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A country profile

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Photo by Kate Evans/CIFOR
Cattle farming, a major driver of deforestation in Brazil.

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Table of contents

List of box, figures and tables

Box

Figures

Tables

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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. Without rapid and radical transformation of food systems, Paris Agreement targets will remain out of reach. This document is a first brief attempt to describe the food system in Colombia in the context of land use, agricultural production, national food supply, diets and food system emissions. It describes the emissions in Colombia's food systems based on data available at FAO, and identifies possible pathways for Colombia to address emission reductions and achieve low-emissions development, by taking a food systems view.

Following IPCC guidelines, data on GHG emissions are generally collected and analysed sectorally, distinguishing four economic sectors, i.e., (i) energy; (ii) industrial processes and product use (IPPU); (iii) agriculture, forestry, and other land use (AFOLU); and (iv) waste. There is therefore an unfortunate lack of comprehensive data on food system emissions that span across these four sectors to describe the food system in Colombia as a whole.

Over the past decade (2010–2020), food system emissions in Colombia have remained stable at around 180 $MtCO_2eq$ per year. Although their relative importance has decreased since 2010 following broader economy-wide development, in 2020 food systems emissions still represented 62.3% of total national emissions. This share is considerably higher than the global average of 31%.

The main emission sources in Colombia's food system can be ranked in terms of their quantitative importance. The primary contributors to emissions are: (i) net forest conversion, which accounts for 45% of total food system emissions; (ii) livestock management, including enteric fermentation and manure management, contributing 35% of emissions; and (iii) food system waste disposal, responsible for 6% of emissions. Together, these three categories make up 86% of all food system emissions. Mitigation strategies in Colombia's food system should prioritize reducing emissions from these sources.

To effectively plan for climate action, it is important to consider not just the size of emissions from each sector, but also the cost and feasibility of implementing low-emission strategies (referred to as the 'political economy'). Taking this into consideration, climate action should also include smaller sources of emissions that can be tackled more efficiently and quickly, with less opposition from adverse forces. By addressing these smaller sources, Colombia can achieve some 'quick wins' to make significant progress in reducing its overall emissions.

For example, beyond-farmgate emissions are not the largest emission source in Colombia, but they represent a significant (13%) and growing share of total food system emissions. Effective measures to reduce beyond-farmgate emissions in Colombia include improving energy efficiency and minimizing food waste across food value chains, reducing waste in consumer households, and enhancing value chain integration, including biomass management.

This country profile therefore emphasizes three key areas for action, aligning with the national priorities outlined in the latest Nationally Determined Contributions (NDC):

1. *Decreased deforestation*: It is crucial to prioritize efforts aimed at reducing the rate

of deforestation. This involves implementing measures and strategies to preserve and protect forests, safeguarding their invaluable ecological benefits.
2. *Sustainable cattle farming:* Supporting sustainable practices in cattle farming to reduce emissions from enteric fermentation and manure management includes implementing improved livestock management techniques, optimizing pasture management approaches, and adopting effective manure management practices to minimize environmental impacts.
3. *Minimize food loss and waste, while enhancing energy and resource efficiency across food value chains:* Efforts should focus on reducing waste across the entire food value chain, from production to consumption. Better data on food waste and losses along the value chain, together with priority setting as identified by stakeholders, would help identify priority areas for action. It is also crucial to improve energy and resource utilization efficiency in food production and distribution processes.

This more comprehensive and integrated approach to reducing GHG emissions, encompassing the entire food supply chain from production to disposal, can be integrated across sectors to support and invigorate the efficient and effective implementation of Colombia's Nationally Determined Contribution (NDC), so the country can make significant strides towards a more sustainable and resilient future.

In addition, data collection needs are evident: More reliable data is needed in particular in three areas: on all food sector emissions, to quantify sources and identify opportunities for low-emission development; on a breakdown of nutrition needs by vulnerable segments of the population, to address a controversy around meat production vs. nutritional needs with better data at hand; and on food loss and waste, to truly quantify those emissions as a basis for more immediate interventions. It is crucial to develop data sets enabling us to understand the economic and social costs of each climate action, and thus identify important barriers to implementation. While reducing emissions from the largest emitting sectors, such as deforestation and enteric fermentation, remains of central importance, exploring opportunities beyond size may enable faster progress in reducing emissions from Colombia's food systems, thus facilitating an effective delivery of mitigation actions.

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

'Mitigate+', an initiative launched under 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 countries where – 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.

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 Food systems and their global 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[1]. It encompasses all aspects of food production and consumption; from the supply of farming inputs like fertilizers, seeds and machinery; to the growing and harvesting of crops and livestock; 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.

Annually, the global food system moves USD 7–8 trillion (EcoNexus and Berne Declaration 2013; World Bank 2019) yet it also generates externalities amounting to USD 12 trillion annually (Nature 2019). Some of these externalities are worrying: 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); 34% of the world's fishery stocks are over-depleted (FAO 2020); and agriculture is an identified threat to 86% of species at risk of extinction (Benton et al. 2021).

1 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".

Importantly, the global food system also generates substantial greenhouse gas emissions. In 2018, according to the latest assessment by the Intergovernmental Panel on Climate Change (IPCC) (Babiker et al. 2022), the global food system was responsible for emissions of 17 $GtCO_2eq$ – that is 31% (accounting for a range of 23–42%) of the total global net anthropogenic emissions of 54 $GtCO_2eq$. Agriculture, consisting of crop and livestock production, accounts for the largest part of these emissions at 6.3 $GtCO_2eq$ per year, or 37% of food system emissions, and 12% of global emissions[2]. 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).

LULUCF emissions are as high as the emissions from energy use across 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).

2 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 greenhouse gas emissions and food system emissions overview

Sector	Subsectors	Emissions ($GtCO_2eq$/year)	Percent of total emissions	Percent of food system emissions	Range of global GHG emissions ($GtCO_2eq$/year) Low	Range of global GHG emissions ($GtCO_2eq$/year) High	Range of global GHG emissions (%) Low	Range of global GHG emissions (%) High
Total global emissions		54	100					
Food system		17	31.5	100	13	23	23	42
	Agriculture (livestock and crop production)	6.3	11.7	37.1	2.6	11.9	5	22
	Land Use, Land Use Change and Forestry (LULUCF)	4	7.4	23.5	2.1	5.9	4	11
	Energy use	3.9	7.2	22.9	3.6	4.4	7	8
	Waste management	1.7	3.1	10	0.9	2.6	2	5
	Industrial processes and product use (IPPU)	0.9	1.7	5.3	0.6	1.1	1	2
	Combined total of energy, waste and IPPU	6.5	12	38.2	5.1	8.1	9	15

Source: Babiker et al. (2022)

However, it is worth noting that when the last three subsectors (energy use, waste management and industrial use) are taken together – arguably a good representation of pre- and post-farm activities – their joint emissions amount to 6.5 $GtCO_2eq$ per year. This accounts for 12% of global emissions, on a par with agriculture, and over one third of food system emissions.

Within this, food loss and waste account for around 8–10% of global emissions, a significant amount, mainly from the production and disposal of wasted food (FAO 2015; Mbow et al. 2019). When food waste ends up in landfills, it also produces methane (CH_4), a potent greenhouse gas[3].

Reducing these emissions is critical to mitigating climate change. Collectively, global food system emissions – which account for 31% of overall global emissions – are on a par with the total GHG emissions of China (31% of global emissions in 2020), and well above total emissions from the United States (13.5%) (data from GCP 2021;[4] FAOSTAT). "Making the food system healthy for people and the planet" has been identified in a recent report for the Club of Rome (Dixson-Declève et al. 2022) as one of only five major "turnarounds"[5] urgently needed to put the planet on a trajectory towards prosperity for all, while keeping resource use within the planetary boundaries.

