT's operations consist of permanent crops, biomass residue is generated from the pruning of coffee shrubs as well as natural leaf fall which results in waste biomass materials including branches and leaves.

The residue is left on soil and the decomposition of the biomass materials releases N_2O. It is assumed that the carbon from the biomass transfers to the soil carbon stock. Direct N_2O emissions from biomass residue added to soil were calculated using Equation and the quantity of biomass residue applied. The quantity of biomass residue generated during the reporting period was estimated using Equation .

Equation 7 – Quantity of biomass residue generated

$$F_{Residue} = \sum_{i=1}^{n} A_i \times Residue\ Rate_{(i)}$$

Where:

- $F_{Residue}$ is the amount of biomass residue generated, in t
- A_i is the area cultivated for crop *i*, in ha
- $Residue\ Rate_i$ is the biomass residue generation rate for crop *i*, in t/ha
- *i* is the crop for which the biomass residue is being calculated
- *n* is the total number of crops produced by the reporting company

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation are provided in Table . Emissions factors were sourced from the IPCC 2019 Refinement, in alignment with the quantification methodology used for this emission source. The location of each facility was used to classify each of them under the IPCC climatic zones of wet or dry to identify the appropriate emission factors.

Table 10 - Emission factors and parameters for residue management

Parameter	Value	Source
EF, crop residue, dry climatic zone	0.005	Table 11.1, Volume 4, IPCC 2019 Refinement [8]
EF, crop residue, wet climatic zone	0.006	
Molar mass, N_2O	44	Section 11.2, Volume 4, IPCC 2019 Guidelines [8]
Molar mass, N_2	28	
Natural leaf fall residue rate, coffee (t dm/ha)	5.5	Mendonza Martinez et al., 2019[10]
Leaf residue N%	3.5%	

ACTIVITY DATA

GMT confirmed by email on 10/31/23 that there was no residue management for all sites in the reporting period, however, it does occur on an infrequent basis.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of direct N_2O emissions from biomass residue:

- It was confirmed by GMT that no pruning of the coffee shrubs occurred in 2022 by email on 10/31/23.
- The nitrogen content in the biomass residue generated by natural leaf fall is also based on literature estimates.

- Emission factors calculate emissions of N_2O-N. These emissions are converted to N_2O using the ratio of the molar mass between N_2O and N_2.
- In accordance with the GHG Protocol, biogenic CO_2 emissions are not included within a GHG inventory and should be reported separately. In this situation it is assumed that the carbon is added to the soil organic matter pool and is not emitted. Biogenic CH_4 and N_2O are however accounted for within the GHG inventory under the appropriate scope.
- There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.

7.4.3. SOIL MANAGEMENT – INDIRECT EMISSIONS FROM NITROGEN APPLICATION

Management of soil results in indirect emissions by two pathways. The first is from the volatilization of nitrogen as ammonia (NH_3) and oxides of nitrogen (NOx), and the deposition of these gases and their products onto soils and the surface of lakes and other waters. The second is from the leaching and runoff from land of N from various sources including synthetic and organic fertilizers, crop residues and mineralisation of N associated with loss of soil C in mineral and drained/managed organic soils through land-use change or management practices. Indirect emissions from nitrogen inputs were quantified using Equation and Equation which are respectively derived from Equation 11.9 and 11.10 from Volume 4 of the IPCC 2019 Refinement[8].

Equation 8 – Indirect N_2O emissions from atmospheric deposition of N

$$N_2O_{ATD} = \sum F_i \times N_i \times EF_{ATD} \times Frac_{GAS,a} \times \frac{Molar\ mass\ N_2O}{Molar\ mass\ N_2}$$

Where:

- N_2O_{ATD} is the quantity of N_2O emitted from nitrogen inputs due to atmospheric deposition, in mass of N_2O
- F_i is the quantity of input *i* applied during the reporting period, in mass
- N_i is the quantity of nitrogen by % mass of input *i*, based on fertilizer specifications
- EF_{ATD} is the emission factor for indirect N emissions from atmospheric deposition of N provided in Table 9
- *a* is the type of input added to soil (e.g., urea, organic fertilizer, crop residue)
- $Frac_{GAS,a}$ is the rate of volatilization of nitrogen as ammonia and nitrogen oxides from input type *a*, in mass of NH_3-NOx per mass of N applied
- Molar mass N_2O/molar mass N_2 is the ratio between the molar mass of N_2O and N_2 used to convert emissions of N_2O-N to N_2O

Equation 9 – Indirect emissions from leaching of applied nitrogen

$$N_2O_{LR} = \sum F_i \times N_i \times EF_{LR} \times Frac_{Leach,a} \times \frac{Molar\ mass\ N_2O}{Molar\ mass\ N_2}$$

Where:

- N_2O_{LR} is the emissions from leaching and runoff of N from applied fertilizers
- F_i is the quantity of fertilizer *i* applied during the reporting period, in kg
- N_i is the quantity of nitrogen by % mass in fertilizer *i*, based on fertilizer specifications

- $Frac_{Leach,a}$ is the fraction of all N added to/mineralised in managed soils in regions where leaching/runoff occurs that is lost through leaching and runoff, in kg N/kg of N additions
- EF_{LR} is the emission factor for N_2O emissions from N leaching and runoff, in kg N_2O–N/kg N leached and runoff
- Molar mass N_2O/molar mass N_2 is the ratio between the molar mass of N_2O and N_2 used to convert emissions of N_2O-N to N_2O

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation and Equation are provided in Table 9. Emissions factors were sourced from the IPCC 2019 Refinement, in alignment with the quantification methodology used for this emission source. The location of each facility was used to classify each of them under the IPCC climatic zones of wet or dry to identify the appropriate emission factors. The irrigation type is also used along with the climatic zones to do so.

