



INITIATIVE ON  
Low-Emission  
Food Systems

# Food systems emissions in Kenya and their reduction potential

## A country profile

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Occasional Paper 7

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Members of Akilimali women association in their farming plot, Yanonge - DRC.

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# Summary

According to the latest IPCC assessment, the global food system is responsible for 23 – 42% of total net anthropogenic emissions. This share is expected to increase in the future, driven by the increasing needs of a growing population and by intentions, expressed in many global and national policy contexts, for progressive decarbonization of the whole global economy system. Therefore, without rapid and radical transformations in food systems, the Paris Agreement targets will remain out of reach.

This document is a first brief description of the food system in Kenya in the context of land use, agricultural production, national food supply, diets and food systems emissions. It describes the emissions in Kenya's food systems based on data available at FAO, and identifies possible pathways to address emission reductions and achieve low-emissions development for Kenya, by taking a food systems view.

Following IPCC guidelines, data on greenhouse gas (GHG) emissions are generally collected and analysed sectorally, distinguishing four economic sectors, namely: (i) energy; (ii) industrial processes and product use (IPPU); (iii) agriculture, forestry and other land use (AFOLU); and (iv) waste. Since the food system emissions span across all these sectors we still lack comprehensive data to describe the food system.

Food systems comprise “all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes” (HLPE 2014). I.e., a food system does equate to AFOLU; it goes beyond land use in including the pre- and post-production elements of food production and consumption.

Based on data available at FAO,<sup>1</sup> food systems emissions in Kenya remained stable in absolute levels over the past decade (2010-2020) going from 65.3 to 63.3 MtCO<sub>2</sub>eq. Although their relative importance decreased since 2010 following broader economy-wide development trends, food systems emissions in 2020 still represented 72% of total national emissions. This share is considerably higher than the global average of 31%.

In Kenya, the main sources of food system emissions are, by decreasing order of importance: (i) enteric fermentation (which accounts for 56% of total food system emissions), (ii) manure left on pasture (24%), and (iii) food waste disposal (11%). Together, livestock related emissions (enteric fermentation and manure left on pasture) represent 80% of all food system emissions. Altogether, these three categories account for 91% of all food system emissions.

In conclusion, this country profile highlights two main priorities for action, in line with national priorities identified in the latest NDC: (i) reduce emission intensities from enteric fermentation and improve the management of livestock feed and manure on pastures, and (ii) encourage climate-resilient food waste management. In addition, Kenya should continue on its path towards reducing deforestation, restoring forests on degraded lands, and increasing forest cover and agroforestry.

Addressing livestock emissions remains central to all low-emission food system transformations in Kenya, in particular with reference to national plans to substantially increase livestock production with the aim to reduce national malnutrition rates, most especially among children. While

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<sup>1</sup> <https://www.fao.org/faostat/en/#home>

livestock related issues have been high on the agenda of many actors attempting to reduce food system emissions, the second-largest source of emissions, food loss and waste (FLW), has been basically absent.

Nevertheless, our understanding of GHG emissions from FLW is also limited by a considerable lack of data on this sector in Kenya (which is consistent with a worldwide lack of data), and may actually be underestimated. Data from other countries show emissions from this source on the rise. Thus, more data collection seems necessary for better planning.

However, to effectively plan for climate action we also consider it important to act on sectoral emissions not only guided by their size, but also by the cost and feasibility (referred to as the ‘political economy’) of any climate action. By this consideration, addressing FLW in Kenya could represent an efficient and quick pathway to early emission reduction. By investing to bring this smaller emission source closer to zero, Kenya can achieve “early wins” and make significant progress in reducing its overall emissions, while working on the more complex questions. Addressing FLW will also help improving food security because more food would reach the market, potentially providing food to more people.

### **Box 1. Mitigate+: a Low-Emissions Food Systems Initiative**

‘Mitigate+’, an initiative launched under the auspices of the Consultative Group for International Agricultural Research (CGIAR), aims to offer a comprehensive and holistic view of food system emissions, considering the whole food supply chain in several partner countries. Working closely with key national actors, the initiative explores so-far neglected yet promising pathways that reduce GHG emissions while enhancing food security and nutrition, and advancing the 2030 Agenda as a whole.

Mitigate+ intends to ensure that civil society, multilateral, government, academic and private sector actors are equipped with the knowledge, information and tools they need to make robust evidence-based decisions as they confront challenges in food system discourse, policy development and implementation to reduce GHG emissions from food systems.





# 1 Introduction

## 1.1 Global food system emissions

The global food system provides critical food security and income to millions on the planet. The term ‘food system’ refers to the complex network of activities, processes, and actors involved in producing, processing, distributing, and consuming food.<sup>2</sup> It encompasses all aspects of food production and consumption, from the supply of farming inputs such as fertilizers, seeds, and machinery, to the growing and harvesting of crops and livestock and further to the packaging, transportation, and sale of food products, as well as the preparation and consumption of food by individuals and communities. The food system also includes the social, economic, and environmental factors that influence food production and consumption, such as land use, labour practices, food policies, and cultural preferences.

The global food system moves annually USD 7-8 trillion (EcoNexus & Berne Declaration 2013, World Bank 2019) yet generates externalities amounting to USD 12 trillion annually (Nature 2019). Several of these externalities give large reason for concern: Some 33% of soils globally are degraded (FAO and ITPS 2015), with 52% of agricultural land affected by soil degradation; some 20% of the world’s aquifers are at risk of running dry (Jasechko and Perrone 2021), and 34% of the world’s fishery stocks are over depleted (FAO 2020); agriculture is identified as a threat to 86% species at risk of extinction (Benton et al. 2021).

Importantly, the global food system also generates substantial GHG emissions. In 2018, according to the latest assessment by the Intergovernmental

Panel on Climate Change (IPCC) (Babiker et al. 2022), it was responsible for emissions of 17 GtCO<sub>2</sub>eq, i.e. 31% [range: 23 – 42%] of the total global net anthropogenic greenhouse gas (GHG) emissions of 54 GtCO<sub>2</sub>eq. Agriculture, consisting of crop and livestock production, accounts for the largest part of these emissions, 6.3 GtCO<sub>2</sub>eq per year, or 37% of the food system emissions and 12% of global emissions.<sup>3</sup> This is followed by land use, land use change and forestry (LULUCF: 24% of food system emissions), energy use (23%), waste management (10%) and industrial processes in the food industry (5%) (Babiker et al. 2022; see also Table 1).

Globally, LULUCF emissions are as high as the emissions from energy use throughout the food supply chain, including electricity, heat and refrigeration. They are followed in size by waste management (food waste, wastewater, and packaging waste) and the relatively low emissions of industrial processes in food systems. The latter, as well as transport emissions, contains a large amount of emissions related to refrigeration (Babiker et al. 2022).

However, it is worth noting that when the last three subsectors (energy use, waste management, and industrial processes) are taken together – arguably a good representation of pre- and post-farm activities–, their joint emissions amount to 6.5 GtCO<sub>2</sub>eq per year, 12% of global emissions, on par with agriculture, and one third of food systems emissions.

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2 By the definition of the High-Level Panel of Experts on Food Security and Nutrition (HLPE 2014), a food system combines “all the elements (environment, people, inputs, processes, infrastructures, institutions, etc.) and activities that relate to the production, processing, distribution, preparation and consumption of food, and the outputs of these activities, including socio-economic and environmental outcomes”.

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3 By another estimate, livestock (meat and dairy) directly and indirectly contributes 60% of global food system emissions (Pörtner et al. 2021). This value includes emissions from related land-use changes, feed production, enteric fermentation (digestion) in cattle, sheep, and goats, manure management, processing and transportation of animal products, as well as waste management. Unlike the emissions from livestock within agriculture in Babiker et al. (2022), it includes on- and off-farm activities along the whole value chain. In its own way this supports the role of the pre- and post-farm activities.

**Table 1. Global GHG emissions and food system emissions overview**

Sector	Subsectors	Emissions (GtCO <sub>2</sub> eq/ year)	Percent of global emissions	Percent of food system emissions	Range of global food system emissions (GtCO <sub>2</sub> eq/ year)		Range of global food system emissions (percent of global emissions)	
					Low	High	Low	High
Total global emissions		54	100.0					
Food system		17	31.48	100.0	13	23	24	43
	Agriculture (livestock and crop production)	6.3	11.67	37.06	2.6	11.9	5	22
	LULUCF	4	7.41	23.53	2.1	5.9	4	11
	Energy use	3.9	7.22	22.94	3.6	4.4	7	8
	Waste management	1.7	3.15	10.00	0.9	2.6	2	5
	Industrial processes (IPPU)	0.9	1.67	5.29	0.6	1.1	1	2
	Total of energy, waste, IPPU	6.5	12.04	38.24	5.1	8.1	9	15

Source: Babiker et al. (2022). LULUCF: Land Use, Land Use Change and Forestry

Within this, food losses and waste account for around 8-10% of global emissions, a significant amount, mainly from the production and disposal of wasted food (FAO and ITPS, 2015; Mbow et al., 2019). Furthermore, when food waste ends up in landfills, it produces methane (CH<sub>4</sub>), a potent GHG.<sup>4</sup>

Overall, reducing these emissions is critical to mitigating climate change. Together, the global food system emissions, at 31% of the global emissions, are on par with the whole GHG emissions of China (31% of global emissions in 2020) and well above the whole emissions of the US (13.5 %) (data from GCP 2021;<sup>5</sup> FAOSTAT). “Making the food system healthy for people and the planet” has been identified in a recent report by the Club of Rome (Dixson-Declève et al. 2022) as

one of only 5 major ‘turnarounds’<sup>6</sup> urgently needed to put the planet on a trajectory towards prosperity for all, while keeping resource use within the planetary boundaries.

