



Ceres2030 Deep Dives into
the Nexus of Food Systems,
Climate Change, and Diets

Achieving Sustainable Food Systems in a Global Crisis:

ETHIOPIA





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Achieving Sustainable Food Systems in a Global Crisis: Ethiopia Ceres2030 Deep Dives into the Nexus of Food Systems, Climate Change, and Diets

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Executive Summary

Ethiopia is not on track to achieve the United Nations Sustainable Development Goals by 2030, with poverty and hunger levels projected to be higher in 2030 than they are today. This is being made worse by the conflict in Tigray, swarms of desert locusts, an economic slowdown, skyrocketing food, fertilizer, and energy prices—exacerbated by the Russian invasion of Ukraine as well as the COVID-19 pandemic—and climate change. To get back on track, it is critical to pursue policy pathways that favour synergies and limit the trade-offs between hunger, poverty, nutrition, and climate change. This report presents an evidence-based and costed country roadmap for effective public interventions to transform agriculture and food systems in Ethiopia in a way that ends hunger, makes diets healthier and more affordable, improves the productivity and incomes of small-scale producers and their households, and mitigates and adapts to climate change.

The report shows that it is possible to achieve sustainable food system transformation in the next decade by increasing public investment by USD 4.6 billion and targeting this spending on a more effective portfolio of interventions that achieve multiple sustainable development outcomes. Importantly, when comparing the financing gap between the long-term investment needed to achieve Sustainable Development Goal 2 and the short-term investment needed for emergency food assistance, there is significant underfunding of the longer-term investment needs (Figure 11). The shortfall in longer-term funding increases the vulnerability of Ethiopia to shocks and crises, increasing the number of people affected by hunger and poverty. Donors should, therefore, simultaneously increase emergency food assistance while ensuring this is linked to—and complemented with—an increase in longer-term investments to build resilience and help mitigate against future shocks and crises.

The findings are based on a review of academic and grey literature, donor-funded projects, micro- and macroeconomic modelling, and engagement and consultations with key stakeholders in Ethiopia. This report is part of a project that explores the interaction between achieving hunger, poverty reduction, and healthy diets while addressing climate change within the evolving food systems in three countries: Ethiopia, Malawi, and Nigeria.

The report finds that:

- 1. Without additional public investment, significant levels of hunger, malnutrition, and poverty will persist after 2030.** The conflict in Tigray has provided a massive blow to the recent economic progress achieved in Ethiopia. It will take the country years to recover from the worsening hunger and poverty levels. Without additional public investment and more effective policy interventions, the poverty rate will go from 24.1% in 2022 to 17.5% in 2030, and the hunger rate will go from 25.9% in 2022 to 22.2% in 2030. Healthy diets are and will continue to be unattainable for more than 75% of Ethiopians by 2030.
- 2. Diet diversity is poor in low-income households, while high-income households have higher dietary diversity with more meat consumption.** The diets of all households are reported to include the major food groups: cereals, pulses, nuts, vegetables, and meat or fish. For the lowest-income households, over



65% of their food expenditures are on cereals, vegetables account for approximately 3%, and animal foods including dairy products take up around 4%. For the highest-income households, a substantial share of food expenditures is on cereals (over 50% throughout Ethiopia), followed by vegetables (approximately 5%), while animal foods, including dairy products, make up almost double the budget share relative to poor households (6%). To transition to healthier diets requires a higher calorie intake, increased consumption of fruits and vegetables (400 g per day, according to the World Health Organization [WHO]), a higher share of calories from pulses and legumes, and a higher share of calories from animal-sourced foods, including dairy (for calcium and B12).

3. **With additional public investment of USD 4.6 billion per year from 2023 to 2030, it is possible to achieve a sustainable food systems transformation in Ethiopia.** The results from using a computable general equilibrium (CGE) model and household-level data show that it would cost an additional USD 4.6 billion in public investment per year from 2023 to 2030 to end hunger, double the incomes of 11.7 million small-scale producers on average, transition to healthier diets for 108 million people, maintain greenhouse gas emission in agriculture to Ethiopia's nationally determined contribution (NDC), and increase resilience to climate change. Of this total additional spending required per year, USD 2.7 billion needs to be provided by external resources (donors), with the remainder, USD 1.9 billion to be provided through domestic resources. Currently, donors provide an average of USD 659 million per year of agriculture and food security official development assistance (ODA).
4. **The financing gap between the long-term investment needs and the short-term emergency food assistance needs is big.** While the total amount of ODA to emergency food assistance increased overall from 2012 to 2014 compared with the period 2017–2019, the total amount of ODA to long-term agriculture and food security has stagnated over the same period. There is insufficient attention to bridging the short-term emergency food assistance programs with longer-term investments in agriculture and food systems, and massive underfunding of the longer-term investment needs.
5. **Increasing agricultural productivity, for both plant and livestock, especially among small-scale producers is a top policy priority.** Generally, Ethiopia's policies and strategies see increasing agricultural productivity as critical to improve the economy's competitiveness, assisting in agricultural transformation, and contributing to poverty reduction. Specifically, policy documents emphasize high-quality and targeted extension support, improved access to technology and farmers' capacity to use it, establishment and support of farmer organizations, and promotion of agricultural research. The focus on improving agricultural productivity is strongly reflected in donor-implemented projects.
6. **The effects of climate change are undermining the country's food and nutrition security.** Due to Ethiopia's complex climate and increasing weather variabilities, it is expected that there will be a decline in agricultural and livestock productivity of between 3% and 30% by 2050. In particular, Ethiopia is highly vulnerable to drought, as rainfed agriculture contributes nearly half of national GDP



and is the mainstay of livelihoods for 85% of the population. Climate change and variability, therefore, have significant impacts on agricultural productivity and related impacts on incomes, food security, and nutrition, as well as biodiversity and forestry. While the government has demonstrated a strong political will to address climate change—developing a National Adaptation Plan (NAP) in 2019 amongst other policies—and there is a prominent focus on sustainable resource use and conservation in donor projects, more effort is required to support climate-resilient agricultural practices and resource conservation together with addressing gender issues and the needs of vulnerable groups in this context.

7. **The contribution of the livestock sector to total and per capita greenhouse gas (GHG) emissions will continue to rise by 2030 and is inadequately supported by government and donors.** Current GHG emissions, total and per capita, in the livestock sector represent a major climate challenge for Ethiopia—and significant growth in the livestock sector is expected in the next decade. The government has responded with a range of policies, strategies, plans, and programs. However, despite the importance given to sustainable livestock intensification in policy documents, the authors found only three of the 32 projects implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit, United States Agency for International Development and the European Union in Ethiopia address livestock interventions.¹ Considerable effort is needed to transform Ethiopia's livestock policies into implemented programs with quantifiable outcomes. Without significant additional public investment in sustainable productivity growth and diversification to small ruminants, Ethiopia will not be able to meet its climate commitments expressed in the country's NDC nor achieve the Sustainable Development Goals.
8. **Interventions to reduce post-harvest losses and food waste are some of the most effective ways to address the nexus of food security, nutrition, incomes, and climate change.** Important gains can be made by prioritizing policies and programs to reduce food loss and waste. Importantly, Ethiopia has policies that stress the need to reduce post-harvest food loss and to improve food safety, including reducing the spoilage of meat, dairy, and other perishable products.
9. **There is limited support for regional and national institutions to improve the capacity to monitor, analyze, and inform on progress and achievements.** Such capacities are critical to monitor the food systems outcomes of investments in the portfolio of interventions, including better disaggregated data to account for subnational and gender differences. While several of the identified donor projects included some form of capacity development to institutional actors on program management and implementation, the authors are aware of only two that specifically addressed the need to support regional and national institutions in their capacity to monitor and disseminate information and analysis of climate change risks and opportunities, as well as broader issues of food security and nutrition.

¹ Analysis of donor-funded or implemented projects is based on a non-exhaustive desk review which looked at current (or recently terminated) projects implemented and/or funded by Deutsche Gesellschaft für Internationale Zusammenarbeit, the European Union, or United States Agency for International Development. Only projects which had a degree of focus on two or more aspects of our nexus were included for review. Overall, 32 projects were reviewed in Ethiopia. See Section 4.1 for more information on the methodology.



The report recommends the Government of Ethiopia and its development partners:

1. **Increase public investment by an additional USD 4.6 billion per year from 2023 to 2030 to successfully transition to sustainable food systems.** Development partners should provide an additional USD 2.7 billion on average per year for 8 years (2023–2030), from a current baseline of USD 659 million per year. The Government of Ethiopia should provide an additional USD 1.9 billion per year. This will reverse the severe underfunding of the longer-term investment needs for agriculture and achieve food security and nutrition.
2. **Prioritize increased spending on farm interventions.** An additional USD 3.18 billion per year on average is needed to improve the productivity and incomes of small-scale producers, an additional USD 964 million per year on average for social protection, education and school feeding programs, and an additional USD 531 million per year to move food to markets. Interventions need to focus on improving plant productivity, especially by targeted extension, access to high-quality seeds, and promoting crops, including staples and pulses as well as crops that deliver nutritional benefits, such as local crops and varieties for fruits and vegetables.
3. **To transition to healthier diets, nutrition education must accompany on- and off-farm investments to improve consumer choices.** Attention needs to be given to the design and implementation of nutrition-sensitive interventions. Initiatives that provide nutrition education and deliver advice on storing and utilizing diverse, nutritious food products are critical to complement and maximize the impact of social protection programs, nutrition programs, and agricultural productivity programs.
4. **Ensure climate resilience and adaptation are integrated into agriculture and food system policies and programs.** It is critical to ensure that food systems interventions also improve the capacities of farmers to adapt and promote the overall resilience of the agricultural sector and reduce its environmental footprint. Farmers' income gains and diet improvements can be jeopardized if climate resilience is not strengthened. To achieve such improvements, gender and the needs of vulnerable groups need to be considered when integrated measures are designed.
5. **Substantially scale up support for environmentally sustainable intensification** to improve both plant and livestock productivity, as emphasized in several of Ethiopia's agricultural development and climate-resilience strategies. The Government of Ethiopia and the donor community should increase the allocation of domestic and external resources supporting these measures, respectively. Ethiopia's policy documents already stress the importance of the private sector focusing on specific measures to improve productivity and promote climate resilience.
6. **Accelerate efforts to reduce GHG emissions and increase climate resilience in the livestock sector.** Policy interventions need to include enhancement of veterinary coverage through private–public partnerships, promotion of fodder production, and accelerated introduction of improved genetics once feed production and health services are in place. Supporting different types of livestock, breeds, and fodder can also help reduce GHG emissions and increase climate resilience in the expanding



livestock sector. Current donor support and priorities are insufficient to support the Ethiopian government's goals and targets on climate change and nutrition.

7. **Continue targeted social protection programs, mostly through cash transfers,** targeting the most vulnerable to support national nutritional and development strategies, and build resilience to climate change. Additional resources need to be allocated to social programs and support for vulnerable groups. Defining needed investments at the regional level, the Seqota Declaration states that governments need to engage in the development of comprehensive costed nutrition investment plans, tailored to local nutrition needs.
8. **Focus interventions and policies to reduce food loss and waste on better storage infrastructure and education.** Specific investments should be focused on enhancing households' knowledge about food waste and safe food storage methods as well as infrastructure development. This would enable producers to reduce losses during the production and storage of foods from animal and plant sources. From a healthier-diet perspective, investments such as cold storage could contribute to preserving highly perishable goods, such as vegetables, fruits, animal products, and fish, as well as efforts to improve food safety.
9. **Increase support for regional and national institutions to improve capacity to monitor, analyze, and inform on progress and achievements.** This will enable institutions to better support the sustainable food systems transformation, including by collecting disaggregated data to account for subnational and gender differences, particularly related to the prevalence of stunting, overweight, and obesity.

These recommendations closely align with Ethiopia's Food Systems Pathway, which emerged from the United Nations Food Systems Summit in 2021 and committed to transforming the Ethiopian food system based on the "common goal of healthy and sustainable diets for all" (FDRE, 2021a, p. 2). Specifically, Ethiopia identified five central goals for food systems transformation: 1) diversify food production and increase the production of nutrient-dense foods; 2) strengthen supply chains, including food management and handling systems; 3) promote resource conservation in food production practices and provide better access to inputs, technologies, and extension services; 4) promote methods that ensure food safety while limiting post-harvest losses; and, 5) enhance resilience to shocks (FDRE, 2021a). The findings and recommendations in this report, therefore, offer an evidence-based and costed roadmap on which to base support for the implementation of food systems transformation in Ethiopia.



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Abbreviations and Acronyms

BAU	Business-as-usual
CGE	Computable general equilibrium
CRGE	Climate Resilient Green Economy
CRS	Creditor Reporting System
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFPRI	International Food Policy Research Institute
LSMS	Living Standards Measurement Survey
NAP	National Adaptation Plan
NAPA	National Adaptation Programme of Action
NDC	Nationally determined contribution
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
PoU	Prevalence of undernourishment
PSNP	Productive Safety Net Programme
R&D	Research and development
SDG	Sustainable Development Goals
SNNPR	Southern Nations, Nationalities and Peoples' Region
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WFP	World Food Programme
WHO	World Health Organization



1.0 Introduction

Agriculture and food systems in Ethiopia face key challenges. They need to simultaneously provide sufficient food for all, improve incomes and productivity for small-scale producers, make diets healthier and more affordable, reduce greenhouse gas (GHG) emissions, and build capacities needed to adapt to climate change. Yet, in the past few years, as a result of the conflict in Tigray, swarms of desert locusts, an economic slowdown, COVID-19, and now rising food, fertilizer, and energy prices, made worse by the Russian invasion of Ukraine, hunger and poverty have been on the rise, healthy diets are unattainable for most people, and the impacts of climate change are experienced more frequently and severely.

The armed conflict in Ethiopia's Tigray region, in particular, has increased food insecurity among the region's population and limited people's access to health care and other public services. The World Food Programme (WFP) reports that 91% of the region's 6 million people required emergency humanitarian assistance during the 7 months of the conflict (WFP, 2021, 2022). While the long-term impacts of this conflict are still unknown (Gesese et al., 2021), the estimated impacts of the Tigray conflict on the prevalence of undernourishment are included in the quantitative analyses. It is predicted that due to the Tigray conflict, 17.5 million more people will be affected by hunger in 2030 compared to projections made prior to the conflict (see Figure 1).

Even among those who do get enough calories, many will be malnourished due, in part, to the unaffordability of diets that provide both sufficient calories and satisfy the complex nutritional requirements of human bodies. The demographic dynamics in Ethiopia will continue to exacerbate these challenges, with the population expected to grow from 114 million people in 2020 to 159 million people in 2030 (United Nations, 2019).

As the population and incomes grow in Ethiopia after the conflict, so too will demand for food and more dietary diversity, which will exacerbate environmental challenges. At the same time, Ethiopia is home to some of the global public goods that are needed to address climate change, preserve biodiversity, and achieve the Sustainable Development Goals (SDGs). Transforming food systems to deliver on hunger, poverty, healthy diets, and climate change, while safeguarding global public goods, will require significant efforts and resources, and, therefore, global solidarity; in other words, more domestic support and more external aid.

To support the transformation to sustainable food systems in Ethiopia, this report aims to equip country-level decision-makers and the donor community with the following: knowledge regarding the cost of sustainable food system transformation; evidence on which to base decisions regarding where and how to make investments to simultaneously contribute to access to sufficient, safe, and nutritious food (SDG 2.1 and 2.2), smallholder productivity and incomes (SDG 2.3), and environmentally sustainable agriculture production (SDG 2.4).

The report combines a review of country-level policy documents and peer-reviewed literature with a microeconomic analysis of changing diets, food consumption habits, and nutrition, four rounds of consultations with in-country stakeholders, and the country-level findings for



Ethiopia from the project, *Ceres2030: Sustainable Solutions to End Hunger*.² The findings are integrated into a computable general equilibrium (CGE) model that estimates the cost of ending hunger, doubling the income of small-scale producers, transitioning to healthier diets, while protecting the climate and investing in climate change adaptation.

Box 1. Defining nutrition in this report

We refer to nutrition as food consumption patterns and healthy diets from sustainable food systems. At the same time, we acknowledge that healthy diets alone will not ensure good nutrition but can be an outcome achieved through building livelihoods, empowering women, improving incomes and access to markets and facilitating access to services, improving food safety, and others.

Section 2 describes the key food system challenges facing Ethiopia today and in 2030, focusing on poverty and hunger, the current composition of diets and their nutritional deficiencies, and the impact and threat of climate change. Section 3 presents the findings as a package of proposed interventions for a pathway to transform the agriculture and food system by 2030 and the implications of this transition, as well as the public investment required by the Government of Ethiopia and external resources to facilitate such a transformation. Section 4 provides an overview of the methodology and research approach used to explore potential pathways for food system transformation, including the scenarios, targets, and interventions included in the CGE model and a discussion of limitations of the research approach. Section 5 provides recommendations and conclusions. A technical appendix provides further details on the research approach and methodology.

² See Laborde et al., 2020a and 2020b for more information.



2.0 Ethiopia's Agriculture and Food System Challenges

This section reviews recent trends for key aspects of the food system in Ethiopia to 2030. Specifically, it focuses on the prevalence of extreme poverty and hunger, the prevalence of the unaffordability of healthier diets, and dietary composition. It also pays attention to the contributions of agriculture to climate change—mostly due to the GHG emissions intensity of the sector, deforestation, and water withdrawal—as well as to efforts to improve resilience and farmers' capacities to adapt to climate change, as described in the country's policy documents.

Critical for agriculture and food systems in Ethiopia, the UN predicts that the country's population will grow from 114 million people (World Bank, 2021)³ to 159 million by 2030 (United Nations, 2019). This population growth is significant for Ethiopia, where over 78% of the population resides in rural areas (World Bank, n.d.), and 70% of the population is under 15 years old (Organisation for Economic Co-operation and Development [OECD] Development Centre, 2018; Mungai et al., 2016). Ethiopia is therefore predicted to continue to experience strong demographic pressure, with an annual population growth rate of 2.3% in the next decade (compared to 1.1% worldwide) (World Bank, n.d.). Combined with a low GDP per capita, this means that Ethiopia will remain among the lowest-income countries in the world despite relatively strong economic growth, projected at 7.2% per year (according to our calculations) (World Bank, n.d.). This demographic pressure and economic need in Ethiopia will necessitate an increase in food consumption and production to address the nutritional needs of its population. However, the projections are not optimistic.

Agriculture accounts for the majority of employment in the Ethiopian economy, employing over 67% of the labour force and representing over 34% of GDP (World Bank, 2021a). However, the sector remains highly inefficient in generating income: the value added per worker in agriculture is about a quarter of what prevails in the rest of the Ethiopian economy (calculations based on World Bank, 2021b). The average productivity of major crops in Ethiopia is less than 1,000 kg/ha on over 60% of farmland (Mungai et al., 2016). In comparison, the OECD suggests that the global average is 3.5 times higher (Mungai et al., 2016). The picture is the same for other agricultural crops and livestock. Furthermore, with most of the cultivated land in the country under rain-fed production, the agricultural sector is very sensitive to climate change and weather variability. However, there is significant potential and opportunity for agricultural development in Ethiopia (see Figure A1).