Table 9 - Emission factors for indirect emissions from volatilization of applied Nitrogen

Parameter	Value	Source
EF_{ATD}, atmospheric deposition, wet climate (kgN–N_2O/(kgNH_3–N + NOx–N volatilised))	0.014	Table 11.3, Volume 4, IPCC 2019 Refinement [8]
EF_{ATD}, atmospheric deposition, dry climate (kgN–N_2O/(kgNH_3–N + NOx–N volatilised))	0.005	
EF_{LR}, leaching and runoff (kg(NH_3–N + NOx–N)/ kgN applied)	0.011	
$Frac_{GASF}$, aggregated fertilizer type (kg(NH_3–N + NOx–N)/kgN applied)	0.11	
$Frac_{GAS}$, urea fertilizer type (kg(NH_3–N + NOx–N)/kgN applied)	0.15	
$Frac_{GAS}$, ammonium-based fertilizer type (kg(NH_3–N + NOx–N)/kgN applied)	0.08	
$Frac_{GAS}$, nitrate-based fertilizer type (kg(NH_3–N + NOx–N)/kgN applied)	0.01	
$Frac_{GAS}$, organic fertilizer (kg(NH_3–N + NOx–N)/kgN applied)	0.21	
$Frac_{LR}$, wet climate (kgN/kgN additions)	0.24	
Molar mass, N_2O (g/mol)	44	Section 11.2.2.1, IPCC 2006 Guidelines [8]
Molar mass, N_2 (g/mol)	28	

ACTIVITY DATA

Emissions were quantified using the quantity, type and characteristics of fertilizer provided collected from GMT operations. No missing data was identified.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of direct N_2O emissions from addition of nitrogen inputs to soil:

- The climate zones for GMT's facilities were determined using figure 3A.5.1 of Chapter 3, Volume 4 of the IPCC 2019 refinement.

- The fertilizer type was determined based on chemical composition of each fertilizer. The "Synthetic" type was used where fertilizer type could not be determined and for amendments that do not include nitrogen.
- Fertilizer type, including synthetic fertilizer sub-types, are used to determine the adequate volatilization factor (FracGASF / FracGASM). When the specific chemical composition of a fertilizer is not known, the aggregated sub-type is assumed by default as a disaggregated emission factor based on fertilizer sub-type cannot be used.
- Emissions of nitrous oxide (N_2O) are calculated by converting N_2O-N to N_2O using the ratio between the molar mass of N_2O and nitrogen (N_2).
- The Fourth National Communication of Brazil (2020)[9] to the UNFCCC uses the IPCC emission factors for direct and indirect fertilizer application, therefore the same emission factors are used in this inventory.
- Direct and Indirect N_2O emissions from synthetic and organic fertilizers were estimated applying the Tier 1 methodology used in the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 11.
- Leaching and runoff of nitrogen application to soil occurs in wet climates or in dry climate regions where irrigation (other than drip irrigation) is used as per IPCC 2019, Chapter 11, Section 11.2.2.2.
- There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.
- GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 values were used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

7.4.4. SOIL MANAGEMENT – EMISSIONS FROM UREA FERTILIZER

The application of urea ($CO(NH_2)_2$) for soil fertilization results in the release of direct CO_2 emissions from the CO_2 fixed in urea in the industrial production process. CO_2 emissions from urea application were quantified using Equation which is derived from Equation 11.13 from Volume 4 of the IPCC 2006 Guidelines[11].

Equation 10 – Direct CO_2 emissions from urea fertilization

$$Urea\ emissions = F_i \times U_i \times EF \times \frac{Molar\ mass\ CO_2}{Molar\ mass\ \mathrm{C}}$$

Where:

- *Urea emissions* is the quantity of CO_2 emitted from urea application, in mass of CO_2
- *F* is the total quantity of input *i* applied during the reporting period, in mass
- *U* is the urea content of input *i*, in %
- *EF* is the CO_2 emission factor for urea application in mass of CO_2 per mass of urea
- *Molar mass CO_2/molar mass C* is the ratio between the molar mass of CO_2 and C used to convert emissions of CO_2 to C

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation are provided in Table 10. Emissions factors were sourced from the IPCC 2006, in alignment with the quantification methodology used for this emission source.

Table 10 - Emission factors and other parameters for urea fertilizer emissions

Parameter	Value	Source
Molar mass CO_2 (g/mol)	44	IPCC 2006 Guidelines, Volume 4, Chapter 11, Section 11.4.1[11]
Molar mass C (g/mol)	12	
Emission factor(kgC/kgCO$(NH_2)_2$	0.2	IPCC 2006 Guidelines, Volume 4, Chapter 11, Section 11.4.2[11]

ACTIVITY DATA

Emissions were quantified using the quantity, type and characteristics of urea fertilizer collected from GMT operations. No missing data was identified.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of direct CO_2 emissions from addition of urea to soil:

– CO_2 emissions from urea application were estimated applying the Tier 1 methodology used in the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. Volume 4: Agriculture, Forestry and Other Land Use. Chapter 11.
– It is conservatively assumed that the urea content of the fertilizers is 100%.
– Emission factors calculate emissions of CO_2-C. These emissions are converted to CO_2 using the ratio of the molar mass between CO_2-C and CO_2.
– The Fourth National Communication of Brazil (2020)[9] to the UNFCCC uses the IPCC emission factors for direct and indirect fertilizer application, therefore the same emission factors are used in this inventory.
– There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.
– The urea content of organomineral fertilizer was confirmed by GMT by email on 11/01/23.

7.4.5. SOIL MANAGEMENT – EMISSIONS FROM LIME FERTILIZER

The application of lime to soils is a common practice to reduce soil acidity and improve plant growth. The conversion of carbonates added to soil leads to carbon dioxide emissions as the carbonate limes dissolve and release bicarbonate ($2HCO_3$-), which evolves into CO_2 and water (H_2O). Whether CO_2 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). CO_2 emissions from lime application were quantified using Equation 6 which is derived from Equation 11.12 from Volume 4 of the IPCC 2006 Guidelines[11].

Equation 6 – Direct CO_2 Emissions from Lime Application

$$Lime\ CO_2 = \left((M_{Limestone} \times EF_{Limestone}) + (M_{Dolomite} \times EF_{Dolomite})\right) \times \frac{Molar\ mass\ CO_2}{Molar\ mass\ C}$$

Where:

- *Lime CO_2* is the annual CO_2 emissions from lime application, tonnes CO_2 per year
- *M* is the annual amount of calcic limestone ($CaCO_3$) or dolomite ($CaMg(CO_3)_2$), tonnes per year
- *EF* is the emission factor, tonne of C per tonne of limestone or dolomite
- *Molar mass CO_2/molar mass C is* the ratio between the molar mass of CO_2 and C used to convert emissions of C to CO_2

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation 6 are provided in Table 11. Emissions factors were sourced from the IPCC 2006 Guidelines, in alignment with the quantification methodology used for this emission source.

