



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

Achieving Sustainable Food Systems in a Global Crisis:

MALAWI





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

September 2022

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This publication has not gone through IFPRI's peer-review procedure. The opinions expressed here belong to the authors and do not necessarily reflect those of IFPRI, IISD, or the OneCG.

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Acknowledgements

Achieving Sustainable Food Systems in a Global Crisis: Malawi is the result of a collaboration between the International Food Policy Research Institute (IFPRI), the International Institute for Sustainable Development (IISD), the Federal Ministry for Economic Development and Cooperation of Germany (BMZ), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the European Union, and the Malawi Ministry of Public Health.

This report was written by Livia Bizikova, Alan De Brauw, Mali Eber Rose, David Laborde, Kulthoum Motsumi, Mike Murphy, Marie Parent, Francine Picard, and Carin Smaller.

The authors would like to express their appreciation and gratitude to Dr. Pensulo Phiri Felix, Director of Nutrition, HIV and AIDS at the Ministry of Health, for his leadership and commitment to the project. The authors would also like to sincerely thank the team at GIZ who provided ongoing support, invaluable feedback and comments, and strong guidance throughout the project: Ousmane Djibo, Christoph Langenkamp, Rike Riesmeier, Julia Goette, Boran Altincicek, and Dierdre McMahon.

Our deepest gratitude goes to the following experts and organizations who contributed time, energy, and knowledge to this project through surveys and questionnaires and for their active participation to a series of online and hybrid consultations: Martina Kress (GIZ), Heike Herden (GIZ), Lilian Chaguluka (IRISH AID), Tomaida Msiska (European Union), Melina Dzwela (Food and Agriculture Organization of the United Nations), Mamadou Ndiaye (United Nations Children's Fund), Stacia Nordin, Dr. Alexander Kalimbira (Lilongwe University of Agriculture and Natural Resources), Maureen Maguza-Tembo (Ministry of Health _Department of Nutrition, HIV and AIDS), Silvia Mapanje (Ministry of Agriculture, Irrigation and Water Development), Readwell Musopole (Ministry of Agriculture, Irrigation and Water Development), Ruth Butao (Afikepo), Grace Omondi (World Food Programme), Mercy Zimpata (Ministry of Agriculture, Irrigation and Water Development), Wycliffe Kumwenda (National Smallholder Farmers' Association of Malawi), Bessie Ndovi (Civil Society Nutrition Alliance), Pamela Kuwali (Civil Society Agriculture Network) and Alfred Kambwiri (Centre for Environmental Policy and Advocacy), Lucy Maseko (Ministry of Finance), Kondwani Mpeniuwawa (Ministry of Health), Janet Guta (Ministry of Health) and Stella Mapemba (Ministry of Health).

Special thanks to Dr. Suresh Badu (International Food Policy Research Institute) for his support throughout the project.

The project is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the European Commission, through the GIZ-implemented projects Knowledge for Nutrition and Agricultural Policy and Food and Nutrition Security.



Executive Summary

Malawi is not on track to achieve the United Nations Sustainable Development Goals by 2030. Its lack of progress is being exacerbated by skyrocketing food, fertilizer, and energy prices; the Russian invasion of Ukraine; 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 Malawi in a way that ends hunger, makes diets healthier and more affordable, improves the productivity and incomes of small-scale producers, and mitigates and adapts to climate change.

This report shows that it is possible to achieve sustainable food system transformation in the next decade by increasing public investment by USD 543 million per year 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, we see that there is significant underfunding of the longer-term investment needs (Figure 10). The shortfall in longer-term funding increases Malawi's 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 the current Ukraine crisis and others, including the considerable rise in the need for emergency food assistance. Donors should increase their allocations to longer-term development priorities in order to support resilience building that would 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 Malawi. The report is part of a project that explores the interaction between achieving healthy diets, reducing hunger and poverty, and addressing climate change within the evolving food systems in three countries—Ethiopia, Malawi, and Nigeria.