2.1 Hunger, Poverty, Small-Scale Producers, and the Unaffordability of Healthy Diets

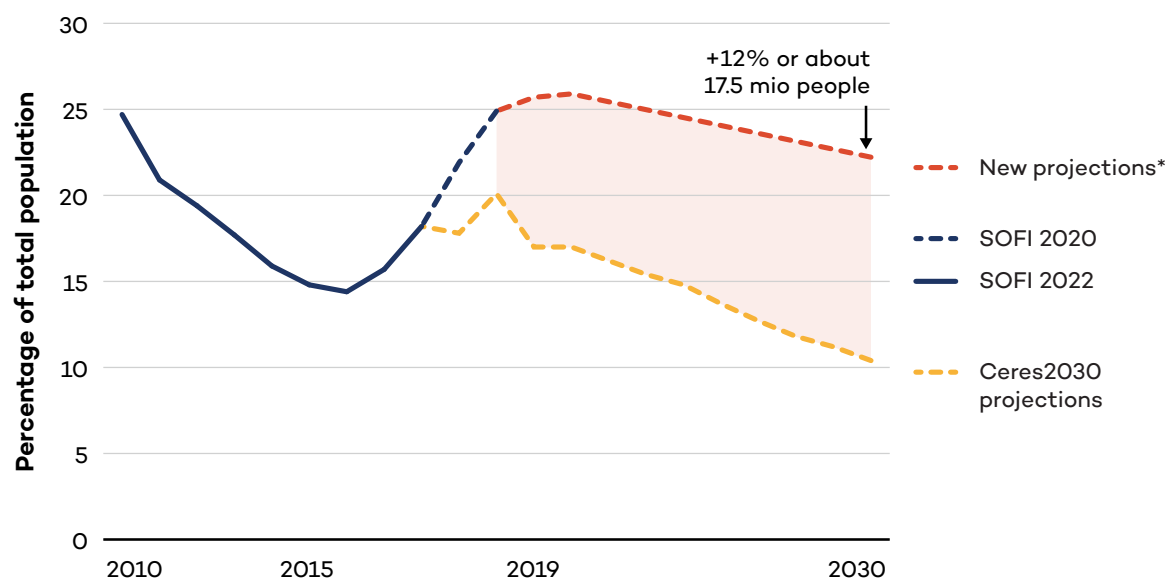
In the decade prior to the current conflict in Tigray, Ethiopia had made impressive progress in reducing the prevalence of hunger and poverty. The prevalence of hunger (as measured by the prevalence of undernourishment [PoU]) dropped from 25% to 15% of the population

³ Using data for 2020.



between 2010 and 2018 (see Figure 1). This progress has been reversed as a result of droughts, desert locusts, the economic effects of COVID-19, skyrocketing food, fertilizer and fuel prices, and now most importantly, the conflict in Tigray. Hunger is back at 26%, much higher than the average of 18% for sub-Saharan Africa (Food and Agriculture Organization of the United Nations [FAO], 2021). It is predicted that due to the Tigray conflict, 17.5 million more people will be affected by hunger in 2030 compared to projections made prior to the conflict (see Figure 1). Extreme poverty (at the USD 1.90 international poverty line) now affects 24% of the population, although the rate remains lower than the average for sub-Saharan Africa which stood at 42% in 2016. (World Bank Development Research Group, 2021) (see Figure D2 for the geographical distribution of poverty across Ethiopia). A comparison of the prevalence of undernourishment prior to and post the outbreak of conflict in Tigray is shown in Figure 1.

Figure 1. Hunger projections in 2030: the situation prior to and post the conflict in Tigray



Note: *New projections based on the MIRAGRODEP model, using same baseline assumptions as in the IFPRI-FAO partnership for SOFI2022 (FAO et al., 2022).

Source: Created using data from FAO et al., 2020, 2022; Laborde et al., 2020b, and approach from FAO & International Food Policy Research Institute, 2022.

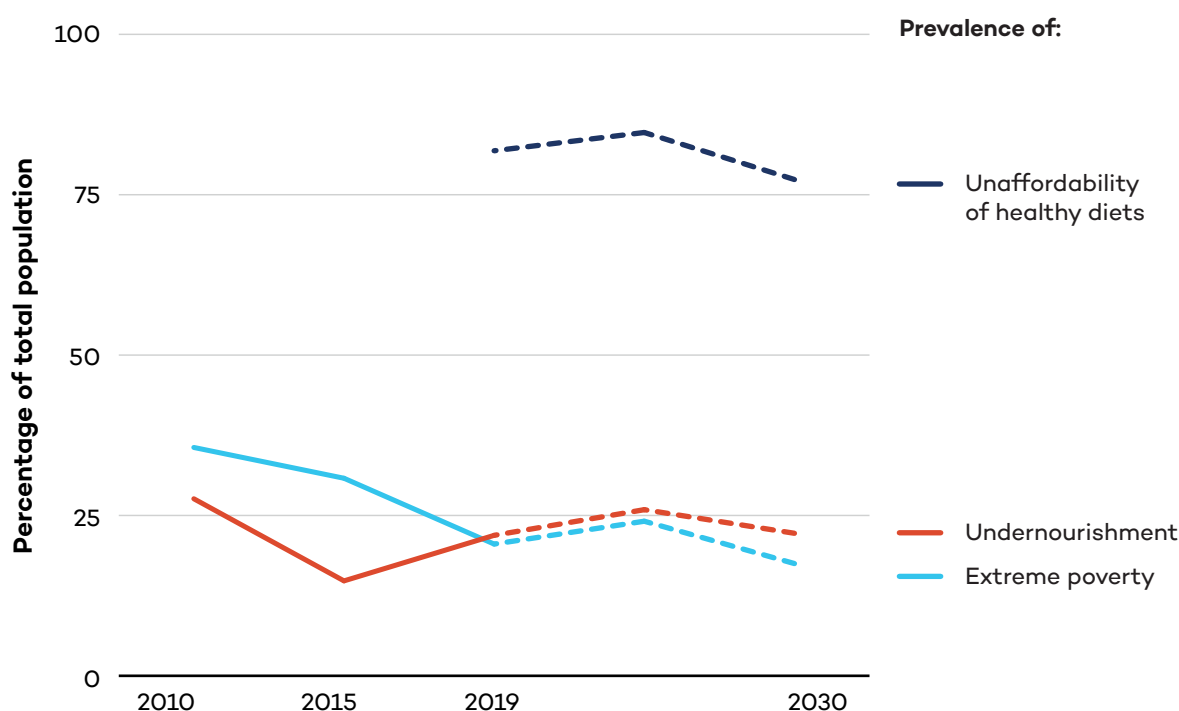
Small-scale producers are particularly vulnerable to poverty, food insecurity and nutritional challenges in Ethiopia. Due to their small plots (often less than 0.5 hectares) and low productivity rates, they have limited capacities to ensure food security or purchase food items, especially those that contribute to healthier diets. They are also highly vulnerable to shocks as they lack the resources to invest in resilience-building capacities (FDRE, 2019; See Section 2.3).

Economic growth projections till 2030 are strong, as are projections for improved agricultural productivity, which will partly accommodate the increasing demand for food and contribute



to a consistent trend toward the reduction of extreme poverty and hunger (Figure 2). The findings from the macroeconomic modelling show that with growing household incomes, the prevalence of extreme poverty will decrease from 20.5% in 2019 to 17.5% in 2030, and the PoU will decrease from 21.9% in 2019 to 22.2% in 2030. Healthy diets will continue to be unaffordable for most, with more than 75% of Ethiopia’s population unable to afford a healthy diet in 2030 if the current trajectory is maintained (Figure 2). Finally, the growing agricultural production and, specifically, livestock expansion will need to rely on environmentally sustainable intensification if the country’s economic and environmental objectives are to be achieved simultaneously.

Figure 2. Prevalence of hunger, poverty, and the unaffordability of healthy diets in 2030



Source: In this figure, we use the approach from the *The State of Food Security and Nutrition in the World 2021* (FAO et al., 2021) to define the (un)affordability of healthy diets.

2.2 Diet Composition and Quality

The composition of diets in the lowest-income households in Ethiopia is poor, but almost all households are reported to have consumed the major food groups: cereals, pulses, nuts, vegetables, and meat or fish. The highest-income households have higher dietary diversity, with more consumption of meat or fish.



2.2.1 A Snapshot of Diets Today

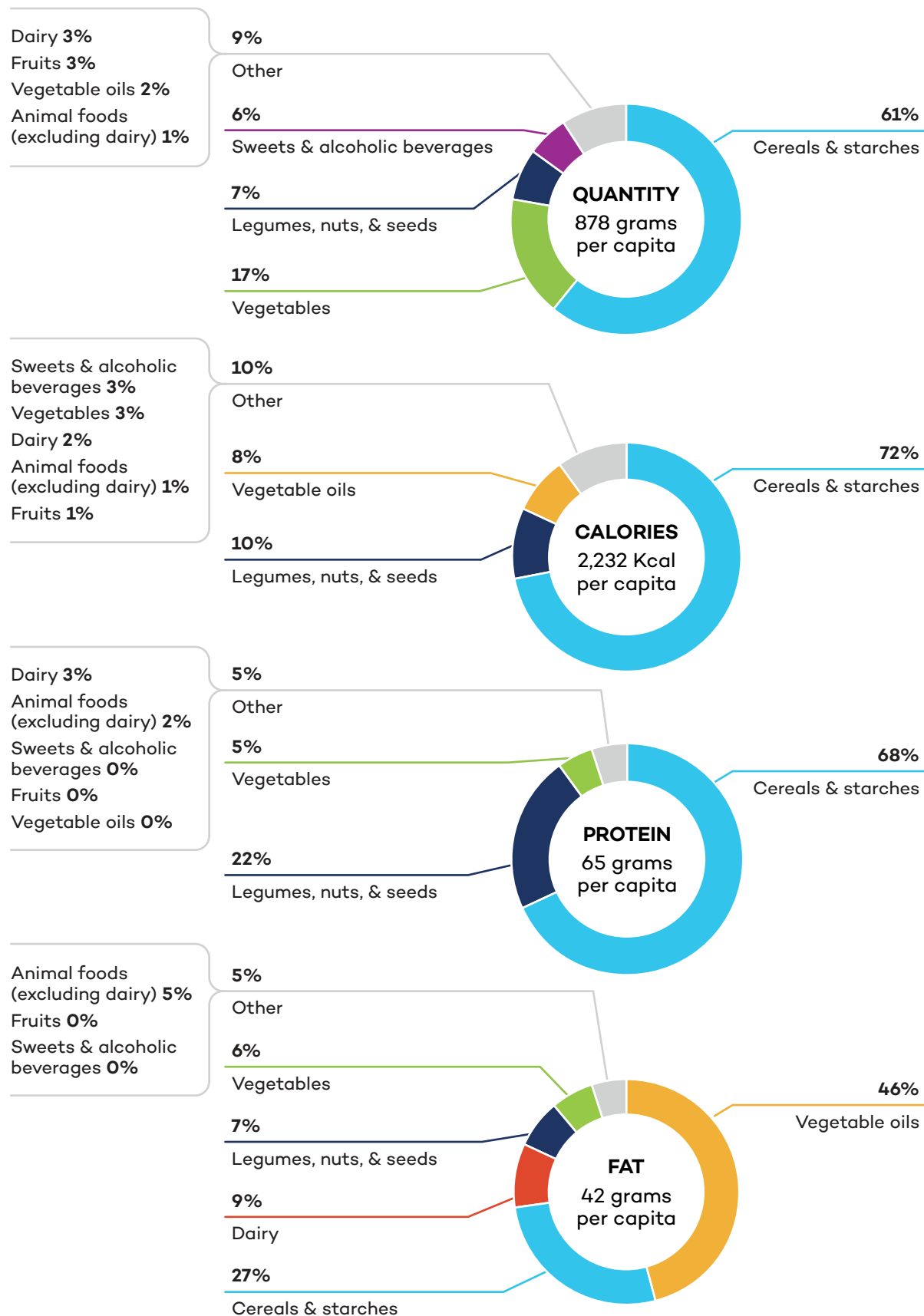
The Ethiopian diet is primarily composed of cereals, which vary by agro-ecological zone and rural/urban location, but include wheat, maize, sorghum, and teff (Berhane et al., 2011). Over 20% of all arable land is used for teff production.⁴ The five main crops (teff, maize, sorghum, wheat, and barley) represent 64% of harvested land, and cereals account for more than half of the Ethiopian diet, in terms of both grams and calories consumed. Using data from the FAO and the Living Standards Measurement Survey (LSMS), Figure 3 illustrates the composition of consumption on average, including overall caloric intake and composition by food group.

In terms of calories, the next most commonly consumed product category is made up of nuts and legumes, but consumption is heavily concentrated toward the latter as pulses are very common in the Ethiopian diet (see Box 3). Oil from oilseeds makes up the next largest caloric component. Vegetables are regularly consumed but in relatively small amounts, and fruits are close to non-existent in the diet. Animal-source foods are also rarely consumed; while regular “fasting” plays a role in reducing animal-source food consumption, averages are low due to a lack of affordability.

⁴ Teff is a small grain, approximately the size of a poppy seed, originating in Ethiopia and Eritrea. Teff seeds are grained and used to make injera—a flat, pancake-like fermented bread.



Figure 3. Overview of dietary composition, aggregated by food group, per capita, per day



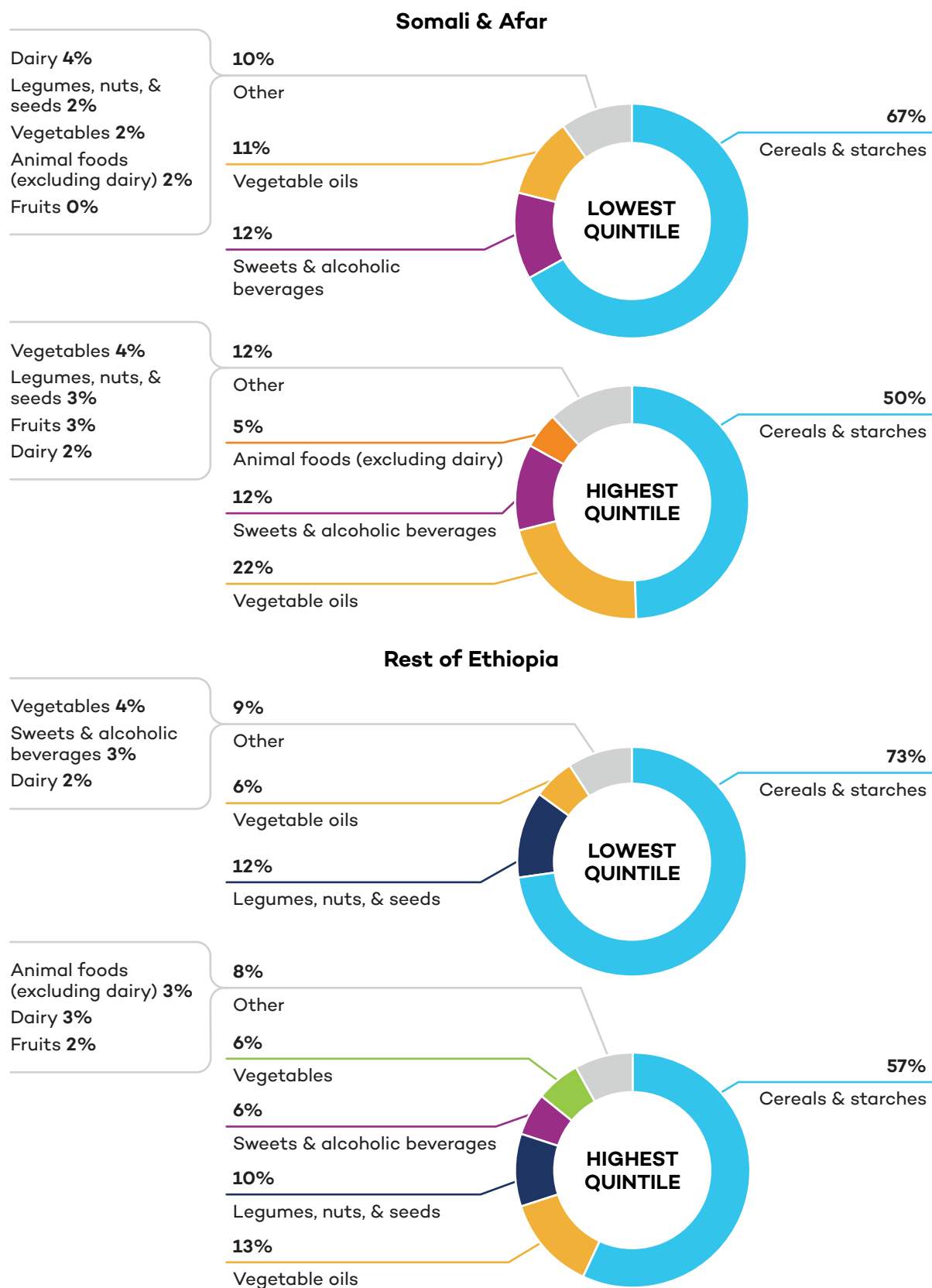
Source: Authors' analysis based on LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020) and nutrient coefficients based on FAOSTAT-Supply And Utilization Account (SUA) (FAO, 2021).



Figure 4 shows the share of calories consumed by food group, comparing the highest and lowest quintile of the population. For households in the lowest quintile of the income distribution, food expenditures are dominated by cereals, with 67% of households' estimated expenditure in the Somali and Afar regions going to this category, and 72% in the rest of Ethiopia. Vegetables account for 2% of total estimated food expenditure in the Somali and Afar regions and 4% in the rest of Ethiopia, whilst animal products (including dairy) account for 6% and 2%, respectively. For households in the highest quintile of the income distribution, cereals comprise a lower but still substantial share of expenditures (over 50% throughout Ethiopia). Vegetables take up a slightly larger share (4% in Somali and Afar regions, and 6% in the rest of Ethiopia), while animal foods (including dairy) take up around 6% throughout Ethiopia.