Table 11 - Emission factors and other parameters for liming emissions

Parameter	Value	Source
Molar mass CO_2 (g/mol)	44	IPCC 2006 Guidelines, Volume 4, Chapter 11, Section 11.3.1[11]
Molar mass C (g/mol)	12	
$EF_{Limestone}$ (kgC/kgCaCO3)	0.12	IPCC 2006 Guidelines, Volume 4, Chapter 11, Section 11.3.2[11]

ACTIVITY DATA

Emissions were quantified using the quantity, type and characteristics of lime application collected from GMT operations. No missing data was identified.

NOTES AND ASSUMPTIONS

The following assumptions were made for the calculation of direct CO_2 emissions from lime application:

- Emission factors calculate emissions of C. These emissions are converted to CO_2 using the ratio of the molar mass between C and CO_2.
- The Fourth National Communication of Brazil (2020) t tWheUNFAC(C)-1
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7.4.6. SOIL MANAGEMENT – OTHER EMISSIONS

The following emissions sources from soil management did not occur during the inventory period at GMT operations:

- Drainage/ management of organic soils (i.e., Histosols). The soils at GMT facilities did not meet the definition of organic soils as the soil organic matter content was reported as below the 20% threshold specified by the 2006 IPCC Guidelines. For all GMT's operations, soil organic matter content was typically in the range of 1% to 5%, as per default SOC values from the IPCC[12].

7.5. LAND USE – SOIL ORGANIC CARBON STOCK CHANGES

The soil management practices result in a flux in the carbon stock of the soil. If the flux results in the carbon stock in the current report year to be lower than the reference year then, the difference is the amount of carbon emissions in the reporting year. Annual change in organic carbon stocks in mineral soils were estimated with Equation 7 using Chapter 2[13] and Chapter 5[14] of Volume 4 of the 2006 IPCC guidelines.

Equation 7 - CO2 emissions from change in organic C stock in mineral soil

$$Soil\ carbon\ emissions\ =\ \frac{SOC_T -\ SOC_{0-T}}{D}\ \times A\ \times\ \frac{Molar\ mass\ of\ CO_2}{Molar\ mass\ of\ C}$$

Where:

- SOC_{0-T} is the soil organic carbon stock at the beginning of the inventory period, and is a reference value based on soil type and climate zone, in tonnes of C per ha
- *SOCT* is the soil organic carbon stock at the end of the inventory period, calculated per Equation 8 below, in tonnes of C per ha
- *D* is the time dependence of stock change factors, in years, default value of 20 years
- *A* is the area for which the change to soil organic carbon content is being calculated in ha
- *Molar mass* CO_2 is the sum of the atomic weight of each atom in a CO_2 molecule
- *Molar mass C* is the sum of the atomic weight of each atom in a C molecule

Equation 8 – Changes in soil organic C stock due to management practices

$$SOC_T =\ SOC_{0-T}\ \times F_{LU} \times F_{MG} \times F_I$$

Where:

- F_{LU} is the default factor for changes to carbon in soil caused by land use activities, and is dimensionless
- F_{MG} is the default factor for changes to carbon in soil caused by tillage activities, and is dimensionless
- F_I is the default factor for changes to carbon in soil caused by input of organic matter, and is dimensionless

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation 7 are provided in Table 12 and were sourced from the IPCC 2006 Guidelines and the IPCC 2019 Refinement.

Table 12 - Emission factors and other parameters for soil organic carbon stock changes

Parameter	Value	Source
Soil Carbon Stock at the Beginning of the Inventory Period (SOC_{REF}), Tropical Moist Climate Zone, Low Activity Clay Soils (Tc/Ha)	38	Table 2.3, IPCC 2019 Refinement, Volume 4, Chapter 2 [13]
Soil Carbon Stock at the Beginning of the Inventory Period (SOC_{REF}), Tropical Dry Climate Zone, Low Activity Clay Soils (Tc/Ha)	19	
Time Dependence of Stock Change Factors (D) (Years)	20	IPCC 2019 Refinement, Volume 4, Chapter 2, Section 2.3.3.1 [13]
Land Use C Stock Change Factor (F_{LU}), Perennial Tree/Crop, Tropical, Dry Climate Zones, Moist/Wet	1.01	Table 5.5, IPCC 2006 Guidelines, Volume 4, Chapter 5 [14]
Tillage C Stock Change Factor (F_{MG}), No-Till, Tropical Dry Climate Zone, Dry	1.04	
Tillage C Stock Change Factor (F_{MG}), No-Till, Tropical Moist Climate Zone, Moist/Wet	1.10	
Input C Stock Change Factor (F_I), Medium, All Climate Zones, Dry And Moist/Wet	1.00	

ACTIVITY DATA

The activity data required for Equation 7 and Equation 8 is the climate zone, soil type and management system for each area that was disturbed as well as the land area disturbed.

GMT provided data on the climate zone and management system for each of its facilities. The soil type was determined using the database from the Instituto Brasileiro de Geografia e Estatística (IBGE)[15] and the address of GMT facilities. For the other parameters, default values from the IPCC 2006 Guidelines and the IPCC 2019 Refinement were used. All data estimates used in the GHG inventory are provided in Table 6.

NOTES AND ASSUMPTIONS

The following assumptions were made for the calculation of CO_2 emissions from soil carbon:

– Annual change in organic carbon stocks in mineral soils were estimated using IPCC guideline, ch.2, and ch.5 of vol.4. Emissions were calculated based on the change in soil organic carbon stock during the inventory period. A decrease in carbon stock change was assumed to be carbon released to the atmosphere during the inventory period. An increase in carbon stock would represent sequestration of carbon in soil (carbon removals). No carbon removals are quantified in this GHG inventory.
– GMT's activities are located in regions classified as "Tropical Dry'' and "Tropical Moist" climate zones per IPCC 2019 Guidelines (Vol.4, Chapter 3, Figure 3A.5.1 (Updated), Delineation of major climate zones).
– All soils in GMT's activities were considered mineral soils, per IPCC Guidelines 2006's Organic soils definition (Vol. 4, Chap. 5). No organic soils calculations were undertaken.

