



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

Achieving Sustainable Food Systems in a Global Crisis

SUMMARY REPORT





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Achieving Sustainable Food Systems in a Global Crisis: Summary Report

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Written by Livia Bizikova, Alan De Brauw, Mali Eber Rose, David Laborde, Kulthoum Motsumi, Mike Murphy, Marie Parent, Francine Picard, and Carin Smaller

Head Office

111 Lombard Avenue,
Suite 325
Winnipeg, Manitoba
Canada R3B 0T4

Tel: +1 (204) 958-7700

Website: www.iisd.org

Twitter: [@IISD_news](https://twitter.com/IISD_news)



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Executive Summary

The world is not on track to achieve the United Nations Sustainable Development Goals by 2030. The prevalence of hunger and poverty—the two core goals which are the litmus test for everything else—are on the rise. This is being made worse by the Russian invasion of Ukraine, skyrocketing food, fertilizer, and energy prices, COVID-19, and climate change. In Africa, the situation is exacerbated by internal conflicts, political unrest, economic recessions, and swarms of desert locusts. To get back on track, it is critical to pursue policy pathways that encourage synergies and limit the trade-offs between hunger, poverty, nutrition, and climate change. This report summarizes the evidence-based and costed country roadmaps for effective public interventions to transform agriculture and food systems in Ethiopia, Malawi, and Nigeria¹ 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 financing gap is immense. This report shows that while it is possible to achieve sustainable food system transformation in Ethiopia, Malawi, and Nigeria, in the next decade, it would require an average additional public investment of USD 10 billion per year from 2023 to 2030 and targeting spending on a more effective portfolio of interventions that achieve multiple sustainable development outcomes. Of the total USD 10 billion, the donor share averages USD 5.8 billion per year, and the country share averages USD 4.2 billion per year. Importantly, 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 shows that while emergency assistance has increased in recent years, there is significant underfunding of the longer-term investment needs. The shortfall in longer-term funding increases the vulnerability to shocks, pushing the number of people affected by hunger and poverty higher. Donors should therefore complement and better link the increased allocation of emergency food assistance with increased investments in longer-term agricultural development priorities to prevent future crises when the next shock hits.

Filling the financing gap of USD 10 billion per year will yield immense economic, social, and environmental benefits. The prevalence of undernourishment in all three countries will decrease to under 3% in 2030 from a current projection of 22% in Ethiopia, 25% in Malawi, and 21% in Nigeria, by 2030. The transition toward healthier diets will be achieved for 248 million people, or roughly 60% of the population in each country. The incomes of 29 million small-scale producers will double on average in 2030 compared to 2015 levels. These economic and social gains will be achieved while confining greenhouse gas (GHG) emissions to nationally determined contribution goals and increasing resilience to climate change of the most vulnerable.

The findings in this report are based on analysis of academic and grey literature, as well as donor-funded projects, micro- and macroeconomic modelling, and engagement and consultations with key stakeholders in Ethiopia, Malawi, and Nigeria. The report summarizes the findings of a project that explores the interactions between reducing hunger and poverty,

¹ For more detailed country level reports on Ethiopia, Malawi, and Nigeria, see Bizikova et al., 2022a, 2022b, 2022c.



achieving healthy diets, and addressing climate change within the evolving food systems in three countries—Ethiopia, Malawi, and Nigeria.

The report recommends the governments of Ethiopia, Malawi, and Nigeria and their development partners:

- 1. Increase domestic and external resources to achieve the transition to sustainable agriculture and food systems.** It would cost an additional USD 10 billion per year on average from 2023 to 2030; USD 4.6 billion for Ethiopia, USD 543 million for Malawi, and USD 4.9 billion for Nigeria. Of the total, the donor share averages USD 5.8 billion per year: USD 2.7 billion for Ethiopia, USD 472 million for Malawi, and USD 2.3 billion for Nigeria. Increased spending on the farm in Ethiopia, Malawi, and Nigeria and social protection programs in Nigeria account for most of the additional need.
- 2. Urgently scale up official development assistance for the longer-term investments in agriculture, food security, and nutrition while strengthening the link between emergency assistance and long-term development goals.** To prevent future shocks leading to crises, donors should strengthen the link between humanitarian and development spending and increase their allocations to longer-term development priorities, including disaster preparedness, to build resilience that would help prevent shocks leading to crises.
- 3. Strengthen the linkages between food systems and the environment** through extension services, better seed choices, investment in machinery, and on-farm interventions that protect soil health, biodiversity, water, and land resources. While all three countries are undertaking efforts to address climate change and enhance climate adaptation, more effort is required to support climate-resilient agricultural practices that address the linkages between agriculture and food systems, food security, and healthy diets. This includes targeted extension services for those most vulnerable, including women and others, better seed choices, investment in machinery and equipment, and interventions to protect soil health and biodiversity, conserve water, and limit land-cover change.
- 4. Scale up and increase support for environmentally sustainable livestock intensification** through better breeding, feed, manure management, and a shift to small ruminants. Environmentally sustainable intensification is needed to improve both crop and livestock productivity, but this is lacking in donor and government-funded programs. The livestock sector is the biggest contributor to GHG emissions, and its contribution to total and per capita GHG emissions in the three countries will continue to rise to 2030. The livestock sector also has low productivity levels, necessitating significant additional investment to drive sustainable productivity growth through better breeding, feed, manure management, and a shift to small ruminants.
- 5. Continue and scale up targeted social protection programs** for the most vulnerable to support national nutritional and development objectives and build resilience to climate change and other shocks. These should build on already successfully designed and implemented social protection programs, particularly those in Ethiopia and Nigeria.



6. **Accompany on- and off-farm investments with nutrition education to improve consumer choices.** 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, nutrition, and agricultural productivity programs.
7. **Focus food loss and waste policies and interventions on better storage infrastructure and education.** Food loss and waste is growing in all three countries, and there is insufficient attention paid to addressing this. The focus of specific investments should be on both enhancing households' knowledge about food waste and safe food storage methods, and on storage infrastructure development along value chains. This would contribute to preserving highly perishable goods and efforts to improve food safety.
8. **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 monitor, coordinate, and accelerate the sustainable agriculture and food systems transformation, including by collecting disaggregated data to account for subnational and gender differences.

These recommendations closely align with the strategies and pathways outlined by Ethiopia, Malawi, and Nigeria in their national pathways for food systems transformation developed in light of the United Nations Food Systems Summit (UNFSS) in 2021 (see Federal Democratic Republic of Ethiopia, 2021a; Federal Republic of Nigeria, 2021c; Government of Malawi, 2021b). The country reports explain the alignment between our recommendations and the country-specific UNFSS food systems transformation pathways (see Bizikova et al., 2022a; 2022b; 2022c for more details). The results, findings, and recommendations of these reports, and the broader project findings, therefore offer an evidence base and a financing plan on which to support the implementation of the key priority action areas identified in the country's UNFSS processes.



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1.0 Food System Challenges

Despite progress toward Agenda 2030 and the Sustainable Development Goals, one in twelve people, or 8% of the global population, will still experience hunger by 2030 (Food and Agriculture Organization of the United Nations [FAO] et al., 2021). Even among those who get enough calories, many are malnourished, due in part to the unaffordability of healthy diets that would provide enough calories but also satisfy complex nutritional requirements. Hunger has grown and will continue to worsen in Ethiopia, Malawi, and Nigeria due to skyrocketing food, fertilizer, and energy prices, exacerbated by the Russian invasion of Ukraine, the ongoing COVID-19 pandemic, violent conflict, economic downturns, and the effects of climate change. In Ethiopia, the conflict in Tigray has rapidly made the situation of hunger and poverty worse. The unique population trajectories, macroeconomic dynamics, food cultures and preferences, responses to climate change, and aspirations of the three countries means a unique package of solutions is needed for each country.

1.1 Hunger, Poverty, Small-Scale Producers, and the Unaffordability of Healthy Diets²

Hunger and poverty are critical challenges in all three countries, with significant levels expected to persist after 2030. According to the most recent estimates available, 24% of Ethiopians, 69% of Malawians (in 2016), and 39% of Nigerians (in 2018) live below the extreme poverty threshold of USD 1.90 per day (World Bank Development Research Group, 2021). In comparison, the average prevalence of poverty in sub-Saharan Africa was 35% in 2019 (World Bank Development Research Group, 2021). These issues are compounded by growing demographic pressure and economic need, necessitating a significant increase in food consumption and production to address the nutritional needs of its population. Yet, the projections are not optimistic. By 2030, the projections from the model show that 18% of Ethiopians, 72% of Malawians, and 46% of Nigerians will live below the extreme poverty threshold.

According to recent estimates, 16% of Ethiopians, 17% of Malawians, and 18% of Nigerians are not receiving sufficient food in a year to meet their physical energy needs, as defined by the prevalence of undernourishment (PoU) (FAO et al., 2021). By 2030, the projections from the model show that 22% of Ethiopians, 25% of Malawians, and 21% of Nigerians will not have sufficient food in a year to meet their body's energy needs. Critically, these statistics also mask in-country variations in subnational prevalence and distribution between genders, regions, and urban and rural areas.