NDCs are usually structured around the four economic sectors identified in IPCC guidelines;[6] however, we are yet to see a comprehensive approach to addressing emissions from the food system that spans these four IPCC economic sectors. Therefore, analysis of food system emissions in diverse countries is complicated by lack of data on activities, missing specific emission factors, data overlap, a lack of overview across food system emissions as a whole, and a lack of systematic data collection across the system.

3 The global warming power of methane is 27 times higher than that of carbon dioxide over a 100-year horizon, according to IPCC AR6 (Nabuurs et al. 2022)

4 https://www.globalcarbonproject.org/carbonbudget/archive/2021/GCP_CarbonBudget_2021.pdf

5 The other turnarounds being poverty, equality, gender empowerment and energy.

6 These four sectors are energy; industrial processes and product use (IPPU); agriculture, forestry and other land use (AFOLU); and waste.

In negotiations at the United Nations Framework Convention on Climate Change (UNFCCC), some actors expressed concerns that addressing food system emissions could threaten food security and nutrition, particularly for the most vulnerable, poor, and hunger-stricken parts of populations. Given the large share of emissions from food systems, as well as the fact that climate change has started to affect all aspects of human life, including food production, this position should be reconsidered. Striving for more holistic, low-emission, resilient, fair, and sustainable food systems that provide food and nutrition to all, and livelihoods to many, is key to ensuring a more sustainable future for the planet and for the people and biota living on it. Such an approach will also help reconcile mitigation of and adaptation to climate change – two objectives often treated separately in climate talks, yet which are inherently interlinked.

While food systems form the basis of food security and nutrition as well as provide meaningful livelihoods and socioeconomic benefits, they remain 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, some knowledge gaps remain: reliable national data are missing in most countries on food system areas like food loss and waste; reliable indicators and MRV systems are missing; and our understanding of drivers of emissions and of complex systemic interactions and feedback loops is insufficient, which must be filled by further research at the global and national level. Effective approaches to prioritizing action are also lacking; these should focus on viable, cost-efficient actions that have multiple benefits.

To foster low-emission development in line with the Paris Agreement without compromising food security and nutrition and livelihoods, it is vital that the knowledge, information, and tools required for evidence-based decision making are available to civil society, 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).

The Low-Emissions Food Systems Initiative (also called 'Mitigate+'), conducted under the Consultative Group for International Agricultural Research (CGIAR), aims to reduce annual global food system emissions by 7% by 2030, working closely with key actors in the target countries to ensure they are equipped to make evidence-based decisions and address challenges in food systems discourse, policy development and implementation to reduce greenhouse gas emissions.

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

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

2 Colombia's national socioeconomic context

Colombia is one the world's "megadiverse" countries, hosting almost 10% of the Earth's biodiversity. It spans 1.1 million km^2 of land area and in 2020 had a population of 50.9 million people. Colombia's total population has increased by 17.5% since 2010 (when there were 45.2 M inhabitants).[7] The share of urban population has increased to over 80%, on par with the Latin American average. Colombia is already highly urbanized. Its five major municipalities Bogotá (7.4 million), Medellín (2.4 million), Cali (2.2 million), Barranquilla (1.2 million) and Cartagena (1.0 million) are home to 40% of the urban population.[8] With its major cities, the Andean region is the most developed area in Colombia. Urban areas in Colombia face significant challenges related to the rapid urban growth, including social inequality, unsustainable resource management, development, and security gaps.[9]

With a Gross Domestic Product (GDP) of USD 270.3 billion in 2020, Colombia is the third largest economy in Latin America after Brazil (which has a GDP of USD 1.5 trillion) and Mexico (USD 1.1 trillion), and the 44th largest economy in the world (World Bank). GDP per capita increased by 13.7% between 2010 and 2020, in constant 2015 USD[10], while GDP per capita in current USD[11] went down by 16.2%. This divergence is due to a large depreciation of the Colombian peso (COP), from less than COP 2,000 per USD in 2013, to more than 3,000 per USD in 2015. Per capita GDP in 2020 stood at USD 5,312 in current values.[12]

According to the Human Development Report (UNDP 2020), Colombia ranked 86th out of 189 countries, with a Human Development Index (HDI[13]) value of 0.767 in 2019. This represents an improvement from the previous year's HDI value of 0.761. While Colombia's HDI value is considered high, there are significant disparities in human development across different regions and population groups within the country. For example, Indigenous and Afro-Colombian communities tend to have lower levels of human development compared to the national average. The mean number of years of schooling for adults aged 25 years and older was 8.2 years in 2019, while the expected number of years of schooling for children was 14.1 years. The HDI report also highlights that Colombia has made significant progress in improving life expectancy, education, and income. In 2019, life expectancy at birth was 77.1 years.

7 For population data, see FAOSTAT Food Balance Sheets: https://www.fao.org/faostat/en/#data/FBS (accessed 19 May 2023)

8 See https://www.oecd-ilibrary.org/sites/10367354-en/index.html?itemId=/content/component/10367354-en

9 See https://unhabitat.org/sites/default/files/download-manager-files/Colombia%20Impact%20Stories%20LowRes.pdf

10 Data are in constant 2015 prices, expressed in U.S. dollars. Dollar figures for GDP are converted from domestic currencies using 2015 official exchange rates. See https://databank.worldbank.org/metadataglossary/world-development-indicators/series/NY.GDP.MKTP.KD

11 Per capita values for gross domestic product (GDP) expressed in current international dollars converted by purchasing power parity (PPP). https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD

12 World Bank data: https://databank.worldbank.org/source/world-development-indicators# (accessed 13 December 2022)

13 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). HDI value is comprised between 0 and 1. Maximum HDI value in 2019 was 0.957 for Norway; minimum HDI value in 2019 was 0.394 for Niger.

3 Land use, agriculture and diets

3.1 Land use

The main land use[14] in Colombia (Agricultural inputs) is natural forest ("naturally regenerating forest" in FAOSTAT terminology), which with around 59 million hectares (Mha) accounts for more than half (52.9%) of total land area. However, natural forest decreased by 2.7% between 2010 and 2020; and planted forest area is still relatively low, at 0.4 Mha, though slightly increasing.

Permanent rangeland ("permanent meadows and pastures" in FAOSTAT terminology) is the second main land use, with around 39.5 Mha, accounting for 35.6% of Colombia's land area and representing 82% of its agricultural land. This rangeland area has remained stable over the past ten years.

With 8.7 Mha, cropland occupies third position. It is more or less evenly divided between arable land for annual crops and permanent crops. The share of cropland in agricultural land is low (18%), but has seen rapid expansion in the past decade. Since 2010, arable land area almost tripled, possibly due to the peace-building process. Since the Peace Agreement of 2016, strong efforts have been made to promote the expansion of crops such as cocoa, beans, cassava and rice, as a means to reduce deforestation linked to conflicts over coca production.[15]

Table 2. Area by land use in hectares (ha)

Land use in Colombia	2010	2020
Total land area	**110,950,000**	**110,950,000**
Agricultural land	**42,503,000**	**48,243,000**
Cropland	3,353,000	8,739,000
Arable land	1,763,000	4,878,000
Permanent crops	1,590,000	3,861,000
Permanent meadows and pastures	39,150,000	39,504,000
Forest land	**60,808,000**	**59,142,000**
Naturally regenerating forest	60,426,000	58,715,000
Planted forest	381,000	427,000
Other land	**7,639,000**	**3,565,000**

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/RL (accessed 17 November 2022)

3.2 Agriculture

3.2.1 Agricultural inputs

In Colombia, the use of nitrogen and phosphate fertilizer on cropland is close to the world average (Table 3). Although nutrient use has continued to grow because of rapid cropland expansion, nitrogen and phosphate use per hectare of cropland in 2020 has reduced by half compared to 2010 levels. Potash levels decreased less severely, by 25.5%, yet agricultural use of this nutrient in Colombia remains about twice the world average. Oil palm, which is one of Colombia's main crops, is highly K-demanding. Farmers receive little technical training on how to apply fertilizers to avoid wastage. These two factors could explain the very high rate of potash application.).

