Module 1: Basics of Greenhouse Gas Emissions

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CSAMSP Climate Action in Agriculture Sector

REPUBLIC OF KENYA
Ministry of Agriculture & Livestock Development

ICAT Initiative for Climate Action Transparency

Module Objectives

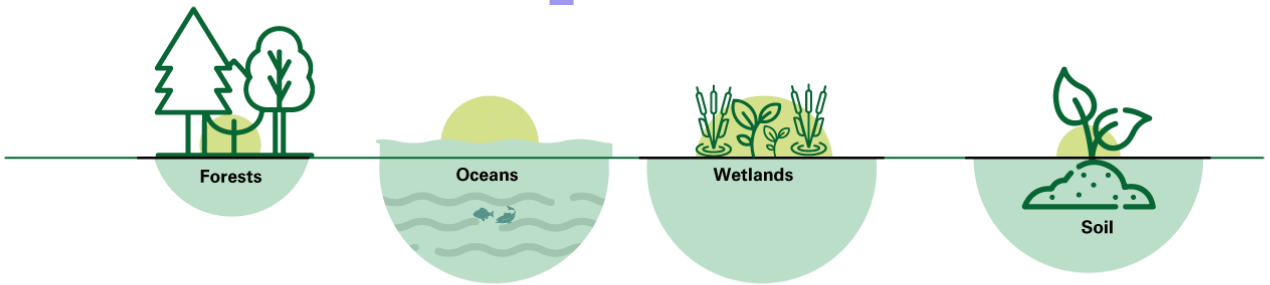
By the end of this module, participants should be able to:

I. Understand the key elements of the carbon cycle and sinks

II. Understand the status of the GHGs emissions in the agricultural sector from a global and national perspective

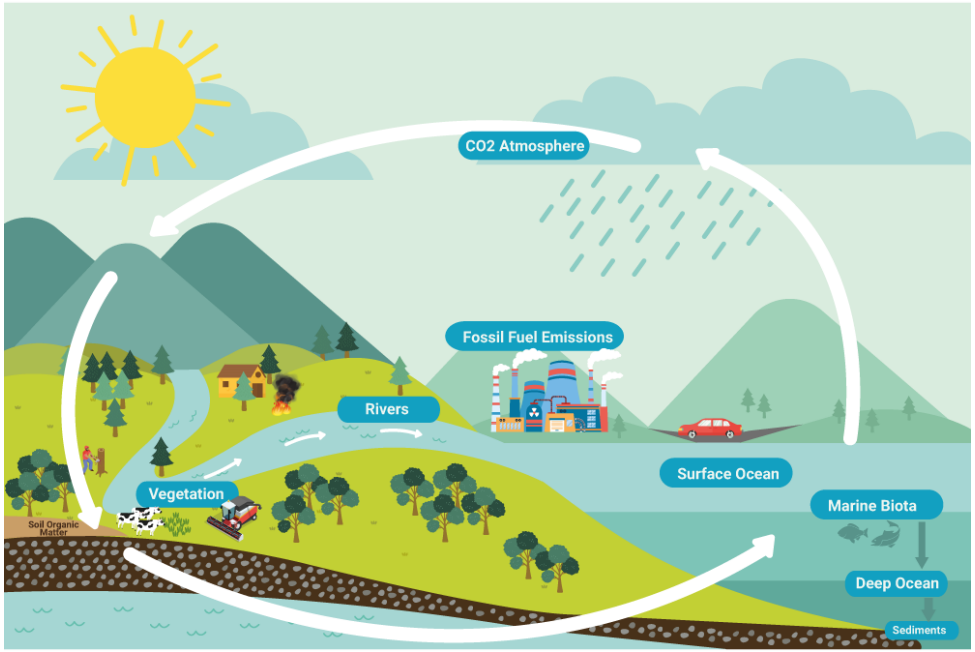
III. Identify the sources, and best practices and innovations for reducing GHG emissions in the crop sector

Global Sinks of CO_2



- Sinks refers to natural or artificial reservoirs that absorb and store greenhouse gases from the atmosphere.
- Carbon sink refers to a system that absorbs more carbon dioxide from the atmosphere than it emits.
- Natural carbon sinks include forests, oceans, and soil, which sequester CO_2 through processes such as photosynthesis and dissolution.
- Enhancing and protecting these sinks is crucial for mitigating the impacts of climate change by reducing the overall concentration of greenhouse gases in the atmosphere.