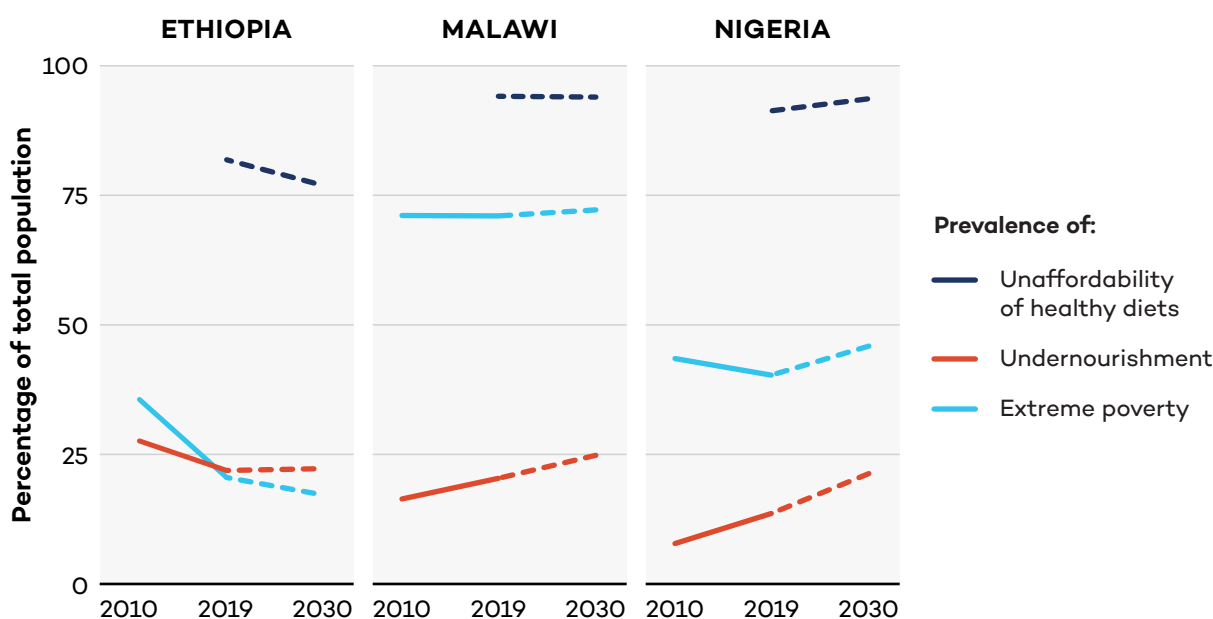
Beyond adequate calories, nutritious diets are unaffordable for most people in all three countries. According to recent estimates, 84% of Ethiopians, 94% of Malawians, and 91% of Nigerians cannot afford a healthy diet, defined by an income of USD 3.50 per day (FAO et al., 2020). By 2030, the projections from the model show that about 77% of Ethiopians, over 90% of Malawians, and over 90% of Nigerians will not be able to afford a healthy diet.

² Note: Associated to SDG targets: 2.1, 2.2 & 2.3



Reductions in hunger are closely linked to improvements in income, but with skyrocketing food, fertilizer, and energy prices, exacerbated by the Russian invasion of Ukraine, the ongoing COVID-19 pandemic and significant deteriorations in security in parts of Ethiopia and Nigeria, these numbers are likely to be understated.

Figure 1. Hunger, poverty, and the unaffordability of healthy diets in 2030 (baseline projection)



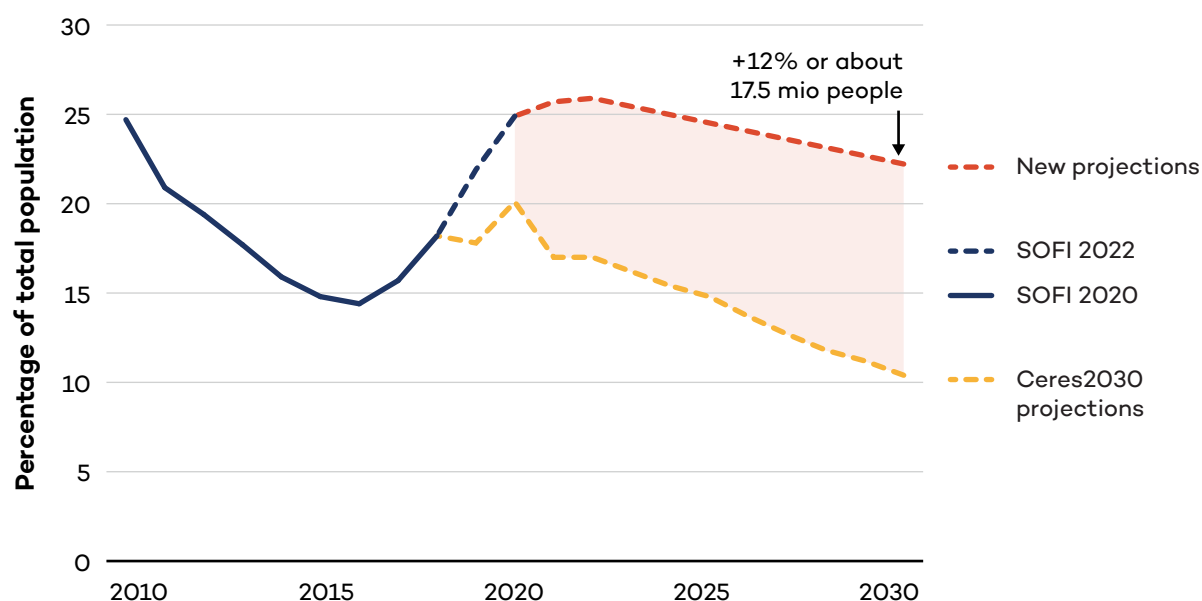
Source: In this figure, we use the approach from *The State of Food Security and Nutrition in the World 2021* (FAO et al., 2021) to define the (un)affordability of healthy diets.

Critically for Ethiopia, the armed conflict in the Tigray region has increased food insecurity among the region's population (see Figure 2) 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 PoU are included in the quantitative analysis. It is predicted that the Tigray conflict will result in an estimated 17.5 million people experiencing undernourishment in 2030 compared to estimates made before the conflict (see Figure 2). The considerable progress Ethiopia had made in eradicating undernourishment between 2010 and 2016 (from approximately 25% to 15%) has been reversed, and significant efforts will be needed to get the country back on track.

In all three countries, small-scale food producers are the people most often affected by poverty and hunger and those most unable to afford healthy diets. In Ethiopia, Malawi, and Nigeria, small-scale food producers face low levels of productivity and incomes, undermining their ability to get out of hunger and poverty, and to be able to afford healthier diets. They are also highly vulnerable to shocks as they lack the resources to invest in resilience-building capacities. They will increasingly face climate pressures, degrading their situations further. The incomes and productivity of these small-scale producers must be addressed to solve these challenges.



Figure 2. Prevalence of undernourishment in Ethiopia from 2010 to 2030, estimates before and including 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 & IFPRI, 2022.