Figure 4. Share of calories consumed, by food group and wealth quintile

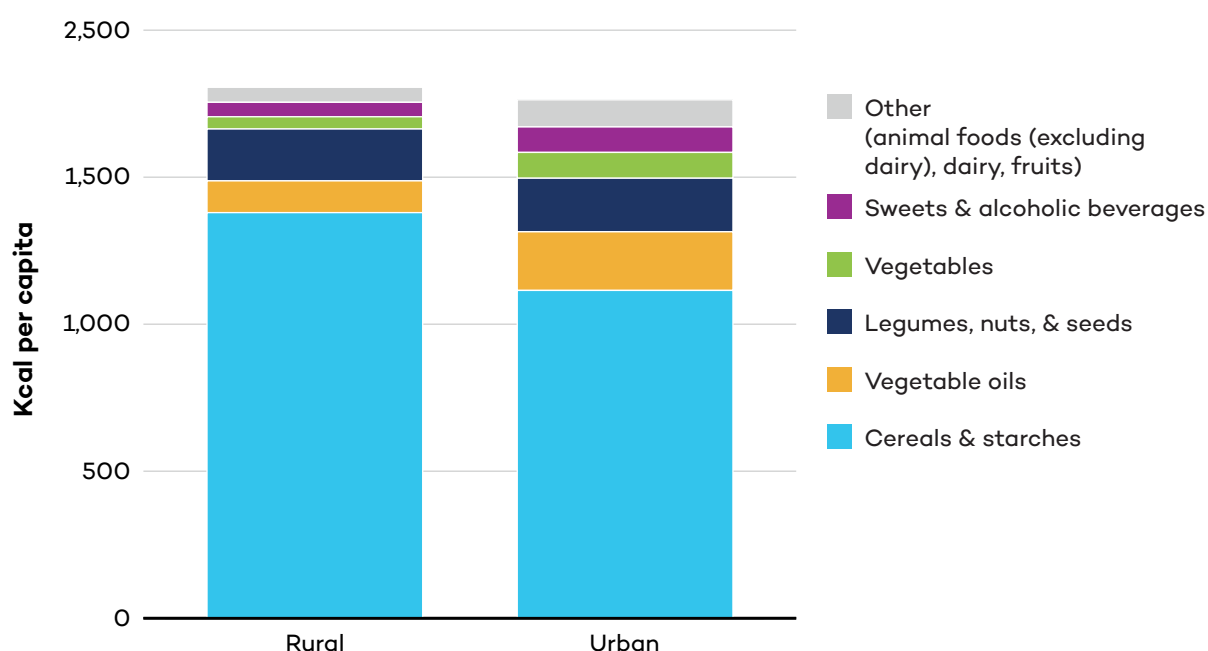


Source: Authors' analysis based on LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020) and nutrient coefficients based on FAOSTAT–SUA (FAO, 2021).



Considering caloric consumption by rural–urban location (Figure 5), we see that there is more variety in the urban diet, though both diets are cereal heavy. The urban diet has roughly 400 fewer calories of cereals consumed relative to rural areas, with a larger share of calories taken up by vegetable oils, vegetables, and animal-source foods. However, note the latter share remains small in urban areas, while it is almost non-existent in rural areas. The literature suggests that diets do marginally improve as people move from rural to urban areas in terms of increasing animal-source food consumption (de Brauw et al., 2018). However, some of the difference in animal-source food consumption between people in urban and rural areas illustrated below may be a result of measurement error in infrequently consumed foods (Abate et al., 2020).

Figure 5. Calories consumed, by food group and location, (Kcal per capita per day)



Note: Figures represent annualized mean values and do not reflect seasonal variations in dietary consumption.

Source: Authors' analysis based on LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020) and nutrient coefficients based on FAOSTAT–SUA (FAO, 2021).

These figures combine to suggest that, on average, dietary diversity is very low, and diet quality is poor. Poor diet quality is consistent with other indicators, including the high poverty prevalence and the unaffordability of more nutrient-dense foods.

2.2.2 Nutrition Indicators

In terms of specific population groups, 7% of children under five are affected by wasting, and 37% are affected by stunting. While wasting rates have remained variable over the last decade, stunting has decreased on average, from 44% in 2011 to 37% in 2019 (Mengesha et al., 2021). However, it is important to note that the prevalence of malnutrition is not uniformly distributed across Ethiopia's regions, and statistics relating to national prevalence



can mask variations in the subnational prevalence and distribution. For example, the national prevalence of stunting masks the variation from 14% in Addis Ababa to 49% in the Tigray region (Amaha, 2020). Similarly, while the prevalence of obesity is very low in the country (3% in 2008 versus 5% in 2016) (FAO, 2021), the statistical average masks significant gender differences. Ethiopia parallels the gender trends visible in Nigeria and Malawi, with overweight and obesity at 28% and 7%, respectively, for women, compared to 13% and 2%, respectively, for men (Global Nutrition Report, 2020). The prevalence of both overweight and obesity has been increasing steadily since 2000 (Global Nutrition Report, 2020), and therefore represents an issue of growing concern, especially considering the gender dimension.

Anemia affects one in four women of reproductive age, which is slightly lower than the average for sub-Saharan Africa. While the prevalence of anemia decreased considerably from 2000 to 2010, there has been a plateau in progress, with numbers even slightly increasing in recent years (Global Nutrition Report, 2020).

2.2.3 Current Dietary Policies

Ethiopia recently adopted food-based dietary guidelines, led by the Ethiopian Public Health Institute (Bekele et al., 2019; FDRE, 2022). To develop these guidelines, first, nationally representative surveys on consumption and micronutrient intakes were processed to identify dietary gaps relative to recommended levels of nutrients. Second, linear programming identified the lowest-cost ways of filling those gaps using prices prevailing in the surveys, provided such foods were available and used for consumption to begin with. Third, the findings were reviewed by local experts, with some iteration between steps two and three, as several things could change after the surveys were collected, including increased consumption of specific foods and/or nutrients, prevailing prices, or migration between areas with different average consumption bundles. These food-based dietary guidelines will now be used to construct an Ethiopia-specific healthy eating index, which can then be used to compare anyone's consumption against the reference diet.



Box 2. Food security and nutrition challenges and solutions as listed during the consultations

- A specific focus on pulses and legumes should be included as a healthier diet target for Ethiopia. Currently, these two food categories are highly prevalent in traditional diets and are already integrated into agricultural practices. There would also be a range of benefits, as legumes and pulses have greater nutrient density than cereals and starches and are linked to healthier soil management and regenerative agricultural practices.
- Ethiopia has a very large livestock population, one of the highest on the continent. This is coupled with very low animal-sourced food consumption. It was noted that productivity of the livestock sector needs to make improvements as it is very GHG-intensive, even compared to other countries on the continent.
- Because of the different quality and availability of the value chains in the country, the price of vegetables or fruits varies considerably depending on the region and season. This poses accessibility limitations on healthy diets and the applicability of broad policy frameworks.
- Public–private partnerships, particularly those related to growing and selling nutritious food, are deemed particularly relevant for Ethiopia as a net importer of food.
- There seems to be a need for increases in production of nutritious crops in order to overcome issues of affordability and seasonality.

Source: Information listed in this box was collected during the project consultations with national stakeholders and donor agencies. For details on the consultations, see Appendix B.

Ethiopia also has several policies related to nutrition and healthy diets. In 2015, the Second National Nutritional Programme was instituted, designed to consolidate policy around improving maternal and child nutrition, and to progress on stunting and underweight among children under 5 years of age. Ethiopia also has a national salt iodization mandate (FDRE, 2016b). Its policy is no longer only focused on undernutrition or micronutrient deficiency. According to the WHO Global Health Observatory (2019), Ethiopia is implementing a multisectoral noncommunicable disease policy to try to reduce the increase in diseases associated with overweight and obesity. To combat overweight and obesity, Ethiopia also has a 40% ad valorem tax on sugary beverages (Bahl & Bird, 2019).

2.3 Climate Change Impacts, Mitigation, and Adaptation Responses

Any effort to address nutritional challenges, food security, and agricultural productivity needs to account for climate change and climate variability, which are already having significant impacts on livelihoods, the economy, and the agricultural sector (FDRE, 2010). Policy pathways geared to food system transformation need to consider responses to climate change, including measures to assist small-scale producers in improving their capacities to adjust



production practices to climate change impacts and variability. It is also critical to focus on overall more sustainable and resilient approaches to production intensification, with a specific focus on integrating environmental and climate perspectives into policies and strategies (see Box 4) (FDRE 2010, 2015).

2.3.1 Climate Change Mitigation and GHG Emissions

Emissions from agriculture⁵ and agriculture-related land use⁶ per dollar of agricultural production are high, at 7.3 metric tonnes per thousand (constant 2014–2016 international dollars), versus 10.9 for least developed countries on average and 3.0 at the global level (FAO, 2018).

GHG emissions from agriculture (i.e., emissions from yearly production activities) are predominantly from livestock production. From 2008 to 2018, GHG emissions from agriculture production (production not including deforestation for agriculture or other uses) increased by 30%, driven in large part by increasing livestock production (Figure 6) (FAO, 2021).

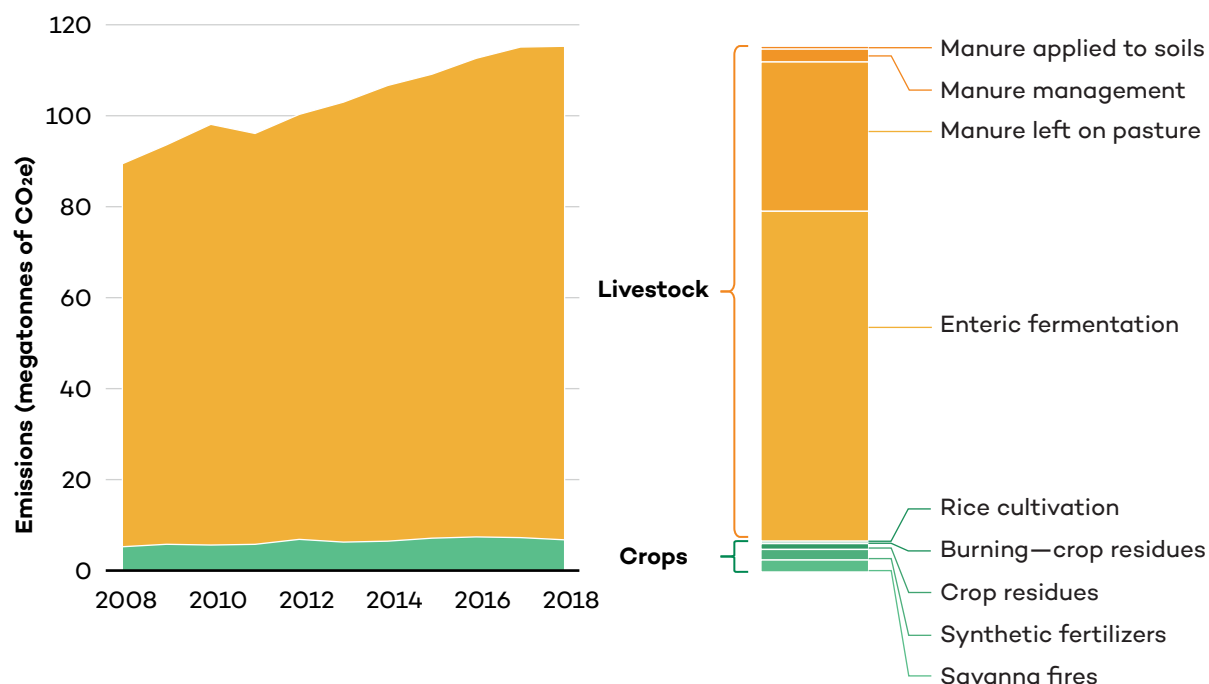
Agriculture-related land-use emissions, which are generally emissions from converting natural land to agricultural land, are only about one-third the magnitude of agriculture emissions and are relatively stable (agriculture-related land-use emissions averaged 33 megatonnes of CO₂eq per year from 2008 to 2018, versus 103 megatonnes for agricultural emissions in 2018) (FAO, 2021).

⁵ Agriculture emissions cover the following sources of emissions: enteric fermentation, manure management, manure left on pasture, manure applied to soils, cultivation of organic soils, rice cultivation, synthetic fertilizers, crop residues, burning of crop residues, burning of savanna, and on-farm energy use. They do not include, and are measured separately from, agriculture-related land-use emissions. See the methodological note available at <http://www.fao.org/faostat/en/#data/GT> for detail. While on-farm energy use is included in the modelling, it is omitted from some items here due to data gaps.

⁶ With a focus on agriculture, the sources of emissions include emissions from cropland, grassland, net forest conversion, and fires from burning of organic soils and humid tropical forests. They do not include, and are measured separately from, agriculture emissions. See the methodological note available at <http://www.fao.org/faostat/en/#data/GL> for detail. While agricultural emissions can largely be conceptualized as flows (emissions that are released each year due to production activities, such that emissions and production occur in the same year), agriculture-related land-use emissions can be better conceptualized as stocks (emissions come from a one-time action such as deforestation or draining of histosols, with emissions occurring over one or many years but not linked to the year of production).



Figure 6. Agricultural GHG Emissions in Ethiopia



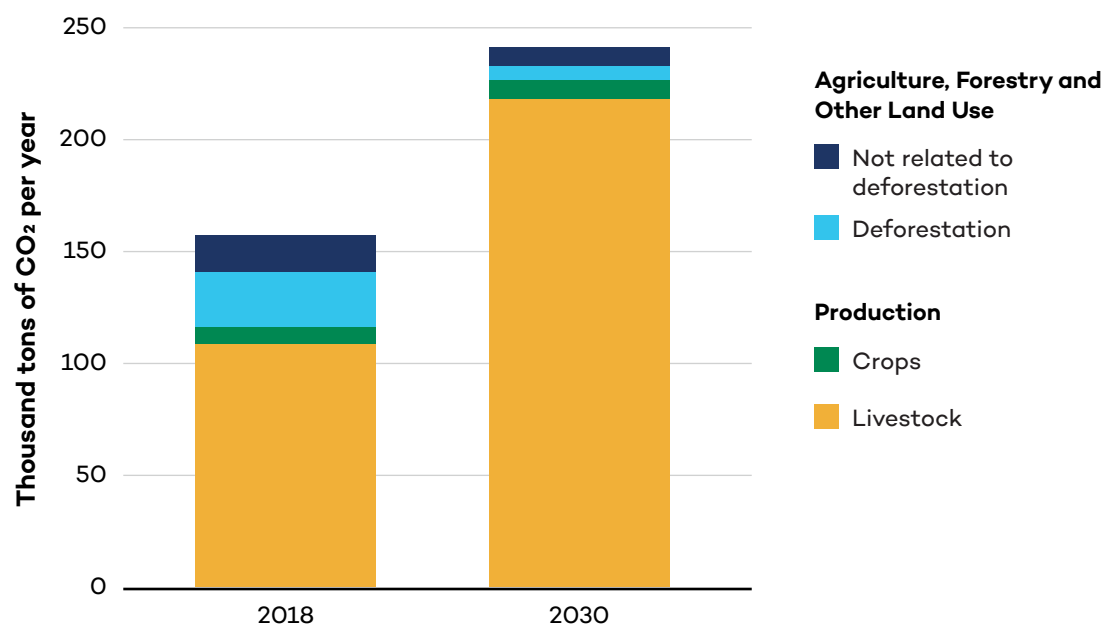
Source: Data from FAOSTAT (FAO, 2021).

During the 2008–2018 period, GHG emissions from agriculture have increased by over 20% (see Figure 6). This has been driven in large part by increased livestock production. This increase in livestock production is expected to continue even without any additional political interventions. The agricultural sector will continue to develop as the demand for food increases, particularly for animal products. In the business-as-usual (BAU) scenario, this will lead to a dramatic increase in the production of GHG emissions, by 5.8% per year till 2030, or 75% in 10 years. The BAU scenario also shows a worsening trend for environmental indicators, including not only GHG emissions from agricultural production but also emissions from land conversion to agriculture, as well as increased deforestation and water use. Land-use change from forestry to agriculture will reach a plateau, with expected limited deforestation, leading to a reduction in forested area by only 1% in the next 10 years.

Nevertheless, the most significant growth and share in total GHG emissions in the country will be from the expanding livestock sector. This represents a major tension between social and economic goals on the one hand and environmental goals on the other. To assist with the transition toward healthier diets and meet the nutritional needs of the people, Ethiopians need to consume more animal-source foods, including dairy. This is essential to ensure people have sufficient calcium and B12 to live a healthy life. Animal-source foods, including dairy, are the most efficient and effective way to absorb this nutrient and vitamin. Therefore, simultaneously improving the emission efficiency of livestock production and finding alternative sources of food to provide vital nutrients and vitamins, are critical if Ethiopia is to keep its GHG emissions within its targets as presented in the country's updated NDC under the Paris Agreement while simultaneously transitioning its population to healthier diets.



Figure 7. Agricultural and land use emissions (domestic emissions only): Scenario without the NDC, 2018 and 2030, total



Source: Authors' diagram based on FAOSTAT (FAO, 2021) for 2018 and MIRAGRODEP model projections. Intergovernmental Panel on Climate Change Tier 1 approach used.

In terms of policy priorities for climate action, Ethiopia submitted to the United Nations Framework Convention on Climate Change (UNFCCC) its updated climate action plan under the Paris Agreement in July 2021 (FDRE, 2021b). In its updated NDC, the country presented its mitigation commitments in the form of GHG emissions reduction targets, contributing to the Paris Agreement goal of keeping the global average temperature rise “well below” 2°C and pursuing efforts to limit the temperature increase to 1.5°C (UNFCCC, 2015). The NDC is based on the country’s Climate Resilience and Green Economy Strategy (FDRE, 2010). In its NDC, the country commits to an unconditional emissions reduction of 14% relative to BAU by 2030,⁷ based on domestically supported and implemented policies and measures. The NDC also puts forward a more ambitious target of a 60% additional reduction by 2030 relative to BAU, but this contribution is contingent on the provision of international support and funding. For both targets, the highest contribution is assumed to come from the energy sector. For the agricultural sector, the updated NDC projects a very minimal (less than 3%) reduction in emissions by 2040 compared to BAU (FDRE, 2021b). However, there is space for significant additional contributions to the country’s conditional emissions reduction targets, including creating a resilient livestock sector with low levels of GHG emissions by 2030 and beyond. Donor support is crucial for such a critical transformation.

⁷ This expected reduction is relative to the BAU scenario used in the updated NDC; please note that this scenario is different than the BAU scenario in Ceres2030.



2.3.2 Climate Change Impacts and Adaptation

Ethiopia's climate is highly variable and will continue to be in the future. The country's average annual temperatures vary from 10°C in the highlands to about 35°C in the lowlands. Observed climate trends in Ethiopia over a 50-year period reveal that temperatures have increased at an average rate of 0.25°C per decade since 1960, with increases varying between 0.1–0.4°C for 10 years, cumulatively amounting to an increase of 1.3°C from 1960 to 2006 (FDRE, 2019). A significant decline in precipitation was also observed in the Belg (the short rainy season in March–April in parts of south-central and eastern Ethiopia) (FDRE, 2015b). Mean annual rainfall decreased between 1951 and 2010 (FDRE, 2015b). While the regions differ significantly in terms of rainfall, the average rainfall shows a decreasing trend for the whole country (FDRE, 2019). Finally, Ethiopia is highly vulnerable to drought, with significant impacts on agricultural productivity and related impacts on incomes, food security, and nutrition.