- Soil types were determined using the Brazilian soil database from the IBGE and matched to USDA soil types and then to IPCC soil types using Figure 3A.5.3 (Vol. 4, Chap. 3).
- The soil carbon stock at the beginning of the inventory period is based on default IPCC parameters for the corresponding climate zone and soil type.
- Time dependence of stock change factors was assumed to be the default value recommended by the IPCC of 20 years.
- It was confirmed that no tillage had occurred during the reporting period by email received 10/31/23.
- It was confirmed by email that all pruning residues are left on the ground with the crop in order to take advantage of all possible organic material for soil improvement by email received 10/31/23. The input level is therefore considered as medium as per IPCC description.
- There are no emissions associated with soil carbon stock changes since the land use, tillage and input practices/parameters resulted in no loss of carbon to the atmosphere. As there were no soil disturbance activities such as tillage during the reporting period, soil carbon emissions were not expected. In future reporting periods if land use management or activities change, soil carbon stocks may decrease resulting in emissions.
- Emission factors calculate emissions of CO_2-C. These emissions are converted to CO_2 using the ratio of the molar mass between CO_2-C and CO_2.
- Per Section 11.2.1.3 of the 2019 IPCC Refinement, a loss of soil organic carbon due to land management practices results in simultaneous mineralization of nitrogen (N) in soil as carbon and nitrogen in soil are linked in the total soil organic matter. This N mineralization is however only expected to occur when soil is a net source of CO_2 emissions. As increases in soil organic carbon are not quantified in this GHG inventory, the certainty of soil as a net source or sink of CO_2 during the reporting period was unknown at the time of completion of the inventory. As such, mineralization of N in soil and resulting N_2O emissions have not been accounted for.
- There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.

7.6. WASTE TREATMENT - COMPOSTING

Composting is an aerobic process through which organic matter is converted into a nutrient-rich soil amendment. Composting is often used as an end-of-life treatment process for organic materials such as agricultural residues. Methane, nitrous oxide and biogenic carbon dioxide are released as by-products during the composting process. GHG emissions from the composting process are quantified using Equation 9 derived from equations 4.1 and 4.2 of Volume 5 of the IPCC 2006 Guideline.

Equation 9 – GHG emissions from composting

$$Composting\ emissions\ = M_i \times EF_{GHG,i}$$

Where:

- *Composting emissions* are the emissions from composting of organic waste in mass of CO_2, CH_4 or N_2O
- *M* is the quantity of crop residues composted in system *i*, in t fresh matter
- $EF_{GHG,i}$ is the emission factor for composting system *i* of green waste, in kg GHG/t fresh matter

EMISSION FACTORS & PARAMETERS

Emission factors and other parameters used in Equation 9 are provided in Table 12 and were sourced from Amlinger, Peyr and Cuhls (2008)[16].

Table 13 - Emission factors and other parameters for composting of organic waste

Parameter	Value	Source
CH_4 emission factor	4 g CH_4/kg waste treated	IPCC 2019, Volume 5, Chapter 4.
N_2O emission factor	0.24 N_2O/kg waste treated	

ACTIVITY DATA

The activity data required for Equation 9 are the quantity of crop residues composted and the type of composting system. Complete data was provided by GMT.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of emissions from waste composting:

- GMT provided the quantity of organic compound (straw and chicken mange) that was applied as fertilizer. This value was used to back calculate the mass of organic waste that was composted by assuming a 19.4% mass loss during the composting process.
- A moisture content of 60% was assumed based on the Breitenbeck and Schellinger study (2013).

7.7. WASTEWATER TREATMENT

Wastewater treatment can result in the emission of methane (CH_4) and nitrous oxide (N_2O). Methane is emitted when wastewater is treated anaerobically or when dissolved CH_4 enters aerated treatment systems. N_2O emissions occur during the wastewater treatment process with certain treatment systems as well as when the effluent of the treatment system is discharged in the environment. Emissions from wastewater treatment were quantified using Equation 10 to Equation 18 which are derived from equations 6.1, 6.2, 6.3, 6.4, 6.5, 6.7, 6.8, 6.9, 6.10, 6.11, 6.12, 6.13 and 6.14 from the IPCC 2019 Refinement.

Equation 10 - N_2O emissions from effluent discharge to aquatic environment

$$Effluent\ N_2O = N_{Effluent,i} \times EF_{Effluent,j} \times \frac{Molar\ mass\ N_2O}{Molar\ mass\ N_2}$$

Where:

- *Effluent N_2O* is the quantity of N_2O emitted by the discharge to aquatic environment of industrial or sanitary effluent in the reporting period
- $N_{Effluent,i}$ is the total nitrogen from effluent i discharged to aquatic environments, in kg N per year
- $EF_{Effluent,j}$ is the emission factor from the specific aquatic environment j in which the effluent is discharged, in kg N_2O-N per kg N
- Molar mass N_2O/molar mass N_2 is the ratio between the molar mass of N_2O and N_2 used to convert emissions of N_2O-N to N_2O

– i is the source of effluent, industrial or sanitary

– j is the specific aquatic environment type in which the effluent is discharged

Equation 11 – Methane emissions from wastewater treatment

$$CH_4\ Emissions = (TOW_i - S_i) \times EF_{ij} - R$$

Where:

– *CH_4 Emissions* is the quantity of CH_4 emitted from industrial or sanitary wastewater treatment in the reporting period
– *TOW_i* is the total organically degradable material in wastewater from source i in the reporting period as calculated in Equation 12 (industrial) or Equation 13 (sanitary), in kg COD (industrial) or kg BOD_5 (sanitary) per year
– *S_i* is the organic component removed from wastewater (in the form of sludge) in inventory year from source i, kg COD (industrial) or kg BOD_5 (sanitary) per year
– *EF_{ij}* is the emission factor for source i from the specific treatment system j used as calculated in Equation 14 (industrial) or Equation (sanitary), in kg CH_4 per kg COD (industrial) or kg BOD (sanitary)
– *R* is the amount of CH_4 recovered or flared in the inventory year, in kg CH_4 per year
– *i* is the source of wastewater, industrial or sanitary
– *j* is the specific treatment system type used

Equation 12 – Total organically degradable material in industrial wastewater

$$TOW_{INDUSTRIAL} = Q \times COD$$

Where:

– *$TOW_{INDUSTRIAL}$* is the total organically degradable material in industrial wastewater during the reporting period, in kg COD per year
– *Q* is the quantity of industrial wastewater produced during the reporting year, in m^3
– *COD* is the chemical oxygen demand of the wastewater entering the treatment system, in kg per m^3
– *i* is the source of wastewater, industrial or sanitary

Equation 13 - Total organically degradable material in sanitary wastewater

$$TOW_{SANITARY} = FTE \times BOD_5 \times Days$$

Where:

– *$TOW_{SANITARY}$* is the total organically degradable material in sanitary wastewater during the reporting period, in kg BOD per year
– *FTE* is the full-time equivalent number of employees
– *BOD_5* is the biological oxygen demand, in kg BOD_5 per person per day
– *Days* is the number of days per year the wastewater treatment system is used