3.2.2 Harvested area for major crops

In 2020, six main crops accounted for only 34.5% of cropland area, as opposed to the 80.6% of cropland area they covered in 2010 (Table 4).

14 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 intended use 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 (FAO/ITPS 2015).

15 https://ciat.cgiar.org/annual-report-2017-2018/boosting-agriculture-as-key-to-lasting-peace-in-colombia/

Table 3. Agricultural use of fertilizers in Colombia

Fertilizer use in agriculture	Colombia				World average
	2010		2020		2020
	Metric tons	kg/ha of cropland	Metric tons	kg/ha of cropland	kg/ha of cropland
Nitrogen N	404,440	120.6	529,909	60.6	72.5
Phosphate P_2O_5	198,056	59.1	257,028	29.4	30.8
Potash K_2O	239,272	71.36	464,516	53.2	25.1

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/RFN (accessed 20 January 2023).

Areas increased for the main four crops, the most dramatic increase being oil palm's (+175.1% in ten years). Maize and plantain banana areas decreased by 30.4% and 23.0%, respectively. This significant decrease in main crops' share in total cropland area is mainly due to the expansion of total cropland. Expansion of total cropland was driven by new crops, including rubber (of which there was no significant cultivated area in 2010; ten years after, it covered 35,818 ha) and the important increase in harvested area for diverse crops; in particular, vegetables and fruits like eggplants (+431.1%), chillies and pepper (+289.9%), avocados (+267.7%), pumpkins, squash and gourds (+247.0%) and lemons (+238.6%).

Smallholder farmers are mainly involved in the production of potato, maize, sugar cane, plantain, cassava, beans, tobacco, cocoa, coffee, vegetables, fruits, and other minor crops. Whereas commercial crops produced by large agribusinesses include sugar cane, banana, flowers, palm oil, rice, cotton, sorghum, and soybean (MADR 2013) .

3.2.3 Livestock

Milk is by far the largest animal-sourced food produced in Colombia. Milk production increased by 13% between 2010 and 2020 (Table 5). According to FAOSTAT, by decreasing order of production quantity, milk is followed by poultry meat, eggs, beef, pig, then sheep and goat meat. The stock of living cattle and buffaloes remained quite stable between 2010 and 2020, at around 28 million heads. However, over the same period, Colombian exports of bovine meat, practically non-existent in 2010, multiplied by 15, reaching 45,000 t in 2020, at the expense of national domestic supply.

3.2.4 Value of agricultural production

Colombian agriculture's gross production value – expressed in current USD – more than doubled (+111.6%) between 2010 and 2020 (Table 6). According to FAOSTAT, sugar cane, which previously ranked sixth in terms of gross production value, is now by far the most important product in Colombia, accounting for 30.7% of

Table 4. Share of harvested area by major crops in Colombia

Area harvested (ha)	2010	2020
Coffee, green	778,052	844,744
Rice	482,297	596,415
Oil palm fruit	203,415	559,583
Sugar cane	348,531	544,493
Maize (corn)	522,237	363,628
Plantains and cooking bananas	368,754	283,901
Total cropland	**3,353,000**	**8,738,544**

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/QCL (accessed 7 December 2022)

Table 5. Production quantities of diverse animal-sourced food products in Colombia

Commodity (metric tons)	2010	2020
Milk, total	6,285,126	7,071,404
Meat, poultry	1,066,943	1,619,784
Eggs primary	584,961	982,897
Beef and buffalo meat, primary	766,591	751,038
Meat of pig with the bone, fresh or chilled	196,614	439,682
Sheep and goat meat	3,339	1,027

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/QCL (accessed 20 January 2023)

Table 6. Value of agricultural production in Colombia

Gross production value (current thousand USD)	2010	2020
Sugar cane	1,189,281	15,765,210
Cattle meat with the bone, fresh or chilled (indigenous)	4,263,832	7,153,952
Chicken meat, fresh or chilled	4,738,670	6,673,894
Coffee, green	1,733,003	3,657,105
Rice	871,643	2,874,551
Other	11,511,023	15,300,320
Total	24,307,452	51,425,032

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/QV (accessed 20 January 2023)

total agricultural gross production value in 2020. Sugar cane's gross production value has increased more than 13 times in just ten years. This sharp increase is explained by a higher increase in producer prices, however; over the same period, national sugar cane production decreased from 32.6 to 25.7 million metric tons.

Colombia's national biofuel policy has created vigorous ethanol and biodiesel industries using sugar and palm oil to produce ethanol and biodiesel. Increased production of bio-ethanol is reducing that of sugar (Palacio-Ciro and Vasco-Correa 2020). The transformation of land into sugar cane monocultures has also negatively impacted local communities and the environment, including deforestation, water pollution and groundwater reduction, and threats to livelihoods as well as conflicts (Zarama-Alvarado 2017).

According to FAOSTAT, sugar cane, cattle and chicken meat together account for more than half (57.5%) of Colombian agriculture's total gross production value. It is currently unclear how much sugar cane goes into bio-ethanol production: different sources put it between 10% and 30%. Future analysis will need to disaggregate biofuels versus food crops, in particular for sugar cane and oil palm.

3.3 Diets

3.3.1 National food supply

The average Colombian diet – expressed in terms of total food, protein, or fat supply – appears quite close to the world average (Table 7). According to FAOSTAT, vegetal and animal products in the average Colombian diet respectively represent about 80% and 20% of the total daily energy intake (in kcal per capita per day). Colombia's average dietary energy requirement is 2,358 kcal/capita/day (in 2021), meaning food supply (2,992 kcal/capita/day in Table 7) is almost 27% higher than the recommended intake.

The national food-based dietary guidelines (FBDGs) (ICBF 2018) recommend keeping fat intake at 30% of total macronutrient intake (i.e., 88.3 g and 70 g per day, respectively, for men and women between 18 and 59 years old). This means Colombians' total fat supply exceeds the average recommended fat intake by 13.7%, however, this is only slightly higher (1.8%) than the world average. Protein supply is lower than the FBDG-recommended protein intake, which stands at 99.5g and 78.7g respectively for men and women aged between 18 and 59 years. Animal-product protein represents a moderately higher share of daily protein intake in Colombia, when compared to the world average; meanwhile, Colombian consumption of vegetal products appears more diverse than the world average. Although vegetal products account for a similar proportion of energy dietary intake (around 80%), the share of cereals is much lower in Colombia.

The share of animal products in Colombian diet is lower than in most developed countries; in the United States, for example, this share reaches 30%. While the share of protein intake from animal products is higher in Colombia (52%) than the global average (40%), new data will reveal whether this is similar across all sectors of the population. Informally interviewed national partners strongly stressed the role of meat protein for nutrition, but data is unclear. It will be necessary to further disaggregate food intake data to detect deficits in food intake (quantities and quality) by strata of the population, like gender, age, vulnerable groups, and Indigenous Peoples.