Ethiopia's projections of future rainfall include both wetter and drier scenarios. Box 4 shows a summary of the projected changes as a result of climate change. Under these complexities and the increase in weather variabilities, it is expected that there will be a decline in agricultural and livestock productivity of between 3% and 30% by 2050 (World Bank, 2021b). With estimates suggesting that livestock revenues could decrease by up to 50% by 2050 (World Bank, 2021b). Temperature increases and declines in rainfall may also lead to the disappearance of certain types of biodiversity (e.g., montane and lower montane wet forest and subtropical desert scrub). These changes may have substantial impacts on the production of timber and non-timber forest products and ecosystem services such as water, soil catchment management, flood protection, and availability of fuelwood (World Bank, 2021b). All of these factors negatively affect food security.

Ethiopia's agricultural sectors, particularly crop cultivation, pastoralism, and agro-pastoralism, are heavily dependent on rainfall. This means that temperature, the level and temporal distribution of rainfall, and other climatic factors during the growing season, are key determinants of crop yields and, in turn, food security, malnutrition, and famine. Rainfed agriculture contributes to nearly half of national GDP and is the mainstay of livelihoods for 85% of the population (FDRE, 2019, 2016). According to the Nutrition Sensitive Agriculture Strategy, dependence on rainfed agriculture and subsistence farming systems is a significant factor contributing to the nutrition problem (FDRE, 2016b). Additionally, crop production is dominated by small-scale subsistence farmers who employ low-intensive technologies with inadequate access to services and infrastructure (United States Agency for International Development [USAID], 2015). Many farmers grow slow-maturing, high-yield “long-cycle” crops that depend on two rainy seasons to reach harvest, and only about 1% of cultivated land is irrigated. This leaves the sector highly vulnerable to a changing and more variable climate, particularly given the insufficient investment in building resilience to climate change. These challenges and sectorial vulnerabilities are often worsened by limited access to resources and capacities for women and vulnerable groups.



Box 3. Summary of historical and projected climate change impacts in Ethiopia

Historic Weather and Climate

- From 1960 to 2016, the temperature increased by 1.3°C (FDRE, 2019).
- Using averages, the number of warm days has increased by 20%, and the number of cold days has decreased, except for the period between December and February. The frequency of cold nights has decreased in all seasons (McSweeney et al., 2010).
- The trend in rainfall does not show a consistent pattern, and rainfall trends have also been highly diverse for the regions of the country (McSweeney et al., 2010).

Projected Weather and Climate (FDRE, 2019)

- The projected temperature increases vary from -0.5°C to 6°C by 2100 compared to a baseline covering the period between 1975 and 2005.
- Models also project an increase in annual precipitation of at least 4% (and up to 12%) by 2100 compared to the 1975–2005 baseline.

The Government of Ethiopia has demonstrated a strong political will to address climate change and its impacts through adaptation and mitigation measures. In 2007, Ethiopia developed its National Adaptation Programme of Action (NAPA), covering 11 priority projects to respond to climate change impacts and build resilience (FDRE, 2007). The 2010 Ethiopian Programme of Adaptation to Climate Change continued to further develop the priority areas listed in the NAPA. The Climate Resilient Green Economy (CRGE) strategy focuses on integrating climate change into the national development strategy and building a climate-resilient future (FDRE, 2011). One of the areas the CRGE aims to promote is climate-smart agriculture to achieve higher rates of food security (FDRE, 2011). The CRGE is also the basis for the integration of climate change impacts and responses into the Growth and Transformation Plan II (GTP II) (FDRE, 2016a) and the Livestock Master Plan (FDRE, 2015c) by focusing on climate-smart agriculture, improving capacities of farmers to adapt to climate change, and improving the management of soil and water.

In 2019, Ethiopia became one of the few countries to develop a National Adaptation Plan (NAP). The NAP identifies 18 adaptation options covering diverse sectors to address vulnerability across Ethiopia's geographical regions and social groups. Among the listed options, the strategy mentions “enhancing food security by improving agricultural productivity in a climate-smart manner and strengthening sustainable natural resource management and improving soil and water management” (FDRE, 2019, p. 14). Ethiopia’s recently updated NDC also stresses the importance of improving productivity in the livestock sector and using advanced fodder to reduce contributions to climate change (FDRE, 2021b).

Climate change and climate variability affect food security in various ways. This includes impacts on agricultural production, both in terms of quantity and quality, as well as in terms of availability of certain foods. Studies that have examined the relationships between diet



diversification and climate variables in Ethiopia reveal a relationship between rainfall and dietary diversity. They show that in places with high rainfall variability, households have low dietary diversity (Hirvonen et al., 2016; Teklewold et al., 2019).

The adoption of climate-smart agriculture and associated technologies has been shown to increase dietary diversity and improve food quality through higher calorie and protein availability, leading to improved nutritional outcomes (Stifel & Minten, 2017; Teklewold et al., 2019). It is noteworthy that higher nutritional outcomes and dietary diversity are associated with an increased use of a combination of technologies related to climate-smart agriculture, as opposed to a single climate-smart agriculture technology (Herforth & Ahmed, 2015; Teklewold et al., 2019). However, access to such advanced technologies may not be possible for vulnerable groups unless specific measures are used to engage them.

From a policy perspective, food security and improving people's access to food are included in the country's major strategies focused on responses to climate change, including its NAPA, CRGE strategy, and NAP (FDRE 2007, 2011, 2019). While these strategies focus less on nutrition and moving toward healthier diets, these aspects are covered in the Seqota Declaration aimed at integrating climate- and nutrition-smart agriculture into existing agricultural programs. The Seqota Declaration has a strong focus on improving the knowledge, attitudes, and practices of smallholder farmers and their households to improve food security and nutrition as well as on initiatives to support the production and consumption of fruits and vegetables, pulses, milk (primarily goat) and dairy products, diverse types of meat products, fish, and honey (FDRE, 2018).

Finally, Ethiopia has identified the private sector as an important player in climate change adaptation. Its updated NDC, CRGE, and NAP highlight that the government will engage with the private sector in the agricultural and energy sectors to support the country's development (FDRE, 2011, 2019, 2021). The role of the private sector, as per the policy documents, includes providing farmers with access to financing and technical assistance, as well as support to build skills needed to adapt to and mitigate climate change.



3.0 Achieving Sustainable Food Systems Transformation in Ethiopia: What would it cost?

This section identifies pathways—and the associated costs and interventions—for addressing the interlinked challenges of the food system in Ethiopia. The focus is on improving hunger, poverty, and nutrition outcomes by increasing incomes, moving toward healthy diets using a more climate-resilient production system with fewer GHG emissions, and improved adaptive capacities of farmers. This section presents a transformation scenario with a trajectory to drive poverty reduction and support a change in food supply and demand, which leads to a “nutrition transition” in diets. However, such a transition creates environmental and land-use impacts that range from changing production patterns, including soil degradation, overuse of water resources, and increased GHG emissions, as well as health challenges associated with obesity and diet-related diseases such as diabetes or cardiovascular disease. These linkages demonstrate that market-based solutions alone will not produce outcomes that simultaneously address environmental and climate constraints while meeting nutritional targets. Thus, the core focus is to identify policy interventions and related public and donor costs to influence production and consumption patterns that lead to better environmental and nutritional outcomes.

This section presents the additional public costs of transforming agriculture and food systems in Ethiopia and the share of external resources needed. The methods and approaches are described in Section 4, including the scenarios, targets, and interventions included in the CGE model and a discussion of the limitations of the research approach.

3.1 The Additional Public Cost of Achieving a Sustainable Food System Transformation

Based on the policy interventions identified to deliver improvements in diets while mitigating and adapting to climate change, the model estimates the cost of public investment, including domestic and external resources needed to achieve the targets for sustainable food system transformation. Sustainable food system transformation is achieved through SDG 2 sub-targets, including 3% or less people affected by hunger (SDG 2.1), healthier diets (SDG 2.2), doubling of the net incomes of small-scale producers on average (SDG 2.3), and GHG emissions in line with NDC commitments (SDG 2.4). While it is not possible to directly incorporate climate change adaptation (SDG 2.4) into the macroeconomic modelling due to the 2030 timeline, it is an important element of achieving resilient agricultural production and needs to be prioritized in the coming decade.

There is currently no universally accepted definition of a healthy diet. And yet, in order to estimate costs, there is a need to establish a healthier diets target in the model.⁸ Therefore,

⁸ All targets apply to all households in the population. Full documentation of our dietary targets selection can be found in a technical note for the project, “Dietary Target Choices” (Bizikova et al., in press).



based on national and international guidelines and policy documents, a review of nutrition literature, and expert consultations, we focus on four targets for achieving healthier diets as appropriate for guiding national-level food system investment:

1. **Overall caloric intake** measured using PoU as a metric, with a target of less than 3% PoU in each country.
2. **Adequate consumption of non-starchy vegetables and fruits**, based on the WHO guidelines of 400 g of fruits and vegetables per day (FAO & WHO, 2003; WHO, 2020).
3. **Adequate consumption of animal-source foods** (including dairy), through a minimum target of at least 10% of households' overall caloric intake to ensure sufficient calcium and B12.
4. **Adequate consumption of legumes, nuts, and seeds**, through a minimum target of at least 10% of households' overall caloric intake.⁹

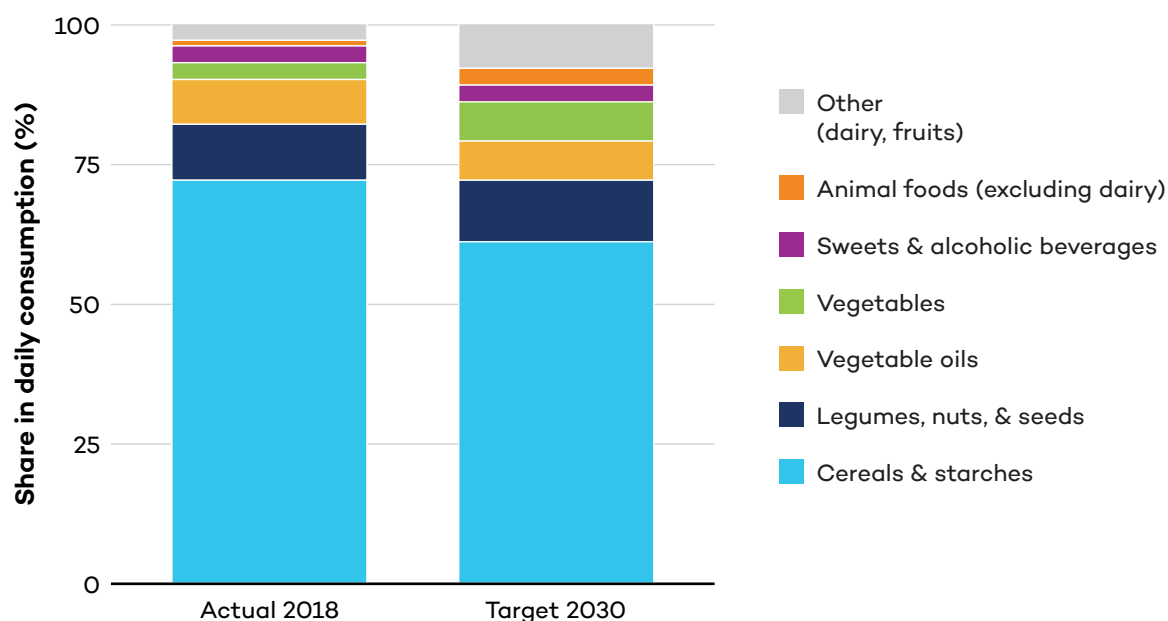
Importantly, the modelling of diets requires that all households achieve caloric sufficiency, but it also demands that households achieve healthier diets. In this way, we model public spending that promotes diversification without compromising on hunger.

Figure 8 compares the existing dietary consumption patterns in Ethiopia and the dietary composition targets included in the modelling framework. When comparing the current diet and a future (healthier) diet, there are considerable differences in terms of consumption of fruit, animal-source food, and legumes and beans. As there is also a need to improve overall daily calorie intake, the consumption of starches also needs to increase.

⁹ For Ethiopia, there is an additional target for the adequate consumption of legumes, nuts, and seeds, due to strong requests from national stakeholders during country consultations. See Box 3 and Food Systems Summit 2021 Dialogues (2021).



Figure 8. Comparison of the current (2018) and targeted dietary composition in Ethiopia: Consumption per capita, actual and targeted (food grams)



Note: For further details about the model targets, see Section 4.2.2.

Source: Authors' diagram, using data from the LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020) and MIRAGRODEP model simulations.

The policy interventions are grouped in three broad areas, following the modelling framework from Ceres2030: Sustainable Solutions to End Hunger:

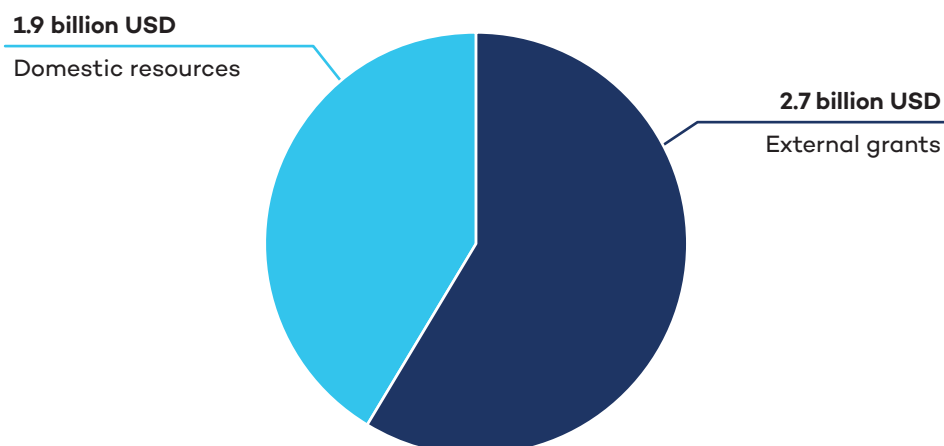
- **Empower the excluded**, which includes actions that directly support consumers, such as social protection programs, nutrition education, vocational training, and school feeding programs.
- **On the farm**, which includes actions that directly support producers such as investment and financial services, fertilizer subsidies, production subsidies, as well as research and development (R&D) and extension services. There are also important interventions to support irrigation infrastructure and livestock production through agroforestry.
- **Food on the move**, which includes actions to improve the functioning of markets and value chains, such as roads, electricity, storage, mobile networks, and other infrastructure interventions.

3.2 The Financing Gap

Results from the modelling show that, in Ethiopia, it would cost an additional USD 4.6 billion in annual public investment from now until 2030 to end hunger, double the incomes of 11.7 small-scale producers on average, transition to healthier diets for 108 million people, and protect the climate.



Figure 9. Summary of total additional public costs required per year, 2023–2030



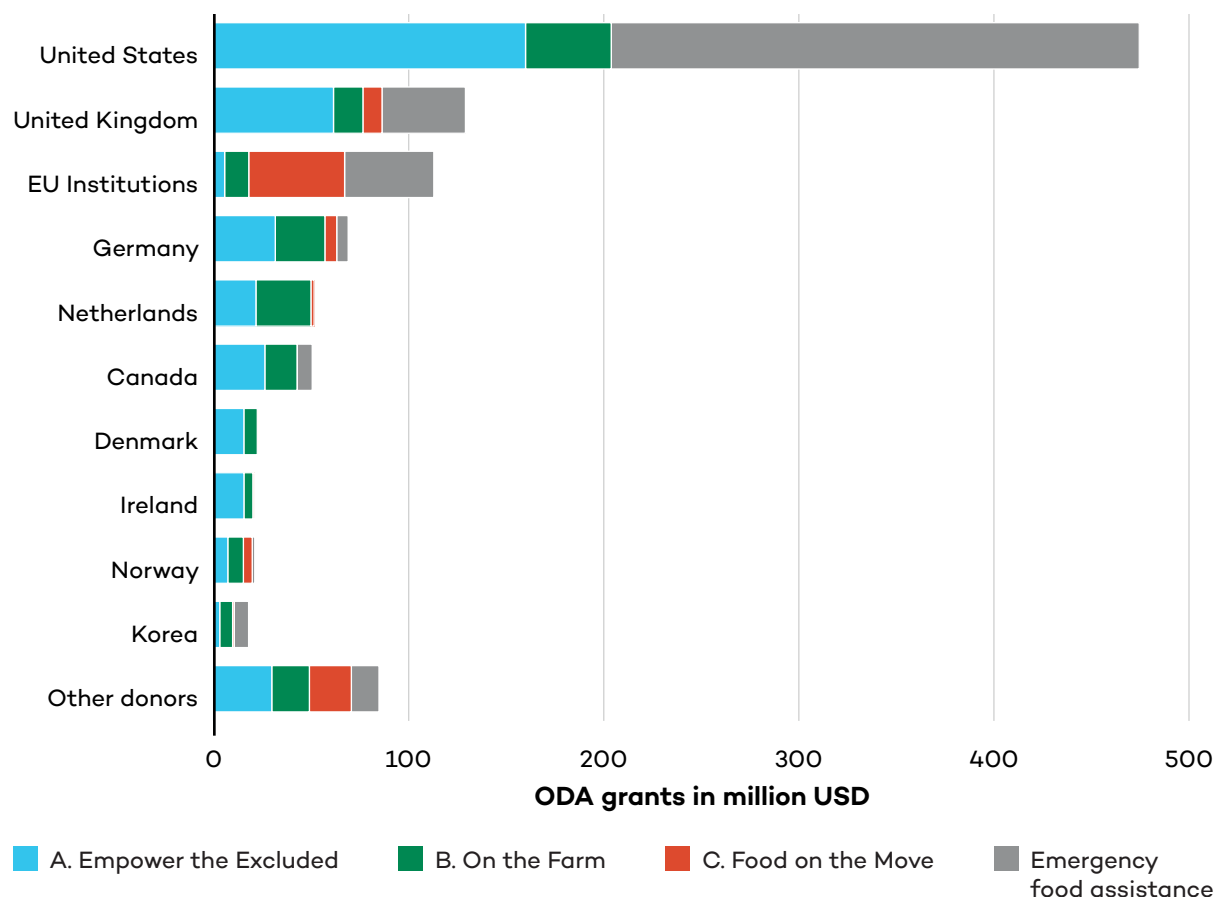
Source: Authors' diagram based on MIRAGRODEP model simulations.

To contextualize this required increase in public costs directed toward the food system, donors currently disburse an average of USD 659 million per year to projects directly affecting agriculture and food security and nutrition in Ethiopia (see Figure 10).