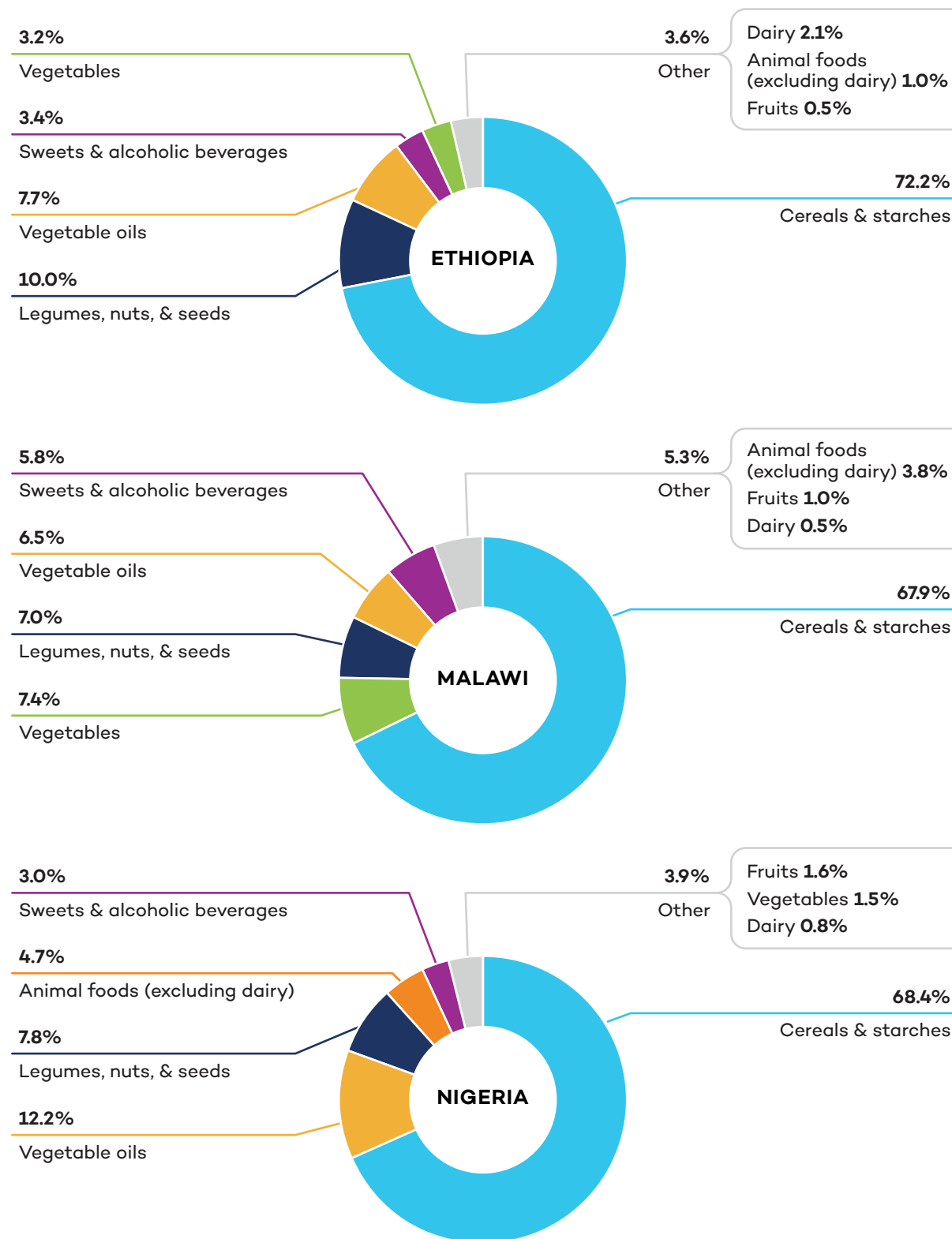
1.2 Diet Composition and Quality³

The unaffordability of healthy diets, along with other factors, means that in all three countries carbohydrate-rich staple foods—including cereals, grains, starchy roots, and plantains—disproportionately dominate food consumption. This holds true across all income groups, although higher-income households have higher dietary diversity. While important for caloric sufficiency, the current overreliance on staple foods leaves significant nutritional gaps (See Figure 3), leading to malnutrition, which is a key risk factor for non-communicable diseases. In addition, childhood malnutrition impacts children’s health and development and their educational and economic outcomes later in life (Branca et al., 2019). Anemia, stunting in children, and wasting are all still prevalent issues in the three countries, while simultaneously the occurrence of obesity is increasing and may become a more salient issue as the countries continue to develop and urbanize.

³ Note: Associated to SDG target 2.2.



Figure 3. Current dietary composition in Ethiopia, Malawi, and Nigeria, aggregated by food group, per capita, per day



Sources: Authors' analysis of Living Standards Measurement Survey (LSMS) data. LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020b), LSMS-IHS Malawi Wave 5 2019–2020 (World Bank, 2020a), LSMS-GHS Nigeria Harvest Questionnaire Wave 4 2018–2019 (World Bank, 2019), and nutrient coefficients based on FAOSTAT-SUA (FAO, 2021).



According to analysis of the LSMS data, most households in the three countries are overly reliant on cereals and starches and under-consume fruits and vegetables (World Bank, 2019, 2020a, 2020b). While there is some variation between regions and income groups, the majority of households in all three countries consume less than the World Health Organization's (WHO's) recommendation of 400 g of fruits and vegetables per day ("vegetables" excludes starchy roots) (WHO, 2020). Despite their importance for meeting a wide variety of micronutrient needs (including vitamin A and iron that are commonly insufficient in diets), fruits and vegetables account for less than 10% of average food intake in each studied country. In particular, fruit consumption is highly seasonal for most households due to high perishability and inadequate transportation infrastructure, especially in rural areas.

To progress toward healthier diets, animal-source foods must be increasingly included in diets in Ethiopia, Malawi, and Nigeria. Animal-source foods are the most efficient and effective way for at-risk populations to get sufficient amounts of key nutrients, such as zinc, iron, vitamin A, vitamin B12, calcium, and selenium (see, for example, Murphy & Allen, 2003; Raiten et al., 2020; Thompson & Amoroso, 2011). This is a key trade-off in the sustainable food systems transition in these countries since animal-source foods are also the ones with the highest GHG emissions. Legumes, nuts, and seeds also contribute important nutrients to diets, especially zinc, iron, and protein. In particular, legumes have a history as an important part of Ethiopian diets, are relatively affordable, and have important benefits for environmentally sustainable agricultural production. Feedback from stakeholder consultations strongly recommended that measures to maintain or increase the consumption of this food group in Ethiopia would have important environmental and health benefits for the population.

In terms of nutrition policies, Ethiopia and Nigeria have national dietary guidelines, while Malawi does not. Like many countries in sub-Saharan Africa, Malawi does not have a set of national food-based dietary guidelines; however, the country's government has broadly committed to improving nutrition, particularly from the perspective of undernutrition. Ethiopia has recently published its national dietary guidelines, launched in March 2022 (Federal Democratic Republic of Ethiopia [FDRE], 2022). Nigeria published food-based dietary guidelines in 2001, providing broad recommendations on aspects of healthy diets, such as limited consumption of sugary and salty foods, and improved consumption of fruits and vegetables, which were reprinted in 2006 (FRN, 2006). The three studied countries also implement national fortification programs to varying degrees, covering a range of products, including fortification of different types of wheat and maize flour with several vitamins and minerals, salt iodization, and fortification of cooking oil with vitamin A.

1.3 Climate Change Impacts, Mitigation, and Adaptation Responses⁴

Climate change is already affecting agriculture and food systems and having wide-ranging impacts on livelihoods, food security, and nutrition in Ethiopia, Malawi, and Nigeria. Temperatures in the three countries have risen by 1°C in Malawi, 1.3°C in Ethiopia, and 1°C in Nigeria since 1960 (Republic of Malawi, 2021c; FDRE, 2019; FRN, 2020a). The effects of

⁴ Note: Associated to SDG target 2.4.



climate change on agriculture range from shifts in the types of crops cultivated and changing the start of seeding and cultivation to decreased crop yields and increased risks of crop failure (FDRE, 2019; FRN, 2020a; Morgan & Fanzo, 2020; Warnatzsch & Reay, 2020). For example, studies show that in a climate change environment in Malawi, maize yields could decrease by 14%–25% by 2050 (Warnatzsch & Reay, 2020). The three countries rely heavily on rain-fed agriculture, and many people rely directly on their own production for income and/or food without protection against the increasing risk of production failure because of increasingly frequent extreme weather events and climate variability (FDRE, 2015a, 2015b; 2019; Olayide et al., 2016; Stevens & Madani, 2016).

Policy pathways geared to food system transformation need to consider responses to climate change, including measures to help small-scale producers adjust their production practices to climate change impacts and variability. It is also critical to focus on more sustainable and resilient approaches to production intensification overall, specifically focusing on integrating environmental and climate perspectives into policies and strategies.

GHG emissions from agriculture, especially livestock, are a problem in all three countries. Emissions from livestock—mainly ruminants, which emit more GHGs in production than poultry or other animal foods—grew quickly in the past decade in all three countries. Livestock already accounted for the majority of GHG emissions in 2018 across the three countries and are predicted to account for the majority of agricultural emissions increases in the baseline projections for the next decade (see Figure 4). The projections show an annual average increase of 5.8% in Ethiopia, 4.4% in Malawi, and 2.3% in Nigeria in GHG emissions from agriculture and related land use⁵ between 2020 and 2030 if no additional efforts are made.