Equation 14 – CH_4 emission factor for industrial wastewater treatment

$$EF_{INDUSTRIAL} = B_{O,i} \times MCF_j$$

Where:

– *$EF_{INDUSTRIAL}$* is the emission factor from the specific treatment system used
– *$B_{O,i}$* is the maximum CH_4 producing capacity, in kg CH_4 per kg COD
– *MCF_j* is the methane conversion factor for the specific treatment system used

– *j* is the specific treatment system type used

Equation 20 – CH_4 emission factor for sanitary wastewater treatment

$$EF_{SANITARY} = B_{O,i} \times MCF_j$$

Where:

– $EF_{SANITARY}$ is the emission factor from the specific treatment system used, in kg CH_4 per kg BOD
– $B_{O,i}$ is the maximum CH_4 producing capacity for source i, in kg CH_4 per kg BOD
– MCF_j is the methane conversion factor for the specific treatment system used
– *j* is the specific treatment system type used

Equation 21 – N_2O emissions from wastewater treatment

$$Wastewater\ N_2O\ = TN_i \times EF_j\ \times \mathrm{T} \times \frac{Molar\ mass\ N_2O}{Molar\ mass\ N_2}$$

Where:

– *Wastewater* N_2O is the quantity of N_2O emitted by the treatment of industrial or sanitary wastewater in the reporting period
– TN_i is the total nitrogen in wastewater from source i as calculated in Equation 15 and Equation 16 respectively, in kg N per year
– EF_j is the emission factor from the specific treatment system j used, in kg N_2O-N per kg N
– *T* is the degree of utilisation of treatment/discharge pathway or system
– *Molar mass* N_2O*/molar mass* N_2 *is the ratio between the molar mass of* N_2O *and* N_2 *used to convert emissions of* N_2O*-N to* N_2O
– *i* is the source of wastewater, industrial or sanitary
– *j* is the specific treatment system type used

Equation 15 – Nitrogen generated in industrial wastewater

$$TN_{INDUSTRIAL} = Q \times N$$

Where:

– $TN_{INDUSTRIAL}$ is the total nitrogen in wastewater generated by source i in the reporting period, in kg N
– *Q* is the quantity of industrial wastewater generated in the reporting period, in m^3
– *N* is the total nitrogen content of the industrial wastewater generated, in kg N per m^3

Equation 16 – Nitrogen generated in sanitary wastewater

$$TN_{SANITARY} = FTE \times Protein_{Supp} \times Protein_{Cons} \times F_{NPR} \times Days$$

Where:

– $TN_{SANITARY}$ is the total nitrogen in wastewater generated by source i in the reporting period, in kg N
– *FTE* is the number of full-time equivalent employees
– $Protein_{Supp}$ is the average protein supply quantity, in g/capita/day
– $Protein_{Cons}$ is the protein consumed as fraction of protein supply
– F_{NPR} is the fraction of nitrogen in protein, in kgN/kg protein, default = 0.16 kg N/kg protein
– *Days* is the number of days per year the wastewater system is used

Equation 17 – N_2O emissions from effluent discharge to aquatic environment

$$Effluent\ N_2O\ =\ N_{Effluent,i} \times EF_{Effluent,j} \times \frac{Molar\ mass\ N_2O}{Molar\ mass\ N_2}$$

Where:

- *Effluent N_2O* is the quantity of N_2O emitted by the discharge to aquatic environment of industrial or sanitary effluent in the reporting period
- $N_{Effluent,i}$ is the total nitrogen from effluent i discharged to aquatic environments, in kg N per year
- $EF_{Effluent,j}$ is the emission factor from the specific aquatic environment j in which the effluent is discharged, in kg N_2O-N per kg N
- *Molar mass N_2O/molar mass N_2 is the ratio between the molar mass of N_2O and N_2 used to convert emissions of N_2O-N to N_2O*
- *i* is the source of effluent, industrial or sanitary
- *j* is the specific aquatic environment type in which the effluent is discharged

Equation 18 – Nitrogen in effluent discharged to aquatic environment

$$N_{Effluent,i} = TN \times (1 - N_{REM})$$

Where:

- $N_{Effluent,i}$ is the total nitrogen in effluent from source i discharged to aquatic environment, in kg N per year
- TN_i is the total nitrogen in wastewater generated by source i in the reporting period, in kg N
- N_{REM} is the fraction of total wastewater nitrogen removed during wastewater treatment
- *i* is the source of wastewater, industrial or sanitary

Emissions from wastewater effluent discharged to aquatic environment (industrial and sanitary) are reported under soil management – direct emissions from nitrogen application as all wastewater effluent is discharged to the soil. Only direct emissions from this source are calculated and not indirect emissions from leaching and atmospheric deposition.

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation 10 to Equation 18 are provided in Table 14. Emissions factors and other parameters were sourced from the IPCC 2006 Guidelines and IPCC 2019 Refinement, in alignment with the quantification methodology used for this source.

Table 14 – Emission factors and other parameters for wastewater treatment emissions

Parameter	Value	Source
COD (kg/m^3), coffee	9	Volume 5, Chapter 6, IPCC 2006 Guidelines, Table 6.9 [4]
B_o (kgCH_4/kgCOD)	0.25	Volume 5, Chapter 6, IPCC 2019 Refinement, Table 6.2[17]
Methane correction factor (MCF), anaerobic deep lagoon	0.8	Volume 5, Chapter 6, IPCC 2019 Refinement, Table 6.3[17], anaerobic deep lagoon
CH_4 emission factor, anaerobic deep lagoon (kg CH_4/kg COD)	0.2	
Nitrogen content of coffee wastewater (mgTN/L)	25	Pin et al., 2020[18] and Fia, de Matos and Luiz Fia, 2013[19]
Nitrogen removal fraction (N_{REM}), secondary biological system	0.8	Volume 5, Chapter 6, IPCC 2019 Refinement, Table 6.10C
N_2O emission factor (EF_{Treat}) (kgN_2O-N/kgN), treatment system, anaerobic lagoons	0	Volume 5, Chapter 6, IPCC 2019 Refinement, Table 6.8A [17]
N_2O emission factor ($EF_{Effluent}$) (kgN_2O-N/kgN), effluent, discharge to soil, wet climate	0.006	Volume 4, Chapter 11, IPCC 2019 Refinement, Table 11.1[20]
N_2O emission factor ($EF_{Effluent}$) (kgN_2O-N/kgN), effluent, discharge to soil, dry climate	0.005	
BOD_5, domestic wastewater, Brazil (g/person/day)	50	Volume 5, Chapter 6, IPCC 2019 Refinement, Table 6.4[17]
B_o (kgCH_4/kgBOD)	0.6	Volume 5, Chapter 6, IPCC 2019 Refinement, Table 6.2[17]
Protein supply quantity ($Protein_{Supp}$) (g/capita/day)	93.76	Food and Agriculture Organization of the United Nations (FAO), 2022[21]
Protein consumed as fraction of protein supply ($Protein_{Cons}$), Latin America	0.92	Volume 5, Chapter 6, IPCC 2019 Refinement[17], Table 6.10A
Fraction of nitrogen in protein (F_{NPR}), default value (kgN/kgProtein)	0.16	Volume 5, Chapter 6, IPCC 2019 Refinement, Section 6.3.1.3[17]
Business days per year in GMT's operations	238	R. Gouveia, email communication, January 26, 2023