Currently, and as recognized in Ethiopia's strategies, ODA plays an important role in promoting resilience, sustainability, and nutrition. The United States is by far the top donor to projects in agriculture and food systems in Ethiopia, followed by the United Kingdom, Germany, and European Union (EU) Institutions. Overall, the top 10 donors account for USD 659 million in annual assistance (2017–2019 average) (see Figure 10). A desk review of the projects implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the EU, and United States Agency for International Development (USAID) found 32 projects that closely related to the nexus of food security, nutrition, and climate change. The focus of these projects ranged from nutrition education and school feeding to production support, agri-development, extension services, and capacity development (see Bizikova et al., 2022a). Most of the identified projects focused on two elements of the nexus. For example, providing agricultural inputs and technological training to support the production of diversified, nutritious crops and providing nutrition education on their usage (Delegation of the European Union to Ethiopia, 2019; GIZ, n.d.-b) or increasing agricultural productivity through the use of climate-smart agriculture or drought-resilient farming techniques (GIZ, n.d.-a, n.d.-i; Global Climate Change Alliance Plus Initiative, 2018b). Three of the identified projects directly addressed all three aspects of the nexus. Two adopted an umbrella-style approach and included a variety of interventions designed to increase agricultural productivity and diversity, address malnutrition through nutrition education, and increase resilience and improve natural resource management (Feed the Future, n.d.; GIZ, n.d.-d). The third, implemented by the EU, focused on the introduction and production of quinoa, which, in containing all the essential food groups required for growth and only needing a small amount of rain to grow, simultaneously addresses all three elements of the nexus (Delegation of the European Union to Ethiopia, 2018b).



Figure 10. Top 10 donors by average annual disbursement, 2017–2019



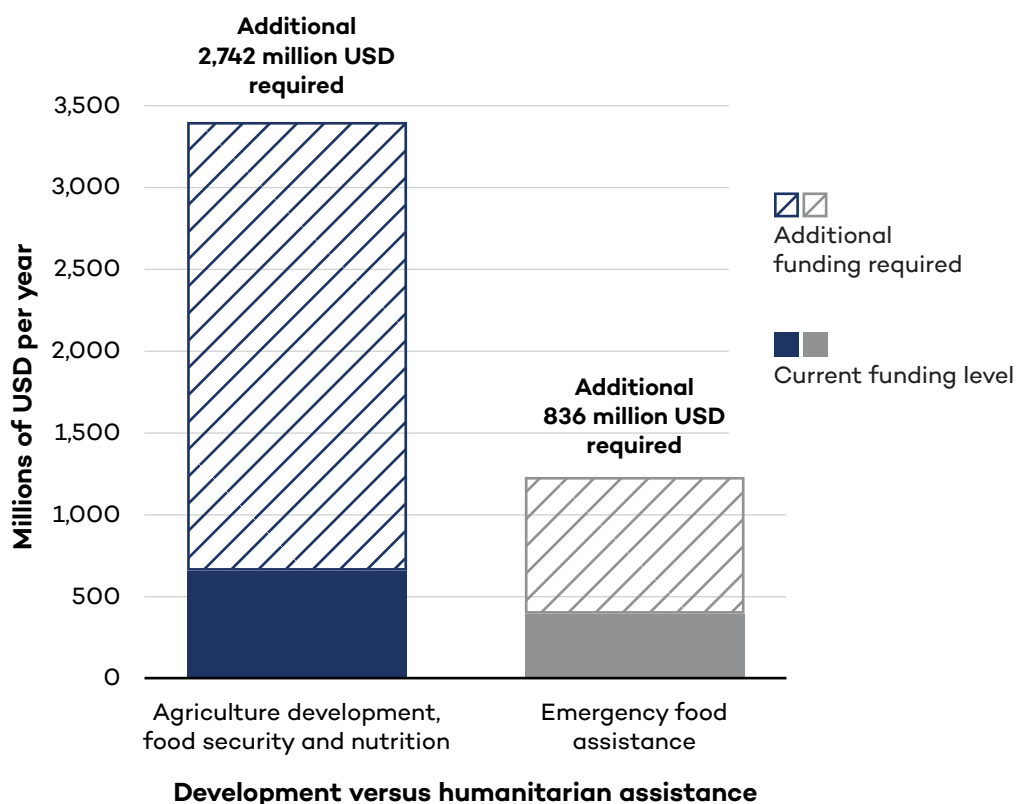
Source: Authors' analysis of OECD's Creditor Reporting System (CRS) (OECD, 2021)

Results from the modelling show that of the additional USD 4.6 billion required, USD 2.7 billion per year on average needs to be provided by external resources (donors). A critical part of these estimates is not only the amount but also the gap between current expenditures and future resources needed. Currently, donors provide an average of USD 659 million per year. Therefore, in Ethiopia, donors need to increase their disbursed resources by over 300%.

Importantly, comparing the gap between the long-term investment needed to achieve SDG 2 and the short-term investment needed for emergency food assistance reveals a significant underfunding of the longer-term investment needs (Figure 11). The shortfall in longer-term funding increases the vulnerability to shocks and crises, pushing the number of people affected by hunger and poverty higher. This is incredibly pertinent given the devastating impacts of current crises, such as the conflicts in Tigray and Ukraine, including the considerable rise in need for emergency food assistance. Donors should increase their allocations to longer-term development priorities in order to support resilience building, which would help mitigate against future shocks and crises.



Figure 11. Additional donor contributions needed for long-term agriculture and food security investment compared to emergency food assistance



Source: Authors' diagram based on MIRAGRODEP model simulations.

3.3 How Should the Money Be Spent?

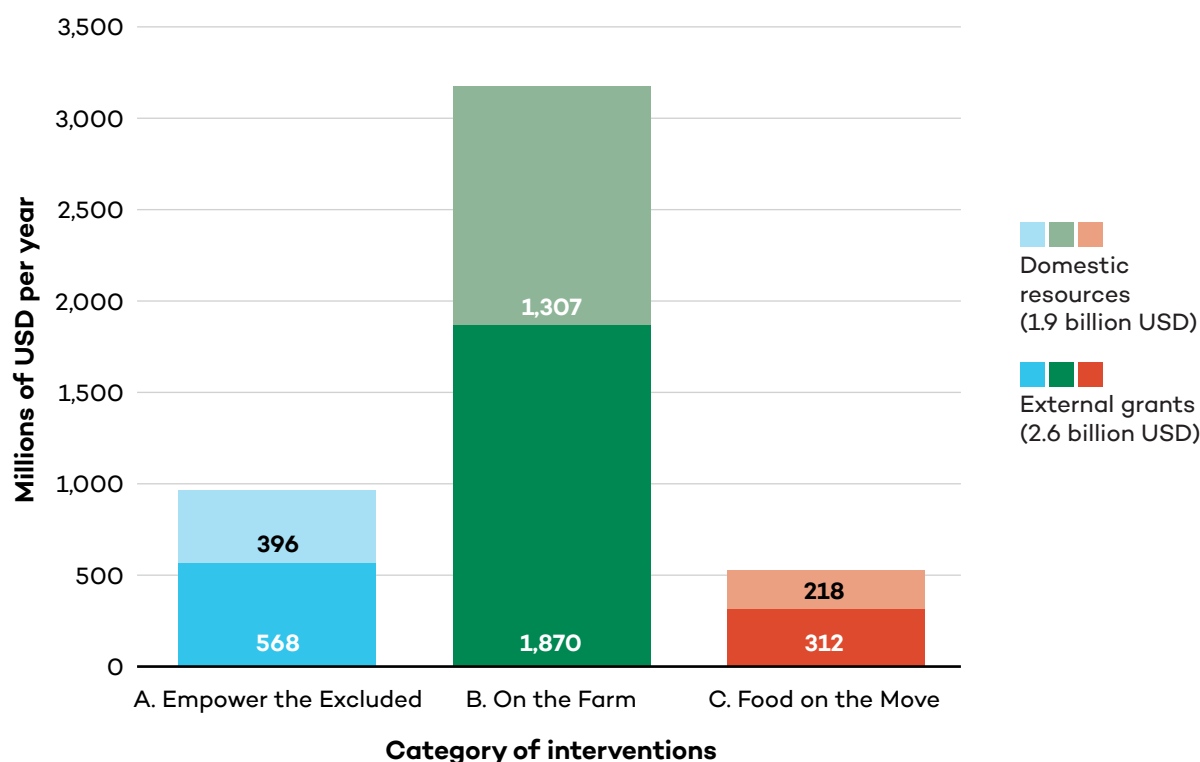
To achieve sustainable food systems transformation, what matters is not only the total public costs, but also the allocations to specific interventions (Figure 12) and policy and strategic support to promote the implementation of these interventions. In this context, it is critical to prioritize the actions and programs outlined in existing policies and strategies (as stressed during the consultations, see Box 5) and, if necessary, complement these policies with additional actions to account for the outcomes of the cost modelling.

3.3.1 Interventions Supporting Food System Transformation

Figure 12 shows the allocation of the total public costs across the three areas: an additional USD 964 million per year is needed to “Empower the Excluded,” USD 3,176 million is needed annually “On the Farm,” and USD 531 million is needed every year for “Food on the Move.”



Figure 12. Summary of additional public funding required, grouped by intervention category



Source: Authors' diagram based on MIRAGRODEP model simulations.

Of the three broad areas, the largest share (USD 3,176 million) is allocated to farm interventions, which provide direct support to farmers to produce more food, improve production quality, and increase production diversity. This category of interventions receives the largest share, as they provide multiple benefits to the farming community by improving capacities (including knowledge and inputs to increase productivity), income, and food security and nutrition.

On-farm interventions not only lead to income improvements—but they also result in improved access to healthier foods, such as fruits and vegetables and animal-source foods. As suggested during consultations, these complement, and need to be complemented by, other nutrition-focused measures such as nutrition education and school feeding programs in order to have maximum effect on dietary outcomes (see Box 5).

The next biggest share goes to empowering the excluded, which amounts to USD 964 million, and includes nutrition education and school feeding programs, which were two priorities that were stressed multiple times by multiple participants during the consultations (see Box 5).

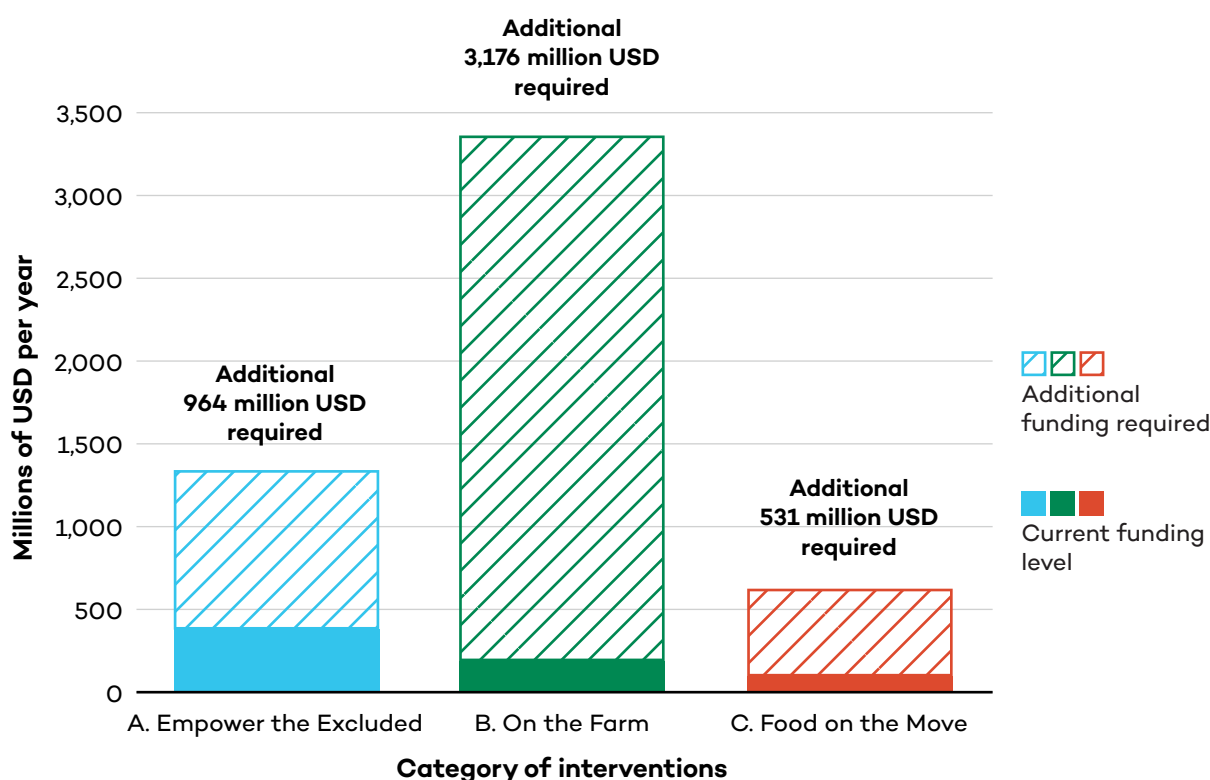
The smallest share of financial allocations (USD 531 million) is to be spent on market and value chain interventions, which are closely linked to farm-level measures and link producers to consumers. These interventions directly contribute to dietary diversity as households with better access to local markets tend to have higher dietary diversity (Hirvonen et al., 2016). In



Ethiopia, promoting access to storage, energy, and water, especially for nutritious foods such as vegetables, fruit, and animal-source products, helps improve the nutrition of households accessing these foods, and this is recognized in the country’s policies (see Box 3 and Box 5; see also Section 3.2.3).

The priority areas for the required increase in donor spending mirror this distribution across the three categories of interventions; an additional USD 1,870 million is needed on the farm, USD 568 million to empower the excluded, and USD 312 million for food on the move (Figure 13).

Figure 13. Total annual external funding required grouped by intervention category



Source: Authors’ diagram, using data from the OECD’s CRS (OECD, 2021) and MIRAGRODEP model simulations.

3.3.2 Policies Supporting Sustainable Food System Transformation: Focus on food security, nutrition, and livelihoods

Several key government strategies emphasize the need to improve the sustainability of the food system in Ethiopia, including the National Nutrition Program (FDRE, 2013), the second Agricultural Growth Program (FDRE, 2015a), the Growth and Transformation Plan (FDRE, 2016a), the Seqota Declaration (FDRE, 2018), and the Nutrition Sensitive Agriculture Strategic Plan (FDRE, 2016b). These strategies stress the important contribution of agriculture to better food security and, in some cases, also nutrition by improving aspects of agricultural production such as productivity, investing in value chains, increasing household



income, and encouraging the uptake of risk management and adaptive strategies to promote climate resilience. The strategies also emphasize the need to consider the environmental impacts of agricultural investments and that priority should be given to environmentally friendly agricultural investments, for example, those focused on climate-smart agriculture. The strategies also acknowledge the role of donor support in promoting sustainability and the need to better target donor support.

From the policy perspective, there are a number of specific strategic and policy actions that support the interventions included in this study. Ethiopia's policy documents and strategies—including the Livestock Master Plan, GTP II, 2015–2020, and the Nutrition Sensitive Agriculture Strategy (FDRE, 2015c, 2016a, 2016b)—identify as top priority farm-level interventions that aim to improve both plant and livestock productivity. These interventions also require the highest financial contribution from the public sector. Generally, Ethiopia's policies and strategies see increasing agricultural productivity (both crop and livestock) as critical to improving the economy's competitiveness, assisting in agricultural transformation, and contributing to poverty reduction. Thus, the significant financial allocations in the model to on-farm interventions are in accordance with Ethiopia's GTP II 2015–2020, which stresses the importance of “full and effective implementation of the existing productivity enhancing strategies” (p. 20), including high-quality and targeted extension support, improved access to technology and farmers' capacity to use it, establishment and support of farmer organizations, and promotion of agricultural research (FDRE, 2016a). The strategy also stresses the importance of enabling smallholder farms to address productivity gaps, mostly by promoting access to technology and extension services, scaling up best practices, and introducing new appropriate technologies and farming practices with a specific focus on productivity. Interventions addressing agricultural productivity are well covered by donor initiatives in Ethiopia. The majority of projects implemented or funded by GIZ, USAID, and the EU, have an objective or strategy that focuses on improving agricultural productivity, including supporting the introduction of locally adapted seeds or climate-smart agriculture practices; providing access to, and training in, agricultural mechanization techniques; enabling smallholder access to national and international markets; and providing capacity development to extension service providers (see Bizikova et al., 2022a).

In addition to the above-listed measures relevant for both plant and animal production, Ethiopia's policies and strategies include specific measures for different types of production. In terms of plant productivity improvements, they recommend focusing on strategic food crops, including staples and pulses, as well as crops that deliver nutritional benefits, such as local crops and varieties of fruits and vegetables (FDRE, 2016b). Donor-funded programs have encouraged the introduction of quinoa and orange-fleshed sweet potatoes due to their climate resilience and nutritiousness (Delegation of the European Union to Ethiopia, 2018b, 2019). Additional measures listed in the policies to support plant productivity include promoting access to high-quality seeds, setting up nurseries for trees, and disseminating improved varieties of crops and animals, including indigenous foods (FDRE 2016b, 2018b). Such measures are also visible in donor initiatives such as GIZ's “Supporting Sustainable Agricultural Productivity in Ethiopia” program, which seeks to support the provision and regulation of locally adapted seeds (GIZ, n.d.-e) or the “Strengthening Drought Resilience in Arid and Semi-Arid Lowlands Programme,” which trains agro-pastoral communities to produce multipurpose and fruit trees in nurseries (GIZ, n.d.-c).



In terms of improving livestock productivity, policy documents stress that priority needs to be given to increasing productivity levels in milk and meat production by addressing feed availability and quality, animal health, and breeds (FDRE, 2016a, 2016b). Specific policy actions to help increase productivity include enhancing veterinary coverage through private–public partnerships to improve animal health, promoting fodder production (also part of the country’s updated NDC), and accelerating the use of more suitable breeds (FDRE 2016b, 2021b). Despite the importance allocated to sustainable livestock intensification in policy documents, the authors only found three of the 32 donor-funded projects in Ethiopia addressed livestock interventions: the EU’s Supporting Horn of Africa Resilience initiative, which offers support to animal health services, including vaccinations (European Commission, 2013); GIZ’s Strengthening Drought Resilience in Pastoral and Agro-Pastoral Communities of Afar and Somali Regional States, Ethiopia, which assists in securing land and water for the production of livestock feed (GIZ, n.d.-i); and USAID’s Feed the Future Project, which seeks to increase the productivity and diversity of the livestock sector (Feed the Future, n.d.). Considerable effort is therefore needed to transform Ethiopia’s livestock policies into implemented programs and visible outcomes.

Measures to improve value chains and access to markets are listed in the GTP II (FDRE, 2016a). The strategy focuses on efforts to reduce post-harvest loss, improve food safety, and reduce spoilage of meat, dairy, and other perishable products. Specific measures include improving producers’ knowledge and skills to reduce food loss during production and storage of animal and plant-based perishable food items, as well as households’ knowledge about food waste and safe food storage methods. Most of the measures, however, aim to reduce food loss through extension services and investments in storage, processing, and packaging technologies that directly target producers and not consumers. This is reflected in the focus of donor-funded projects. Of the three identified projects that included measures to tackle food loss and waste, two focused solely on post-harvest production and processing techniques, with the intention of improving product quality (GIZ, n.d.-g, n.d.-f). Only GIZ’s “Global programme Food and Nutrition Security, Enhanced Resilience” project addressed actions at the household level to produce, store, and prepare diverse and nutritious foods (GIZ, n.d.-b). Potential alternative measures to address food loss and waste, include improved cold storage and packaging of foods such as vegetables, fruits, and animal products, and efforts to improve food safety.