As NDCs are usually structured around the four economic sectors identified in IPCC guidelines,<sup>7</sup> there is yet no comprehensive approach to easily address emissions from the food system which span across these four IPCC economic sectors. Therefore, an analysis of food systems emissions in countries is compounded by lack of data on activities, missing specific emission factors, data overlap, and a general ‘myopic’ view towards considering food system emissions systematically.

In the context of negotiations at the convention on global climate change (UNFCCC), addressing

<sup>4</sup> The global warming power of methane is 27 times more potent than that of CO<sub>2</sub> for a 100-year horizon, according to IPCC AR6 (Nabuurs et al. 2022)

<sup>5</sup> [https://www.globalcarbonproject.org/carbonbudget/archive/2021/GCP\\_CarbonBudget\\_2021.pdf](https://www.globalcarbonproject.org/carbonbudget/archive/2021/GCP_CarbonBudget_2021.pdf)

<sup>6</sup> The other turnarounds being poverty, equality, gender empowerment, and energy.

<sup>7</sup> These four sectors are Energy; Industrial Processes and Product Use (IPPU); Agriculture, Forestry and Other Land Use (AFOLU); and Waste

food system emissions is seen by some Parties as a potential threat to food sovereignty and food security and nutrition, particularly for the most vulnerable, poor and hunger-stricken parts of the populations. Given the large share of emissions from the food systems, and also given the fact that climate change has started to affect all aspects of human life, including food production, this position should be re-considered. It is essential to create holistic, low-emission food systems through a fair and equitable transformation, in order to achieve resilient and sustainable food systems that provide food and nutrition to all, while allowing for the prosperity of many. This is necessary to ensure a more stable and sustainable future for the planet, its inhabitants, and its biodiversity. Such an approach will also allow for a better reconciliation of two climate change objectives, i.e. the mitigation of and the adaptation to climate change, often treated separately in climate talks yet inherently linked to each other.

Nevertheless, Article 2 of the 1992 Climate Change Convention<sup>8</sup> and Article 2.1.b of the Paris Agreement<sup>9</sup> both state that limiting GHGs should be done in a way that ensures food production is not threatened. Actions proposed to reduce food systems emissions need to adhere to that principle.

While food systems are the basis of food security and nutrition and provide meaningful livelihoods and socioeconomic benefits, they are also key contributors to climate change, soil degradation, freshwater depletion and biodiversity loss. We have enough scientific evidence, technical, human and financial resources to advance low-emission and sustainable food systems. However, there are still knowledge gaps to be addressed: reliable national data is lacking in many countries for certain food system sectors such as food loss and waste (FLW). Reliable indicators and measurement, reporting and verification (MRV) systems are absent, and our understanding of the drivers of emissions and the complex systemic interactions and feedback loops in food systems

is inadequate. Further research is thus needed at global and national levels. We also miss effective approaches to prioritization for action that should focus on viable, cost-efficient climate action bringing multiple co-benefits.

To foster low-emission development in line with the Paris Agreement without compromising food production and nutrition security and livelihoods, it is vital that the knowledge, information and tools required for evidence-based decision-making are available to civil society and multilateral, governmental, academic and private-sector actors that reflect the context of target countries. This is the main purpose of the Mitigate + Initiative (see Box 1).

## 1.2 Food system emissions in Kenya

The Low-Emissions Food Systems Initiative (also called ‘Mitigate+’), conducted under the auspices of the CGIAR aims to reduce annual global food systems emissions by 7% by 2030. It is working closely with key actors in the target countries to ensure they are equipped to make evidence-based decisions and address challenges in policy discourse, development and implementation to reduce GHG emissions.

To achieve this goal, one objective of this project is to offer novel views onto so-far neglected, yet promising pathways to emission reductions, by taking a view across the sectors normally separated in NDCs, but which together belong to the food system. CIFOR-ICRAF, as part of the Mitigate+ initiative, is developing a series of analytical papers, low-emissions food systems “country profiles”, identifying the issues that emerge when taking a food-systems view on emission reductions. Country partners generally receive this approach positively, encouraging CIFOR-ICRAF to further go down this path.

This document is the first version of the low-emissions food systems country profile for Kenya. It describes issues related to GHG emissions of food systems in Kenya and identifies possible options for reducing these emissions. Beyond Kenya, similar country profiles are also being developed for other countries (China, Colombia, and Viet Nam). By using publicly available global datasets (mainly FAOSTAT) we facilitate comparisons between these four countries.

8 United Nations Framework Convention on Climate Change. Available at <https://unfccc.int/resource/ccsites/zimbab/conven/text/art02.htm#:~:text=ARTICLE%202,OBJECTIVE&text=Such%20a%20level%20should%20be,proceed%20in%20a%20sustainable%20manner>.

9 United Nations, 2015. Available at [https://unfccc.int/sites/default/files/english\\_paris\\_agreement.pdf](https://unfccc.int/sites/default/files/english_paris_agreement.pdf)

## 2 National socio-economic context

Kenya exhibits a wide variety of ecological zones, spanning from the coastal plains in the east to the Kenyan highlands, culminating at Mount Kenya at 5,199 meters above sea level. The Great Rift Valley cuts across Kenya's central and western regions, dividing the highlands into an eastern and western section. Moving westward, the land gradually descends toward Lake Victoria. The North consist of expansive arid lands that are progressively being developed to sustain the livelihoods of pastoralist communities and wildlife ranching initiatives (Ministry of Environment and Forestry 2020a). These drylands extend into neighbouring countries.

Kenya covers 569,140 km<sup>2</sup> of land area and counted a population of almost 54 million inhabitants in 2020, a 27.9% increase compared to the 42 million inhabitants counted in 2010.<sup>10</sup> The urban population has increased by more than 49%, on par with Eastern and Southern Africa average (+50%).<sup>11</sup> However, Kenya is still mainly rural in 2020, with 72% of the population living in rural areas. The share of urban population in Kenya is considerably below the average for Eastern and Central Africa, which stands at 37% in 2020 (and 32% in 2010). The four largest cities rank by size as follows: Nairobi, Kenya's capital (4.4 million inhabitants), Mombasa (1.2 M), Nakuru (0.6 M), and Ruiru (0.5 million inhabitants).<sup>12</sup> Nairobi concentrates around 30% of the urban population of Kenya. At national level, two areas of very high population density (the Western Highlands and the

Eastern flank of the Central Plateau, where Mount Kenya is located) concentrate 15 and 11 million inhabitants, respectively.<sup>13</sup> The urban in Kenya raises important challenges as access to services remains low, informality of human settlements and jobs predominates, and poorly functioning land markets make investing in housing and infrastructure expensive and inefficient.<sup>14</sup>

Kenya is the seventh largest economy in Africa (after Nigeria, Egypt, South Africa, Algeria, Morocco, Ethiopia, and Angola) and is rapidly expanding. The GDP, expressed in current USD, was multiplied by 2.5 over the last decade (from USD 45 to USD 113 billion). Over the same period, the GDP per capita almost doubled (from USD 1,094 to USD 2,099). Kenya's GDP per capita followed the opposite trend than Eastern and Southern Africa average, for which constant and current GDP per capita decreased respectively by 5% and 17% over the same period.<sup>15</sup>

Kenya is also the largest economy in East and Central Africa,<sup>16</sup> with a GDP of USD 314.32 billion<sup>17</sup> and a GDP per capita of 1,872 current USD. It is followed by Tanzania (62.4 billion USD) and the Democratic Republic of the Congo (48.7 billion). Over the last decade, GDP per capita increased by almost 20% in constant 2015 USD, and by 77% in current USD. Its large relative economic size has led us to include Kenya in the context of the Mitigate+ study.

10 FAOSTAT. Available at <https://www.fao.org/faostat/en/#data/OA>. Extracted on 26 July 2023. The Kenya National Bureau of Statistics gives 47.5 million inhabitants for 2019 (<https://www.knbs.or.ke/2019-kenya-population-and-housing-census-results/>) but we cite FAO data to maintain comparability to companion country profiles (e.g. Martius et al., 2023).

11 UNDESA World urbanization prospects. Available at <https://population.un.org/wup/>

12 Kenya National Bureau of Statistics (2020). Kenya Population and Housing Census. Analytical Report on Urbanization. 78 pp. Available at: <https://www.knbs.or.ke/download/2019-kphc-analytical-report-on-urbanization-vol-ix/>. Extracted on 22 September 2023.