Global carbon cycle



The hydrosphere, encompassing all water bodies on Earth such as oceans, seas, lakes, rivers, and groundwater, plays a critical role as a carbon sink.

Photosynthesis by Phytoplankton reducing carbon from the atmosphere.

When marine organisms die, their remains sink to the ocean floor, where the carbon in their bodies is sequestered in sediments.

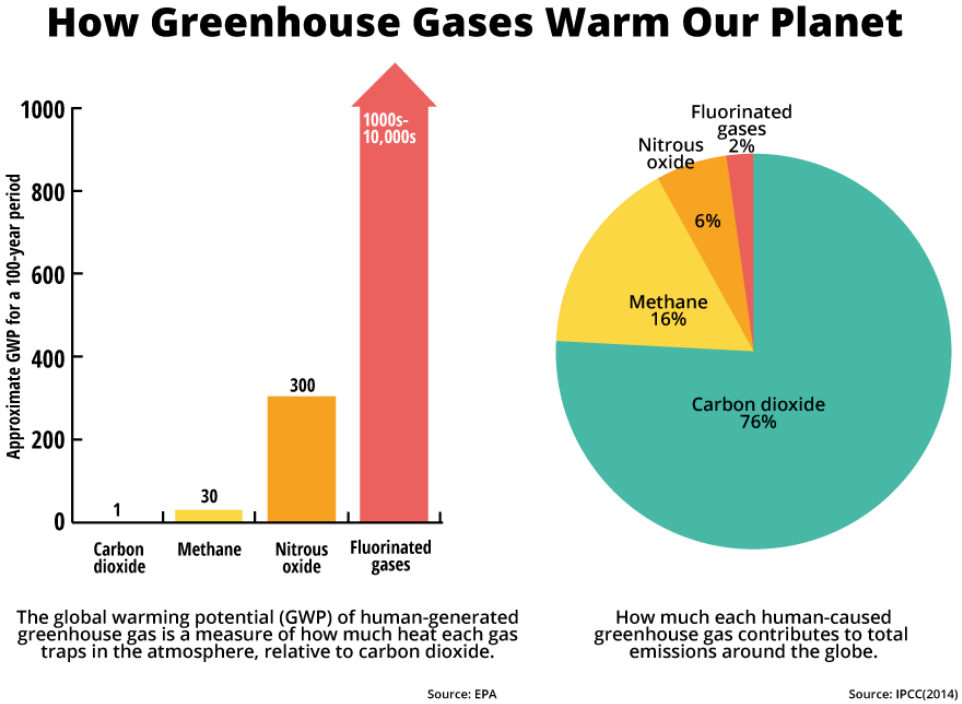
GHG Emissions

It refers to the release or discharge of substances (typically gases or pollutants) into the atmosphere.

These pollutants includes; carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases, which contribute to global warming and climate change.