ACTIVITY DATA

The activity data required for emissions from industrial wastewater are the volume of wastewater produced, it's characteristics (BOD or COD and total nitrogen) as well as information on the treatment system type and the environment where the effluent of the treatment system is discharged.

GMT estimated the quantity of wastewater generated during the reporting period at facility operations by using the following calculation: number of bags*500L*2L*0.7 converted to m3, as the water consumed in production will be around 30%. The nitrogen content was estimated based on rates from literature for coffee processing.

The activity data required for emissions from sanitary wastewater are the number of full-time equivalent employees, the characteristics of the sanitary wastewater (BOD) and total nitrogen) as well as information on the treatment system type and the environment where the effluent of the treatment system is discharged.

GMT did not measure the quantity of nitrogen in the sanitary wastewater generated during the reporting period at facility operations. Therefore, all activity data for emissions quantification from sanitary wastewater management was estimated based on the number of permanent and temporary employees at each facility. The protein supply quantity for Brazil was obtained from the FAO Food Balances data. Factors for protein consumed, nitrogen in protein, additional nitrogen from household products and nitrogen in non-consumed protein disposed in sewer system were obtained from the IPCC 2019 Refinement[5].

GMT uses two anaerobic lagoons as the wastewater treatment systems. The effluent is discharged to sinkholes. All data estimates used in the GHG inventory are provided in Table 14.

NOTES AND ASSUMPTIONS

The following assumptions were made for the calculation of CH_4 and N_2O emissions from wastewater treatment and discharge:

- CH_4 and N_2O emissions are estimated using methodology described in IPCC 2019[22].
- No methane is recovered of flared in GMT's operations as per email from 10/31/23.
- Industrial wastewater volume was estimated based on parameters provided by GMT and the quantity of coffee produced over the reporting year. The calculation multiplies the number of 500L bags, by 2L of water. It then accounts for 70% wastewater, as 30% is consumed during production. This is a change in calculation from FY21, as in FY21 it assumed 30% wastewater.
- It is assumed that the organic component removed from wastewater as sludge is equal to 0 as per IPCC 2019, vol.5, ch.6 for systems other than aerobic treatment plants and septic systems.
- The quantity of sanitary wastewater produced was not available from GMT, therefore the default value of biological oxygen demand rate per person and the number of full-time equivalent employees on site was used instead.
- Nitrogen rate in coffee wastewater based on values reported in literature excluding extreme values.
- The average protein supply was determined based on the average protein supply quantity for years 2010 to 2019 for Brazil from the Food and Agriculture Organization of the United Nations (FAO).
- The protein consumed as fraction of protein supply is using the default value for Latin America from the IPCC 2019 Refinement.
- The fraction of nitrogen in protein uses the default value from the IPCC 2019 Refinement.
- The additional nitrogen from household products added to the wastewater (NHH) and the factor for nitrogen in non-consumed protein disposed in sewer system (NNON-CON) were considered as unapplicable in the context of GMT's operations and were excluded from the calculation of total nitrogen in sanitary wastewater.
- Emission factors calculate emissions of N_2O-N. These emissions are converted to N_2O using the ratio of the molar mass between N_2O and N_2.
- N_2O emissions are negligible for anaerobic lagoons as per the IPCC 2019, Volume 5, Chapter 6, Table 6.8A.
- It is assumed that 100% of the wastewater generated is treated in the anaerobic lagoons as per email from 10/31/23

- Wastewater treatment systems can be classified as primary, secondary and tertiary treatment. Secondary treatment consists of a combination of biological processes that promote biodegradation of wastewater constituents by microorganisms, including anaerobic lagoons.
- The effluent is discharged to the soil and is considered an organic input to the soil. Some of the remaining nitrogen in the effluent is then emitted as N_2O. Only direct emissions from this source are calculated and not indirect emissions from leaching and atmospheric deposition. Indirect emissions have not been calculated since the estimates for direct emissions are likely already overestimated because of the use of maximum values from the literature for wastewater characteristics.
- GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 values were used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

7.8. REFRIGERANTS

Gases used in refrigeration and air-conditioning systems are powerful greenhouse gases that can leak at different stages during the lifecycle of the systems. Those gases, hydrofluorocarbons (HFCs) and, to a very limited extent, perfluorocarbons (PFCs), are serving as alternatives to ozone depleting substances (ODS) being phased out under the Montreal Protocol. Equation 19 is derived from equation 7.13 from chapter 7, volume 3 of the IPCC 2019 Refinement[23].

Equation 19 – GHG emissions from refrigerants

$$CO_2e\ emissions\ from\ refrigerants = \sum_{j=1}^{m}\sum_{i=1}^{n} M_{o,\,j} \times x_j \times GHG_i \times GWP_i$$

Where:

- $M_{o,\,j}$ is the initial capacity of refrigeration unit j in kg of refrigerant
- x_j is the annual loss of refrigerant from refrigeration unit j over its operating life, in %
- GHG_i is the quantity of GHG_i in the refrigerant, in %
- GWP_i is the global warming potential (GWP) of GHG_i relative to CO_2
- n is the total number of GHGs in each refrigerant
- m is the total number of refrigeration units operated by the reporting company

EMISSION FACTORS AND PARAMETERS

Emission factors and other parameters used in Equation 19 are provided in Table 15. Emissions factors and other parameters were sourced from the IPCC 2019 Refinement.