13 Africapolis, 2015. See: <https://africapolis.org/en/country-report/kenya>

14 <https://blogs.worldbank.org/sustainablecities/how-can-kenya-achieve-sustainable-urban-future>

15 From the same source: <https://blogs.worldbank.org/sustainablecities/how-can-kenya-achieve-sustainable-urban-future>

16 East and Central Africa counts the following 16 countries: Burundi, Cameroon, Central African Republic, Chad, Comoros, Congo (Republic of), Djibouti, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Kenya, Rwanda, Somalia, South Sudan, Uganda

17 <https://databank.worldbank.org/source/world-development-indicators>

Kenya has been one of the fastest growing economies in Africa in the past ten years, giving it the status of a lower-middle income country. Economic growth in Kenya is driven by ongoing public infrastructure projects and strong public and private investments, according to the National Treasury of Kenya.<sup>18</sup> Mose (2021) has identified that public investment, government consumption, quality of governance and institutions, electricity infrastructure, and human capital stocks have been the main determinants of economic growth in Kenya in recent years.

According to the Human Development Report (UNDP 2020), the Human Development Index (HDI)<sup>19</sup> value of Kenya for 2019 is 0.601, similar to the previous year's HDI value of 0.599. By

HDI, Kenya ranks 141<sup>st</sup> out of 189 countries. The life expectancy at birth is 66.7 years. The average number of years of schooling for adults aged 25 years and older was 6.6 years, while the expected average number of years of schooling for children were 11.3. The Human Development Report (HDR) for Kenya shows that the country has achieved a medium level of human development, with an average annual Human Development Index (HDI) growth rate since 2000.

Notwithstanding, Kenya continues to face a high level of inequality, which is a central challenge to sustain shared growth. Improving basic services like electricity, water, sanitation, transport and digital access, while stimulating job creation, is a priority (Hansen and Ndungu 2022).

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18 <https://www.treasury.go.ke/kenya-economy/>

19 The HDI is a composite measure of three basic dimensions of human development: health (measured by life expectancy at birth), education (measured by years of schooling), and standard of living (measured by Gross National Income per capita).

# 3 Land use, agriculture and diets

## 3.1 Land use

The main land use<sup>20</sup> in Kenya (Table 2) is agricultural land, which covers almost half of Kenya’s land area (48.5%) with 27.6 million hectares (ha) in 2020. The agricultural land area remained stable (+1%) between 2010 and 2020.

Within agricultural land, rangelands (“permanent meadows and pastures” in the table, in FAOSTAT terminology) occupy most of the agricultural lands, with 21.3 million ha accounting for 77% of all agricultural lands and 37% of total land use, and the area remained stable over the last decade.

Covering 6.3 million ha, cropland is the second-largest agricultural land use in Kenya. The 5% increase in cropland area between 2010 and

2020 was mostly driven by an increase in arable land, which accounts for 92% of the cropland area (5.8 million ha). With only 0.5 million ha, the share of permanent croplands in agricultural land is extremely low (2%; compared to ca. 10% globally);<sup>21</sup> however, tea area is increasing rapidly (see Section 3.2.2).

Outside of agricultural land, forest land covers only 6.3% of total land area, of which 96% of naturally regenerating forest. The forest area remained stable between 2010 and 2020. However, the government of Kenya led by President Ruto launched the national tree planting initiative, aiming to plant 15 billion tree by 2032.<sup>22</sup> The aim is to restore 5.1 million hectares of deforested and degraded landscapes, stop and reverse deforestation, and reduce greenhouse gas emissions.

**Table 2. Area by land-use in 2010 and 2020 in Kenya**

Land use (1000ha)	2010	2020
Land area	56,914	56,914
Agricultural land	27,320	27,630
Cropland	6,020	6,330
Arable land	5,500	5,800
Permanent crops	520	530
Permanent meadows and pastures	21,300	21,300
Forest land	3,616	3,611
Naturally regenerating forest	3,464	3,458
Planted Forest	153	153
Other land	25,978	25,673

Source: FAOSTAT. Available at: <https://www.fao.org/faostat/en/#data/RL> Extracted on 17 November 2022

<sup>20</sup> Land use refers to the destination of the land while land cover refers to the (bio)physical cover observed on the Earth’s surface. For instance, after a clear cut, a forest remains a forest if its destination does not change, even if the land cover has changed temporarily. Land use changes include changes in land cover and changes in land management practices.

<sup>21</sup> <https://www.fao.org/sustainability/news/detail/en/c/1274219/>

<sup>22</sup> Republic of Kenya. Available at <https://www.treasury.go.ke/national-tree-planting-initiative-launch/>

**Table 3. Agricultural use of fertilizers by nutrient in 2020 in Kenya**

Fertilizers by nutrient	Kenya 2010		Kenya 2020		World average in 2020
	Agriculture use (tonnes)	Agriculture use (kg/ha of cropland)	Agriculture use (tonnes)	Agriculture use (kg/ha of cropland)	Agriculture use (kg/ha of cropland)
Nitrogen N	78,916	13.1	183,931	29.1	72.5
Phosphate P <sub>2</sub> O <sub>5</sub>	80,341	13.3	163,863	25.9	30.8
Potash K <sub>2</sub> O	21,102	3.5	30,483	4.8	25.1

Source: FAOSTAT. Available at <https://www.fao.org/faostat/en/#data/RFN> Extracted on 19 December 2022.

## 3.2 Agriculture

### 3.2.1 Agricultural inputs

Agriculture use of fertilizers for all three nutrients (nitrogen (N), phosphorus (P), and potassium (K)) increased considerably between 2010 and 2020. This is particularly true for N and phosphate, the overall use of which more than doubled (+133% and +104%, respectively, see Table 3). N and P use per hectare of cropland followed the same trend, approximately doubling from 2010 to 2020. This large increase is consistent with the liberalization of fertilizer markets in 1990 (Balié et al. 2019). Two papers have examined the Kenyan fertilizer policy in the wider context of agricultural policies to reduce food insecurity in Kenya. Food security has for long been high on the political agenda in Kenya (Njora and Yilmaz 2021). After failures of direct fertilizer subsidy schemes, the Kenyan government has proposed a complete overhaul of the current subsidy schemes until 2029. It has facilitated the establishment of two fertilizer plants and expanded agricultural extension programmes (Boulanger et al. 2020).

Yet, Kenya's agricultural use of fertilizers is currently still significantly below the world average, especially for N and K. Nitrogen use in kg/ha of cropland in Kenya was only at 40% of the world average use in 2020. Phosphate use per cropland area was only 16% lower than world average, but per-hectare potash use, although increased by 37%, was still only 20% of the global average in 2020.

Poor access to input markets, farmers' difficulty to save harvest income to purchase fertilizers for the next season, and limited information on using fertilizers properly have been identified as the three

main barriers to adequate fertilizers use in Kenya (Balié et al. 2019). Declining average maize yields that remain well below their potential, increasing soil acidity due to the overuse of inappropriate fertilizers, and lack of awareness about soil needs are some of the challenges identified in the Agricultural Sector Transformation and Growth Strategy 2019-2029.<sup>23</sup>

### 3.2.2 Harvested area for major crops

In 2020, the two main crops (maize and beans) covered 52.7% of the total cropland area, up from 44.8% for the two main crops (maize and beans as well) in 2010 (Table 4). This may indicate a trend towards specialization and simplification of crop rotations. Maize production alone occupied 34.6% of total cropland area, and its harvested area increased by 9% between 2010 and 2020. Harvested area for beans saw a significant increase of 66%, resulting in Kenya's crops being heavily concentrated around maize and beans. Maize production in rain-fed areas, however, is dropping due to more frequent droughts (Kang'ethe et al. 2020). Maize is the main staple crop in Kenya; many farmers rely on it for their income. Smallholder farmers account for 70% of national maize production. Maize is grown in six agroecological zones: highland tropical, moist transitional, dry transitional, moist mid-altitude, dry mid-altitude and lowland tropical (Kang'ethe et al. 2020).

An increasing number of farmers are seeing the benefits of growing other crops such as tea, which saw an increase by 57% in ten years (see Table 4). This dramatic increase in harvested tea area between 2010 and 2020 made tea replace sorghum as the

<sup>23</sup> Ministry of Agriculture, Livestock, Fisheries and Irrigation. Available at: <https://kilimo.go.ke/wp-content/uploads/2022/03/ASTGS-Abridged-version.pdf>



**Table 4. Share of harvested area by major selected crops in 2010 and 2020 in Kenya**

Area harvested (1000 ha)	2010	2020
Maize (corn)	2,008	2,136
Beans, dry	689	1,148
Tea leaves	172	269
Cow peas, dry	168	239
Sorghum	226	220
<b>Total cropland</b>	<b>6,020</b>	<b>6,330</b>

Source: FAOSTAT. Available at: <https://www.fao.org/faostat/en/#data/QCL>. Extracted 19 April 2023

third most cultivated crop, even though tea still represents only 4.5% of total cropland area. However, tea production is limited to suitable areas. Currently, the main tea-producing areas in Kenya are located in the Central region around Mount Kenya, and between the Rift Valley and Nyanza in the West, concentrated in the higher areas of districts of between 1,500 and 2,300 metres above Sea level.<sup>24</sup>

Other farmers grow mango and avocados; small-scale mango production integrates well with the production of staple crops whereas the majority of small-scale farmers growing avocados intercrop them with coffee, banana, maize and other staples. Kenya's diverse agro-ecological landscapes allow the production of mango and avocados throughout the major part of the year (Snel et al. 2021).