Measures to empower the excluded, which include financial allocations to the most vulnerable, are aligned with Ethiopia’s national agricultural and climate change strategies focused on improving food security and promoting nutrition-sensitive agriculture (FDRE, 2016b, 2018). Measures listed in these strategies focus on ensuring access to food as well as specific healthier food options, including fruits, vegetables, and milk and related products. In addition, the Government of Ethiopia adopted the National Social Protection of Ethiopia policy (FDRE, 2012) aimed to support vulnerable groups impacted by economic and social deprivation, including those lacking health and unemployment insurance, mostly by targeted cash transfers. The findings indicate that additional resources need to be allocated to such social programs that offer support for vulnerable groups.



Social safety nets are well established in Ethiopia and have had a considerable positive impact on reducing caloric hunger, such as the Productive Safety Net Programme (PSNP)¹⁰ which is credited with reducing the hungry season for its participants in Ethiopia by an average of 1.29 months per year (Berhane et al., 2014 cited in Wouterse, 2020). However, the effect of social safety net programs on nutrition outcomes, including healthier diets, is less notable. Participants in the consultations noted that even where the PSNP consciously attempts to introduce nutrition-sensitive interventions, there is little significant impact in terms of dietary quality and diversity at the household level due to insufficient contact between mothers and health extension workers (see Box 4; Food Systems Summit 2021 Dialogues Ethiopia, 2021). While increasing social protection to support Ethiopia's most vulnerable is therefore crucial to achieving sustainable food systems transformation, attention needs to be given to the design and implementation of nutrition-sensitive interventions if both caloric and dietary goals are to be met. Initiatives that provide nutrition education, such as the projects implemented by GIZ, USAID, and the EU,¹¹ which deliver advice on storing and utilizing diverse, nutritious food products are critical to complement social protection programs, nutrition programs, and agricultural productivity programs if multiple and complementary outcomes are to be achieved. These projects also align with the Seqota Declaration (2018), which, in defining needed investments at the regional level, specifically states that governments need to engage in the development of comprehensive costed nutrition investment plans that tailor nutrition needs to the local situation.

Nutrition gaps in the transition toward healthier diets can also be bridged by providing fortified foods, especially to those most impacted by nutritional challenges. While Ethiopia's focus on promoting the production and consumption of biofortified crops and fortified foods is limited, the importance of such foods is highlighted in the Nutrition Sensitive Agriculture Strategy (FDRE, 2016b), which specifically lists orange-fleshed sweet potato, high iron content beans, and maize with high levels of protein. The strategy stresses the need to invest in agricultural research on biofortified crops and create varieties with nutrition-dense content. The authors reviewed one donor-funded project that addresses biofortification—the EU's Quality Diets for Better Health initiative—which supports the incorporation of biofortified orange-fleshed sweet potatoes in local diets and farming systems through nutrition education and the provision of seeds, technologies, and advice on commercialization (Delegation of the European Union to Ethiopia, 2019). Any new investments should adopt a similar approach addressing both the production and consumption of biofortified foods.

Finally, outmigration from rural areas to access employment opportunities in urban centres and support economic diversification can help reduce poverty and inequality as very small farms in agricultural and rural areas cannot produce enough income for workers (Beyene et al., 2020; FDRE, 2016a).

¹⁰ See also EU's Supporting Horn of Africa Resilience initiative (European Commission, 2013) or USAID's Food for Peace (USAID, 2018).

¹¹ See GIZ's Global programme Food and Nutrition Security, Enhanced Resilience (GIZ, n.d.-b); GIZ's Transitional aid measure: Improving food security and disaster risk management to enhance resilience in Afar, Ethiopia (GIZ, n.d.-d); EU's Quality Diets for Better Health (Delegation of the European Union to Ethiopia, 2019); USAID's Feed the Future Growth through Nutrition (USAID, 2021)



3.3.3 Policies Supporting Sustainable Food System Transformation: Focus on climate change mitigation and adaptation

The transformation scenario presented illustrates the types of interventions and policy options needed to end hunger, double incomes and productivity for small-scale producers, and make healthy diets more affordable. At the same time, because of the growing impacts of climate change and the need to reduce GHG emissions, policy-makers need to make sure that implementation of the transformation scenario also improves the capacities of farmers to adapt while promoting the overall resilience of the agricultural sector and reduces its environmental footprint. Farmers' income gains and diet improvements can be jeopardized if climate resilience is not strengthened.

Climate change impacts, responses, and resilience building need to be an integral part of any future agriculture and food systems strategy. In Ethiopia, promoting environmentally sustainable intensification, particularly in the livestock sector, is key to building a climate-resilient green economy where productivity would increase in ways that would also help the country meet its climate mitigation targets alongside poverty, food security, and dietary goals (FDRE, 2010).¹² Such priorities also align with Ethiopia's GTP II and its NDC (FDRE, 2016a, 2021), which aim to increase the share of renewable energy in agricultural production and promote choices that address climate adaptation needs. Finally, Ethiopia's climate change and agricultural strategies stress that production practices need to take natural resource conservation to the next level, with a focus on rural land administration, watershed management, and expansion of small-scale irrigation. Many donor-funded projects already address these crucial areas, such as USAID's Feed the Future Ethiopia Livelihoods for Resilience project, which supports watershed rehabilitation and management to improve year-round water access and irrigation (USAID, 2020); the EU Support to the Sustainable Land Management Programme, implemented by GIZ, which supports the adoption of sustainable land and water-management technologies (GIZ, n.d.-h); or GIZ's two initiatives in the Somali Region which aim to strengthen the resilience of communities affected by drought by rehabilitating degraded dry valleys or introducing water-spreading weirs and lowland dry-stone measures (GIZ, n.d.-a, n.d.-i). This focus on sustainable resource use and conservation, although already prominent amongst donor-funded initiatives, needs to be maintained and mainstreamed into all policies to ensure that Ethiopia's food system transformation is sustainable and adaptive to the effects of climate change.

Importantly, Ethiopia's agricultural policies that aim to improve productivity also stress the need to account for food security and, to some extent, healthier diets by prioritizing certain crops and dairy products. The policies note that this should be achieved by ensuring that both plant and livestock production is resilient and able to meet the country's climate change mitigation priorities. This is significant because dietary improvements achieved as a result of focusing on existing technologies and agricultural production choices alone will likely exacerbate agricultural GHG emissions and make climate change mitigation targets challenging to implement. Environmentally sustainable intensification will require improving

¹² Through the Global Climate Change Alliance, the EU and GIZ offer capacity development and support for sustainable land management to support Ethiopia in achieving the Climate Resilient Green Economy (The Global Climate Change Alliance Plus Initiative, 2018a).



agricultural productivity with production techniques that are GHG efficient, such as improved breeds and fodder, promoting a diversity of small, medium, and large ruminants, and the uptake of renewable energy (also part of the country's GTP II [FDRE, 2016a]). The policies will also need to make these techniques more economically attractive and commercially viable for small-scale food producers than the available alternatives.

In terms of climate change mitigation, the transition scenario assumes considerable increases in livestock production, similar to the country's NDC (FDRE, 2021b). Indeed, livestock production, while critical for the transition to healthier diets, is a major contributor to the country's GHG emissions. Increased livestock production, therefore, needs to be achieved in a way that would enable Ethiopia to meet its GHG emissions reduction targets listed in its updated NDC. Potential policies include the modelled interventions focused on livestock production, which assume a move toward small ruminants, improved feed choices and manure management—practices that help reduce agricultural emissions. It is also important to stress that setting up a sustainable path for the growing livestock sector by 2030 is critical for achieving the more ambitious climate change mitigation targets set out in the country's NDC, although they are conditional on additional donor support (FDRE, 2021b).

Current donor support and priorities are insufficient and inadequate to support the Ethiopian government's goals and targets. GIZ, USAID, and the EU, despite being among the top five donors in agriculture and food systems in Ethiopia, only mention livestock as an objective in three¹³ of the 32 identified projects. The objectives of these projects are increasing the productivity and diversity of the livestock sector (Feed the Future, n.d.), securing resources for livestock feed (GIZ, n.d.-i), and providing support for animal health services such as vaccination (European Commission, 2013). While such projects are a good start, the lack of concerted effort on sustainable intensification of the livestock sector is a significant concern that needs to be addressed. Efforts toward environmentally sustainable livestock intensification need to be substantially scaled up by both the Ethiopian and donor community if Ethiopia is to meet its nutrition and GHG emissions-reduction targets.

Interventions in the model support the achievement of Ethiopia's climate change adaptation goals through investments in improved planting and crop choices, irrigation and soil management, and access to improved storage and markets. Interventions in the model reduce post-harvest losses and increase processing and storage capacity through policy actions, such as targeted extension services that improve economic resilience, improving availability of breeds, and providing support services so that farmers can adjust production to account for climate change impacts. The on-farm model interventions provide direct support to farmers to produce more food, improve production quality, and increase production diversity, which contributes to climate adaptation and resilience building. Thus, there is a role for extension services and targeted subsidies to promote crop diversification away from grains and cereals toward more legumes, oilseeds, fruits, vegetables, and meat production.

¹³ See Strengthening Drought Resilience in Pastoral and Agro-Pastoral Communities of Afar and Somali Regional States, Ethiopia (GIZ, n.d.-i); Feed the Future (Feed the Future, n.d.); and Supporting Horn of Africa Resilience initiative (European Commission, 2013).



Finally, while the model is not able to integrate institutional reform and capacity building, this is the foundation for success of any of the policy interventions. Such institutions are critical for monitoring the achievement of the portfolio of interventions, using appropriate indicators for farm-level, individual, household, system-wide, and aggregate outcomes to cover productivity improvements as well as climate change impacts on production and the agricultural sector's resilience, including that of smallholders. While several of the donor-funded projects identified included some form of capacity development to institutional actors on program management and implementation, only two—the Global Climate Change Alliance Plus Initiative Plus in Ethiopia and the INFORMED program—specifically addressed the need to support regional and national institutions in their capacity to monitor and disseminate information and analysis of climate change risks and opportunities, as well as broader issues of food security and nutrition (Delegation of the European Union to Ethiopia, 2018a; Global Climate Change Alliance Plus Initiative, 2018a, 2018b). Building the capacity of institutions to monitor, analyze, and inform on the progress toward achieving outcomes is essential for delivering results.

Box 4. List of policy priorities, measures, and interventions to address food security, nutrition, and agricultural transformation challenges from the consultations

- Ethiopia's PSNP tries to be nutrition sensitive, but it often fails to have any significant effect on nutrition outcomes beyond caloric availability and consumption. In particular, due to inadequate contact between mothers and health extension workers, there is limited impact on children's diet and nutrition indicators.
- In the country, the implementation of development programs, especially those concerning nutrition, is often not as good as their design.
- An increase and repurposing of social protection programs could both ensure sufficient access to food and provide more nutrition knowledge and benefits.
- The promotion of access to water and energy would enable households to improve their abilities to prepare and preserve food.
- There are opportunities to address nutritional challenges, including using the school curriculum and school feeding programs to promote diverse dietary intakes. Increasing the number of nutrition frontline worker or educated nutrition professionals would be beneficial as well.
- It is important to identify potential sources of additional external public resources. In the current context of stagnating or decreasing foreign aid budgets, there is a need to be creative and innovative about how financing is being accessed.

Source: Information listed in this box was collected during the project consultations with national stakeholders and donor agencies. For details on the consultations, see Appendix B.



3.3.4 Trade-offs and Synergies in the Context of Sustainable Food System Transformation

Addressing the compound challenge of food system transformation in light of climate change and the need to achieve healthy diets will require trade-offs. For example, achieving healthier diets will require people to consume more diverse foods, including animal-source foods, which will lead to higher GHG emissions. These tensions are real for people in Ethiopia. In this context, Ethiopia's policies that focus on linking aspects of nutrition and agricultural production serve as an important step toward addressing this trade-off on the production side. Further policy efforts that focus on consumers by promoting nutrition education, access to healthier, affordable foods, and school feeding programs can also help reduce these tensions. However, this only addresses the food security and nutrition nexus.

Improvements to diets delivered through the use of existing technologies alone will exacerbate GHG emissions in agriculture and make it challenging to achieve climate change mitigation commitments. Solutions need to build on the capacities of small-scale producers to simultaneously improve agricultural productivity while making GHG-efficient production techniques more commercially viable alternatives. The emphasis on improved practices at the farm level means that specific policies, programs, and interventions need to be designed to also foster climate change adaptation and build resilience, including promoting access to modern irrigation, renewable energy, and adjusting planting practices and crops, as well as supporting post-harvest storage.

Tensions will not only be created at the level of actual measures, but also during policy development and coordination. As mentioned during the consultations, integrating a focus on nutrition and healthier diets into agricultural and food security programs could help increase positive synergies from limited resources (Box 5). Thus, adopting a multisector approach, combined with coordination across sectors and agencies, could help prioritize interventions with benefits across different sectors and help address implementation issues. However, additional efforts are needed to identify additional sources of financing from both domestic and external sources (Box 5).

Ethiopia will need to decide what trade-offs they are willing to make, based on the best available evidence, while maximizing synergies at the same time. To some extent, new policies and interventions can help manage and mitigate some of the tensions. For example, Ethiopia's focus on supporting aspects of environmentally sustainable intensification can help reduce GHG emissions from agriculture and accelerate efforts to reduce food loss and waste, so that more food is available. These efforts should go hand-in-hand with addressing the immense productivity gap in agriculture, particularly in the livestock sector. This is typically achieved through more and better feed, and better animal health and genetics—and most of these measures are included in Ethiopia's agricultural development strategies.

Another key factor is how manure is dealt with, as it accounts for a large portion of GHG emissions from animal agriculture. The model includes interventions that collectively offer some proxy for interventions to improve the GHG efficiency of animal agriculture, such as R&D, extension services, and livestock subsidies for agroforestry and improved forage. The GHG limits also “bias” the model against ruminant meat since ruminants are much more



GHG intensive per calorie than eggs, poultry, pork, fish, and other non-ruminant foods. The results point to the importance of public investment in measures that promote emissions-efficient animal-source foods, especially since consumption of these foods will tend to increase as incomes rise, even without public intervention.

Finally, as mentioned earlier, indicators for farm-level, individual, household, system-wide, and aggregate outcomes need to be designed in a way that would account for possible trade-offs so that policy-makers and other stakeholders are able to track progress on managing these trade-offs and adjust policies along the way.



4.0 Methods for Researching and Modelling Food System Transformation

This section presents the methods and approaches used, including a review of academic and grey literature, policy documents, national plans and programs, donor-funded projects, several rounds of stakeholder consultations, and microeconomic modelling to map dietary diversity and macroeconomic modelling to estimate the additional public costs of policy interventions.

4.1 Methodological Approach: Literature review and consultations

The literature review focused on peer-reviewed literature, reports, and briefing notes developed by major agencies such as FAO, the World Bank, major development agencies (GIZ, USAID, UKAID, and others), as well as the country's policy documents. To access peer-reviewed literature, we used the ScienceDirect database (www.sciencedirect.com), which we searched for papers focused on Ethiopia and papers outlining regional trends with specific details on Ethiopia regarding issues such as climate change adaptation, food security, nutrition, and agriculture. We covered the period from 2017 to 2022 (papers in pre-publishing), and collected 2,867 papers. The research team briefly screened the abstracts of the papers, and those papers that were deemed relevant were included in the study. For reports and briefing notes by international and government agencies, we visited the agencies' websites and reviewed their publications for the 2010–2022 time period. A total of 43 documents were collected. Finally, we reviewed strategies and policy documents published by ministries and government agencies in Ethiopia and selected 29 documents for the 2010–2022 time period. These sources contributed to informing our understanding of current trends and policy-making priorities with respect to agriculture, food security, nutrition, and environmental and climate change impacts of agricultural production; feeding into the stakeholder consultations; and informed the selection of interventions included in the model.

To inform the development of pathways for food system transformation, the research draws on four rounds of consultations with in-country stakeholders and an inventory of ongoing development projects and policies. The consultations, which targeted EU delegations, GIZ clusters, USAID missions and national partners, included online and in-person events, as well as surveys. To support the consultations, a non-exhaustive desk review was undertaken to review the current (or recently terminated) projects implemented and/or funded by GIZ, the EU and USAID. Only projects that had a degree of focus on two or more aspects of our nexus were included for review. Overall, 32 projects were reviewed. See Bizikova et al. (2022a) for the names, objectives, and strategies of the projects included.

The consultations offered stakeholders the opportunity to feed into and provide feedback on the research process, results, and findings at various stages. The purpose of the consultations was also to validate the model targets for healthier diets in each country. In addition, a network of experts that formed as a result of their participation in the consultations engaged in disseminating results of the research, which helped develop joint ownership of the final recommendations and increased the probability of utilization of the research. For a detailed overview of the consultations, see Appendix B.



4.2 Methodological Approach: Quantitative modelling

The findings of the literature review and consultations were integrated into a hybrid micro- and macroeconomic modelling approach to the food system of Ethiopia, based on the analytical framework developed in the Ceres2030 project¹⁴ (www.ceres2030.org).

As part of the project’s modelling approach, and as another important contribution of the project, a microeconomic analysis of changing diets, food habits, and nutrition was undertaken. To do so, micro-level consumption data from the LSMS was aggregated into multiple sets of categories. This “meso-level” data was then linked to disaggregated macro-level statistics. The microdata was used to perform cluster analysis: a data-driven approach that allows households to be classified based on commonalities in observed diets, complementing top-down analysis based on observed household characteristics (such as urban/rural status). The detailed microdata enabled us to estimate a demand system for the country, so that our CGE model estimates of how dietary patterns change in response to changes in income are driven by household survey reports. Full details of the microeconomic approach are described in Appendix B.

4.2.1 Scenarios for Identifying Policy Pathways and Costs

In order to identify potential pathways for food system transformation, the findings from the stakeholder consultations, literature review, and microeconomic analysis have been used to apply a CGE model¹⁵ hybridized with microeconomic household modelling to project two future scenarios until 2030.

- **Baseline scenario:** This scenario is a projection of the focus countries’ economies based on current trends, without additional public spending. We make the assumption that agriculture-related GHGs are kept to the countries’ NDCs. When no specific targets for agriculture are defined, the evolution, in percentage, of the nation-wide target is applied to agriculture.
- **Food System, Climate Change, and Healthy Diets Transformation scenario:** This scenario addresses the key challenges laid out in Section 2. Specifically, the PoU is reduced (to less than 3%), nutritious food targets to achieve healthier diets (e.g., fruits, vegetables, and animal-source proteins), the average net incomes of small-scale producers double in 2030 compared to 2015 levels, and agriculture-related GHGs are kept to the countries’ NDCs. These four targets are related to SDG targets 2.1, 2.2, 2.3, and 2.4, respectively.

4.2.2 Establishing Model Targets for Food System Transformation

To model and provide a costing for sustainable food system transformation, quantitative targets are required. The model seeks to achieve zero hunger (SDG 2.1), a nutritious food target to achieve healthier diets (SDG 2.2.), doubling the incomes and productivity of small-scale producers (SDG 2.3), and constraining GHG emissions in agriculture (SDG 2.4).