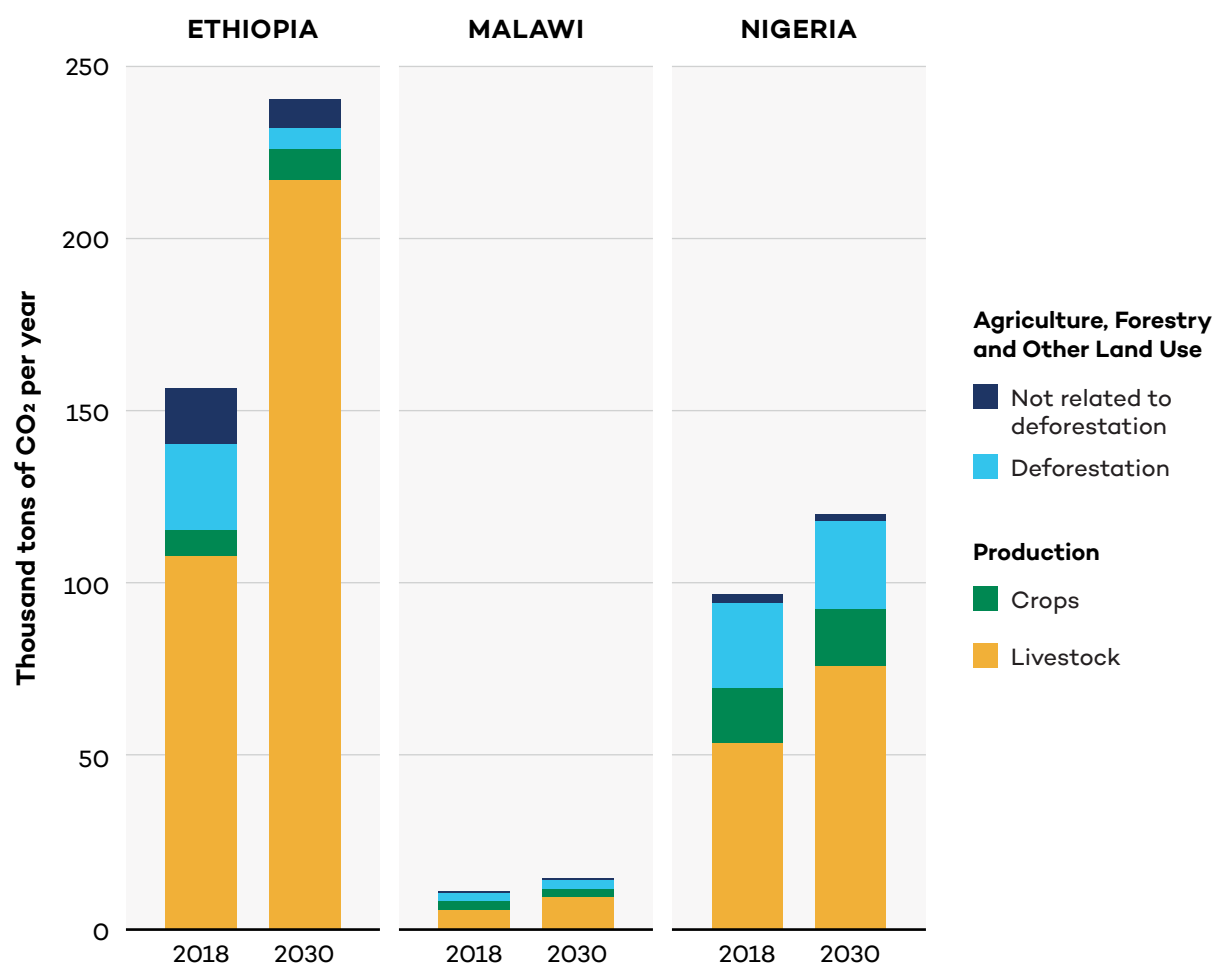
All three countries have committed to reducing GHG emissions. Based on the nationally determined contribution (NDCs) of the three countries (original reports and updated versions published in 2021), Malawi commits to an unconditional emissions reduction of 6% relative to business-as-usual (BAU) by 2040, Nigeria commits to an unconditional emissions reduction of 20% relative to BAU by 2030, while Ethiopia commits to an unconditional emissions reduction of 14% relative to BAU by 2030 (FDRE, 2021b; FRN, 2021b; Republic of Malawi, 2021a).⁶ For Malawi and Nigeria, the highest contribution to reduction targets is assumed to come from the energy sector, followed by agriculture. Ethiopia's updated NDC projects a very minimal (less than 3%) reduction in agricultural emissions by 2040 compared to BAU (FDRE, 2021b). All three countries will need to be supported through their emission reduction efforts, including from livestock production and the move toward resilient and sustainable agricultural land management practices.

⁵ Agricultural emissions in our modelling include emissions from crop and livestock production and associated activities: 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. Agricultural-related land use emissions are also included in our projections. Our model data comes from FAOSTAT; see the methodological note available at <http://www.fao.org/faostat/en/#data/GT> for details on this data.

⁶ 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.



Figure 4. Agricultural and land-use GHG emissions in Ethiopia, Malawi, and Nigeria (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, building resilience and adapting to climate change are critical to addressing the challenges in the agri-food system today and in the future. National adaptation plans and resilience strategies in the three countries stress actions, such as improving the efficiency of water use and resilience to drought, more favourable access to financial resources for small-scale food producers, extension services that address new climate challenges, and improving access to technologies and markets that can buffer against climate shocks (FRN, 2020b; FDRE, 2019; GoM, 2013). Such actions are crucial to reduce the impact of climate change on agri-food systems, enhance adaptation, and reduce GHG emissions. For these actions to be effective, policy documents also recognize the importance of addressing gender issues in the design and implementation of such actions.



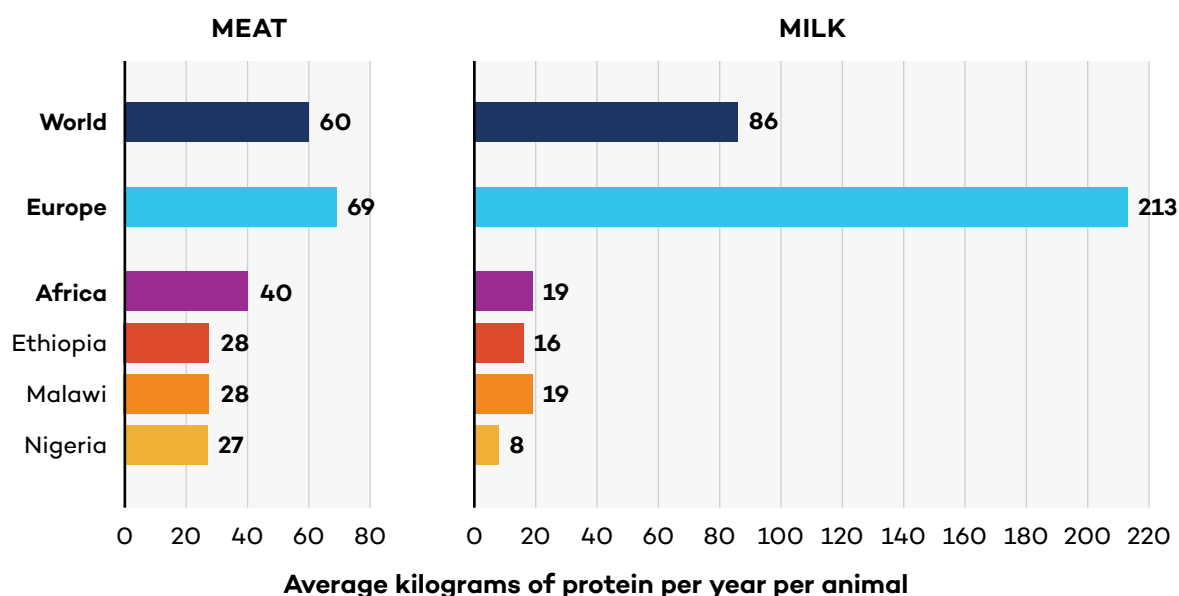
2.0 Food System Opportunities

2.1 Productivity Gap

Demographic pressure and economic needs in all three countries necessitate an increase in food consumption and production to address the nutritional needs of their citizens. Food systems transformation toward healthier diets will, therefore, not be possible without improving agricultural productivity. The average productivity of major crops in all three countries is less than 1,000 kg/ha on over 60% of farmland (Mungai et al., 2016). In comparison, the Organisation for Economic Co-operation and Development (OECD) database suggests the global average is 3.5 times higher (Mungai et al., 2016). The picture is the same for other crops and livestock. Critically, there is significant potential and opportunity for agricultural development to improve productivity in all three countries.

All three countries demonstrate low productivity levels in both plant and livestock sectors. Figure 5 shows the livestock productivity of bovine animals in Ethiopia, Malawi, and Nigeria compared to the average in Europe and Africa. Both meat and milk productivity levels are significantly lower than average, with milk productivity levels in all three countries being almost 14 times lower than the European average. This reflects the trend of low livestock productivity in low- and middle-income countries compared to high-income countries (Baltenweck et al., 2020). The livestock sector in developing countries is therefore simultaneously the biggest contributor to GHG emissions while suffering from low productivity.

Figure 5. Livestock productivity levels for bovine animals, 2018–2020 average



Source: Data extracted from FAOSTAT (FAO, 2021) for 2018, using the approach of Laborde (2022).

Significant additional investment is urgently needed to drive sustainable productivity growth through better breeding, feed, manure management, and a shift to small ruminants;



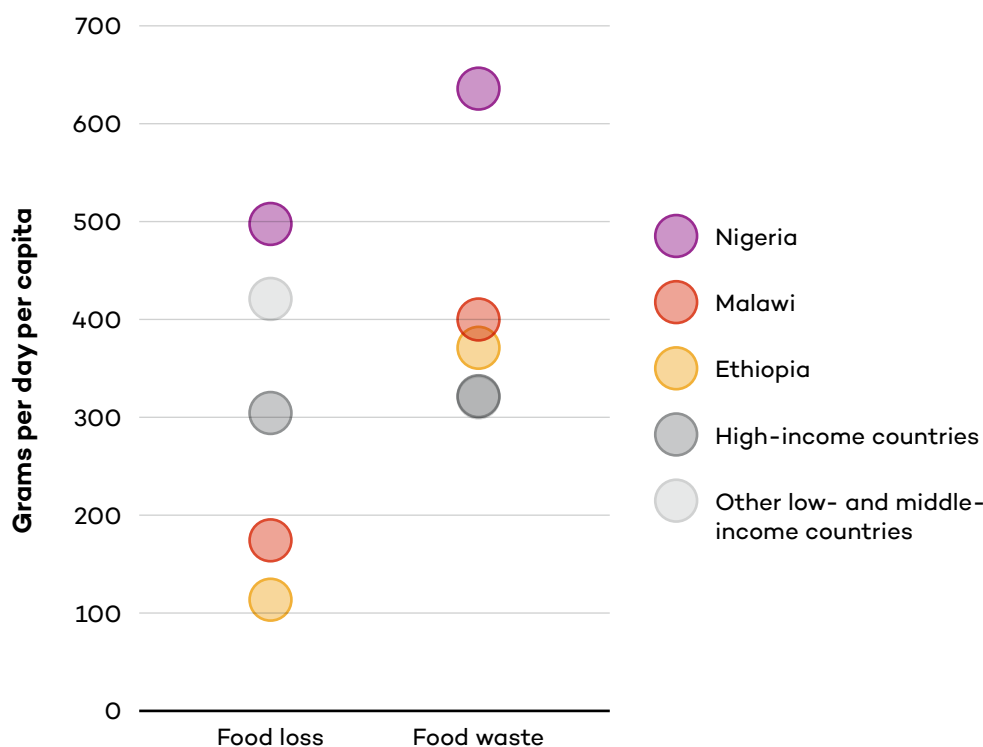
this represents an area of significant opportunity. It also requires favouring production techniques compatible with each country’s climate adaptation and mitigation commitments, including fiscal incentives to make sure improved techniques are economically attractive and commercially viable for small-scale producers. Small-scale producers need to be assisted in achieving significant improvements in productivity and income, access to markets, and climate resilience, as this will contribute significantly to meeting the nutrition and food security needs of a growing population in a way that does not increase vulnerability to climate change and environmental degradation.