The report finds that

1. **Without additional investment, significant levels of hunger, malnutrition, and poverty will persist after 2030.** By 2030, economic growth in Malawi will be insufficient to reduce the number of people affected by hunger and poverty. Without additional investment and more effective policy interventions, the poverty rate in 2030 will remain extremely high, from 71% in 2019 to 72% in 2030, and the hunger rate will increase from 20% in 2020 to 25% in 2030. Healthy diets are and will continue to be unattainable for more than 90% of Malawians by 2030.
2. **Diet diversity is poor, especially for low-income households, but this can be changed.** For both low- and high-income households, cereals make up the largest dietary share, particularly due to the consumption of maize flour used to make nsima (cornmeal porridge). Vegetables account for a much larger dietary share in poor households (18.7%) relative to wealthy households (10.6%), while meat and animal



products make up a much larger share in wealthier households (23.7%) compared to those in the poorest households (10.4%). 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), and a higher share of calories from animal-source foods, including dairy (for calcium and B12).

3. **With additional public investment of USD 543 million per year from 2023 to 2030, it is possible to achieve a sustainable food systems transformation in Malawi.** The results of a computable general equilibrium (CGE) model and household-level data show that it would cost an additional USD 543 million in public investment per year from 2023 to 2030 to end hunger, double the incomes of (2.9 million small-scale producer[s] household on average, transition to healthier diets for 14 million people, maintain greenhouse gas (GHG) emissions in agriculture to Malawi's nationally determined contribution (NDC) goals, and increase resilience to climate change. Of the total additional public spending required per year, USD 472 million needs to be provided by external resources (donors), with the remainder, USD 71 million, to be provided through domestic resources. Donors currently provide an average of USD 215 million per year.
4. **The financing gap between the long-term investment needs and the short-term emergency food assistance needs is enormous.** While the total amount of official development assistance (ODA) to emergency food assistance has increased overall from 2012 to 2014 compared to 2017 to 2019, the total amount of ODA to long-term agriculture and food security has stagnated over the same period (International Food Policy Research Institute & International Institute for Sustainable Development, in press). 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.
5. **Improving the economic productivity of small-scale food producers is the top priority.** Malawi's policy documents and strategies identify farm-level interventions as a top priority for public financing. These include improving farmers' access to high-quality inputs, including seeds, fertilizers, and technologies, as well as access to mechanization services, markets, and extension services such as the introduction of local crops, agroecology, and soil management practices. Such interventions seek to enable smallholder farmers, who constitute the bulk of agricultural producers in Malawi, to address productivity gaps and adjust production practices to climate change impacts. These interventions need to be designed to take into account gender differences and their impacts on vulnerable groups.
6. **The effects of climate change and variability are undermining Malawi's ability to become food and nutrition secure.** Malawi is vulnerable to the impacts of increasing rainfall variability and temperatures—impacts that are heightened by its heavy reliance on rain-fed agriculture. Key steps to address climate change have been taken in both national policy priorities and many donor-funded initiatives emphasizing the need to build resilience. In particular, resilience planning has included adopting climate-smart agriculture; developing national- and district-level capacities to mainstream, plan, and implement climate-resilient development projects; and



enhancing farmers' access to machinery, inputs, markets, and extension and skills development services. Improving farmers' access to agricultural inputs to move toward resilience practices needs to target women farmers and other vulnerable groups in particular.

7. **The contribution of the livestock sector to total and per capita GHG emissions will continue to rise by 2030 and is inadequately addressed by government and donors.** The most significant area of growth and share in the total GHG emissions in Malawi to 2030 will be increased livestock production. Existing livestock policies do not build in synergies with climate change mitigation targets and adaptation plans, focusing instead primarily on breeding, veterinary services, and necessary infrastructure investment. While such investments are necessary, in order to create a prosperous livestock sector, policies should also prioritize manure management and a focus on small ruminants. Despite its prominence in policy documents, there is inadequate donor focus on sustainable livestock intensification.¹
8. **Interventions to reduce food loss and waste are some of the most effective ways to address the nexus of food security, nutrition, income, and climate change.** There is too little attention given by the government and its development partners to reducing food loss and waste. There is limited coverage in initiatives to reduce food loss and waste in both policy documents and donor-funded projects.
9. **There is limited support for regional and national institutions to improve the capacity to monitor, analyze, and inform people on progress and achievements.** Such capacities are critical to monitoring the food systems outcomes of investments in the portfolio of interventions, including better-disaggregated data to account for subnational and gender differences.