¹⁴ See Laborde et al., 2020a and Laborde et al., 2020b for more information.

¹⁵ The model is adapted from the MIRAGRODEP model. See Laborde et al. (2013).



4.2.2.1 Hunger and Poverty

Corresponding to SDG target 2.1, the model simulates the removal of households from the status of hunger, as defined by FAO's PoU's metric. Specifically, the level of undernourishment in the country is reduced to less than 3%.

4.2.2.2 Healthier Diets

Although Ethiopia recently adopted food-based dietary guidelines (FDRE, 2022), in order to estimate costs for achieving healthier diets, there is a need to establish a quantitative target in the model. Four quantitative targets are used in the model as key indicators of a healthy diet. With a food group-based approach, we model diets that are “healthier” than current diets, rather than achieving a “universally healthy” diet. Under current policy scenarios, we do not believe “universally healthy” diets will be feasible by 2030 for all Ethiopians. Additionally, we do not define one singular “healthy” diet, since multiple healthy diets (diets that differ by the exact food group composition but are each healthy) are possible, and cultural acceptability, preferences, and other aspects of appropriateness can vary within Ethiopia. The targets therefore represent progress toward food system transformation and healthier diets, balanced with an assessment of what could feasibly be achieved in the next decade.

Based on the recently adopted food-based dietary guidelines, national and international guidelines and policy documents, a review of nutrition literature, and expert consultations, we have focused on four targets for achieving healthier diets in Ethiopia:¹⁶

1. **Overall caloric intake**, measured using the PoU, with a target of less than 3% PoU in each country.
2. **Adequate consumption of non-starchy vegetables and fruits**, based on WHO guidelines of 400g of fruits and vegetables per day (FAO & WHO, 2003; WHO, 2020).
3. **Adequate consumption of animal-source foods** (including dairy) through a minimum target of at least 10% of households' overall caloric intake to ensure calcium and vitamin B12.
4. **Adequate consumption of legumes, nuts, and seeds** through a minimum target of at least 10% of households' overall caloric intake.¹⁷

A set of targets for sufficient caloric intake at the household level is based on the modelling of household consumption in comparison to calorie requirements (FAO, 2001), adjusted for age and sex of household members. For fruits and vegetables, a minimum target of 400 g per person per day is set based on WHO guidelines, adjusting for household demographic characteristics (FAO & WHO, 2003; WHO, 2020). As with caloric intake, the target is adjusted for each household in the sample based on the age and sex of its respective members. Vegetables and fruits are important for meeting a wide variety of micronutrient needs, including vitamin A and iron, that are commonly insufficient in diets. An overall minimum

¹⁶ All targets apply to all households in the population. Full documentation of our dietary targets selection can be found in a technical note for the project, *Dietary Target Choices* (Bizikova et al., in press).

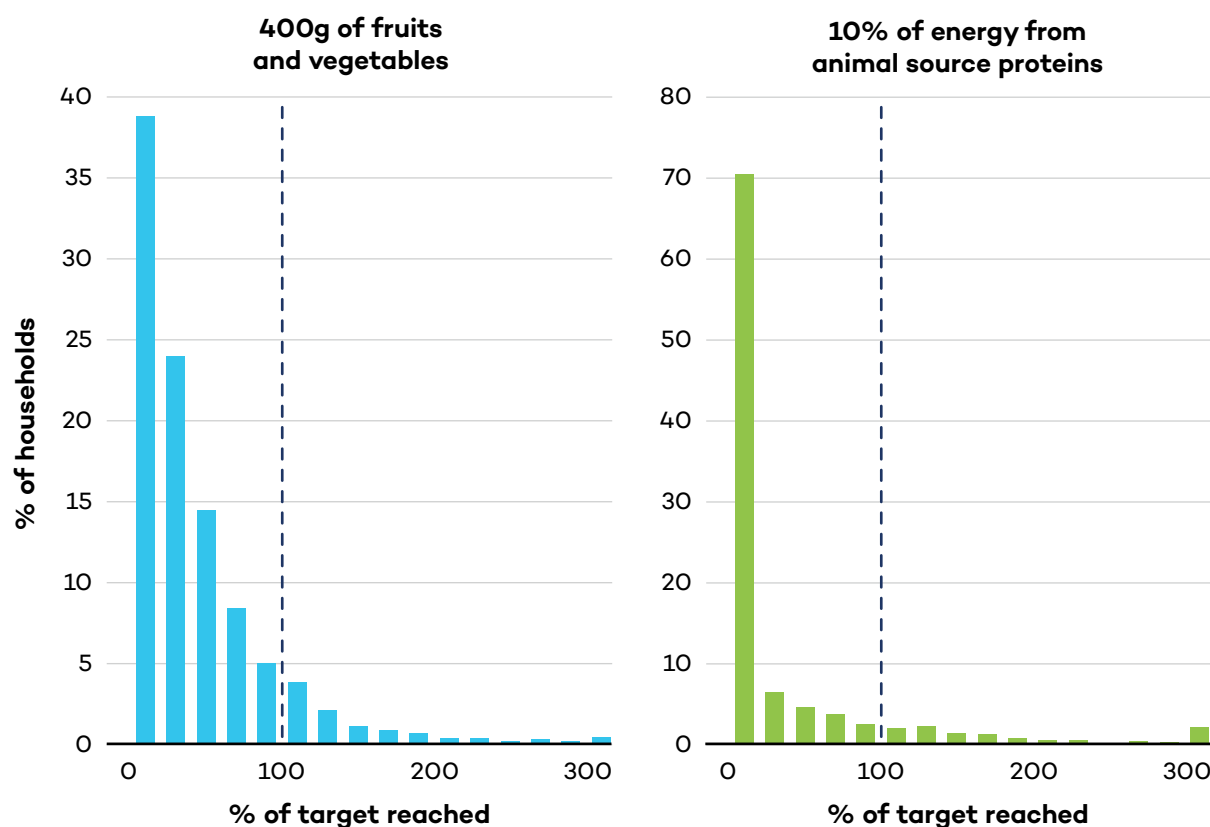
¹⁷ For Ethiopia, there is an additional target for the adequate consumption of legumes, nuts, and seeds, due to strong requests from national stakeholders during country consultations. See Box 3 and Food Systems Summit 2021 Dialogues (2021).



target for animal-source foods, including dairy, is set to at least 10% of households’ overall caloric intake. The inclusion of animal-source food in the diet is a key means for at-risk populations, especially children, to get sufficient amounts of nutrients, such as zinc, iron, vitamin A, vitamin B12, calcium, and selenium. An overall minimum target for legumes, nuts, and seeds is set to at least 10% of households’ overall caloric intake. This is based on the food-based dietary guidelines, the strong consensus from most of the stakeholders consulted, and the strong synergies between nutrition and environmental goals. All targets apply to all households in the population. Full documentation of our dietary targets' selection can be found in Bizikova et al. (in press).

While the dietary targets are relatively general, their achievement would indicate large nutritional progress for Ethiopia. Figure 14 shows the distribution of households in Ethiopia for two of these indicators by the share of the overall target achieved.¹⁸

Figure 14. Current distribution of households, by share of healthy diets target



Source: Authors' analysis based on LSMS-IHS Ethiopia Wave 5 2018-2019 (World Bank, 2020) and nutrient coefficients based on FAOSTAT-SUA (FAO, 2021).

4.2.2.3 Smallholder Income

SDG target 2.3 envisions the net incomes of small-scale producers doubling on average between 2015 and 2030.

¹⁸ For visualization, a small number of households whose share exceeds 300 percent are excluded from the figure.



4.2.2.4 Climate Change Mitigation and Adaptation

While it is not possible to integrate climate change adaptation (SDG 2.4) directly in the macroeconomic modelling, it is important to achieve resilient agricultural production, and consideration of the impact of - and impacts on - climate change is central to the nexus approach. To reflect this, we follow the approaches of the water-energy-food nexus that highlight the critical importance of including climate change impacts and responses.¹⁹ Climate change is integrated into the model by accounting for the gradual impacts of climate change on crop production using FAO crop projections under climate change. This approach suggests that by 2030, climate change will lead to less than a 10% drop in production for major crops in sub-Saharan Africa, especially if drought-resistant crops are planted (Malhi et al., 2021). In the model, GHG emissions for agriculture conform to the commitments made in the countries' iNDCs or NDCs. For Ethiopia, the iNDC, submitted in 2015, which was updated in 2021 (FDRE, 2021b), focuses on emission reduction targets till 2030. The country has a carbon budget (permitted GHG emissions) for agriculture, and land-use emissions and emissions from energy and fertilizer use are included in this budget. The model maintains the budget through a domestically determined carbon tax.

4.3 Portfolio of Interventions

The complexity of the interrelationships among the key food system challenges requires a balanced mix of interventions. For example, the necessary changes in consumption patterns to progress toward healthier diet targets will require, and trigger, changes in production patterns. Those changes will have to be compatible with the shift toward a more resilient agriculture and food system, in particular in the context of climate change mitigation (reduction of GHG emissions) and adaptation (resilience to weather variability and the changing climate). While climate-smart agriculture addresses production-side issues, diets must also adapt to allow for more environmentally sustainable food systems. Food system interventions should, therefore, not be considered as isolated fixes but rather as an integrated portfolio designed to meet complex objectives.

The set of interventions included in the model represents such a portfolio of interventions, designed to leverage synergies and balance trade-offs within food system transformation. In total, there are 15 interventions integrated into the model. These represent a combination of all 13 interventions used in Ceres2030 and an additional two interventions that specifically target nutrition:²⁰ nutrition education²¹ and school feeding programs. In consultations, national stakeholders in Malawi, Ethiopia, and Nigeria emphasized the importance of opportunities to increase nutritional outcomes through changes to school curricula, the introduction of dietary guidelines in school feeding programs, or in improvements to the provision of food in boarding schools. It was noted that these interventions would work toward

¹⁹ Recent water-energy-food nexus studies often call for a climate change, water, energy and food nexus (Hoff, 2011).

²⁰ The quantitative inclusion of interventions in our research is limited by the availability of detailed, relevant costing information, which is required to integrate an intervention into the modelling framework.

²¹ Participants in the consultations in Malawi noted that nutrition education should also qualitatively include social and behavioural changes.



addressing the nutritional challenges and stereotypes that emerge at an early age. Stakeholders in all three countries emphasized that the production of diversified crops would not be effective unless accompanied by education on their utilization, storage, and the end products that can be created. Nutrition education and school feeding programs are, therefore, crucial complementary measures to maximize the effectiveness of supply-side interventions.

The 15 interventions are categorized into three broad action areas based on the Ceres2030 framework – “Empower the Excluded,” “On the Farm,” and “Food on the Move.” The list of interventions and their breakdown into categories are summarized in Table 1.

Table 1. Policy interventions included in the model.

Category	Interventions in the model
Empower the excluded	1. Social protection (Food subsidy)
	2. Vocational training
	3. Nutrition education
	4. School feeding programs
On the farm	5. Investment subsidy
	6. Fertilizer subsidy
	7. Production subsidy
	8. Capital endowment
	9. R&D
	10. Extension services
	11. Rural infrastructure (irrigation)
	12. Livestock subsidy (agroforestry)
	13. Livestock subsidy (improved forage)
Food on the move	14. Storage post-harvest losses
	15. Rural infrastructure (roads)

 Shaded interventions linked to adaptation.

Note: Nutrition education and school feeding programs are included based on feedback from stakeholder consultations to ensure stronger targeting of nutrition in the model.

The interventions were selected based on their relevance for addressing the multi-dimensional challenges of the food system and their potential to deliver on hunger, diet, small-scale food producer income, and climate change mitigation and adaptation targets. At the systemic level, and through the model interactions, all the interventions contribute to improved diets, and could lead to stronger resilience of the food system and its actors. Nonetheless, how each



intervention affects each of the four modelled targets can be complex, particularly as the model accounts for both direct and indirect effects on the economic system. However, there are some rules of thumb for how the modelled interventions affect each target.

- **SDG 2.1 (hunger):** Generally, any intervention that increases household incomes can contribute to reducing hunger. For example, a social protection program, like a food subsidy or direct cash transfer, increases the income of a household and their ability to buy more food.
- **SDG 2.2 (nutrition):** Similarly, anything that increases income allows people to improve their diets. As incomes increase, households tend to increase their consumption of animal-source foods, while increases in the consumption of fruits, vegetables, legumes, nuts, and seeds tend to be relatively small compared to increases in income. Actions that decrease the price of important under-consumed food groups relative to other foods can also play a role in improving diets.
- **SDG 2.3 (small-scale producers):** Poverty reduction is critical in the countries studied. Thus, anything that increases the incomes of small-scale producers, including income from non-farm sources, or allows those unable to make good livelihoods in agriculture the option to do something else, contributes toward the target of doubling the income of small-scale producers. Examples of this include investment subsidies to help small-scale producer households increase their agricultural income, vocational training to enable employment that is more lucrative than agriculture, or social protection programs which provide non-farm income.
- **SDG 2.4 (sustainable agriculture):** Anything that improves the GHG efficiency of agricultural production or other components of the food system contributes to limiting overall GHG emissions from agriculture and land use. While an intervention such as agroforestry subsidies has obvious benefits for GHG mitigation, an intervention like fertilizer subsidies can also increase the overall GHG efficiency of a crop's production. When used in a context where fertilizer use and yields are very low, fertilizer subsidies can lead to land savings outcomes, delivering higher yields on existing cropland, which could reduce deforestation and slash-and-burn practices.

The impacts of climate change on average temperatures and rainfall are included in the model, but due to the 2030 time horizon, they play a minor role in the assessment. However, given the increased frequency and intensity of extreme weather events in all three countries, there is a need to scale up public investment to increase the climate resilience of food systems. Of the 15 interventions included in the model, nine contribute to building resilience and promote adaptation to climate change (see Table 1). While all the interventions should be designed and implemented in a diet- and climate-sensitive way, these nine interventions are in line with climate change adaptation priorities as stated in national policy documents, peer-reviewed literature, and stakeholder feedback in the three countries. In addition to contributing to climate change adaptation, these interventions promote the economic resilience of small-scale producers and their households by improving food production and access to diverse agricultural inputs, increasing incomes, and providing access to financial services and social transfers for small-scale food producers with limited capacities. This type of synergistic approach, with interventions simultaneously progressing toward multiple, complex targets, is at the core of the food systems notion and is critical if the targets of SDG 2 are to be met by 2030.



4.4 Limitations and Challenges of the Methodological Approach

As with any nexus report, there were a number of challenges due to the complexity of the nexus' elements and its translation to a quantitative model. Limitations include the inability to incorporate gender issues, extreme weather/climate events, regional differences, and institutional challenges. The constraints we are most concerned about include modelling within-year variation in hunger and diets and modelling at the individual level, especially with respect to gender. This section provides an overview of critical aspects impacting the food system, including climate change, nutrition, and other challenges, that we were unable to integrate in the model.

4.4.1 Data Limitations

The microdata used in the analysis were intended to give the best possible representation of diets in Ethiopia. The primary data source is the World Bank LSMS, which provides interview data drawn nationally and sub-nationally from representative samples of households in each of the target countries. As part of each interview, data on food consumption is recorded over a 7-day recall period. This forms the basis of our estimation of current and projected dietary trends.

4.4.1.1 Gender and Other Individual Characteristics

The unit of observation for the LSMS surveys is the household, and hence food consumption is reported at the household level. This is logical both from an economic perspective since food resources are typically pooled (i.e., food is purchased for and consumed by the household) and from a practical perspective, since it would be extremely difficult and costly to obtain individual-level food consumption data at a nationally representative level. A key consequence of this for the analysis is that it is not possible to observe the intra-household allocation of consumption items: while it is possible for a given household to observe what the average household member consumes, it is not possible to attribute individual consumption levels. For a household with male and female members, it is not possible to attribute the amount of a given food item consumed by males versus females, and hence it is not possible to make gender-disaggregated comparisons. This is an important limitation of the analysis that we hope can be addressed in the future through improved resources and methods for gender-disaggregated data collection.

4.4.1.2 Seasonality and Its Impact on Diets

Many households in Ethiopia experience variations in the availability and price of different food items at different points in the year. This is particularly true of certain categories of perishable items, such as fruits, which may only be available in some areas for limited periods. Similarly, where market integration is limited, the price of locally produced staple crops may be low around harvest season and high during planting season. These, and other factors, contribute to seasonal variation in diets, resulting in differences in the quantity of macro- and micro-nutrients individuals receive at different points in the year. There is variation in the timing of surveys that allows us to partially observe seasonal variation across households (see



Bizikova et al., in press). However, since each household was not interviewed at all points in the year, we do not observe seasonal variations within households. The estimates, therefore, reflect average consumption in a given year. Within-year variation in diets is an important concern which should be considered in the design and implementation of nutritional and other interventions relating to food consumption.

4.4.1.3 Use of Non-standard Measurement Units

Food items are frequently purchased, exchanged, and consumed in quantities which respondents may not be able to easily estimate in terms of standard units of weight or volume. For example, a respondent will typically report consuming a bowl of porridge, rather than a number in grams or millilitres. Efforts were made during the survey process to get the best possible estimates of these measures through discussion with respondents and the use of standardized visual aids, with auxiliary data also collected from local markets to enable the conversion of non-standard units to metric units. While these procedures reduce measurement error in quantities, some noise in estimates remains, and for a small group of rarely consumed food items, it is not always possible to convert the reported amount into metric units. We discuss these conversion issues in greater detail in Bizikova et al., (in press).

4.4.2 Impacts of Extreme Events

While the research approach considers gradual responses to climate change, the impacts of extreme events such as droughts, floods, and heavy rainfall pose a serious challenge for the analyzed countries. For example, in Ethiopia, natural disasters—including droughts, floods, diseases and pests (specific to some regions)—have affected the livelihoods of significant numbers of people (FDRE, 2019). The interventions included in the model indirectly contribute to increasing the resilience of farming households through improved food production, access to healthier food, and access to diverse agricultural inputs. However, analysis of the frequency and intensity of extreme weather events and their impacts that might affect these outcomes were beyond the scope of this project.

4.4.3 Conflict in Tigray

The armed conflict in Ethiopia's Tigray region, in particular, has increased food insecurity among the region's population and limited people's access to health care and other public services. The WFP (2021, 2022) reports that 91% of the region's 6 million people required emergency humanitarian assistance during the seven months of the conflict. While the long-term impacts of this conflict are still unknown (Gesese et al., 2021), the estimated impacts of the Tigray conflict on the PoU are included in the quantitative analyses. It is predicted that due to the Tigray conflict, 17.5 million more people will be affected by hunger in 2030 compared to projections made prior to the conflict (see Figure 1).