Table 15 - Emission factors and other parameters for refrigerant emissions

Parameter	Value	Source
System capacity (M_o) (kg), domestic refrigeration	0.5	Volume 3, Chapter 7, IPCC 2019 Refinement, Table 7.9[23]
Annual loss of operating unit (x) (%), domestic refrigeration	0.5	

ACTIVITY DATA

The activity data required for Equation 19 is the amount of refrigerant by type in new installations for the year, in units currently operating for the year and in units that reached their end of life for the year. No refrigeration units were installed or reached end-of-life during the reporting period at GMT's operations. There are five refrigeration units which operated during the reporting period. GMT did not collect data on refrigerant leakage or top-ups required during the reporting period. Only the type of units and refrigerants was available. As such, default emission factors for annual operating losses were used to calculate emissions.

NOTES AND ASSUMPTIONS

The following assumptions were made for the calculation of emissions from refrigeration and air-conditioning:

- The GWP used for isobutane is according to the GWP of butane from sixth assessment report from the IPCC. It was assumed that isobutane has the same GWP as butane as they are isomers.
- The system type was determined to be "Domestic Refrigeration" for all units after searching for the brand and model of each unit online.
- Maximum capacity for each unit type from IPCC 2019 default values was used as a conservative estimated and confirmed as appropriate with GTM by email on 10/31/23.
- There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.
- GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 values were used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

7.9. ELECTRICITY CONSUMPTION

Scope 2 emissions are indirect emissions from the generation of energy purchased for use in on-site operations and are classified as Scope 2 under the GHG Protocol. Scope 2 emissions were quantified in accordance with the GHG Protocol's Scope 2 guidance (Scope 2 Guidance)[24].

The Scope 2 Guidance requires dual reporting of Scope 2 emissions from purchased electricity using both the location-based and market-based methods. Under the location-based approach emissions are calculated using emission factors for a regional or national grid average. Under the market-based approach, companies can use market-based instruments (MBI) or supplier-specific emission factors when reporting emissions from energy consumption. This reflects the emissions associated with the electricity that a reporting company is purchasing rather than what is produced regionally or nationally (the electricity grid).

SCOPE 2 LOCATION-BASED, PURCHASED ELECTRICITY EMISSIONS

The calculation methodology for location-based emissions for purchased electricity is provided in Equation 20 in alignment with the Scope 2 Guidance[24].

Equation 20 – Scope 2, location-based emissions from purchased electricity

$$LB\ emissions = \sum GridEF_i \times\ GridElectricity_i$$

Where:

- *LB emissions* is the GHG emissions from purchased electricity using the location-based approach for the reporting period
- $GridEF_i$ is the emission factor for electricity in grid region i, in mass of GHG per kWh of electricity purchased, provided in Table 16
- $GridElectricity_i$ is the total quantity of electricity purchased in grid region i, measured in kilowatt-hours (kWh)

MARKET-BASED ELECTRICITY EMISSIONS

The Scope 2 Guidance[24] provides the following hierarchy of emission factors for use in the market-based approach:

- Energy attribute certificates (i.e., Guarantees of origin (GOs) or Renewable Energy Certificates (RECs))
- Direct contracts such as power purchase agreements (PPAs), where other instruments or energy attribute certificates do not exist
- Supplier-specific emission rates
- Residual mix
- Use of location-based emission factors as a default if none of the above information is available

At the top of the hierarchy are energy attribute certificates (EACs) which guarantee electricity is generated from renewable sources. They allow users to report that the electricity they consume is from renewable sources and emits 0 tCO_2e/kWh at the point of production. Direct electricity contracts such as PPAs, can also convey zero carbon emissions associated with generation. It is only with these instruments that a company can claim that all the energy purchased is from renewable sources and has zero emissions associated with its generation. If suppliers are offering differentiated products, such as green tariffs, then these should include a supplier-specific emission factor which will generally be lower than the grid-average. Once certificates have been assigned, an emission factor is calculated for all unclaimed or untracked energy, known as the residual mix emission factor. This underlying energy generation will generally have a higher emissions factor than that of the grid average because the certified renewable energy is deducted from the fuel mix to avoid double counting.

GMT did not purchase renewable electricity in the current reporting year. The calculation methodology for market-based emissions from purchased electricity is provided in Equation 21 in alignment with the Scope 2 Guidance[24].

Equation 21 – Scope 2, market-based emissions from purchased electricity

$$MB\ emissions = \sum \Big(EF_i \times\ (GridElectricity_i -\ MBIElectricity_i\ ) + \sum EF_{MBI,a,i} \times\ MBIElectricity_{a,i} \Big)$$

Where:

- *MB emissions* is the GHG emissions from purchased electricity using the market-based approach for the reporting period
- EF_i is the emission factor for the electricity in grid region i, which may be supplier specific, a residual grid emission factor or the location-based emission factor for the grid, as available per the Scope 2 Guidance hierarchy
- $GridElectricity_i$ is the total quantity of electricity purchased from the grid in location i, measured in kWh
- *MBIElectricity* is the total quantity of purchased electricity covered by a market-based instrument (MBI), in grid region i, measured in kWh
- $MBIElectricity_{a,,i}$ is the quantity of purchased electricity covered by MBI type a, in grid region i, measured in kWh
- a is the type of MBI purchased by the reporting company, such as a REC or PPA
- $EF_{MBI,a,i}$ is the emission factor for the MBI type a, in grid region i

EMISSION FACTORS AND PARAMETERS

Emission factors used in Equation 20 and Equation 21 are provided in Table 16. Emissions factors were sourced from the Ministry of Science, Technology and Innovation, Archives of the average CO_2 grid emission factors month/year - 2022.

Table 16 - Emission factors and other parameters for purchased electricity emissions

Parameter	Value	Source
Grid Emission factor(kgCO_2e/kWh) – Brazil, 2022 average emission factor	0.0426	Ministério da ciência, tecnologia e Inovações, (2023)[25]

ACTIVITY DATA

Emissions were quantified based on the amount of electricity consumed and the associated grid factors for Brazil. The grid electricity consumption for all operations was available for GMT.

NOTES AND ASSUMPTIONS

The following list provides notes and assumptions used for the calculation of emissions from consumption of purchased electricity

- There is no data for Bela Vista as the facility is pre-operational during the reporting period, confirmed with GMT by email on 10/31/23.
- As residual grid emission factors for the grid electricity purchased by GMT were not available, the location-based grid emission factors were used in the calculation of market-based emission. This is consistent with the hierarchy of emission factors for the market-based emissions.
- GMT confirmed by email on 11/01/23 that Atlântca Agro was no longer under the operational control of GMT as of December 16, 2022. As GMT does not have data on Atlântca Agro for 2022, the 2021 values were used as a proxy and prorated based on the 343 days Atlântca Agro was under GMTs operational control in 2022.