Sources of emissions; industrial activities, transportation, agriculture, deforestation etc

Global Warming Potentials



- Methane (CH4) - 28 times the global warming potential of CO2
- Nitrous oxide (N20) - 273 times the global warming potential of CO_2

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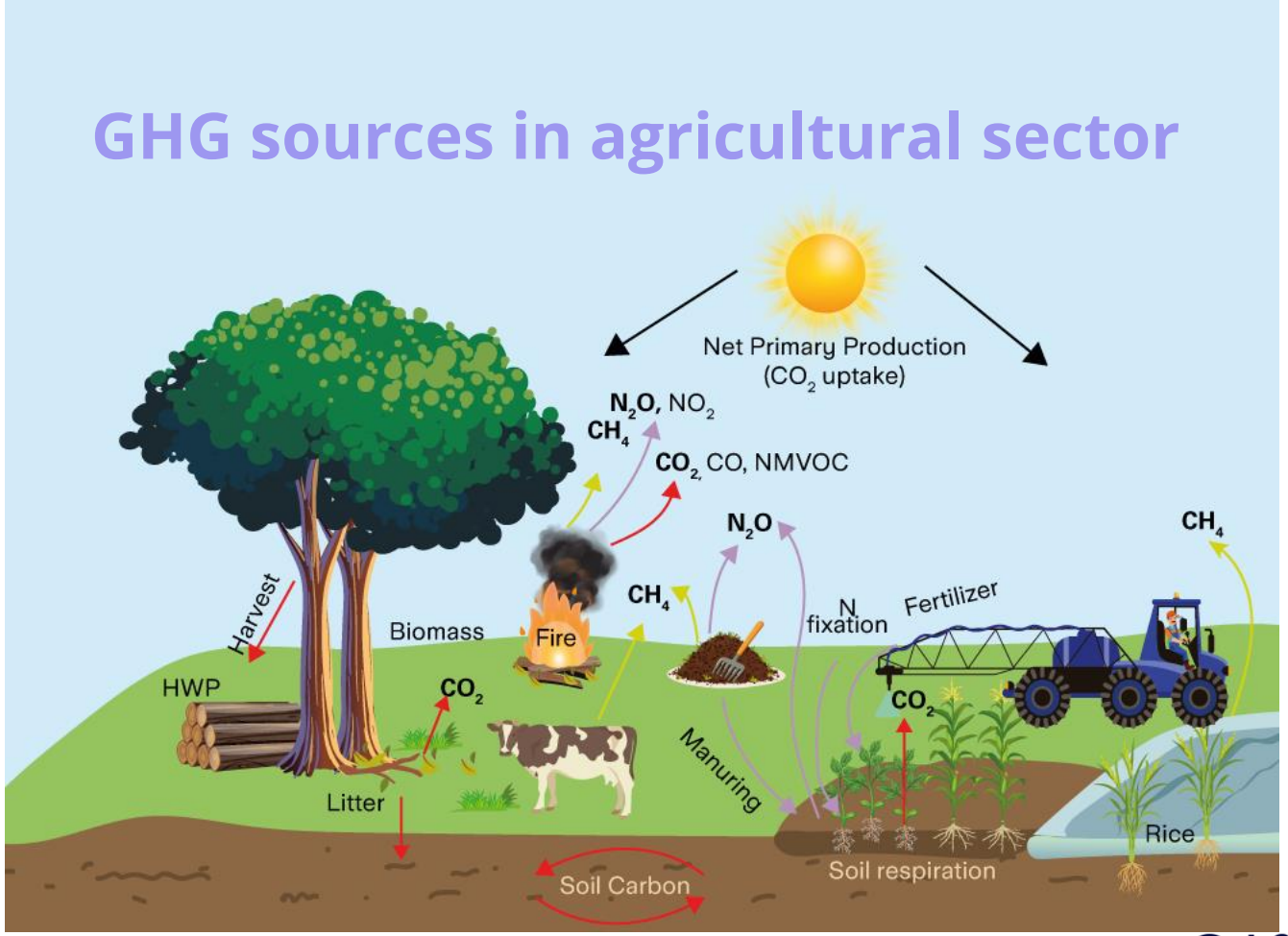
GHG sources in agricultural sector