Table 7. Supply of food, fat and protein across the main food groups in 2019

	Colombia (value)	Colombia (%)	World (value)	World (%)
Total food supply (kcal/capita/day)	**2,992**	**100.0%**	**2,963**	**100.0%**
Animal products, including meat	**559**	**18.7%**	**532**	**18.0%**
Meat only	279	9.3%	240	8.1%
Vegetal products, including cereals (*excluding beer*)	**2,432**	**81.3%**	**2,431**	**82.0%**
Cereals only (excluding beer)	863	28.8%	1312	44.3%
Total fat supply quantity (g/capita/day)	**90.0**	**100.0%**	**88.0**	**100.0%**
Animal products, including meat	**37.7**	**41.9%**	**38.9**	**44.2%**
Meat only	21.4	23.8%	19.7	22.3%
Vegetal products, including cereals (*excluding beer*)	**52.3**	**58.1%**	**49.1**	**55.8%**
Cereals only (excluding beer)	2.8	3.1%	6.1	6.9%
Total protein supply quantity (g/capita/day)	**72.7**	**100.0%**	**83.2**	**100.0%**
Animal products, including meat	**38.1**	**52.4%**	**33.2**	**39.9%**
Meat only	19.9	27.4%	14.6	17.6%
Vegetal products, including cereals (*excluding beer*)	**34.6**	**47.6%**	**50.0**	**60.1%**
Cereals only (excluding beer)	19.9	27.3%	32.4	38.9%

Source: FAOSTAT: https://www.fao.org/faostat/en/#data/FBS (accessed 13 December 2022)

3.3.2 Food security and nutrition

Members of the Colombian population suffer from being underweight and overweight (Table 8). The prevalence of undernourishment in the total population is higher than the world average. However, only 13.1% of children under 5 years of age[16] suffer from stunting; this is half of the 26.9% found globally in this category. Prevalence of obesity among adults in Colombia is almost twice the world average. This is attributed to the increasingly sedentary lifestyle in recent years, the traditional ('creole') diet based on high sugar and fat intake, and an overall increase in the consumption of processed foods (IANAS, n.d.).

Table 8. Food security indicators (excluding waste)

Indicator	Colombia	World
Prevalence of undernourishment across total population	12.3%	8.4%
Prevalence of stunting in children under 5	13.1%	26.9%
Prevalence of overweight in children under 5	5.1%	5.6%
Prevalence of obesity in adult population (over 18)	20%	11.5%
Prevalence of anaemia in women aged 15–49	22.6%	28.5%

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

16 Depending on the statistic used for the number of children under 5 in the country, either World Bank (2020) or UNDESA (2021).

4 Food system emissions in the context of national emissions

4.1 Economy wide emissions

Colombia's share of global emissions (including from land use, land-use change, and forestry, LULUCF) remained quite stable between 2010 and 2020 (around 0.55% with LULUCF, and 0.40% without LULUCF) (Table 9). Total emissions with LULUCF increased by 10.3%, whereas emissions without LULUCF increased by 13.2%.

Colombia's reported total annual emissions from the four sectors typically considered in NDCs was 259 $MtCO_2eq$ (Table 10). In 2012, the latest year for which data are available (IDEAM et al. 2017), energy was the second largest sector for emissions, while emissions from waste and industry (IPPU) were the smallest. Across these NDC sectors, most emissions came from agriculture, forestry and other land use (AFOLU). However, Colombia's AFOLU sector also represents a significant carbon emissions sink; this is not reflected in the FAO data but offsets about half of Colombia's AFOLU emissions.

Table 9. Colombian and global emission totals (according to FAOSTAT)

	2010		2020	
	Colombia	World	Colombia	World
Total greenhouse gas emissions – across all sectors with LULUCF (in $MtCO_2eq$/year)	266	48,738	294	52,011
Total greenhouse gas emissions – across all sectors without LULUCF (in $MtCO_2eq$/year)	186	47,099	210	50,617

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/GT (accessed 17 March 2023)

4.1.1 Emissions per capita

GHG emissions per capita are lower in Colombia than the world average (Table 11). The difference is more significant for emissions without including land use, land-use change and forestry (LULUCF). In 2020, GHG emissions per capita with and without LULUCF were respectively 13.1% and 36.0% lower than the world average. Colombia's emissions per capita with LULUCF slightly decreased (-2.9%) while they stayed stable (-0.4%) without LULUCF. According to the World Bank

Table 10. Annual GHG emissions by IPCC sector in Colombia

Sector ($MtCO_2eq$/year)	2012[a]	2010[b]	2020[b]
Energy	78	90	103
Industrial processes and product use (IPPU)	9	6	9
Agriculture, forestry and other land uses (AFOLU) (emissions)	159	149	155
Agriculture, forestry and other land uses (AFOLU) (sink)	-73	-	-
Waste	13	21	25
All sectors, including land use, land-use change and forestry (LULUCF)	259	266	293

a IDEAM et al. (2017)
b FAOSTAT

Table 11. Colombia's total emissions per capita

Indicator	2010		2020	
	Colombia	World	Colombia	World
CO_2 emissions per capita (with LULUCF) (tCO_2eq per capita and year)	5.9	7.0	5.8	6.6
CO_2 emissions per capita (without LULUCF) (tCO_2eq per capita and year)	4.1	6.7	4.1	6.5

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/GT (accessed 17 March 2023)

Table 12. Food system greenhouse gas (GHG) emissions in Colombia

Indicator	2010		2020	
	Colombia	World	Colombia	World
Food system GHG emissions ($MtCO_2eq$/year)	182.74	15,921.259	183.02	16,137.65
Share of food system GHG emissions in total national emissions (percent)	69%	33%	62%	31%

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/GT (accessed 27 January 2023)

(using the latest available data, from 2019[17]), Colombia's overall emissions per capita increased by 13.9% between 2010 and 2019. An average person in Colombia emitted just 87% of the world per-capita average in 2020.

4.2 Food system emissions

Although, at absolute levels, food system[18] emissions remained stable (+ 0.2% between 2010 and 2020), their share in national emissions decreased considerably between 2010 and 2020. However, food system emissions in Colombia still account for a very large part of total national emissions (Food system emissions per capita). In 2010, food system emissions represented 68.7% of total emissions (with LULUCF) and 98.4% of total emissions (without LULUCF), meaning that land-use change, forestry, and food systems were responsible for almost all national emissions. In 2020, the food system still accounted for 62.3% of total emissions (with LULUCF), much higher than the world's average (31%, see Babiker et al. 2022 and Table 12).

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

18 FAOSTAT uses the term 'agrifood emissions', but we have adopted 'food system' across this paper

4.2.1 Food system emissions per capita

In 2020, food system emissions per capita in Colombia were 74.6% higher than the world average. However, they decreased by 11.9% between 2010 and 2020, following the same trend as the world average, which decreased by 9.7% over the same period. In 2020, food system emissions represented 3.6 tCO_2eq per capita (Table 13).

4.2.2 Disaggregating food system emissions

While Colombia's Third National Communication (IDEAM et al. 2017), the latest available, does not disaggregate emissions related to food systems, its methodology does include energy emissions for the food, drinks, and tobacco processing industries (IDEAM et al. 2017). These numbers do not provide a comprehensive view, but they do hint at the size of this subsector's full emissions: Together, these sources are the second largest emitter of GHG from fuel combustion (16% of total CO_2 emissions from fossil fuel combustion) after metallurgy (IDEAM et al. 2017: 42). The Third National Communication also repeatedly mentions that food supply and food security are important national development objectives; it also discusses aligning climate change actions with these.

FAOSTAT data from 2010 and 2020 provide the first overview of Colombia's food system emissions (Table 14). Total food system emissions in 2020 accounted for 183.0 $MtCO_2eq$, remaining almost unchanged since 2010 (see also Food system emissions per capita). FAOSTAT splits food system emissions into three categories: (i) emissions from land-use change (83 $MtCO_2eq$ in 2020); (ii) farmgate emissions (77 $MtCO_2eq$); and (iii) emissions beyond the farmgate, from pre- and post-production activities (23 $MtCO_2eq$). This corresponds respectively to 45%, 42% and 13% of Colombia's food system emissions.