Generally, the three studied countries’ policies and strategies see increasing agricultural productivity, particularly in the livestock sector, as critical to improving the economy’s competitiveness, assisting in agricultural transformation, and contributing to poverty reduction. More could be done to ensure that this increased productivity is done in an environmentally sustainable way.

2.2 Food Loss and Waste

In Ethiopia, Malawi, and Nigeria, both post-harvest losses and food waste are considerable. In Nigeria, there are losses of up to 60% for perishable crops, mainly stemming from inadequate infrastructure and storage systems as well as inefficient transport systems (FRN, 2016). Figure 6 shows the significant levels of food loss and waste in our three focus countries compared to the average in high-income and other low- and middle-income countries.

Figure 6. Food losses and waste in Ethiopia, Malawi, and Nigeria, 2021



Source: FAOSTAT (FAO, 2021) & UNEP (2021).

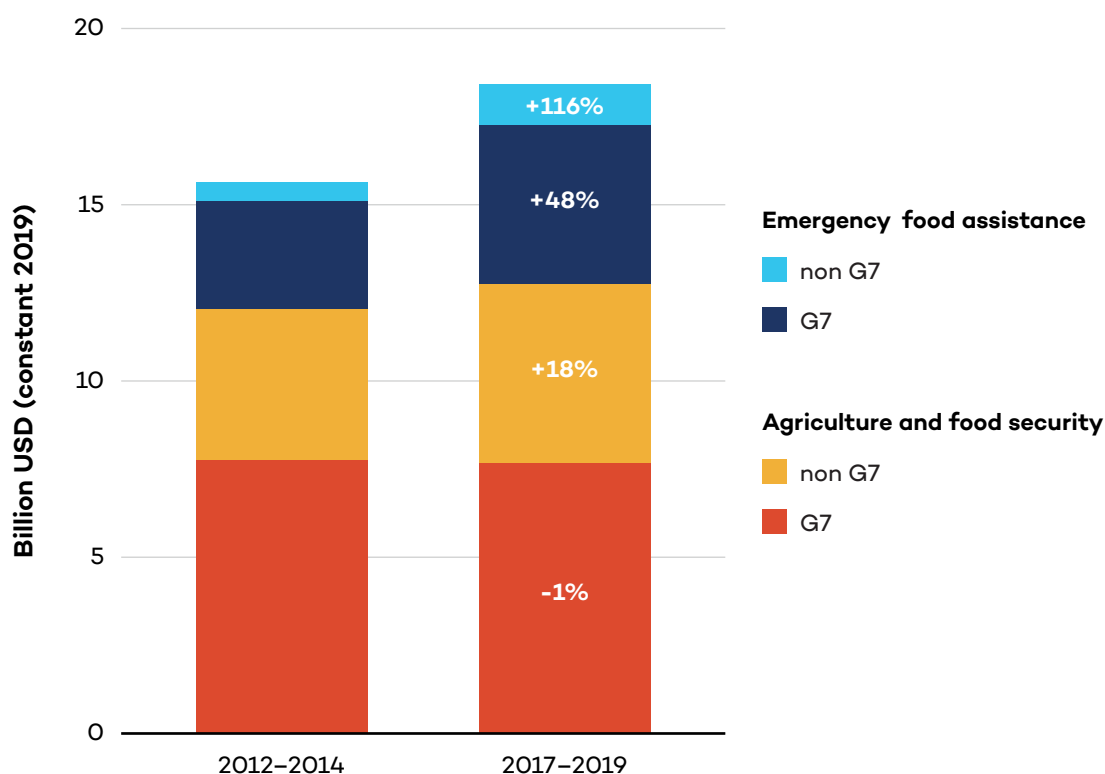


Addressing issues of food loss and waste would help alleviate issues of undernutrition and poor-quality diets by increasing the availability of nutrient-dense perishable foods. Additionally, reducing post-harvest losses would mitigate the need for increased production by increasing the availability of food on the market. Governments and donors should therefore pay more attention to reducing food loss and waste, particularly among perishables.

2.3 Financing Gap

The financing gap between the long-term investment needs and the short-term emergency food assistance needs is enormous. While total official development assistance (ODA) to emergency food assistance has increased overall from 2012 to 2014 compared to 2017 to 2019, the total ODA to long-term agriculture and food security has stagnated over the same period (see Figure 7). There is insufficient attention to bridging short-term emergency food assistance programs with longer-term investments in agriculture and food systems, and there remains massive underfunding of the longer-term investment needs. This shortfall in longer-term funding increases the vulnerability to shocks and leads to crises that push the number of people affected by hunger and poverty higher. Donors should complement and better link the increased allocation of emergency food assistance with increased investments in longer-term agricultural development priorities to build resilience to help mitigate against future shocks.

Figure 7. Financing gap between long-term investment needs in agriculture and food security, compared to emergency food assistance



Source: Data extracted from Laborde & Smaller, 2022 and OECD (2021).



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

The goal of this report is to identify pathways, and the associated costs, for addressing the interlinked challenges of the agri-food system described above: hunger, poverty, unaffordability of healthy diets, and climate change. The focus is on improving nutritional outcomes through healthy diets using a more climate-resilient production system with fewer GHG emissions. More specifically, the aim is to illustrate how—and with what composition and scale—public investment might transform agri-food systems to end hunger, double incomes and productivity for small-scale producers, make diets healthier and more affordable, and mitigate and adapt to climate change.

3.1 Additional Public Cost of Achieving Sustainable Food System Transformation

The research draws on four rounds of consultations with in-country stakeholders,⁷ a qualitative assessment of climate change adaptation in the agricultural sector of each focus country, microeconomic analysis of changing diets, food habits and nutrition, and the country-level findings from Ceres2030: Sustainable Solutions to End Hunger.⁸ A computable general equilibrium model,⁹ hybridized with microeconomic household modelling, is used to project two scenarios of the future until 2030: a baseline scenario and a sustainable agri-food system, climate change, and healthy diets transformation scenario.

The sustainable food systems transformation scenario is achieved through SDG 2 sub-targets, specifically 3% or fewer people affected by hunger in each country (SDG 2.1), healthier diets for around 60% of the population in each country (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 impossible to directly incorporate a climate change adaptation target (SDG 2.4) in the macroeconomic modelling due to the 2030 timeline, the interventions prioritized for investment represent many of the needed interventions to achieve more climate-resilient agricultural production in the coming decade, such as research and development (R&D) investments in climate-resilient crops, more targeted extension services, improved livestock feed practices, increased agro-forestry and better-targeted investment and capital endowment subsidies, such as farm machinery and equipment.

SDG sub-targets 2.1, 2.3, and 2.4 have quantitative targets associated with their achievement. However, there is no universally accepted definition, or measure, of a healthy diet (SDG 2.2).

⁷ The objective of the rounds of consultation was to produce an accurate inventory of ongoing projects and policies to integrate into the research and modelling; validate our operational definition of healthier diets in each country and guarantee that various stakeholders feel confident in using our criteria; and to disseminate the results of the research, develop joint ownership, and increase uptake in the short term (UN Food System Summit) and long term (country-level strategies & Food System Pathways).

⁸ See Laborde et al., 2020a and 2020b for more information.

⁹ The model is adapted from the MIRAGRODEP model. See Laborde et al., 2013.



And yet, to estimate costs, there is a need to establish a quantitative target in the model.¹⁰ Therefore, based on national and international guidelines and policy documents, a review of nutrition literature, and expert consultations, three quantitative targets are achieved to make diets healthier:

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 the 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 adequate calcium and vitamin B12.

For Ethiopia, there is an additional target for the adequate consumption of legumes, nuts, and seeds due to strong recommendations from national stakeholders during country consultations. The minimum target for legumes, nuts, and seeds is at least 10% of households' overall caloric intake.