Source: Macleod et al (2015);https://doi.org/10.1787/18156797

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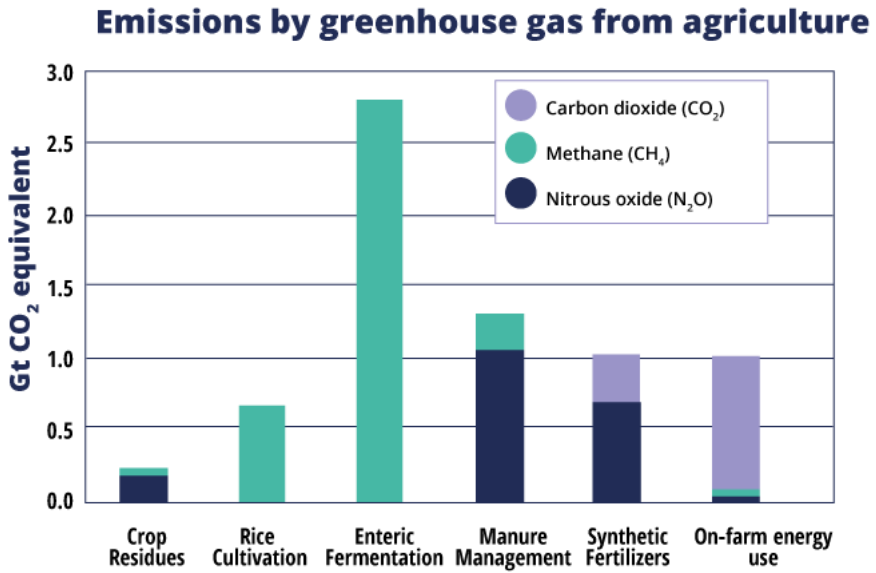
Emissions from agricultural activities



Source: Rosa & Gabriella, (2023):DOI 10.1088/1748-9326/acd5e8

1. Nitrous oxide

- Manure management and emissions in croplands
- Soil management, i.e. fertilizer application and cropping practices

2. Methane

- Rice cultivation
- Enteric fermentation, i.e. digestion from ruminant animals
- Manure management, i.e uncovered manure/storage
- Field burning of agricultural residues, that is from incomplete combustion of biomass

3. Carbon dioxide

- Agricultural management and cropping practices, e.g. tillage
- Machinery use in the farms
- Field burning of agricultural residues

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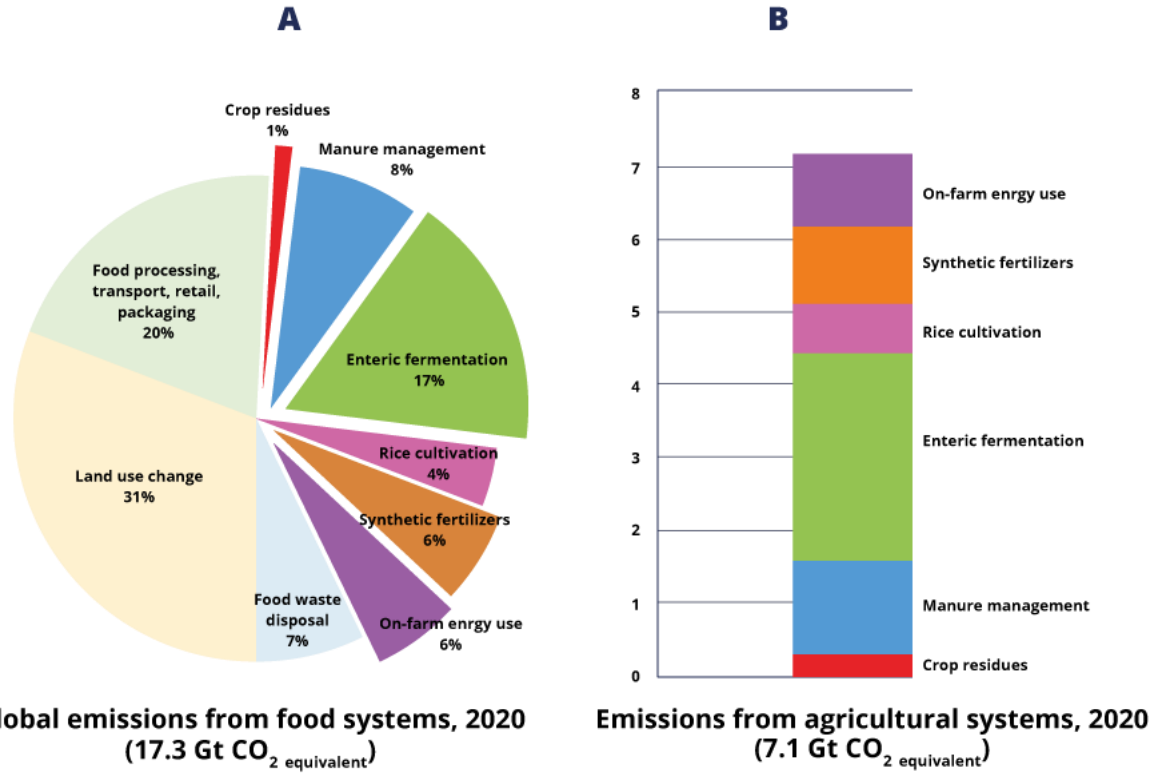
Global food systems and agricultural emissions