### 3.2.3 Livestock

In terms of weight, milk is the largest animal product in Kenya. Its production increased by 13% between 2010 and 2020 (Table 5). Milk production is followed by beef meat,<sup>25</sup> sheep and goat meat, and eggs. According to FAOSTAT, beef meat production fell to 50% from 2010 to 2020 whereas sheep and goat meat production increased by 82%. Poultry meat production also significantly increased (+155%), reaching 69.2Mt in 2020 compared to 27.1 Mt in 2010. Despite the importance of milk national production, Kenya's milk consumption per capita (82.5 kg per capita in 2020), is still slightly below the world average

(85 kg per capita)<sup>26</sup> but far above the average consumption in Africa (only 27 kg per capita in 2020; Alonso et al. 2023).

### 3.2.4 Value of agricultural production

The total value added of Kenya's agricultural production (Table 6) increased by 5.5% from 2010 to 2020. According to FAOSTAT, the main agricultural product by value in 2020 was maize by far. In 2010, maize had been only the 5<sup>th</sup> agricultural product of Kenya in terms of value added. Its total gross production value added increased by 47%, driven by a 6% increase in harvested area and a 34% increase in producer prices (from 217 to 291 USD per tonne in annual average value). Cassava gross production value increased more than 7 times over the same period, because yields almost tripled (from 52 to 144 q/ha) and producer prices more than doubled (from 189 to 507 USD per tonne).

Tea leaves production increased by 43% over the period, from 1.7 to 2.5 million tonnes, driven by a strong increase in harvested area (+57% see above) and interannual yield variations. However, because FAOSTAT data on the value of tea leaves production in Kenya are inconsistent with this, we do not show the data here, even though tea may be the highest-value crop product in Kenya. According to the economic survey 2022 of the Kenya National Bureau of Statistics, earnings from tea production amounted 122.2 billion KSh in 2020 (approximately 830 million USD at current rate).<sup>27</sup>

24 Government of Kenya, Tea Directorate. Available at: <https://tea.agricultureauthority.go.ke/index.php/sectors/overview#:~:text=Tea%20growing%20in%20Kenya&text=The%20highlands%20are%20spread%20across,Tharaka%2DNithi%2C%20and%20Meru>.

25 The complete FAO category is beef and buffalo, but with no buffalo production in Kenya, we report this here as beef only

26 <https://ourworldindata.org/meat-production#milk-production-across-the-world>. Extracted 13 April 2023

27 Republic of Kenya, Kenya National Bureau of Statistics. Available at <https://www.knbs.or.ke/wp-content/uploads/2022/05/2022-Economic-Survey1.pdf>

**Table 5. Size of animal production for selected commodities in 2010 and 2020 Kenya**

Commodity (1000 tonnes)	2010	2020
Milk, total	4,849.9	5,500.1
Beef meat, primary	462.0	244.2
Sheep and goat meat	88.4	160.4
Eggs primary	92.6	110.4
Meat, poultry	27.1	69.2
Meat of camels, fresh or chilled	64.5	61.3

Source: FAOSTAT. Available at <https://www.fao.org/faostat/en/#data/QCL>. Extracted on 13 April 2023

**Table 6. Value of Agricultural Production for selected commodities in Kenya in 2020**

Gross production value (current 1000 USD)	2010	2020
Maize (corn)	752,654	1,103,411
Potatoes	777,152	541,594
Tomatoes	272,777	504,168
Beans, dry	246,146	487,385
Cassava, fresh	61,055	449,814
<b>Total</b>	<b>13,196,388</b>	<b>13,918,120</b>

Source: FAOSTAT. Available at: <https://www.fao.org/faostat/en/#data/QV>. Extracted on 20 January 2023

### 3.3 Diets

#### 3.3.1 National food supply

Total food supply in Kenya is significantly below the world average (26.5% lower; Table 7). According to FAOSTAT, the national food supply in Kenya reaches 2,193 kcal per capita per day in 2020, which is well above the minimum dietary energy requirement (MDER) of 1,751 kcal per capita per day, but slightly below the average dietary energy requirement (ADER) of 2,244 kcal per capita per day.<sup>28</sup> Within this, the average Kenyan diet is slightly less dependent on meat than the world average.

<sup>28</sup> In a specified age/sex category, the MDER is the minimum amount of dietary energy per person that is considered adequate to meet the daily energy needs at a minimum acceptable body mass index (BMI) of an individual engaged in low physical activity. The ADER is the amount of food energy needed to balance energy expenditure in order to maintain body weight, body composition, and levels of necessary and desirable physical activity that are consistent with long-term good health. The ADER represents the reference level for adequate nutrition in a population. If referring to an entire population, the MDER and ADER are the weighted average of the MDER and ADER of the different age/sex categories. For more information, see FAO, WHO, and UN expert Consultation (2001) or [https://www.who.int/data/nutrition/nlis/info/population-below-minimum-level-of-dietary-energy-requirement-\(undernourishment\)](https://www.who.int/data/nutrition/nlis/info/population-below-minimum-level-of-dietary-energy-requirement-(undernourishment))

The National food-based dietary guidelines (FBDGs) (Ministry of Health 2017, page 33) recommend keeping fat intake at 30% of total energy intake for 20-59 year-old adults, equivalent to approximately 74g per capita per day. Kenya's per-capita fat supply is therefore 35% below recommendation.<sup>29</sup>

Protein supply is lower than the world average. Animal products and meat represent a relatively small part of the food, protein and fat intake. Kenya's consumption of animal products is only 43% of the world average in terms of food supply, 35% for fat supply and 38% for protein supply. This is even more visible for meat consumption: Kenya's food supply of meat is only 23% of the world average. It is therefore understandable that the Kenyan government wants to increase the consumption of meat and dairy products to fight malnutrition, above all in children. This plan could have large repercussions for food system emissions, unless the current high emission intensities are addressed by increasing productivity.

<sup>29</sup> calculated using 1 g fat = 9 calories. See <https://my.clevelandclinic.org/health/articles/4182-fat-and-calories>

**Table 7. National supply of food, fat and protein for the main food groups in 2020 in Kenya**

	Kenya		World	
	(kcal/ capita/day)	% of total	(kcal/ capita/day)	% of total
<b>Total food supply</b>	<b>2,193</b>	<b>100.0</b>	<b>2,982</b>	<b>100</b>
Animal Products, including meat	230	10.5	533	17.9
Meat only	54	2.5	233	7.8
Vegetal Products, including cereals (excl. beer)	1,962	89.5	2,449	82.1
Cereals only (excluding beer)	1,071	48.8	1,317	44.2
<b>Total fat supply quantity (g/capita/day)</b>	<b>50</b>	<b>100</b>	<b>89</b>	<b>100.0</b>
Animal Products, including meat	15	29.2	39	43.4
Meat only	4	8.1	19	21.4
Vegetal Products, including cereals (excl. beer)	35	70.8	50	56.6
Cereals only (excluding beer)	8	16.6	6	6.9
<b>Total protein supply quantity (g/capita/day)</b>	<b>59</b>	<b>100.0</b>	<b>85</b>	<b>100</b>
Animal Products, including meat	13	22.3	34	40
Meat only	4	7.1	15	17
Vegetal Products, including cereals (excl. beer)	46	77.7	51	60
Cereals only (excluding beer)	28	48.5	33	38

Source: FAOSTAT (<https://www.fao.org/faostat/en/#data/FBS>, Extracted 13 December 2022)

**Table 8. Comparison of Food Security Indicators for Kenya and World average**

Indicator (in %)	Kenya	World
Prevalence of undernourishment in total population	20.6	8.4
Prevalence of stunting in children under 5	29.2	26.9
Prevalence of overweight in children under 5	4.8	5.6
Prevalence of obesity in adult population (over 18)	5.6	11.5
Prevalence of anaemia in women aged 15-49	28.7	28.5

Source: FAOSTAT (<https://www.fao.org/faostat/en/#data/FS>). Extracted 13 December 2022

Cereals account for almost half (48%) of the vegetal product consumption, a higher share than the world average (at only 39%).

### 3.3.2 Food security and nutrition

Food security indicators for Kenya (Table 8) are quite close to the world average except for a marked difference in two indicators. First, undernourishment rates in Kenya are 2.4 times higher than the world average, making one person out of five undernourished. Second, the obesity rate in the adult population is only half the world average. However, Ford et al. (2017) show an increase of overweight and

obesity in the population, a trend on par with the increasing prevalence rates in low and middle income countries (LMICs). According to this document, 28% of Kenyans aged 18-69 years are either overweight or obese, with the percentage being significantly higher in women (38.5%) than men (17.5%) (Ministry of Health 2017). Not surprisingly, the prevalence of obesity and overweight is higher among people living in urban areas, and people with higher income (Mkuu et al. 2021).