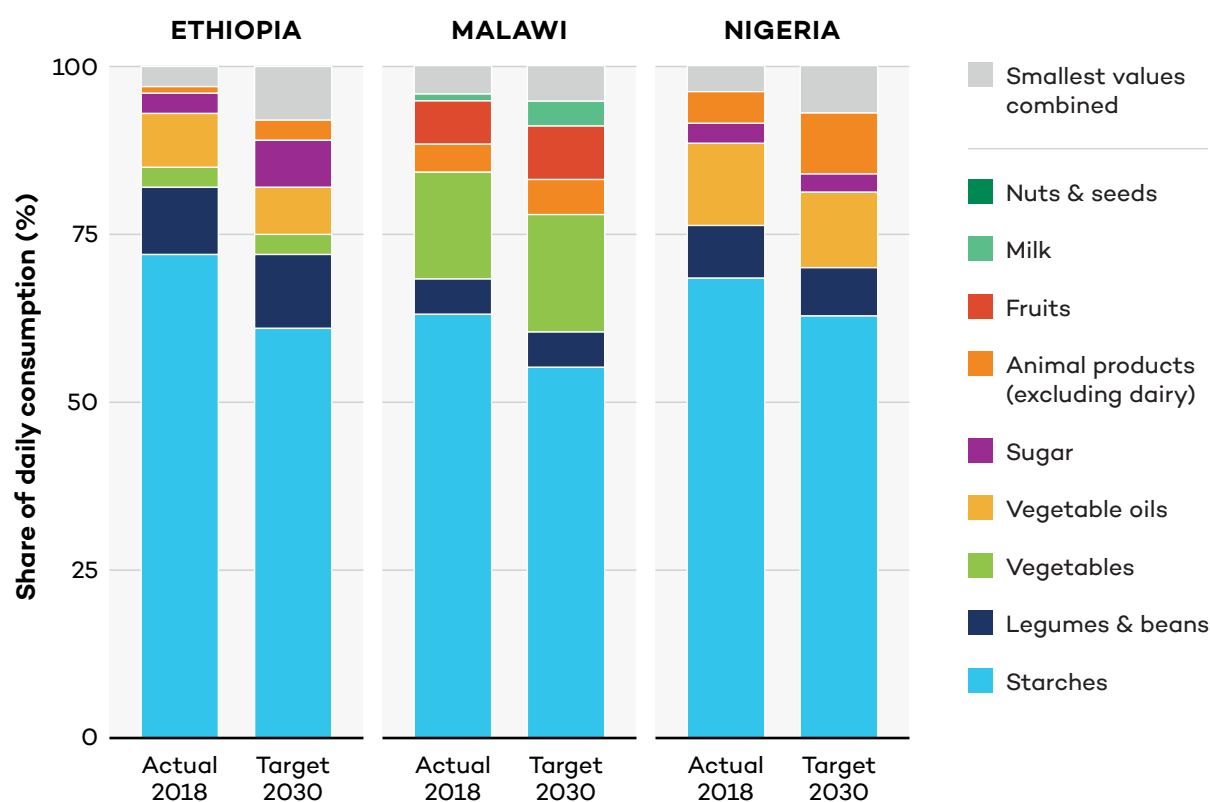
The modelling of diets requires that all households achieve caloric sufficiency, but it also demands that households achieve healthier diets. In this way, the additional public spending promotes diversification without compromising on hunger.

Figure 8 shows the current (2018) consumption patterns in the three countries compared to the consumption targets in the model for 2030. While the dietary targets are relatively general, the figure shows how their achievement would indicate significant progress toward healthier diets.

¹⁰ 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).



Figure 8. Comparison of the current and targeted dietary composition in Ethiopia, Malawi, and Nigeria: consumption per capita



Source: Authors' diagram, using data from LSMS-IHS Ethiopia Wave 5 2018–2019 (World Bank, 2020b), LSMS-IHS Malawi Wave 5 2019–2020 (World Bank, 2020a), LSMS-GHS Nigeria Harvest Questionnaire Wave 4 2018–2019 (World Bank, 2019), and MIRAGRODEP model simulations.

To estimate the domestic and external resources needed to achieve the targets for sustainable food system transformation, the model allocates funding to a portfolio of policy interventions. The interventions in the model were selected based on their relevance for addressing the multidimensional 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. This synergistic approach, with interventions simultaneously progressing toward multiple complex targets, is at the core of the agri-food systems notion and is critical if the targets of SDG 2 are to be met by 2030.

In total there are 15 interventions in the model representing a combination of the 13 interventions used in Ceres2030 and an additional two interventions that specifically target improved nutrition¹¹—nutrition education and school feeding programs (see Table 1). Of the 15 interventions, 9 contribute to building climate resilience and adaptation to climate change. These interventions are in line with stated adaptation priorities in national policy documents, peer-reviewed literature, and stakeholder feedback from the three countries.

¹¹ 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.

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

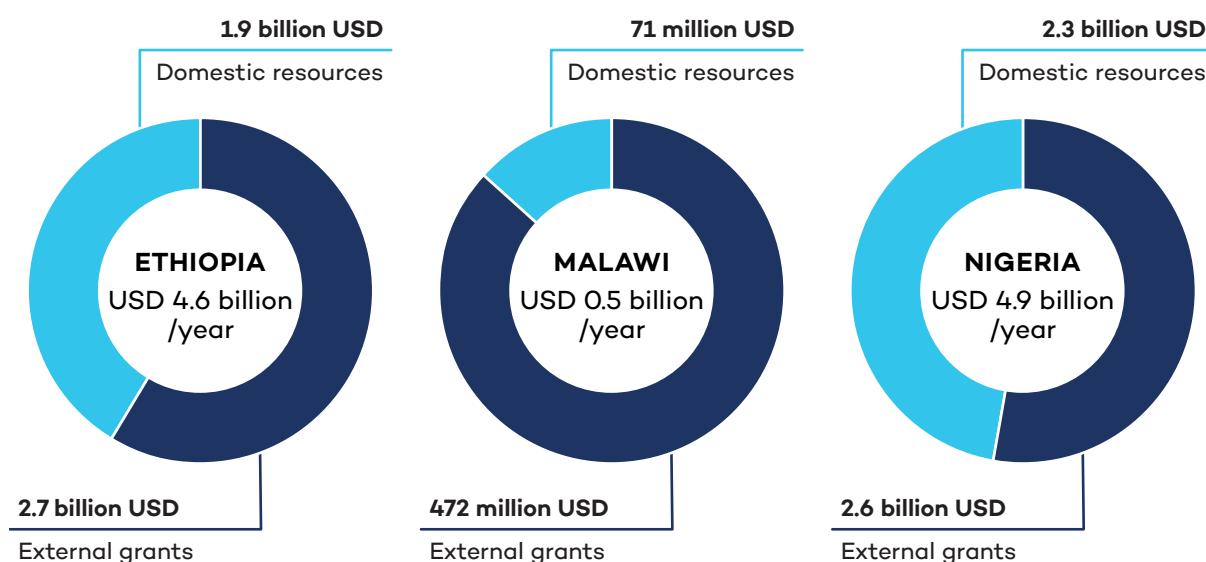
- **Empower the excluded**, which includes actions that directly support consumers, such as social protection programs, nutrition education, vocational training, and school feeding programs.
- **On the farm**, which includes actions that directly support producers, such as investment and financial services, fertilizer subsidies, production subsidies and 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

The financing gap is immense. Results from the modelling show it would cost an additional USD 10 billion of public investment per year on average from 2023 to 2030: USD 4.6 billion for Ethiopia, USD 543 million for Malawi, and USD 4.9 billion for Nigeria. Of the total additional public investment, the governments of Ethiopia, Malawi, and Nigeria must raise an additional USD 4.2 billion per year: USD 1.9 billion for Ethiopia, USD 70 million for Malawi, and USD 2.3 billion for Nigeria. Donors must provide the remaining USD 5.8 billion per year: USD 2.7 billion for Ethiopia, USD 472 million for Malawi, and USD 2.3 billion for Nigeria per year on average (See Figure 9). While Malawi and Ethiopia are more dependent on external resources, Nigeria has the greatest need, requiring a 20-fold increase in agriculture and food security ODA.