Table 13. Food system emissions per capita in Colombia

Indicator	2010		2020	
	Colombia	World	Colombia	World
Food system emissions per capita (tCO_2eq per capita and year)	4.1	2.3	3.6	2.1

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/GT; https://www.fao.org/faostat/en/#data/OA (accessed 17 March 2023)

Table 14. Greenhouse gas emissions from the food system in Colombia

Sources of GHG emissions	2010 GHG emissions (Mt CO_2eq/ year)	2020 GHG emissions (Mt CO_2eq/ year)	Percentage of total emissions (2020)	Percentage change 2010–2020
Food system (= I + II + III)	182.7	183.0	**100**	0
I. Land-use change	88.8	82.9	**45**	-7
Fires in humid tropical forests	0.1	0.4	**0**	579
Fires in organic soils	-	-	**0**	
Net forest conversion	88.7	82.5	**45**	-7
II. Farmgate	72.4	76.7	**42**	6
Burning – crop residues	0.1	0.1	**0**	-8
Crop residues	0.2	0.3	**0**	30
Drained organic soils (CO_2)	0.6	0.7	**0**	13
Drained organic soils (N_2O)	0.0	0.0	**0**	13
Enteric fermentation	47.1	47.8	**26**	2
Manure applied to soils	1.8	1.6	**1**	-12
Manure left on pasture	11.2	11.9	**7**	7
Manure management	1.7	1.9	**1**	10
On-farm energy use	3.2	4.2	**2**	33
Rice cultivation	2.8	3.5	**2**	24
Savanna fires	1.4	1.7	**1**	20
Synthetic fertilizers	2.2	2.9	**2**	31
III. Pre- and post- production	21.6	23.5	**13**	9
Fertilizer manufacturing	1.0	0.5	**0**	-48
Household food consumption	3.0	2.8	**2**	-8
Food packaging	0.4	0.8	**0**	79
Food processing	2.1	4.0	**2**	87
Food retail	0.6	0.7	**0**	12
Food system waste disposal	11.5	11.6	**6**	1
Food transport	2.4	2.9	**2**	21
On-farm electricity use	0.4	0.1	**0**	-63

Source: FAOSTAT. https://www.fao.org/faostat/en/#data/GT (accessed 20 January 2023). Food system corresponds to FAOSTAT's term 'agrifood system'.

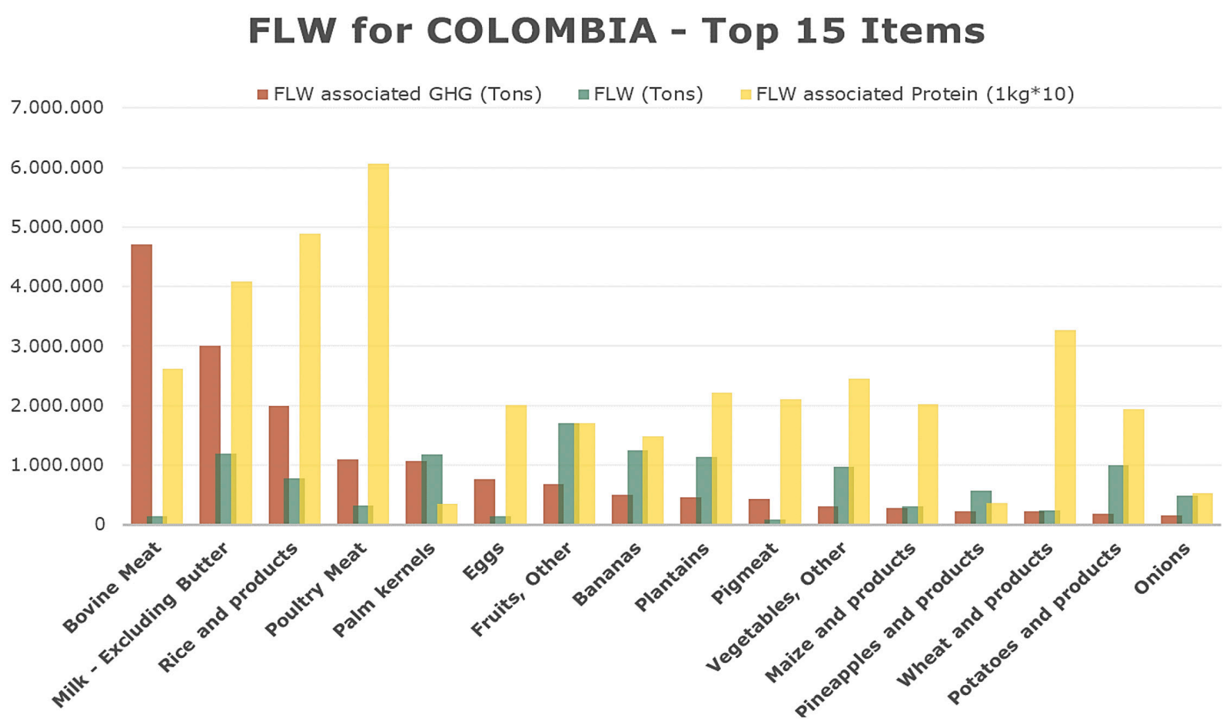

Figure 1. Top 15 hotspot categories of food loss and waste, ranked on FLW-associated GHG emissions (in tCO_2eq), loss and waste volumes, and loss of protein.

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).

Land-use change is the largest contributor to food system emissions. In 2020, land-use change accounted for 82.9 $MtCO_2eq$, around 7% lower than in 2010. Land-use change emissions represent 45% of the country's food system emissions; and net forest conversion is responsible for almost all emissions from land-use change (99.5%).

The second largest emission source in Colombia's food system – and largest emission source within the farmgate category – comes from a combination of two factors that are integral to livestock production: the enteric fermentation in the digestive systems of ruminants like cows, sheep and goats, and manure management on rangelands (other manure management activities are not livestock-related). Together, these mean the livestock sector contributes 33% of food system emissions in Colombia (26% from enteric fermentation and 7% from manure left on pasture). Together, emissions from land-use change and livestock production account for 80% of all food system emissions in the country.

The third largest food system emissions source in Colombia is food system waste disposal (6%). This FAO data category refers to both waste (decrease in quantities at the production stage), and loss (decrease in quantities during retail, food service provision and consumption) (Axmann et al. 2022). There are indications that FAO data underestimate food loss and waste (see Section 4.3).

Farmgate emissions in 2020 were 76.7 $MtCO_2eq$, around 6% higher than in 2010, due to overall increases in crop residues, on-farm energy use, and synthetic fertilizers. The largest relative emission reductions were seen at farmgate (on-farm use of electricity, manure applied to soils, the burning of crop residues) and from pre- and post-production (manufacturing of fertilizers, household consumption). Pre-and post-production emissions amounted to 23.5 $MtCO_2eq$ in 2020, around 9% more than in 2010, with large increases in food processing, packaging, and transport. Emissions from the manufacturing of fertilizers were reduced by almost half in a decade, and emissions from household food consumption fell by 8%.

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). However, food loss and waste (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.[19] 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 food loss and waste (FLW – SDG12.3) would make a critical contribution to food security and nutrition, while alleviating the pressure on natural resources.