In February 2017, the Kenyan government declared a national disaster related to a drought in 2016 and 2017 which caused livestock

deaths, reduced crop yields, and left 3.4 million people in urgent need of food assistance (Umweltbundesamt 2018), pointing to important regional differences as the drought was most strongly felt in the Northern dry areas of the country. This drought is not over yet even in 2023<sup>30</sup> and has made millions of Kenyans food insecure.<sup>31</sup> In February 2023, the

Integrated Food Security Phase Classification (IPC) estimated that around 4.4 million people were facing high levels of Acute Food Insecurity due to several risk factors amongst which drought was one of the main reason, increasing resource-based conflicts coupled with rising food commodity prices due to decreasing crop production.<sup>32</sup>

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30 See Wikipedia: [https://en.wikipedia.org/wiki/2020%E2%80%932023\\_Horn\\_of\\_Africa\\_drought](https://en.wikipedia.org/wiki/2020%E2%80%932023_Horn_of_Africa_drought) Extracted 22 September 2023

31 See UN Office for the Coordination of Humanitarian Affairs (OCHA), ReliefWeb: <https://reliefweb.int/report/ethiopia/horn-africa-drought-regional-humanitarian-overview-call-action-published-4-july-2022> Extracted 22 September 2023

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32 OCHA. Available at <https://reliefweb.int/disaster/dr-2014-000131-ken>

## 4 Food systems emissions

### 4.1 Economy wide emissions

Kenya's share of global emissions is extremely low and remained relatively stable between 2010 and 2020 for all sectors with LULUCF (around 0.18%, see Table 9), and absolute level of emissions remained stable as well, at around 88 MtCO<sub>2</sub>eq (-1.1% between 2010 and 2020). However, the share of total emissions without LULUCF slightly increased, representing, respectively in 2010 and 2020, 0.16% and 0.19% of the world's emissions. According to FAOSTAT,

total emissions without LULUCF increased by 29.5%. These FAOSTAT figures suggest that the LULUCF sector has become an important carbon sink and contributes to balance the increased emissions from other sectors.

Kenya's updated NDC in 2020 reports national annual emissions from five sectors in 2015 to be 93.7 MtCO<sub>2</sub>eq (Table 10), an increase of 65% since 1995 (where emissions stood at 56.9 MtCO<sub>2</sub>eq). The values are approximately consistent with those of FAOSTAT. Agriculture

**Table 9. Kenya's FAOSTAT Emissions Totals**

Indicator	2010		2020	
	Kenya	World	Kenya	World
Total GHG emissions (MtCO <sub>2</sub> eq) – all sectors with LULUCF	89	48,738	88	52,011
Total GHG emissions (MtCO <sub>2</sub> eq) – all sectors without LULUCF	74	47,099	95	50,617

Source: <https://www.fao.org/faostat/en/#data/GT>. Extracted on 17 March 2023

**Table 10. Emissions by IPCC sector for 2015 from Kenya's updated NDC, and for 2010 and 2020 from FAOSTAT**

Sector (MtCO <sub>2</sub> eq)	NDC* 2015	FAOSTAT 2010	FAOSTAT 2020
Agriculture	37.5	42.5	54.6
LULUCF	35.6	15.2	-7.6
Energy	16.9	21.9	27.7
Industrial Processes and Product Use (IPPU)	2.8	1.8	3.3
Waste	0.9	6.9	9.1
Other	-	0.5	0.7
<b>Total</b>	<b>93.7</b>	<b>88.8</b>	<b>87.8</b>

Note: \*The sectoral values for the NDC were re-calculated using the total emissions and sectoral percentages given in the NDC

Source: Kenya's updated NDC (Ministry of Environment and Forestry 2020b) and FAOSTAT data available at <https://www.fao.org/faostat/en/#data/GT> (extracted on 20 March 2023).

**Table 11. Kenya's FAOSTAT total emission per capita**

Indicator	2010		2020	
	Kenya	World	Kenya	World
CO <sub>2</sub> emissions per capita (with LULUCF) (tCO <sub>2</sub> eq per capita)	2.1	7.0	1.7	6.6
CO <sub>2</sub> emissions per capita (without LULUCF) (tCO <sub>2</sub> eq per capita)	1.8	6.7	1.8	6.5

Source: FAOSTAT. Available at <https://www.fao.org/faostat/en/#data/GT>. (Extracted on 17 March 2023)

**Table 12. Food system GHG emissions in Kenya**

Indicator	2010		2020	
	Kenya	World	Kenya	World
Food system GHG emissions 2020 (MtCO <sub>2</sub> eq)	65.3	15,921	63.3	16,138
Share of food system GHG emissions in total national emissions (%)	73.5	32.7	72.0	31.0

Source: FAOSTAT. Available at <https://www.fao.org/faostat/en/#data/GT> ( Extracted on 27 January 2023)

accounted for the largest share of GHG emissions in 2015 with 37.5 MtCO<sub>2</sub>eq, followed by the LULUCF sector with 35.6 MtCO<sub>2</sub>eq and the energy sector with 16.9 MtCO<sub>2</sub>eq. In both datasets, agriculture is the largest emitting sector. FAOSTAT data show a 29% increase of agricultural emissions from 2010 to 2020.

However, while FAOSTAT figures present the LULUCF sector as a sink, absorbing 7.6MtCO<sub>2</sub>eq in 2020, according to the NDC (Ministry of Environment and Forestry 2020b) the sector was actually contributing to emissions. It is unclear for which reasons Kenya ignores the LULUCF sink in the NDC.

Finally, according to FAOSTAT, energy was the second largest contributor to national emissions in 2020, with emissions in 2020 25% over those in 2010. IPPU emissions were rather negligible in any year, but are on the rise, not surprising given Kenya's economic development (cf. section 2). IPPU would contain part of the Kenyan food processing industry, but that share cannot currently be disaggregated. Waste seems to be on the rise when one looks at FAOSTAT data alone, but the discrepancy to the NDC data suggests data gaps or inconsistencies that need to be investigated.

Emissions per capita in Kenya are much lower than the world average (Table 11). In 2020, GHG emissions per capita without LULUCF were around a quarter of the world average

(28.4%). Kenya's emissions per capita considerably decreased: when accounting for all sectors including LULUCF, emissions decreased by 21% in ten years, whereas emissions per capita without LULUCF slightly increased (+3.4%).

## 4.2 Food system emissions in Kenya

GHG emissions from the food system<sup>33</sup> in Kenya were 65.3MtCO<sub>2</sub>eq in 2010 and slightly fell to 63.3 MtCO<sub>2</sub>eq in 2020 (Table 12). Total national emissions also decreased by 3.2% during the same period. Food system emissions account for a very important part of total national emissions in Kenya (73.5 to 72%), a share much higher than the world's average of 31% (Babiker et al. 2022).

In 2020, food system emissions per capita in Kenya represented 1.2 tCO<sub>2</sub>eq per capita, or 69% of the world average. They decreased by only 3.2% between 2010 and 2020, while the world average decreased by 9.7% during the same period (Table 13).

Kenya's Second National Communication (National Environment Management Authority 2015), the latest one available, does not disaggregate emissions related to food systems. However, it highlights that food security is a critical issue to consider when integrating climate

<sup>33</sup> FAOSTAT uses the term 'agrifood emissions', but we have adopted 'food system' across this paper

**Table 13. Kenya's Food system emissions per capita**

Indicator	2010		2020	
	Kenya	World	Kenya	World
Food system emissions per capita (tCO <sub>2</sub> eq per capita)	1.6	2.3	1.2	2.1

Source: FAOSTAT. Available at <https://www.fao.org/faostat/en/#data/GT> and <https://www.fao.org/faostat/en/#data/OA> Extracted on 27 January 2023 and 17 March 2023

**Table 14. GHG emissions from the food system in Kenya**

Sources of GHG emissions	2010 GHG emissions 2020 (MtCO <sub>2</sub> eq)	2020 GHG emissions 2020 (MtCO <sub>2</sub> eq)	Percent of total emissions (2020)	Percent change 2010-2020
<b>Food system (= 1 + 2 + 3)</b>	<b>65.3</b>	<b>63.3</b>	<b>100</b>	<b>-3</b>
<b>1. Land use change</b>	<b>15</b>	<b>0</b>	<b>0</b>	<b>-100</b>
Fires in humid tropical forests	0	0	0	80
Fires in organic soils	0	0	0	
Net forest conversion	15	0	0	-100
<b>2. Farmgate</b>	<b>43.1</b>	<b>55.0</b>	<b>87</b>	<b>28</b>
Burning - crop residues	0.2	0.2	0	9
Crop residues	0.3	0.4	1	17
Drained organic soils	0.2	0.2	0	-4
Drained organic soils (CO <sub>2</sub> )	0.2	0.2	0	-5
Drained organic soils (N <sub>2</sub> O)	0	0	0	-4
Enteric fermentation	27.9	35.6	56	27
Manure applied to soils	0.3	0.4	1	26
Manure left on pasture	12.1	15.2	24	26
Manure management	1.1	1.4	2	33
On-farm energy use	0.4	0.3	0	-29
Rice cultivation	0	0.1	0	38
Savanna fires	0.1	0.3	1	221
Synthetic fertilizers	0.4	1.0	2	133
<b>3. Pre- and post-production</b>	<b>7.3</b>	<b>8.2</b>	<b>13</b>	<b>12</b>
Fertilizers manufacturing			0	
Food household consumption	0.3	0.5	1	49
Food packaging	0.1	0	0	-77
Food processing	0.1	0	0	-52
Food retail	0	0.1	0	29
Food systems waste disposal	6.2	6.8	11	11
Food transport	0.6	0.7	1	29
On-farm electricity use	0	0	0	54

Note the units (MtCO<sub>2</sub>eq)

Source: FAOSTAT: <https://www.fao.org/faostat/en/#data/GT> (extracted on 20 March 2023). Food system corresponds to FAOSTAT's term "agrifood system".

change into Kenyan policies and strategies. The combined effect of rapid population growth and an expected decline in food production due to climate change is reckoned to increase food insecurity. Over-dependence on rain-fed agriculture (98% of Kenya's agriculture is rain-fed) is identified in the National Communication as a challenge that needs to be addressed to ensure food security.