Figure 9. Additional public spending and donor contribution per year, 2023–2030, in Ethiopia, Malawi, and Nigeria

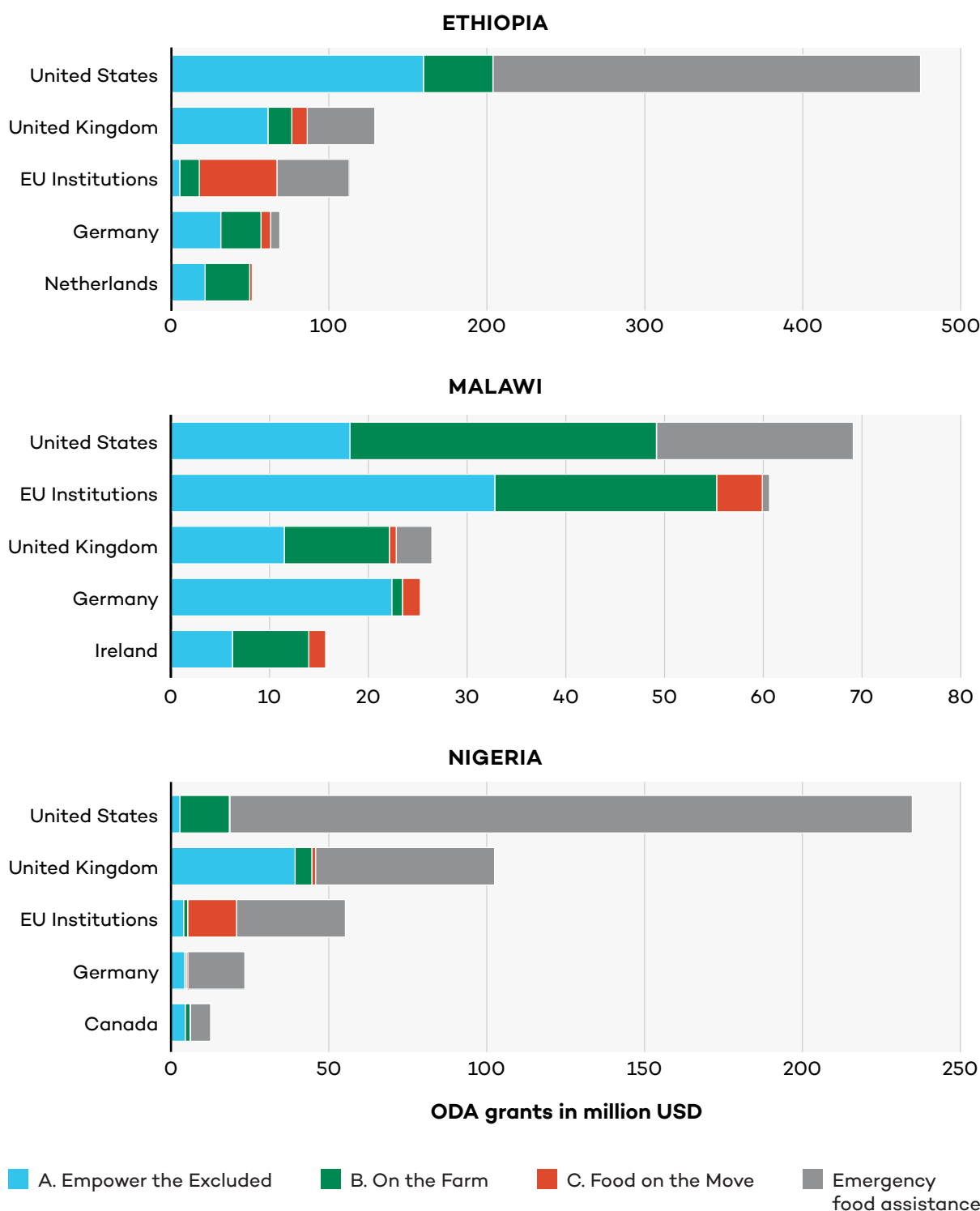


Source: Authors' diagram based on MIRAGRODEP model simulations.

Filling the financing gap of USD 10 billion per year will yield immense economic, social, and environmental benefits. The PoU in all three countries will decrease to under 3% in 2030 from a current projection of 22% in Ethiopia, 25% in Malawi, and 21% in Nigeria by 2030. The transition toward healthier diets will be achieved for 248 million people, or roughly 60% of the population in each country: 108 million people in Ethiopia, 14 million people in Malawi, and 126 million people in Nigeria. The incomes of 29 million small-scale producers will double on average in 2030 compared to 2015 levels: 11.7 million in Ethiopia, 2.9 million in Malawi, and 14.6 million in Nigeria. These economic and social gains will be achieved while limiting GHG emissions to NDC goals and increasing resilience of the most vulnerable to climate change.



Figure 10. Top 5 donors by average annual disbursement, 2017–2019: Ethiopia, Malawi, and Nigeria



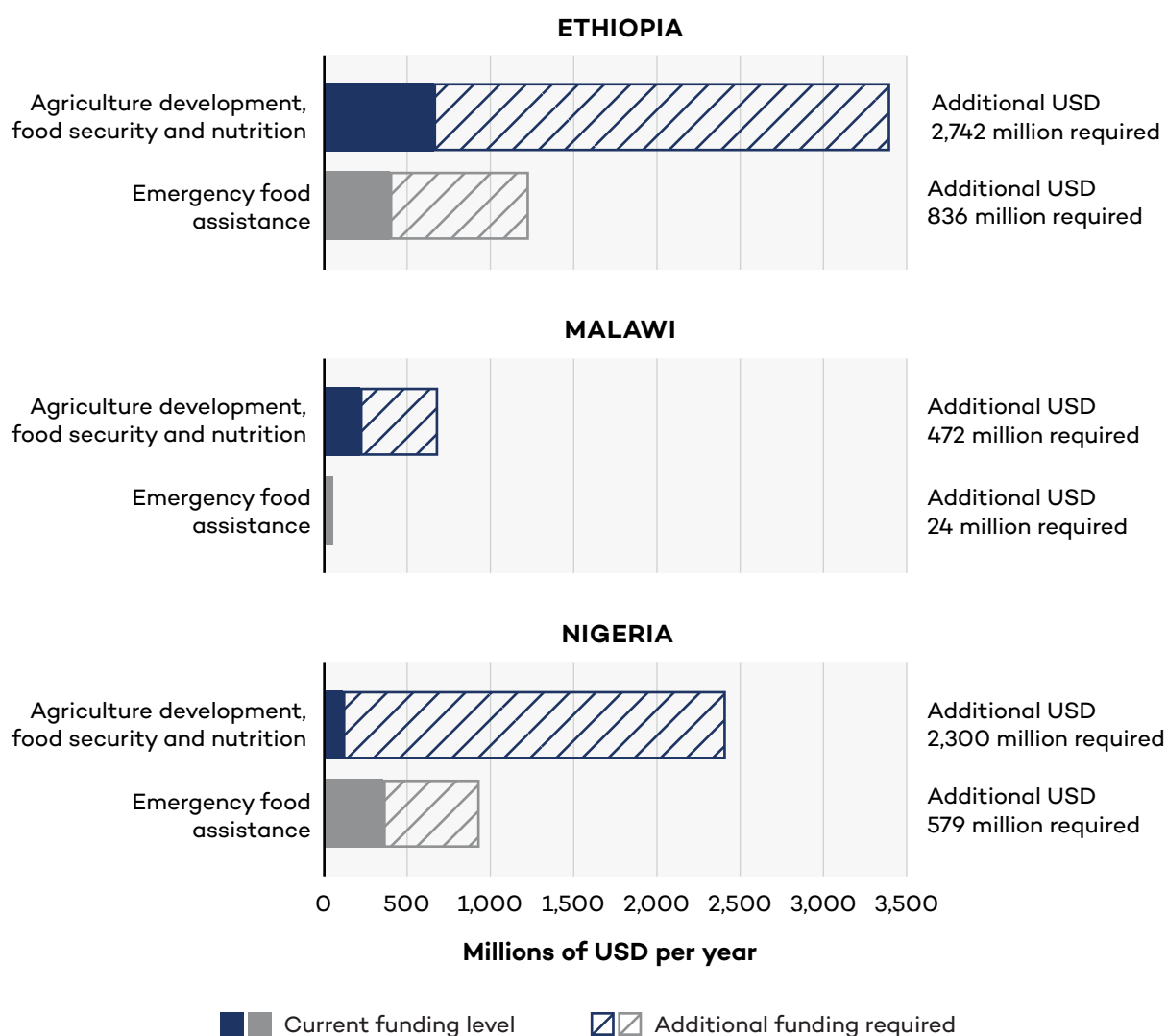
Source: Authors' analysis of OECD's Creditor Reporting System (OECD, 2021).

To contextualize this required increase in public costs directed toward the food system, donors disburse an average of USD 988 million per year to projects directly affecting agriculture and food security and nutrition in Ethiopia, Malawi, and Nigeria (see Figure 10); USD 659



million for Ethiopia, USD 215 million to Malawi, and USD 114 million to Nigeria. The required increase in spending therefore represents an almost 10-fold increase compared to current levels. The investment gap is significant. Particularly in Nigeria, where external public investment needs to increase by an order of magnitude—to over 20 times current levels (from around USD 0.1 to USD 2.3 billion)—to meet the challenges the country will face in the next decade. This extreme situation is due in part to the loss of oil revenues, economic recession, and conflict. In Ethiopia and Malawi, donors need to increase their disbursed resources by over 300% and 100%, respectively.

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.

Comparing the gap between the long-term investment needed to achieve the SDG 2 sub-targets and the short-term investment needed for emergency food assistance shows there is significant underfunding of the longer-term investment needs (Figure 11). Unless corrected, shocks will continue to lead to crises, with consequently massive rises in hunger and poverty



levels. This is pertinent given the devastating impacts of the multiple current crises, including the considerable rise in the need for emergency food assistance. Donors should therefore increase their allocations to longer-term development priorities to support resilience building, which would help prevent crises when future shocks arise.

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 combined with 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 and, if necessary, complement these policies with additional actions to account for the outcomes of the cost modelling.

In all the three countries, the largest share should be allocated to on-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 it provides multiple benefits to small-scale producers to improve capacities, including knowledge and inputs to sustainably increase productivity, increase income, achieve food security, and improved nutrition.