Global emissions from food systems, 2020 (17.3 Gt $CO_{2\ equivalent}$)

Emissions from agricultural systems, 2020 (7.1 Gt $CO_{2\ equivalent}$)

Source: Rosa & Gabriella, (2023):DOI 10.1088/1748-9326/acd5e8

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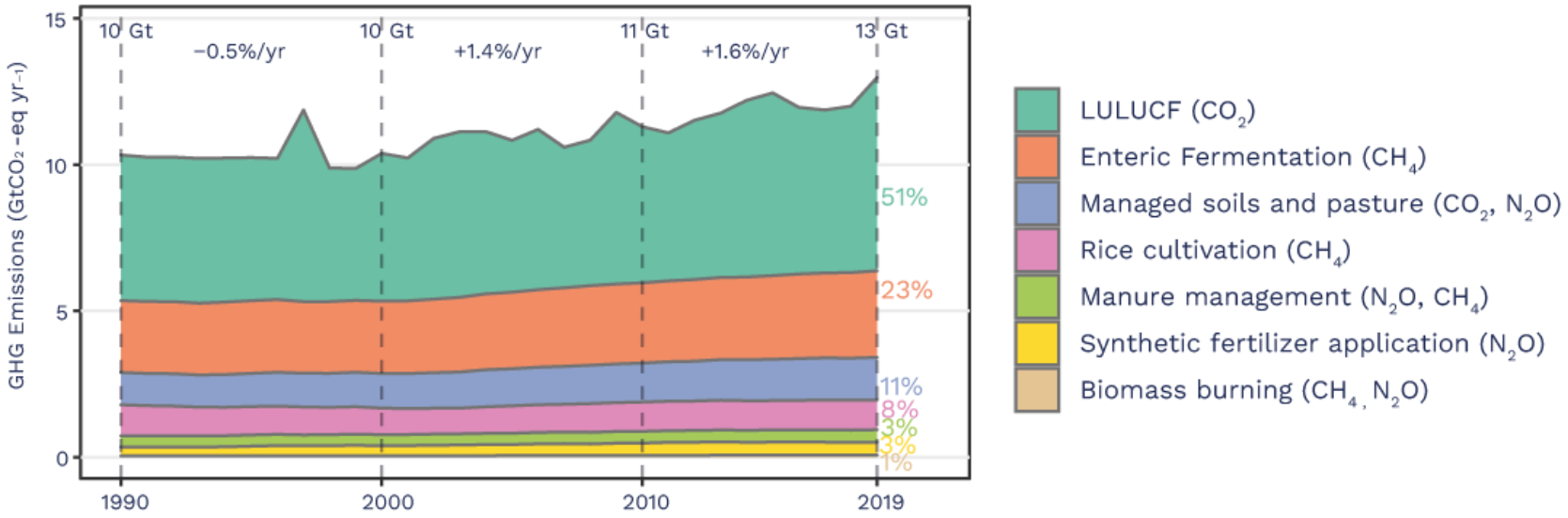
Global trends of GHGs emissions