Table 14 splits food systems emissions into three main categories: land use change, farmgate,<sup>34</sup> and pre-and post-production emissions. Farmgate emissions are by far the largest, accounting for 87% of total food systems emissions. Farmgate emissions were 55.1 MtCO<sub>2</sub>eq in 2020, ca. 28% higher than in 2010, due increased emissions from enteric fermentation, manure left on pasture and synthetic fertilizers. Enteric fermentation<sup>35</sup> is the main source of GHG emission from farmgate activities but also from the whole food system, followed by manure left on pasture. Altogether, these two activities (enteric fermentation and manure left on pasture) are responsible for 92% of farmgate emissions and 80% of the total food system emissions in 2020. Emissions from enteric fermentation increased by 27% between 2010 and 2020. Emissions related to manure management (the three categories taken together: manure applied to soils, manure left of pasture, manure management)<sup>36</sup> increased by 27% in the same period, amounting all together to 17.1MtCO<sub>2</sub>eq in 2020.

Pre- and post-production activities account for 13% of food system emissions and emitted 8.2MtCO<sub>2</sub>eq in 2020. Emissions from food system waste disposal represent 83% of all emissions beyond farmgate, from pre- and post-production activities and 11% of total food systems emissions. They increased by 11% between 2010 and 2020.

34 'Farmgate emissions' are those GHG emissions produced directly from agricultural activities at the farm level. This includes emissions from livestock, manure management, fertilizer use, and fuel combustion in agricultural machinery. 'Emissions beyond farmgate' denotes all food system related emissions, from pre- and post-production activities which do not occur within the boundaries of the farm, in the various stages of the agricultural value chain, such as transportation, processing, packaging, and distribution of food products, or emissions from the manufacturing and use of agricultural inputs such as seeds, fertilizers and pesticides.

35 A livestock digestive process in ruminants which also releases methane as a by-product.

36 Manure management is the process in which animal excretion is captured, stored, treated or used.

Thus, the largest emissions from the food system are, by decreasing order of size, emissions from enteric fermentation (56%), emissions from manure left on pasture (24%), and food system waste disposal (11%). Altogether, these three categories account for 91% of total food systems emissions in Kenya. Food system waste disposal excludes food losses, and therefore further data collection is needed in this area.

The pre- and post-production sectors' emissions are – with the exception of food waste and household consumption – very small and their relative changes from 2010 to 2020 may be due more to data errors than actual changes – and therefore also here, more data needs to be collected for these sectors to be represented properly.

### 4.3 Food Loss and Waste

FAO considers emissions from food waste disposal (Table 14), which does not include food loss (Karl and Tubiello 2021).<sup>37</sup> However, FLW is a more inclusive category referring both to the decrease in quantities at production, processing and distribution stages (food loss) and the decrease in quantities at retail and consumption stages (food waste) (Axmann et al. 2022).

Globally, 31% of food is lost or wasted.<sup>38</sup> Consensus is growing that the world produces enough food for everybody, and that eliminating hunger and malnutrition is more a problem of fair distribution than one of sufficient food production. Therefore, halving FLW as suggested under Sustainable Development Goals (SDG) 12.3 would make a critical contribution to food security and nutrition while reducing the food system emissions overall.

Using a bottom-up mass flow model developed by Guo et al. (2020), the University of Wageningen considered the main FLW hotspots across food value chains at country level in terms of FLW associated GHG emissions and nutrient loss (Figure 1; Axmann et al. 2022). Vegetables;

37 More precisely, FAOSTAT methodology covers four categories of food systems waste disposal: (1) solid food waste disposed in landfills; (2) domestic wastewater; (3) industrial wastewater; and (4) incineration of materials used in food systems (Karl and Tubiello 2021).

38 Ca. 14% of food produced is lost between harvest and retail, and 17% of is wasted (11% in households, 5% in the food service and 2% in retail). See: <https://www.un.org/en/observances/end-food-waste-day> (accessed 19 March 2023)



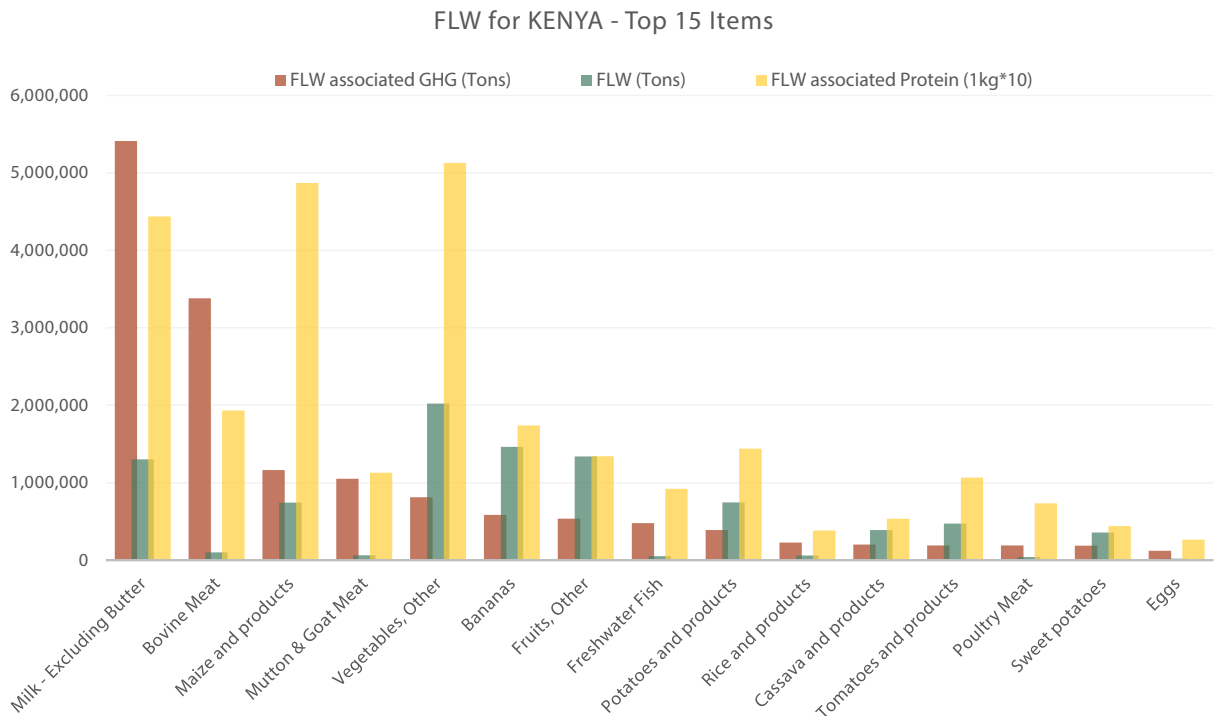
fruit and banana; and milk are the main FLW categories in terms of and lost food (green bars) in Kenya.

However, if ranked by their GHG emissions, the four main FLW hotspots (brown bars) are milk and dairy products (5.4 MtCO<sub>2</sub>eq); bovine meat (3.3 MtCO<sub>2</sub>eq); maize; and mutton and goats (the associated emissions reaching over 1 MtCO<sub>2</sub>eq). Together, these four main FLW hotspots account for emissions of approximately 10.8 Mt CO<sub>2</sub>eq. Including all products, beyond those four hotspots, actual total FLW emissions in Kenya using the methodology of Guo et al. (2020) are likely to be higher, which would suggest that a stronger role for FLW emission reduction might sensibly contribute the overall mitigation effort of Kenya.

There are claims that actual FLW in developing countries could potentially be lower than this, due to opportunities for capturing and re-utilizing lost and wasted food in the informal economy. However, there is a lack of data to confirm this.

It becomes evident that a lack of data is significantly impeding a comprehensive understanding of FLW GHG emissions. Without knowing which products and which parts of their production chain must be predominantly addressed, interventions cannot be targeted and efficient. The collection of primary FLW data in key value chains is essential to direct the formation of FLW interventions tailored to these chains.

Were such data to become available, they can help identify potential interventions to reduce loss and waste that would directly reduce the emissions of food supply chains. These interventions may include hardware solutions such as improved packaging and cooling systems, organizational solutions such as better arrangements in supply chains (so-called orgware in industry jargon),<sup>39</sup> and software solutions such as improved knowledge and information sharing. Additionally, comparison of supply chains for similar product categories can help identify best practices that can be adopted to improve the efficiency of supply chains (Axmann et al. 2022).



**Figure 1. Top 15 hotspot categories of food loss and waste in Kenya, ranked on FLW-associated GHG emissions (in tCO<sub>2</sub>eq/year), loss and waste volumes, and loss of protein**

Note: Protein losses are depicted by 100 kg to make the values visible and comparable; FLW total values are in metric tons (figure taken from Axmann et al. (2022) – Initial release of an evolving dataset, subject to ongoing elaboration and updates).

39 The “systems set of organizational, economical, legislative and managerial arrangements” (Dobrov 1979).

# 5 Kenya's Nationally Determined Contribution (NDC)

Kenya submitted its Nationally Determined Contribution (NDC) in December 2016 and updated it in December 2020 (Ministry of Environment and Forestry 2020b). However, the underlying data are presented in the Second National Communication (National Environment Management Authority 2015). This latter document is briefly analysed in the following sections.