Using a bottom-up mass flow model developed by Guo et al. (2020), the University of Wageningen considered the main food loss and waste (FLW) hotspots across food value chains at country level, looking at FLW-associated GHG emissions and nutrient loss (Figure 1). In Colombia, the four main FLW hotspots – ranked according to associated GHG emissions (red bars in Figure 1) – are bovine meat (4.7 $MtCO_2eq$), milk (3 $MtCO_2eq$), rice (2 $MtCO_2eq$) and poultry (over 1 $MtCO_2eq$). However, when considering FLW as a percentage of total production (55%; green bars in Figure 1), then fruits, bananas, plantains, and vegetables as well as milk become the main hotspots.

Together, these four main FLW hotspots account for emissions of 11.5 $MtCO_2eq$. This is in a similar range as the FAO data related in Table 14, yet this figure for food loss and waste is not compatible with the FAO data for food waste alone. However, given that only four hotspots are calculated in Guo et al. (2020), total FLW emissions could be higher for Colombia; this could indicate that FLW emission reduction might play a more significant role in climate change mitigation efforts in Colombia.

The FLW associated to protein production (yellow bars in Figure 1) indicate possible pathways to reducing meat-based emissions without fully eliminating meat production, e.g., by switching from FLW-high poultry to bovine meat.

Collecting primary FLW data in priority value chains will be indispensable to guide the design of value chain specific FLW interventions. Were such primary FLW data to become available, they could 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), 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).

19 Around 14% of food produced is lost between harvest and retail, and 17% 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)

5 Colombia's Nationally Determined Contribution (NDC)

Colombia, strongly committed to reducing its emissions, submitted its updated Second Nationally Determined Contribution (NDC)[20] in December 2020. The updated NDC commits to:

- reduce emissions by 51% in 2030 compared to a business-as-usual (BAU) scenario, equivalent to 169.44MtCO_2eq emissions per year by 2030
- aim towards carbon-neutrality by 2050
- establish carbon budgets for 2020–2030 no later than 2023
- reduce black carbon emissions by 40% compared to 2014 levels, equivalent to 9,195 tCO_2eq maximum in 2030. This target concerns all sectors, including AFOLU, but does not include black carbon emissions associated with forest and grassland fires
- reduce the deforestation rate to 50,000 ha per year in 2030, against an expected trend of
- deforestation of 155,000 ha per year in 2022, and 100,000 ha/year in 2025
- stop deforestation of natural forests by 2030.

Colombia classified its GHG emissions in the business-as-usual scenario in two ways: the first classification, intended for international communication, disaggregates national emissions by IPCC sectors (Figure 2); the second classifies national emissions according to national portfolios (i.e., ministries) to facilitate allocation, management and reporting of national commitments.

According to the business-as-usual scenario, deforestation-related emissions are projected to reach 87.4 MtCO_2eq in 2030, which would represent 50% of emissions relating to the AFOLU sector.

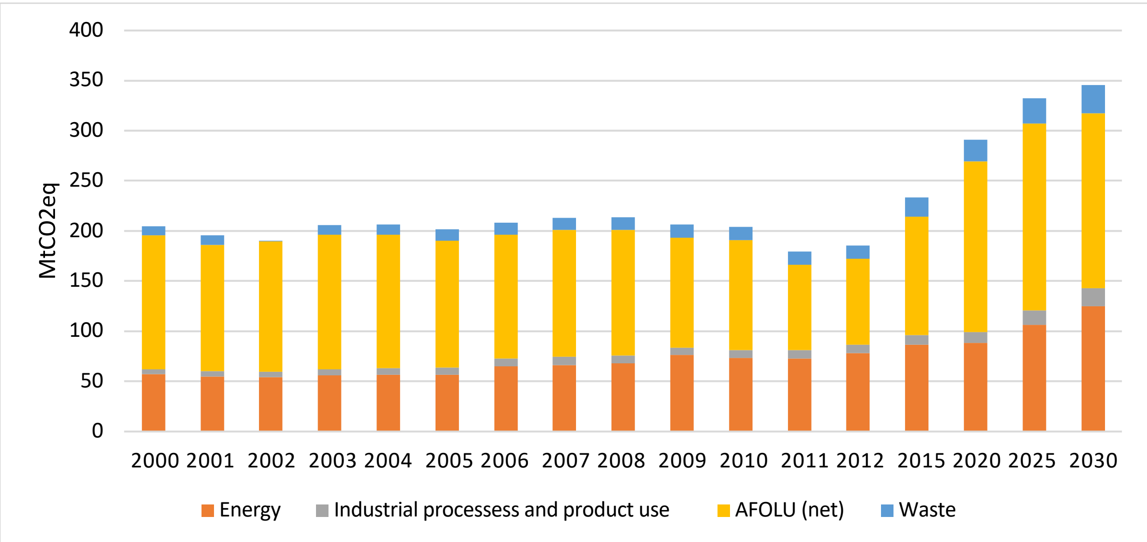

Figure 2. Disaggregation (2000 to 2012) and forecast (2015 to 2030) of emissions in Colombia according to the IPCC classification in the baseline scenario.

Note: Agriculture, forestry, and land use (AFOLU) is the net balance of sink and source emissions. Residues = waste.

Source: Own graph based on data taken from Government of Colombia (2020) and IDEAM et al. (2017)

20 https://unfccc.int/sites/default/files/NDC/2022-06/NDC%20actualizada%20de%20Colombia.pdf