4.4.4 Institutional Challenges

In practice, agricultural, food security, and nutrition policy interventions can be delivered in a variety of ways that rely on different delivery mechanisms and supporting systems. This report includes information on income, seasonality in rates of undernourishment, gender,



and family status, and model factors such as access assets and caloric intake (Bizikova et al., 2022a). Other factors that are also important in shaping effective interventions in this context include the use of formal and informal institutions, access to knowledge and physical infrastructure, as well as consideration of social, historical, and cultural conditions when promoting the interventions. In the report, for instance, the impact of food subsidies (e.g., food stamps) that can be delivered through universal unconditional cash transfer, depending on the country context, is considered. The model does not currently integrate an appraisal of institutions and delivery mechanisms that would likely speed up implementation or increase effectiveness. However, such delivery mechanisms are critical and often include agencies of central or regional governments, or other public or non-governmental entities to ensure that, for example, a fertilizer subsidy reaches its intended beneficiaries. For more accurate estimates, institutional preparedness and the effectiveness of delivery of interventions should be considered in future work.



5.0 Recommendations and Conclusions

Ethiopia is not on track to achieve the SDGs by 2030. Without more and better public investment, poverty will persist, healthy diets will remain unattainable for most of the population, GHG emissions will continue to grow, and the impacts of climate change will become more extreme and frequent. This is not how the United Nations 2030 Agenda was meant to unfold.

All of this could be reversed. This report shows that Ethiopia needs an additional USD 2.8 billion between 2023 and 2030 to end hunger, double the incomes and productivity of small-scale producers on average, transition toward healthier diets, maintain GHG emissions in agriculture to Ethiopia's NDC, and increase resilience to climate change.

The report recommends the Government of Ethiopia and its development partners:

- 1. Increase public investment by an additional USD 4.6 billion per year from 2023 to 2030 to achieve the transition to sustainable food systems.** Development partners should provide an additional USD 2.7 billion on average per year for 8 years (2023–2030) from a current baseline of USD 659 million per year. The Government of Ethiopia should provide an additional USD 1.9 billion per year. This will reverse the severe underfunding of the longer-term investment needs for agriculture and achieve food security and nutrition.
- 2. Prioritize increased spending on farm interventions.** An additional USD 3.18 billion per year on average is needed to improve productivity and incomes of small-scale producers, an additional USD 964 million per year on average for social protection, education and school feeding programs, and an additional USD 531 million per year to move food to markets. Interventions need to focus on improving plant productivity, especially by targeted extension, access to high-quality seeds, and promoting crops, including staples and pulses as well as crops that deliver nutritional benefits, such as local crops and varieties for fruits and vegetables (FDRE, 2016b).
- 3. To transition to healthier diets, nutrition education must accompany on- and off-farm investments to improve consumer choices.** Attention needs to be given to the design and implementation of nutrition-sensitive interventions. Initiatives that provide nutrition education and deliver advice on storing and utilizing diverse, nutritious food products are critical to complementing and maximizing the impact of social protection programs, nutrition programs, and agricultural productivity programs.
- 4. Ensure climate resilience and adaptation are integrated into agriculture and food system policies and programs.** It is critical to ensure that food systems interventions also improve the capacities of farmers to adapt and promote the overall resilience of the agricultural sector and reduce its environmental footprint. Farmers' income gains and diet improvements can be jeopardized if climate resilience is not strengthened. To achieve such improvements, gender and the needs of vulnerable groups would need to be considered when integrated measures are designed.



5. **Substantially scale up support for environmentally sustainable intensification** to improve both plant and livestock productivity, as emphasized in several of Ethiopia's agricultural development and climate-resilience strategies. The Government of Ethiopia and the donor community should increase the allocation of domestic and external resources supporting these measures, respectively. Ethiopia's policy documents already stress the importance of the private sector, focusing on specific measures to improve productivity and promote climate resilience.
6. **Accelerate efforts to reduce GHG emissions and increase climate resilience in the livestock sector.** Policy interventions need to include enhancement of veterinary coverage through private–public partnerships, promotion of fodder production, and accelerated introduction of improved genetics once feed production and health services are in place (FDRE, 2015c, 2018). Supporting different types of livestock, breeds, and fodder can also help reduce GHG emissions and increase climate resilience in the expanding livestock sector. Current donor support and priorities are insufficient and inadequate to support the Ethiopian government's goals and targets on climate change and nutrition.
7. **Continue targeted social protection programs, mostly through cash transfers,** targeting the most vulnerable to support national nutritional and development strategies and build resilience to climate change. Additional resources need to be allocated to social programs and support for vulnerable groups. Defining needed investments at the regional level, the Seqota Declaration (FDRE, 2018) states that governments need to engage in the development of comprehensive costed nutrition investment plans tailored to local nutrition needs.
8. **Focus interventions and policies to reduce food loss and waste on better storage infrastructure and education.** Specific investments should be focused on enhancing households' knowledge about food waste and safe food storage methods, and on infrastructure development. This would enable producers to reduce losses during production and storage of foods from animal and plant sources. From the healthier diet perspective, investments such as cold storage could contribute to preserving highly perishable goods, such as vegetables, fruits, animal products, and fish, as well as efforts to improve food safety.
9. **Increase support for regional and national institutions to improve capacity to monitor, analyze, and inform on progress and achievements.** This will enable institutions to better support the sustainable food systems transformation, including by collecting disaggregated data to account for subnational and gender differences, particularly related to the prevalence of stunting, overweight, and obesity.



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Appendix A. Research Questions

The project will answer seven research questions by applying them to the three countries—Ethiopia, Malawi, and Nigeria—and aims to study food system transitions and support decisions to trigger transformative changes:

1. What are the expected trends in terms of diets for the three countries?
2. What is the definition of a healthy diet for a country, when considering cultural and economic specificities and the nutritional value of different food items?
3. Based on micro-econometric evidence, how well do we understand consumer decisions regarding food, in particular in transitioning food systems (for example, with rising income, urbanization, food processing, and food consumed away from home)?
4. What are the policy instruments and the food system innovations required to achieve healthier diets?
5. What are the costs and benefits, both in economic and environmental terms (GHG focus), of these diets, and what is their mitigation value?
6. Considering the answers from questions 2–4, what is the most efficient set of actions to achieve this transformation? (Criteria to assess efficiency include these factors: feasibility, potential costs/benefits, gender-transformative or -sensitive aspects, if applicable).
7. How do the different sets of actions in question 6 translate in terms of weather or climate risk exposure to future food systems?



Appendix B. Country Consultation

The project encompassed four rounds of country-level consultations which focused on linking the research conducted in the two other components—the large-scale modelling exercise based on the Ceres2030 modelling framework and the research into food-demand behaviour at the household level—with the country policy and institutional environment and ongoing projects.

More specifically, the objectives of the consultations were threefold:

1. To produce an accurate inventory of ongoing projects and policies impacting our main research question in order to identify potential strategy gaps by development actors and integrate as much as possible country actions in the modelling exercise.
2. To validate our operational definition of healthier diets in each country and guarantee that various stakeholders feel confident in using our criteria.
3. To disseminate the results of the research and develop joint ownership on the final recommendations, and increase the probability of utilization of the research in the short term (food system discussions) and long term (country-level strategies).

First Consultation

The first set of consultations consisted of a round of online surveys, supported by bilateral phone/zoom interviews. The consultations aimed to assess how the nexus between food security, environmental sustainability and healthy diets are integrated in various agencies' strategies and national policy framework. In particular, it identified existing initiatives and projects aimed at incentivizing healthy diets (consumption lens) as well as projects aimed at fostering the climate-smart production of nutrient-dense food. This stage informed the scope of policy instruments to be considered but also the cost information, and potential benefits, from monitoring and evaluation reports to improve the costing information included in the Ceres2030 model. For more details on the process and findings from the first round of consultations, including a list of relevant donor-funded projects relevant to the nexus of food systems, climate change, and healthier diets, see the Ethiopia Country Diagnostic Report (Bizikova et al., 2022a).

Second Consultation

The second consultation was organized as an Independent Dialogue of the United Nations Food Systems Summit, and was held on the May 17, 2021. The consultation included a group of 44 stakeholders and national actors. See <https://summitdialogues.org/dialogue/17917/> for more details.

The specific purpose of the Dialogue was to receive inputs on reasonable steps toward a food system transition pathway to healthier diets in Ethiopia. Specifically, the focus of the Dialogue was to receive inputs and feedback from stakeholders on proposed context-sensitive healthy diets, what they view to be the criteria and consideration for healthier diets and food system



transformation, and the possible interventions and policies to achieve this based on their prior experience and opinion on potential opportunities.

The main areas of discussion in the Dialogue were the role of interventions that diversify production and increase the production of nutritious foods, the need for an increase in nutrition education and educational awareness of healthier diets, and the role of policy frameworks and legislation in sustainable food system transformation.

The overarching finding from the Dialogue was the need to consider policy interventions as a package rather than just stand-alone programs. For example, supply-side interventions to encourage the production of nutritious crops need to be accompanied by interventions that encourage market development and integration in order to overcome issues of affordability and seasonality in Ethiopia. Similarly, the provision of seeds without nutrition education about how to grow and cook the produce will not be effective. Sustainable food system transformation therefore requires a package of interventions and a long-term horizon. This links to another of the main findings of the Dialogue regarding the adoption of policy frameworks. While Ethiopia is adopting a Food and Nutrition Strategy 2030, trade-offs will be necessary between these ideal standards and what is feasible. Importantly, it is important to consider the regional and seasonal variations in Ethiopian diets, as well as the affordability of nutritious foods. It is therefore necessary to ensure that implemented interventions take account of diversity and are context specific.

Finally, participants of the Dialogue highlighted that nutrition education is an important step in any policy roadmap that attempts to progress toward sustainable food system transformation. There are many opportunities for this ranging from school curriculum and school feeding programs to the promotion of diverse dietary intakes during the Orthodox Christian fasting period. It is necessary to explore this area further to ensure that interventions are both cost-effective and have an impact beyond caloric increases. For a more detailed report on the second consultation see <https://summitdialogues.org/dialogue/17917/official-feedback-17917-en.pdf?t=1627396339>.

Third Consultation

The third round of consultations occurred on September 17, 2021, in the form of a virtual webinar. With a smaller group of participants (11), this consultation presented the preliminary results of the research and modelling approach in order to receive feedback and comments from national stakeholders, both on the findings and research approach.

The key pending questions and suggestions from participants during this consultation were as follows:

- There was almost unanimous consensus amongst the participants that a pulses and legumes target should be included as a healthier diets target for Ethiopia. Currently, these two food categories are highly prevalent in traditional diets and are already integrated into agricultural practices, so it could be a low-hanging fruit to achieve. There would also be a range of benefits, as legumes and pulses have a greater nutrient density than cereals and starches and are linked to healthier soil management and



regenerative agricultural practices. In order to figure out a specific pulses and legumes target, links should be made with the Ethiopian Public Health Institute and those developing the Food-Based Dietary Guidelines in Ethiopia.

- Ethiopia has a very large livestock population, one of the highest on the continent. This is coupled with very low animal-sourced food consumption. Participants questioned the extent to which our estimates considered per capita livestock numbers in the analysis.
- It was noted that the productivity of the livestock sector needs to make improvements as it is very GHG intensive, even compared to other countries on the continent. Discussants asked whether the modelling work could build in different scenarios that account for different levels of achievement in efficiency gains.
- Participants noted that it could be a useful key contribution in the reports to raise questions about the potential sources of additional external public resources. In the current context of stagnating or decreasing foreign aid budgets, there is a need to be creative and innovative about how financing is being accessed.
- Participants highlighted previous and ongoing research projects and initiatives that have similarities and areas of overlap with this research project. They emphasized the need to align—and where possible coordinate—with these ongoing in-country activities such as the Ethiopian Public Health Institute nutrition gap analysis, the national technical working group (looking at the cost of diets), the John Hopkins/International Fund for Agricultural Development report on healthier diets, and those involved in the United Nations Food Systems Summit process in Ethiopia. This will ensure that our research and findings have maximum effect on practical implementation.

Fourth Consultation

A final e-consultation was held in which the final draft of the country report was presented to a wide group of national and international stakeholders for feedback. These comments were taken into consideration before the final versions of the reports were published and disseminated.

All the feedback, questions, and comments received during the rounds of consultations fed into this final country report.



Appendix C. Microeconomic Approach

Table C1. Summary statistics of key nutritional indicators

	Mean	SD	Min	Max.	N
Calories (Kcal)	2,125.41	1,464.72	0.00	16,550.42	6,770
Cereals and starches	1,402.13	1,203.87	0.00	15,740.09	6,770
Legumes, nuts, and seeds	200.29	278.37	0.00	9,628.46	6,770
Vegetables	83.69	226.48	0.00	11,359.90	6,770
Fruits	15.94	35.15	0.00	431.39	6,770
Dairy	39.56	110.37	0.00	1,594.91	6,770
Animal foods (excl. dairy)	38.74	101.38	0.00	1,132.11	6,770
Vegetable oils	236.14	265.81	0.00	3,788.58	6,770
Sweets and alcoholic beverages	108.92	127.81	0.00	1,054.76	6,770
Protein (grams)	58.17	44.14	0.00	515.57	6,770
Cereals & starches	38.59	34.39	0.00	493.73	6,770
Legumes, nuts, and seeds	12.55	16.25	0.00	322.84	6,770
Vegetables	3.45	8.83	0.00	428.73	6,770
Fruits	0.19	0.43	0.00	4.99	6,770
Dairy	1.55	4.63	0.00	62.75	6,770
Animal foods (excl. dairy)	1.64	4.00	0.00	49.17	6,770
Vegetable oils	0.00	0.00	0.00	0.00	6,770
Sweets and alcoholic beverages	0.18	0.57	0.00	8.70	6,770
Fat (grams)	48.97	42.96	0.00	637.89	6,770
Cereals and starches	9.64	8.95	0.00	89.97	6,770
Legumes, nuts, and seeds	3.06	9.50	0.00	442.81	6,770



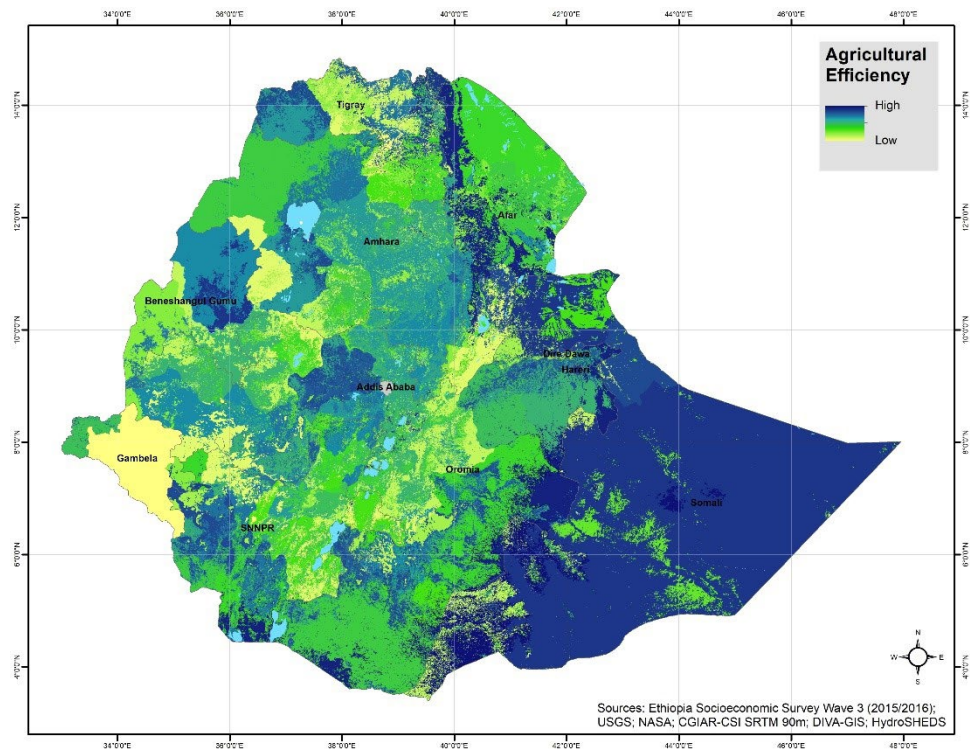
	Mean	SD	Min	Max.	N
Vegetables	2.84	10.39	0.00	617.63	6,770
Fruits	0.06	0.13	0.00	1.65	6,770
Dairy	3.15	10.05	0.00	178.94	6,770
Animal foods (excl. dairy)	3.50	9.48	0.00	106.14	6,770
Vegetable oils	26.71	30.07	0.00	428.57	6,770
Sweets and alcoholic beverages	0.01	0.03	0.00	0.36	6,770

Source: Authors' calculations using LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020).



Appendix D. Country Maps

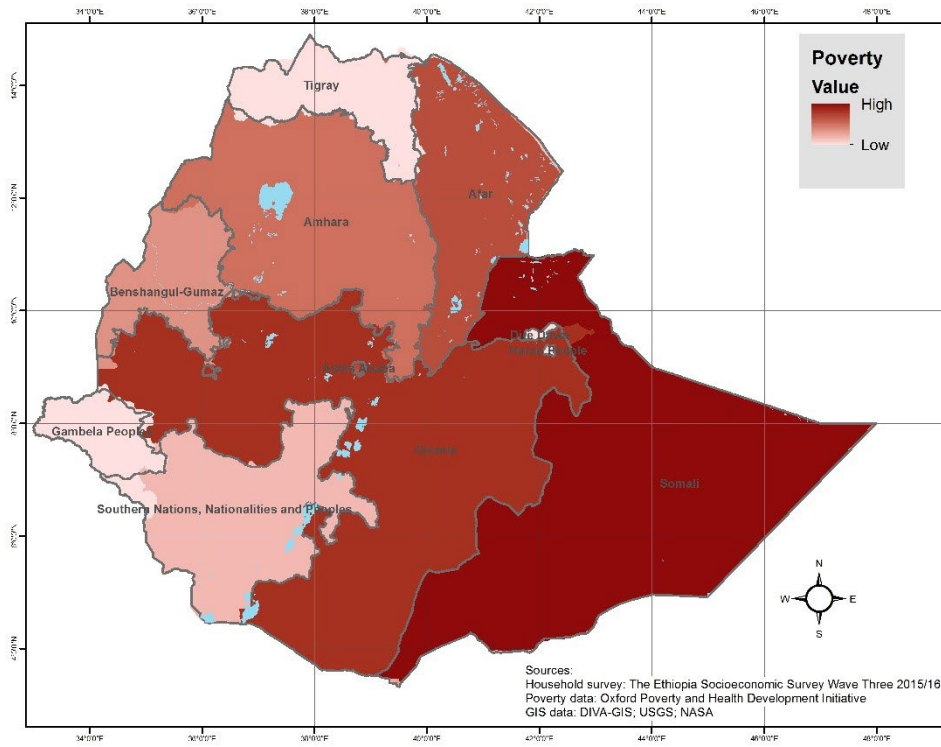
Figure D1. Agricultural potential in Ethiopia



Source: Maruyama et al., 2018.



Figure D2. Poverty in Ethiopia



Source: Maruyama et al., 2018.

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