Source: Wiedmann et al (2021); https://doi: 10.1088/1748-9326/abee4e

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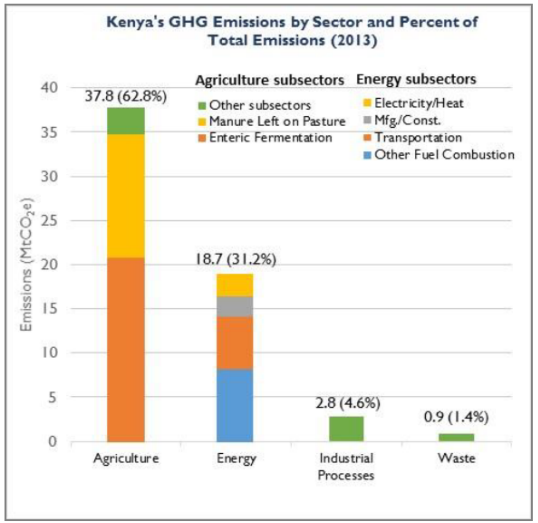
Kenya's GHG emissions by sector



Sources: WRI CAIT 2.0, 2017; FAOSTAT, 2017.
Note: Percent of total emissions exclude LUCF – see Footnote 2.

No.	Sector	2000 Emissions (CO2e - Gg)				TOTAL	TOTAL as %
		CO2	CH4	N2O	HFCs		
1	ENERGY SECTOR	7,227	1,932	601		9,760	17.76
2	INDUSTRIAL PROCESS SECTOR	694			118	812	1.48
3	SOLVENT AND OTHER PRODUCT USE					-	-
4	AGRICULTURE SECTOR	-	13,041	9,498		22,539	41.01
5	LAND USE, LAND-USE CHANGE AND FORESTRY	20,571	57	9		20,637	37.55
6	WASTE	7	697	502		1,205	2.19
	TOTAL	**28,499**	**15,726**	**10,611**	**118**	**54,955**	**100**

Sources:
Kenya's Second National Communication to the UNFCCC, 2015
https://www.climatelinks.org/sites/default/files/asset/document/2017_USAID_GHG%20Emissions%20Factsheet_Kenya.pdf
https://www.macrotrends.net/countries/KEN/kenya/ghg-greenhouse-gas-emissions