## 5.1 Business-As-Usual (BAU) Scenario

The business-as-usual (BAU) scenario forms the baseline against which the mitigation potential is calculated for each sector. Kenya disaggregated its emissions for the BAU scenario based on a national inventory of historical GHG emissions over 2000–2010 (Figure 2). Emissions were then projected till 2030, reaching 138 MtCO<sub>2</sub>eq and increasing in all sectors except LULUCF.

## 5.2 Emissions reduction target

Kenya's updated NDC commits to reduce GHG emissions by 32% until 2030 relative to the Business-as-Usual (BAU) scenario of 143 MtCO<sub>2</sub>eq.<sup>40</sup> The total cost of implementing mitigation and adaptation measures is estimated at USD 62 million (of which 13.2% are expected to come from domestic funding sources). Mitigation costs are estimated at USD 17.7 million, and Kenya intends to bear 21% of these. This updated NDC covers the period 2021–2030 with milestones targets in 2025.

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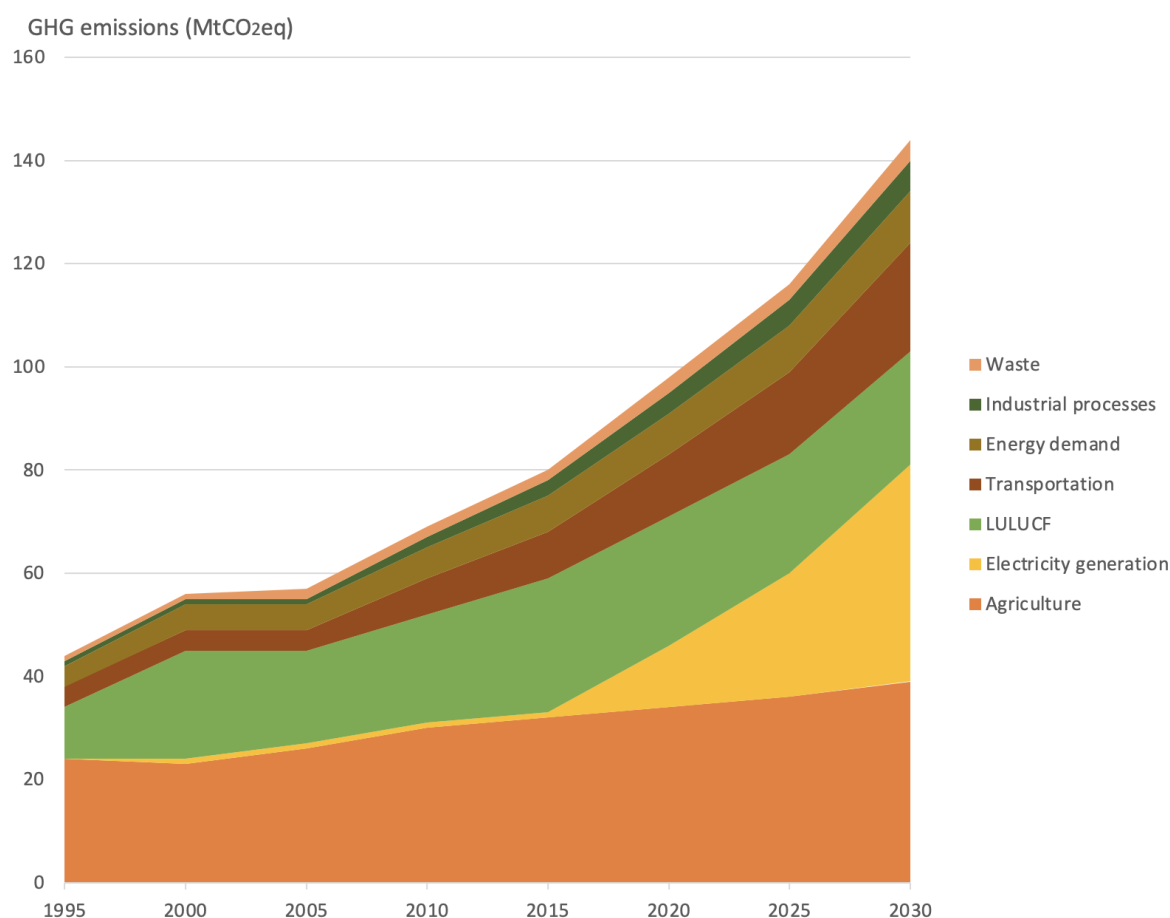
<sup>40</sup> The BAU scenarios given in the NDC and in the NCCAP (cf. section 5.3) for 2030 differ slightly from the Second National Communication, with total emissions in 2030 now reaching 143 MtCO<sub>2</sub>eq instead of the 138 MtCO<sub>2</sub>eq in the Second National Communication referred to in Section 5.1. This is due to an increase in projected emissions in the forestry (from 20 to 22 MtCO<sub>2</sub>eq) and transportation sectors (from 17 to 21 MtCO<sub>2</sub>eq).

The Kenyan government adopted the Climate Change Act 2016 (Government of Kenya 2016) which provides a framework for climate-resilient, low-carbon economic development. This act mandates the government to develop a National Climate Change Action Plan (NCCAP) (Government of Kenya 2018) and update it every five years to implement Kenya's NDC through the definition of sectoral priority mitigation targets and actions. The current NCCAP was launched on September 4th, 2023 and covers the period 2023–2027. It is the third 5-year nationwide sectoral plan to guide Kenya's climate change actions (the first NCCAP covered 2013–2017 and the second 2018–2022) and it aligns national plans with the country's Medium-Term Plan development cycle and updated NDC targets. The Climate Change Amendment Bill, signed in August 2023, amends the Act by adding “guidance and policy direction on carbon markets to the national and county governments, the public and other stakeholders”.<sup>41</sup>

To achieve its NDC target, Kenya must reduce its GHG economy-wide emissions by 42.9 MtCO<sub>2</sub>eq relative to the BAU scenario by 2030 (30% reduction). An NDC analysis for Kenya (Umweltbundesamt 2018) examined what was realistically doable in each of three sectors (reforestation, afforestation and decreasing deforestation; efficient biomass and renewable energy cookstoves; and accelerating renewable electricity), which are fully or partially related to the food sector. The first one would have “a technical emissions reduction potential of over 40 MtCO<sub>2</sub>eq in 2030, including carbon sinks from growing forests” (Umweltbundesamt 2018); renewable electricity, 16 MtCO<sub>2</sub>eq, and biomass and cookstoves, 5.6 MtCO<sub>2</sub>eq, but it is difficult to separate the food- from the non-food sector

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<sup>41</sup> Parliament of Kenya. Available at <http://www.parliament.go.ke/sites/default/files/2023-08/THE%20CLIMATE%20CHANGE%20%28AMENDMENT%29%20BILL%2C%202023.pdf>



**Figure 2. GHG emissions in the BAU scenario of the updated NDC for Kenya**

Source: Own graph based on data in National Environment Management Authority (2015: page 13)

emissions in these data. Also, these technical emission reduction potentials can only be met, in the case of the forestry targets, to ca. 25-50% in low- to high-emission reduction scenarios (Umweltbundesamt 2018). The Umweltbundesamt (2018) report discusses the forestry emission reduction options in great detail.

### 5.3 Documents supporting NDC implementation related to food systems

The following national documents support the planning and reporting on activities towards implementing the NDC in Kenya:

- Third Medium Term Plan 2018-2022 (Republic of Kenya 2016)
- Kenya National Adaptation Plan 2015-2030 (Ministry of Environment and Natural Resources 2016)
- Second National Climate Change Action Plan (NCCAP 2018-2022) (Government of Kenya 2018)
- Third National Inventory Report

The sectoral policies to support the implementation of climate change adaptation and mitigation actions related to food systems are the following:

- Climate Risk Management framework
- National Livestock Policy 2015
- National Oceans and Fisheries Policy 2008
- Agricultural Sector transformation and Growth Strategy
- Kenya's Climate Smart Agriculture (CSA) Strategy (2017-2028)
- Kenya Climate Smart Agriculture Implementation Framework (2018-2027)
- Reducing Emission from Deforestation and Forest Degradation (REDD+)
- Water Act
- Forest Conservation and Management Act (No. 34 of 2016)

The Climate Smart Agriculture Strategy (Ministry of Agriculture, Livestock and Fisheries 2017) formulates the goal to reduce agricultural emissions to 32.2MtCO<sub>2</sub>eq in 2026, compared to 39.8MtCO<sub>2</sub>eq in the BAU scenario and describes actions to reach this goal.