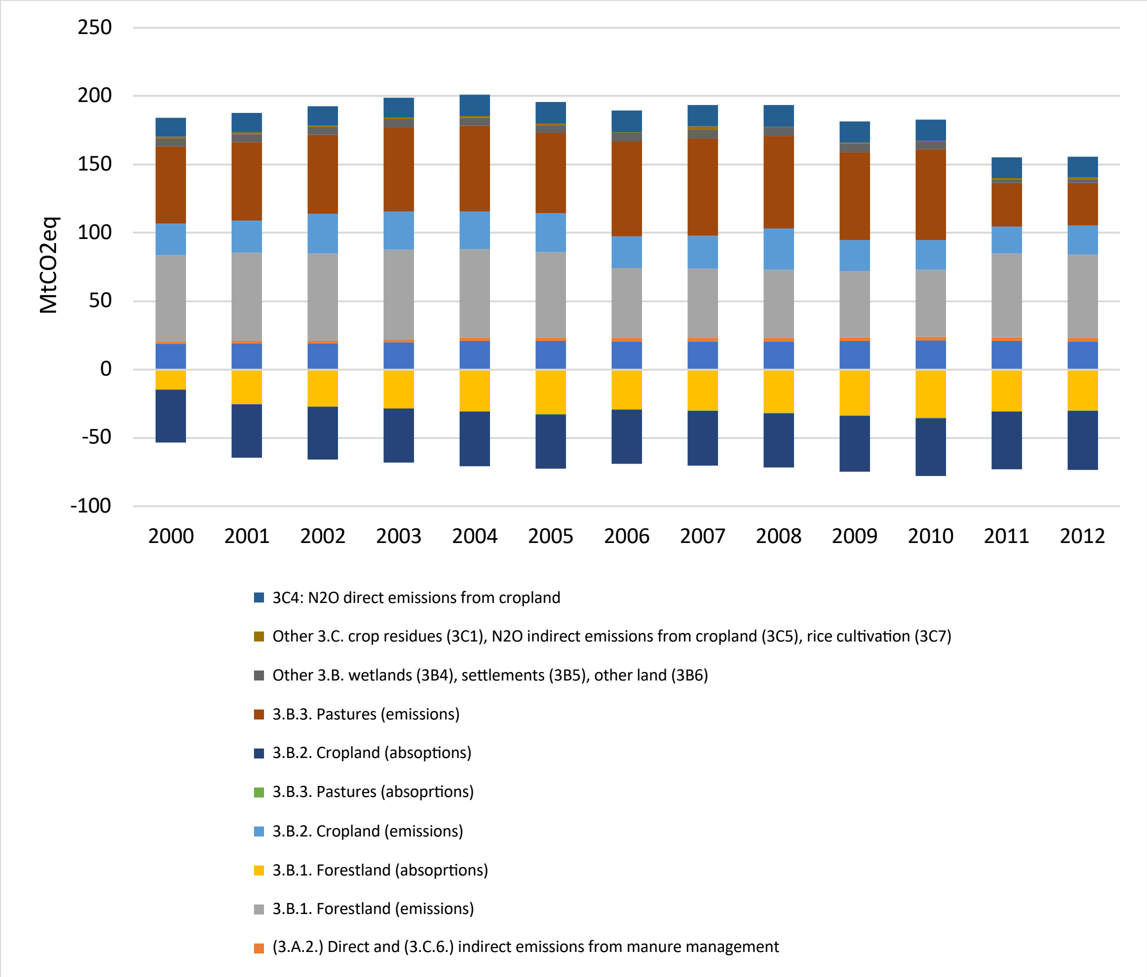

Figure 3. Disaggregation of emissions from the AFOLU sector in Colombia

Source: Own graph; Data from Government of Colombia (2020) and IDEAM et al. (2017)

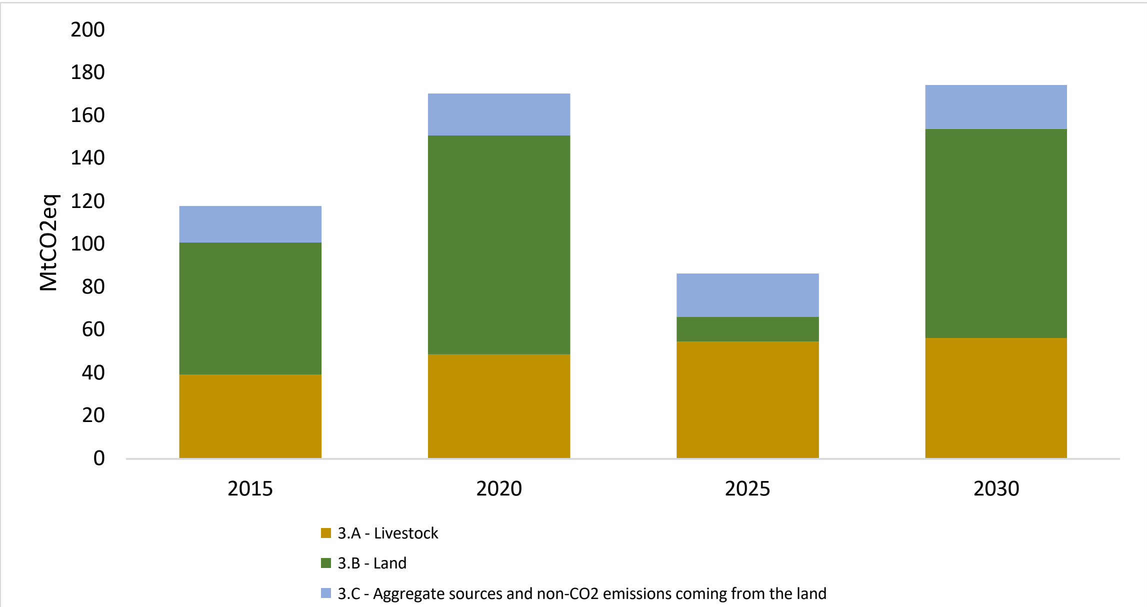

Figure 4. Disaggregation and forecast of emissions from the AFOLU sector in Colombia in the baseline scenario

Source: Figure taken from Government of Colombia (2020) and IDEAM et al. (2017)

The list of climate change mitigation measures, broken down by portfolios and ministries, can be found in a document providing a portfolio of sectoral emission actions (Government of Colombia 2020). As emissions from the AFOLU sector represent an important part of total emissions in Colombia, the NDC shows disaggregated emissions in this sector (Figure 3).

The implementation period for this updated NDC is 2020–2030. The following national documents support the planning and reporting of activities related to NDC implementation:

- Comprehensive Sectoral Climate Change Management Plans ('Plan Integral de Gestión de Cambio Climático Sectorial – PIGCCS'): Agricultural sector
- Biennal Report – Update on Climate Change in Colombia (Informe Bienal De Actualización De Cambio Climático De Colombia)
- National Climate Change Adaptation Plan (Plan Nacional de Adaptación al cambio climático (PNACC))
- Colombian Strategy for Low-Carbon Development (Estrategia Colombiana de Desarrollo Bajo en Carbono – ECDBC)
- Integrated Deforestation Control and Forest Management Strategy (Estrategia Integral de Control a la Deforestación y Gestión de los Bosques – EICDGB)

A breakdown of activities by sector can be found in Government of Colombia (2020). Various sectoral policies support the implementation of climate change adaptation and mitigation actions. In the NDC (Government of Colombia 2020), Colombia established a total of 148 measures to achieve its GHG mitigation goals. Mitigation measures associated with the Ministry of Agriculture and Rural Development are listed in an annex of the NDC (Government of Colombia 2022: xxxix–xIi). These include:

1. **Nationally Appropriated Mitigation Action (NAMA) – Sustainable Cattle Farming:** Reducing GHG emissions caused by land-use change, and increasing sequestration through silvopastoral systems, improved pastures, and manure management. Reducing emissions from enteric fermentation in agricultural areas where livestock is currently in use and improve management of slaughterhouses. The main gases targeted are CO_2 and CH_4, and the annual mitigation potential is estimated at 11.15 $MtCO_2eq$.
2. **Development and consolidation of the forest plantation production chain for commercial purposes:** Technical and economic articulation of the production of timber from forest plantations for commercial purposes; this chain's action plan has an annual mitigation potential estimated at 10.37 $MtCO_2eq$.
3. **Strategies to reduce GHG emissions in the life cycle of cocoa production**: Increase, restore and rehabilitate the area dedicated to cocoa cultivation under agroforestry systems, to increase the carbon stock. The corresponding annual mitigation potential is estimated at 0.16 $MtCO_2eq$ when aggregated with the NAMA Sugar Cane (see below).
4. **Massive adoption of technology (AMTEC 2.0)**[21] **for rice production**: Implementation of a technology transfer model founded on sustainability and social responsibility; this improves producers' organization, competitiveness, and profitability by increasing yields and reducing production costs. This model includes weather forecasting, crop modelling, precision agriculture and the multiple-inlet rice flood distribution (MIRI) irrigation system. This measure holds a mitigation potential estimated at 0.08 $MtCO_2eq$, considering only the reduced N_2O emissions from lower fertilizer consumption.
5. **NAMA – Colombia Coffee**: Developing and implementing GHG mitigation strategies for coffee cultivation and primary processing in Colombia. CO_2, CH_4 and N_2O are the main GHGs covered, and the annual mitigation potential is estimated at 0.28 $MtCO_2eq$ for the AFOLU sector, plus 0.085 $MtCO_2eq$

21 The Colombian National Federation of Rice Growers (Fedearroz) promotes the development and adoption of technology that increased crop competitiveness, sustainability and resilience to climate change by implementing a technology transfer programme known as the Massive Technology Adoption Program (Adopción Masiva de Tecnología, AMTEC) on rice. AMTEC combines various interventions, such as data collection, climate projections, technology transfer, capacity building, and knowledge sharing of good practices. The model involves all stakeholders across the value chain through the AMTEC platform. For more information, see https://www.mdpi.com/2071-1050/13/20/11143

when aggregated with NAMA Sugar Cane (for wastewater and energy efficiency).