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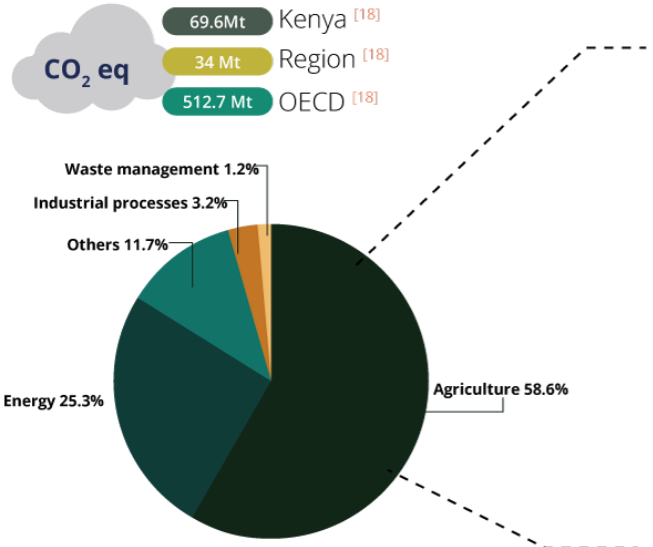
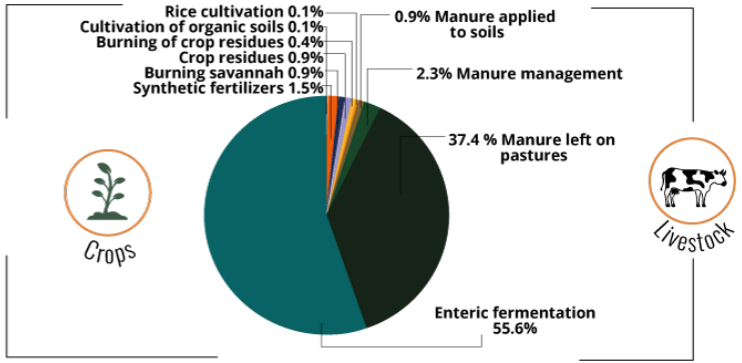
CO_2 emissions

Total Emissions



Period	$GtCO_2eq$
1990-1999	22.6 megatons
2000-2010	28.5 megatons
2011-2020	39.9 megatons

Agriculture GHG Emissions



3.8%
1.5 megatons
of total agricultural GHG emissions from cropland

96.2%
37.2 megatons
of total agricultural GHG emissions from livestock

Source:
https://climateknowledgeportal.worldbank.org/sites/default/files/2019-06/CSA%20KENYA%20NOV%2018%202015.pdf
FAOSTAT

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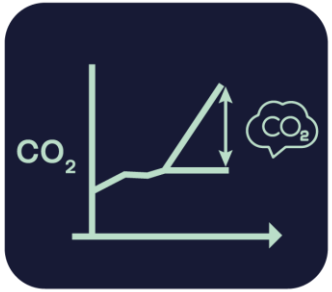
Mitigation vs Adaptation



Mitigation - Efforts to reducing GHGs emissions

- Emission reduction measured relative to the previous land use or supply chain processes
- Reference for quantifying emission reduction can be a base year or baseline projection into the future showing business as usual

Adaptation - reducing the risk associated with climate change

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Mitigation of cropland emissions

No-till or reduced tillage

Reduces decomposition and release of CO_2 emissions

Reduced soil disturbance and respiration from the soils

Agroforestry

Incorporation of trees in agricultural systems increases the above- and below-ground organic matter inputs. Trees reduce soil erosion, enhance soil water retention, and increase the organic matter inputs to the soils.

Paddy Rice

Alternate wet and drying to reduce methane emissions
Agroforestry

Cover cropping

Reduces soil exposure and slows decomposition

Manure application

Enhances crop production and thus absorption of CO2 from the atmosphere

Enhances nutrient supply to improve the health of crops and soils. Organic amendments improve soil structure and the water holding capacity in soils

Introduction of perennial crops

They do not need to be replanted hence less soil disturbance and less carbon loss to the atmosphere.

Crop diversification and rotation

With legumes with Biological Nitrogen fixation capabilities which enhance production and CO2 sequestration.

Cover bare ground during planting seasons, reduce erosion and prevent nutrient losses through leaching and runoff. Improve SOC through increasing above- and below-ground vegetation biomass

Integrated pest management

Reduce over reliance on pesticide and fungicide

Intercropping

Intercropping cereal crops with legumes allows the crops to benefit from the nitrogen that is fixed by legumes. This increases crop production and enhances SOC through more above- and below-ground biomass transfer to the soils.

Crop residue retention

Increases organic matter inputs and soil nutrients, promotes soil water retention and reduces soil erosion

Carbon sequestration

Fertilizer application

Improves the soil nutrient to maintain high crop productivity, which directly enhances SOC through increased biomass inputs

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Thank you for your attention!

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