8. QUALITY MANAGEMENT

Following the quantification of emissions, the GHG inventory should be assessed for quality control and assurance. The GHG Protocol recommends establishing an Inventory Quality Management Plan, which is a rigorous procedure to embed quality assurance procedures within the development of the GHG Inventory. This plan describes the steps a company is taking to implement its quality management system, which should be incorporated into the design of its inventory program from the beginning, although further rigour and coverage of certain procedures may be phased in over multiple years. The plan should include procedures for all organizational levels and inventory development processes—from initial data collection to final reporting of accounts. For efficiency and comprehensiveness, companies should integrate (and extend as appropriate) existing quality systems to cover GHG management and reporting.

Table 17 - Quality management process for GHG Inventory

Quality Management Step	Quality Management Measures
Data gathering, input and handling activities	– Check a sample of input data for transcription errors – Identify spreadsheet modifications that could provide additional controls or checks on quality – Ensure that adequate version control procedures for electronic files have been implemented
Data documentation	– Check that assumptions and criterion for selection of boundaries, base years, methods, activity data, emission factors, and other parameters are documented – Check that changes in data or methodology are documented – Confirm that bibliographical data references are included in spreadsheets for all primary data – Check that copies of cited references have been archived
Calculating emissions and checking calculations	– Check a representative sample of calculations, by hand or electronically – Check the data processing steps (e.g., equations) in the spreadsheets – Check that spreadsheet input data and calculated data are clearly differentiated – Check if units are properly labeled and correctly carried through from beginning to end of calculations – Check whether emission units, parameters, and conversion factors are correct and appropriately labeled – Check the aggregation of data across source categories, business units, etc. – Check some calculations with abbreviated calculations (i.e., back of the envelope calculations) – Check consistency of time series inputs and calculations

9. GHG INVENTORY SPREADSHEET

GMT's GHG Inventory is developed in a Microsoft Excel-based spreadsheet. Activity data is entered in the *Data Inputs* worksheets which are combined with the emission factor and other default parameters to calculated GHG emissions in the *Calculations* worksheets. The GHG emissions are summarized in the *Results* worksheet.

9.1. ANNUAL UPDATES TO GHG INVENTORY

The GHG Protocol suggests that the GHG inventory should be quantified annually for consistency, avoidance of errors, and progress tracking.

The GHG inventory development process should be followed annually for updating the GHG Inventory. Specific steps to update GMT's GHG Inventory on an annual basis are provided below.

1. Review organizational and operational boundary to confirm any new changes from the previous reporting period, including changes in operations (e.g., acquisitions, divestments, etc.) or identification of additional emissions sources.
2. Gather required activity data for the reporting period following the data collection process described in Figure 2.
3. Enter activity data in the *Data Inputs* worksheets in the GHG Inventory. Perform any required conversions or data manipulations to transform raw activity data into the required format for GHG calculations (e.g., unit conversions).
4. Review emission factor sources and update any emission factors and default parameters in the GHG Inventory. Emission factors for Scope 2, electricity should be updated on an annual basis. All other emission factors should be reviewed to ensure the most recent and relevant data is being used per reporting period.
5. Update calculations in GHG Inventory for the new reporting period. Review all calculations following the quality management process described in Table 17.
6. Update the *Results Summary* table in the GHG Inventory.
7. Perform the GHG trend analysis described in Section 9.2 to assess results.
8. Update the IMP with any changes to GHG Inventory to ensure the boundaries, emission sources, and assumptions are clearly identified.

9.2. GHG TREND ANALYSIS

Following the annual updates to the GHG Inventory, GHG data can be assessed against previous reporting periods to identify trends in organization GHG emissions. The analysis can aid in identification of errors as well as to assess impacts of any operational changes including any mitigation efforts. Annual trends can also track progress towards any organizational GHG targets. A trend analysis comparing GHG emissions between the current and previous reporting periods is available in the Trend Analysis worksheet of the GHG Inventory.

APPENDIX A – GMT S/A ORGANIZATION CHART

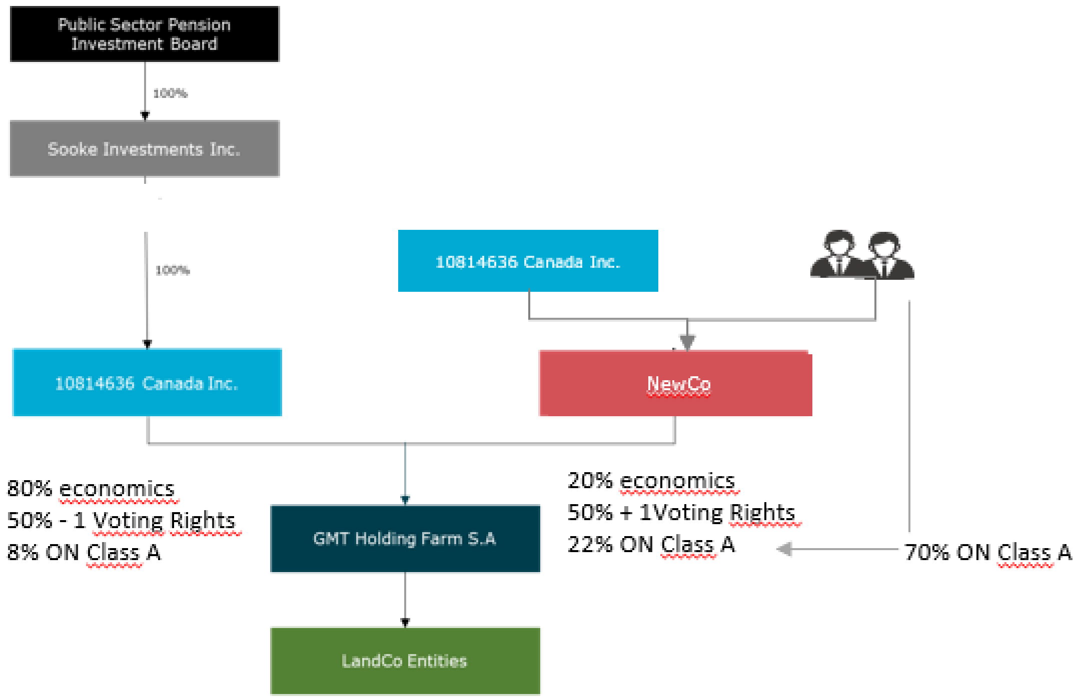

Figure 3 - GMT S/A Organizational Chart

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