On-farm interventions are prioritized in the policies of all three countries through measures to improve plant productivity, especially by targeted extension; promoting access to high-quality seeds; and promoting crops including staples and pulses as well as crops that deliver nutritional benefits. The three countries' current policies also address gaps in livestock productivity through farm-level interventions such as enhancing veterinary coverage through public-private partnerships, promoting fodder production, introducing improved genetics once feed production and health services are in place, and addressing conflicts over pasture use (FDRE, 2016b; FRN, 2020b; GoM, 2018a, 2018b). Supporting different types of livestock, breeds, and fodder can also help reduce GHG emissions and increase resilience in the growing livestock sector.

On-farm interventions lead not only to income improvements but also 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 to have maximum effect on dietary outcomes. Finally, when designing these interventions in practice, specific attention needs to be devoted to addressing gender issues and the needs of vulnerable groups.

The next biggest share goes to empowering the excluded, and includes social protection programs, vocational training, nutrition education, and school feeding programs. Nutrition education and school feeding programs were two priorities stressed multiple times by multiple participants during the consultations. In Nigeria, social protection programs form a significant share of the total additional resources. In the three countries, several efforts are underway to support the most vulnerable, for example, the development of comprehensive costed nutrition investment plans tailored to local nutrition needs in Ethiopia under the Seqota Declaration (FDRE, 2018). Other efforts include improving income and promoting access to cash



transfers, providing free access to health care for vulnerable groups, and promoting school feeding programs in all three countries (FRN, 2021a; GoM, 2012).

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



Source: Authors' diagram based on MIRAGRODEP model simulations.



The smallest share of financial allocations in all three countries is to be spent on market and value chain interventions, which are closely linked to farm-level measures and connect producers to consumers. In all three countries, there is a strong focus on infrastructure development, market access, farmers' organizations, and access to irrigation (FRN, 2016; FDRE, 2016a; GoM, 2016). In addition, all three countries need to reduce post-harvest losses incurred during production and improve storage of foods from animal and plant sources. From a healthy diet perspective, investments could target cold storage and preservation of food items such as vegetables, fruits, and animal products, including fish, and efforts to improve food safety. From a climate change perspective, access to improved storage and more diverse markets is an important factor in building farmers' climate resilience by improving the sources of income and diversity of products in the face of negative impacts from climate change.



4.0 Recommendations

Addressing the challenges of agri-food systems, climate change, and healthy diets will not happen without trade-offs. For example, achieving healthier diets will require people to consume more diverse foods, including animal-source foods that are the most effective and efficient to absorb key nutrients, mostly calcium and vitamin B12. But animal-source foods are also those that contribute most to higher GHG emissions. There are also trade-offs between hunger and malnutrition. To reduce hunger could lead to prioritizing increasing access and availability to the cheapest staple foods with less consideration for their nutrient value—to the disadvantage of more nutrient-rich foods, like meat, dairy, fruits, and vegetables. These tensions are real in all three countries given the high and rising PoU. Nigerian stakeholders, for example, raised concerns regarding the international community's tendency to neglect the persisting issue of caloric deficits in favour of diet diversification and healthy diets (Food Systems Summit 2021 Dialogue, 2021).

4.1 Small-Scale Producers and GHG Emissions

Sustainably increasing agricultural productivity for both crops and livestock, especially among small-scale producers is a top policy priority, but is lacking in donor and government-funded programs. Support for environmentally sustainable livestock intensification needs to be scaled up and increased through better breeding, feed, manure management, and a shift to small ruminants.

Sustainable intensification of production systems is critical to addressing the immense crop and livestock productivity gap, particularly livestock, given the fact that it is the largest contributor to GHG emissions in all three countries. In the three countries, supporting sustainable intensification for both crop and livestock is prioritized in agriculture and climate strategies but has not yet led to significant programs and projects. The three countries' current policies on livestock production already assume a move toward small ruminants and improved feed choices and manure management—practices that contribute to the reduction of GHG emissions.

The livestock sector needs significant additional investment to drive sustainable productivity growth through better breeding, feed, manure management, and a shift to small ruminants. This also requires favouring production techniques compatible with each country's climate adaptation and mitigation commitments, including fiscal incentives to make sure improved techniques are economically attractive and commercially viable for small-scale producers. Together, existing and new policies and interventions for agricultural production need to make the livestock sector more GHG efficient to balance the trade-offs between the required increase in animal-source foods for healthier diets and the need to minimize agricultural GHG emissions.

Setting up a sustainable path for the growing livestock sector by 2030 and beyond is critical for achieving the more ambitious climate change mitigation targets that, as per the countries' updated NDCs, are conditional on donor support (FDRE, 2021b; FRN, 2021d; GoM, 2021a). However, the achievement of these goals will also require the engagement of the



private sector, consideration of gender issues, and accounting for the impacts and needs of vulnerable groups in specific measures to improve productivity and promote resilience, and identify incentives to make such measures economically attractive for small-scale food producers to integrate them into production.

4.2 Food Loss and Waste

Government and donors should pay more attention to reducing food loss and waste through better storage infrastructure and education, particularly for perishables.

Food loss and waste policies and interventions should be focused on better storage infrastructure and education, especially for perishables. The focus of specific investments should be both on enhancing households' knowledge about food waste and safe food storage methods, and on infrastructure development. This would enable producers to reduce losses during the 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 supporting efforts to improve food safety. Generally, reducing food loss and waste can contribute to increased availability of food, especially nutritious food such as fruits and vegetables, that tend to spoil. In Nigeria, specific focus should be given on interventions to improve the country's road network and storage capacities, including cold storage.

4.3 Nutrition and Diets

Nutrition education must accompany on- and off-farm investments to improve consumer choices, alongside more biofortified foods.

Attention needs to be given to the design and implementation of nutrition-sensitive interventions if multiple and complementary outcomes are to be achieved. 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, nutrition, and agricultural productivity programs.

Finally, all three countries focus, albeit to a different extent, on the production and consumption of biofortified foods, especially by the most vulnerable, who are significantly affected by low nutrition in their diets. Ethiopia is the most advanced on this, followed by Nigeria and then Malawi. Biofortification policies and programs will need to be more strongly integrated into future plans.

4.4 Adapting to Climate Change

Ensure building climate resilience is at the forefront of agriculture and food system priorities or risk rising food insecurity and malnutrition.

This requires stronger linkages between food systems and the environment through extension services, better seed choices, investment in machinery, and on-farm interventions that protect soil health, biodiversity, and water and land resources.



Integrating climate adaptation and resilience into agri-food systems is critical to long-term improvements in diets, food security, and farmers' incomes. Food systems interventions must improve the capacities of farmers to adapt, promoting the overall resilience of the agricultural sector, and reducing its environmental footprint. Farmers' income gains and diet improvements can be jeopardized if climate resilience is not strengthened. This includes targeted extension services for those who are most vulnerable, better seed choices, investment in machinery and equipment, and interventions to protect soil health and biodiversity, access to improved animal feed and breeds to protect soils and biodiversity, conserve water, and limit land-cover change.

4.5 Social Protection

Continue and scale up targeted social protection programs for the most vulnerable to support national nutritional and development objectives, and build resilience to climate change and other shocks.

Social protection programs must continue to be scaled up and supported, targeting the most vulnerable to support national nutritional and development objectives and build resilience to climate change and other shocks. Nigeria and Ethiopia have highly effective social protection programs in place which can be built upon.

4.6 Capacity Building

There is a need for more support to regional and national institutions to improve capacity to monitor, analyze, and inform on progress and achievements.

Challenges such as those regarding malnutrition, stunting, overweight, and obesity, are masked by datasets, especially in Ethiopia and Nigeria. Capacity development is critical to enabling institutions to better monitor the food systems outcomes of investments in the portfolio of interventions, including by collecting better-disaggregated data to account for subnational and gender differences. Capacity development will therefore allow for the better coordination of, and hence the acceleration of, sustainable agri-food systems transformation.



5.0 Conclusion

Ethiopia, Malawi, and Nigeria are not on track to achieve the SDGs by 2030. Without more and better public investment, hunger and poverty will rise in all three countries by 2030. Healthy diets will remain unattainable for most of the population, GHG emissions will continue to grow (particularly in the livestock sector), and the impacts of climate change will become more extreme and frequent. This is not how the UN 2030 Agenda was meant to unfold.

This could be reversed. This report shows that Ethiopia, Malawi, and Nigeria need an additional USD 10 billion on average per year between 2023 and 2030, to end hunger, double the incomes and productivity of small-scale producers on average, transition toward healthier diets, maintain agricultural GHG emissions to each country's NDC commitment, and increase resilience to climate change. Of the total, the three countries will require external resources of USD 5.8 billion per year on average, while the governments will need to raise an additional USD 4.2 billion per year in domestic resources.

The benefits would be truly transformative. The PoU in all three countries will decrease to under 3% in 2030 from a current projection of over 20% in all three countries. The transition toward healthier diets will be achieved for 248 million people, or roughly 60% of the population in each country. The incomes of 29 million small-scale producers would be doubled on average. And all these economic and social gains could be achieved while limiting GHG emissions to NDC goals and increasing resilience to climate change.



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Ceres2030 is a partnership between academia, civil society, and economists, led by three institutions—Cornell University, the International Food Policy Research Institute, and the International Institute for Sustainable Development—who share a common vision: a world without hunger, where small-scale producers enjoy greater agricultural incomes and productivity, in a way that supports sustainable food systems.



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