6. **NAMA – Sugar Cane**: Developing a central planning, management, institutional and financial articulation strategy for low-emission development and the contribution to sustainable development of panela (unrefined whole cane sugar) production in the country. The NAMA seeks to support:
   - the transfer of alternative technology (replacement of diesel engines with electric motors and more efficient use of energy in the combustion of bagasse[22] in the stoves)
   - the introduction of improved production practices (more efficient use of synthetic fertilizers, reduced burning, lower energy consumption in soil tillage and wastewater management
   - the restoration of natural ecosystems
   - capacity building
   - and the validation of a monitoring, reporting and verification (MRV) system.

   The corresponding annual mitigation potential of NAMA Sugar Cane is 0.02 $MtCO_2eq$ for the AFOLU sector, plus 0.085 $MtCO_2eq$ when aggregated with NAMA Coffee (for wastewater and energy efficiency).

Through these measures, Colombia is addressing the largest GHG-emitting food sectors, livestock, and forest conversion. However, through its NAMAs the country also addresses emissions related to agricultural commodities like cocoa, rice, coffee, and sugar cane, with an apparent focus on the agricultural and pre-production (fertilizer) part, as well as fuel consumption.

In December 2021, Colombia enacted the Climate Action Law (Law No. 2169/2021), engraving both its NDC and net zero targets into law. This law promotes low-carbon development through establishing minimum targets and measures for carbon neutrality and climate resilience.

In 2022, the newly elected president Gustavo Petro placed climate change mitigation and transition towards a low-carbon economy at the top of his political priorities, calling for protecting forests, reducing emissions from deforestation, supporting a sustainable energy transition away from oil investment, and stopping hydraulic fracking. However, despite this renewed political will, the Climate Action Tracker (CAT)[23] still rates Colombia's climate policies and targets as "insufficient" to achieve the +1.5°C climate target of the Paris Agreement. According to the CAT, Colombia is not on track to meet its updated NDC (2020): current policies result in the country generating around 24% more emissions than targeted in the NDC. Colombia's NDC target itself is consistent with 3°C of warming when compared to modelled emissions pathways, and 2°C of warming when compared to its fair share contribution.[24]

Reducing emissions from deforestation is central to reaching Colombia's climate mitigation target. Land-based mitigation measures account for approximately 70% of the total mitigation potential outlined in Colombia's updated NDC (2020). If fully implemented, this NDC could turn Colombia's land sector from a current net source of emissions to a net sink.

22 Dry pulpy fibrous material that remains after crushing sugar cane to extract juice; it is used as a biofuel

23 See: https://climateactiontracker.org/countries/colombia/ (updated 9 November 2022 and accessed 15 December 2022).

24 See the CAT website for more information on the methodology used

6 Conclusions

This country profile aims to provide an overview of Colombia's land use, agriculture and diets analysing greenhouse gas (GHG) emissions from its food system to identify potential strategies for reducing them. Analysis is based primarily on data from FAOSTAT, national communications, and other publicly available databases; the narrative is organized around key facts and their corresponding messages, outlining the main priorities for climate action in the coming years. This initial synthesis of findings will be further expanded and explored in the Mitigate+ project in future, also through consultations of relevant national and international experts, and a joint elaboration of opportunities, data, and methods.

After natural forests, the main land use in Colombia is permanent rangelands, which cover 82% of all agricultural land. In 2020, animal products represented about 30% of Colombia's agricultural gross production value (in current USD); however, this does not consider the proportion of crops used for feed – about 46% of cereals consumed domestically (in quantity) were used as feed. Looking at GHG emissions in Colombia's food system, following emissions from net forest conversion (45% of emissions in 2020), the main emission source at farmgate is enteric fermentation (26%) followed by manure left on pasture (7%). Beyond farmgate, food systems waste disposal is the next largest source of GHG emissions (6%), followed by food processing (2%)[25].

According to Climate Action Tracker, Colombia's NDC targets and commitments are still insufficient to reach the Paris Agreement +1.5°C target (Section 5). Hence, accelerating climate action to fulfil and go beyond the NDC seems imperative for Colombia.

25 See FAOSTAT: https://www.fao.org/faostat/en/#data/GT (accessed 27 January 2023)

Based on this analysis, the three main priorities for climate action in Colombia emerge to be:

1. Reduce deforestation, which addresses the bulk of emissions (45%) in the food system
2. Increase the sustainability of cattle farming through improved livestock, pasture, and manure management, addressing the second-largest emitting subsector in the food system (26%)
3. Reduce food loss and waste (FLW) and improve energy- and resource-use efficiency along food value chains (addressing 13% of food system emissions).

While 80% of food system emissions relate to forest conversion, livestock production and manure management, a not insignificant 20% of those emissions are generated by a combination of farmgate emissions unrelated to livestock production (7%), and from various pre- and post-production activities (13%). Addressing these emissions may not target the largest sources – reducing forest conversion and enteric fermentation emissions remain the primary concern here – however, climate action is most effective when cost-efficient and relatively easy to implement. Reducing emissions from food waste, on-farm, and post-harvest fuel emissions (for on-farm traffic and food transport), processing and household consumption could provide relatively easy and early gains for Colombia, thus providing the required acceleration. Climate action addressing these 20% of emissions could prove fast, efficient, and cost-effective, catalysed by developments like electrification of transport and scaling the successful mitigation action happening in other sectors (see Section 4.2.2). Similar actions implemented across the food chain could bring down overall emissions fast, while more economically, politically, and socially complex problems around deforestation and unsustainable cattle farming are being discussed and progressively addressed.

One significant obstacle is the substantial data gap that exists; numerous sectoral emissions have yet to be adequately quantified. FAOSTAT data relies on national reporting, but countries may lack capacity to comprehensively collect and quantify those data, e.g. for food loss and waste (Heike Axmann, personal communication 2023), an area where technical solutions may be easily available and implementable. Both greater transparency around the methodologies employed, and direct data collection, are crucial to effectively prepare and design climate action strategies based on reliable evidence. Much data remains to be generated, which presents an opportunity for collaborative, participatory action for evidence-based policy development.

Data gaps also exist related to nutrition where we need better data according to age groups and vulnerable population segments, and their need of protein and other nutritious food; these are needed to develop better answers to the nutrition and emission debate, and design low-emission solutions around meat and dairy products. Finally, it should be noted that this document does not assess fisheries and aquaculture production in Colombia, although the production, and hence, related GHG emissions, are relatively small (OECD 2021).

It will be crucial for future climate action planning in the area of food system emissions to develop data sets enabling us to understand the economic and social costs of important climate actions, once the priorities are defined and agreed upon, to identify barriers to implementation in these two realms. This includes the use of economic tools to determine the costs of climate action (Marginal Abatement Cost Curves, so-called MACCs), and of social tools to gauge the extent to which certain actions represent broad consensus and are based on true participation.

In view of this, comprehensive action priorities will be further examined and developed in close collaboration with all sectors and national partners in Colombia, within the framework of the Mitigate+ project.

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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 Low-Emissions Food Systems (Mitigate+) Initiative 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. This document focuses on Colombia.

Colombia´s food system emissions remained stable in absolute level over the past decade (2010-2020) at around 183 $MtCO_2eq$. Although the relative importance of these food system emissions decreased since 2010 in line with the broader economic development, in 2020 they still represented two thirds (62%) of total national emissions. The largest sources of emission in Colombia's food system are net forest conversion (45% of total emissions), enteric fermentation (26%), manure management in the broad sense (9%), and food waste disposal (6%). Altogether, these four categories account for 86% 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: (i) decrease deforestation; (ii) support sustainable cattle farming; and (iii) minimize food loss and waste, while enhancing energy and resource efficiency across food value chains. It also highlights the need for future data collection.

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