The strategy includes three strategic goals:

1. **Minimize emissions from key sources** in agricultural production systems. The key sources identified in the CSA are:
  - In the crops sub-sector:
    - **paddy rice production system**, with poor management of rice straw in flooded paddy rice production system, application of rice straw to paddy fields and burning of rice residues
  - In the livestock sector:
    - **enteric fermentation** (low-quality and low-digestibility of ruminant feeds, poor animal health and husbandry and limited intensification of livestock management system) and **manure management** (low adoption of recommended measures to address emissions related to housing, manure collection, storage system and utilization)
2. **Minimize emissions from other sources** in agricultural production systems. Other sources identified are:
  - In the crops sub-sector:
    - inappropriate tillage, burning of agricultural residues, clearing of trees in farmlands and inappropriate use of fertilizers, as well as emissions from agricultural machinery, post-harvest practices, agro-processing and residue management.
  - In the livestock sector:
    - overstocking, overgrazing and burning of pastures in rangelands.
  - In the fishery sector:
    - use of fossil fuel and inefficient engines, long fishing hours, transportation, storage and processing of fish, as well as aquaculture and the establishment of fish ponds. Upstream land degradation and fishing of depleted fish stocks are also important factors leading to an increase in fuel use per kilogram of landed fish.
  - In the forestry sector:
    - a lack of effective incentive mechanisms to motivate REDD+<sup>42</sup> in farming systems limits the potential for carbon absorption.
3. Adequate **MRV System** in the agriculture sector

A set of 18 actions corresponding to these strategic goals is presented in the NCCAP. These actions include:

- The development and use of low-emissions technologies to manage livestock feed and manure;
- The formulation of improved feeds and feed additives to reduce emission intensities from enteric fermentation;
- The development of breeding schemes and improvement of herd health to enhance efficiency in production;
- The development of programs for improving efficiency in irrigated rice production systems;
- The production of rainfed rice;
- The development of agroforestry/farm forestry and the adoption of practices such as conservation agriculture with trees, forest conservation, sustainable management of forests and enhancement of carbon stocks, including in rangelands;
- Nationally Appropriate Mitigation Actions (NAMAs) to mainstream Sustainable Land Management for livestock, cropland, rangeland and agroforestry;
- The prevention of fire in rangeland and cropland;
- The reduction of emissions associated with processing and transportation of agricultural inputs and products;
- The promotion of fuel efficiency or green energy along the agricultural value chain.

Hence, Kenya is addressing the largest GHG-emitting activities from the food system, notably emissions from enteric fermentation and manure management. Through its Climate-Smart Agriculture Strategy and its NAMAs, it also addresses land-use related emissions and stresses the importance of sustainable land management. However, data issues may hinder deeper analysis of additional measures, e.g., a more nuanced evaluation of the opportunities for emission reduction linked to FLW in Kenya.

Climate mitigation was not prioritised in former President Uhuru Kenyatta's Big Four Agenda, which included universal healthcare, housing, food security and manufacturing, nor in the country's Vision 2030. However, President William Ruto elected in September 2022 has placed climate change mitigation and adaptation at the top of his development agenda. He has announced a

42 REDD+ = UNFCCC Framework to reducing emissions from deforestation and forest degradation, plus conservation, enhancement of forest carbon stocks and sustainable management of forests

reforestation program to grow at least 15 billion trees and reach 30% tree cover by 2032 in Kenya. He pledged for securing and protecting public forests. Climate Action Tracker (CAT)<sup>43</sup> estimates that Kenya's policies and action are "1.5°C compatible", with the forestry and waste sectors on track to meet their 2030 sectoral emissions reduction targets (respectively 91.4% reduction and 7.7% below BAU by 2030). However, it

estimates that the priority mitigation actions for energy demand and industrial processes sectors are insufficient to comply with their 2030 targets. Even though the NDC 2030 target itself is considered as "1.5°C compatible" when compared with its fair-share contribution to climate action, the *CAT* gives the overall rating of "almost sufficient",<sup>44</sup> as "*there is still significant potential for Kenya to strive for further emissions reductions in all sectors*".

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43 See <https://climateactiontracker.org/countries/kenya/> updated in May 2022. Accessed on 14 July 2023

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44 See <https://climateactiontracker.org/methodology/> for more information on the methodology used

## 6 Conclusions

This country profile aims to provide an overview of Kenya's land use, agriculture, and diets in order to analyze GHG emissions of the country's food system and identify potential strategies for reducing these emissions. The analysis is primarily based on data from FAOSTAT and other publicly available global databases. This section presents an initial synthesis of the findings, which will be further expanded and explored in the future by the Mitigate+ project. The narrative is organized around key facts and their corresponding messages, outlining the main priorities for climate action in the coming years.

The main land-use in Kenya is permanent rangeland, which covers 77% of all agricultural land and 37% of total land area. Animal products accounted for a third of Kenya's agricultural gross production value in 2020.

Kenya's consumption of animal products is less than half the world average in terms of absolute food supply (in kcal per capita per day), and below the world average in terms of their share in food supply per capita (about 10% in Kenya against almost 18% for the world average). The share of protein and fat intake from animal products is very low (respectively 29% and 22%) compared to the world average (43% and 40%). This lends some credibility to Kenya's intentions to increase meat and dairy production to enhance national food security and nutrition.

The three primary sources of emissions in Kenya's food system, ranked in decreasing order of importance, are:

1. enteric fermentation, accounting for 56% of total food system emissions;
2. manure left on pasture contributing to 24% of total food system emissions; and

3. food system waste disposal, responsible for 11% of emissions. Mitigation strategies in Kenya's food system should prioritize reducing emissions from these sources.

Two livestock related activities taken together (enteric fermentation and manure left on pasture), account for by far the largest share of farmgate emissions, representing 80% of the total food systems emissions. Mitigation actions in the livestock sector are thus very important due to the major share of livestock emissions in Kenya's food system emissions, providing multiple benefits, as they would also result in adaptation benefits and increased productivity. In fact, through two Nationally Appropriate Mitigation Action (NAMA) for the dairy sub-sector and for solid waste management, Kenya supported important efforts to measure GHG emissions in these sectors and implement adequate mitigation actions (Government of Kenya 2018).

Beyond-farmgate emissions represent a significant and growing share (13%) of total food system emissions. Within this sector, food system waste disposal is by far the main source of emission (11% of total food system emissions). This indicates that food loss and waste management should become a priority action for emissions mitigation in Kenya's food systems.

A comprehensive and integrated approach to reducing GHG emissions, encompassing the entire food supply chain from production to disposal, can be integrated across sectors to ensure the efficient and effective implementation of Kenya's Nationally Determined Contribution (NDC).

The main priorities for actions, identified in this analysis, are consistent with the priorities highlighted in national strategies briefly presented in Section 5:

1. Promotion of low-emission livestock management through reduced emission intensities from enteric fermentation, improved livestock feed and manure management;
2. Promotion of improved energy efficiency and minimized food loss along food value chains, minimizing food waste in retail and consumer households, and enhancing value chain integration, such as biomass management.
3. Kenya should also continue reducing emissions from deforestation and forest degradation, and build and preserve forest carbon stocks as an insurance against further global warming, as well as a resource important to support livelihoods.

While FLW-related emissions are not the largest by size, they may offer pathways to relatively accessible, straightforward and low-cost climate action towards drawing down emissions quickly and efficiently. There is a potential field for improvement that may represent accessible, viable, cost-efficient and effective emission reduction actions across food supply chains. These improvements can be implemented in relatively straightforward ways, and bring down overall emissions while the more economically, politically and socially more complex problems around deforestation and unsustainable cattle farming are being discussed and progressively addressed. Effective climate action planning should not only consider the size of sectoral emissions but also consider the cost and feasibility (referred to as ‘political economy’) of implementing transformative measures.

Technological but also institutional and organizational innovations will have to play a central role in this perspective. Political, institutional and financial stumbling blocks will have to be removed.

A significant obstacle that hampers progress in pursuing these mitigation pathways is the substantial data gap that exists. A considerable number of sectoral emissions have yet to be adequately quantified. The data available in FAOSTAT relies on national reporting, and there may be limited quantitative primary data on FLW, especially in countries lacking the capacity to comprehensively collect such information (Heike Axmann, personal communication 2023). Therefore, it is essential to prioritize greater transparency regarding the methodologies employed and to make increased efforts towards direct data collection. This is crucial for effectively preparing and designing climate action strategies based on reliable evidence.

This presents a wide-ranging opportunity for collaborative, participatory action and evidence-based policy development, although there is still a considerable amount of data and information that needs to be generated. Within the framework of the Mitigate+ project, these comprehensive action priorities will be further examined in close collaboration with all sectors of society, and in cooperation with our national partners in Kenya. This country profile serves as the initial step in identifying current opportunities.

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The global food system accounts for 23 – 42% of total net anthropogenic greenhouse gas (GHG) emissions. This share is expected to increase. Therefore, rapid and effective transformations are required in food systems to achieve the Paris Agreement targets. The Initiative on Low-Emissions Food Systems (Mitigate+) aims to offer a comprehensive and evidence-based view of national land use, agricultural production, diet, and food system emissions in various countries (China, Colombia, Kenya and Viet Nam) and explore possible pathways that reduce emissions while enhancing food security, nutrition, livelihoods and preserving the environment in these countries. This document focuses on Kenya.

Kenya's food system emissions remained stable in absolute level over the past decade (2010-2020) at around 63 MtCO<sub>2</sub>eq. Building a large forest-related carbon sink has contributed in curbing emissions significantly between 2010 and 2020. So far, the largest sources of emission in Kenya's food system are enteric fermentation (56% of total emissions), manure left on pasture (24%), and food waste disposal (11%). Altogether, these three categories account for 91% of all food system emissions.

This document highlights various priorities for action based on size of the emissions but also viability of the mitigation action. Effective climate action should not only consider the size of sectoral emissions, but also the cost and feasibility of implementing transformative measures. We therefore recommend as priority interventions: (i) reducing emission intensities from enteric fermentation and improve the management of livestock feed and manure on pastures; (ii) encouraging climate-resilient food waste management.

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