The report recommends that the Government of the Republic of Malawi and its development partners

1. **Increase public investment by an additional USD 543 million per year from 2023 to 2030 to achieve the transition to sustainable food systems.** Development partners should provide an additional USD 472 million on average per year for 8 years (2023–2030), from a current baseline of USD 215 million per year. The Government of the Republic of Malawi should provide an additional USD 71 million 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 on-farm interventions, particularly irrigation infrastructure, livestock productivity, and agroforestry.** An additional USD 364 million per year is needed to improve farm productivity and incomes; an additional USD 119 million per year is needed for social protection, education, and school feeding programs; and an additional USD 60 million is needed

¹ Analysis of donor-funded or donor-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 the United States Agency for International Development. Only projects that had a degree of focus on two or more aspects of our nexus were included for review. Overall, 17 projects were reviewed in Malawi. See Section 4.1 for more information on the methodology.



per year to move food to markets. Interventions to support irrigation infrastructure and livestock production through agroforestry can have particularly strong synergies for simultaneously improving access to food, healthier diets, and climate change mitigation and adaptation. Policies that encourage the adoption of climate-proof water management, climate-resilient crops, and extension support for farmers to adjust production to account for climate change impacts must accompany other farm-level interventions together with a focus on women and other vulnerable groups.

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 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 complement and maximize the impact of social protection programs, nutrition programs, and agricultural productivity programs.
4. **Ensure climate resilience is built into agriculture and food system policies and programs.** This recommendation includes targeted support to improve productivity in the context of climate change by providing extension services for those most vulnerable, particularly women; seed choices that promote climate resilience; investment in climate-resilient machinery and equipment; and interventions to protect soil health and biodiversity, conserve water, and limit land-cover change. In addition, targeted improvements in disaster preparedness should address severe climate change impacts.
5. **Increase support for environmentally sustainable intensification** to increase crop and livestock productivity with production techniques that are compatible with Malawi's climate adaptation and mitigation commitments. Livestock policies should prioritize breeding, manure management, and a focus on small ruminants, as well as fiscal incentives to make sure improved techniques are economically attractive and commercially viable for small-scale producers.
6. **Continue targeted social protection programs,** targeting the most vulnerable to support national nutrition and development strategies and build resilience to climate change.
7. **Develop and adopt food-based dietary guidelines,** which currently do not exist in Malawi and which would help set country-led targets for the transition to healthier diets. These should be consistently implemented across all levels of government.
8. **Increase coverage of food loss and waste in policy priorities and donor-funded projects.** Reducing food loss and waste can contribute to increased availability of food, especially nutritious food such as fruits and vegetables, which tend to spoil.
9. **Increase support for regional and national institutions to improve their 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.



These recommendations overlap significantly with Malawi's National Pathway for Food Systems Transformation, which was endorsed in support of the 2030 Agenda and in light of the United Nations Food Systems Summit in 2021. Specifically, Malawi identified the need to increase the production of diverse and nutritious foods; increase dietary diversification and the consumption of nutrient-dense foods; address issues of food waste and loss; strengthen agri-value chains, including processing, storage, and transport; and build resilience to climate change and shocks (Republic of Malawi, 2021b). The findings and recommendations in this report therefore offer an evidence-based and costed roadmap on which to base support for the implementation of the key priority action areas identified in Malawi's National Pathway for Food Systems Transformation.



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Abbreviations and Acronyms

BAU	business as usual
CGE	computable general equilibrium
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
GHG	greenhouse gas
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
IFPRI	International Food Policy Research Institute
IISD	International Institute for Sustainable Development
LSMS	Living Standards Measurement Survey
NDC	nationally determined contribution
OECD	Organisation for Economic Co-operation and Development
PoU	prevalence of undernutrition
SDG	Sustainable Development Goal
TCO₂e	tonnes of CO ₂ equivalent
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development



1.0 Introduction

Agriculture and food systems in Malawi 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 climate change, economic slowdowns, and 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.

Even among those who do get enough calories, many will be malnourished due, in part, to the unaffordability of diets that both provide sufficient calories and satisfy the complex nutritional requirements of human bodies. The demographic dynamics in Malawi will continue to exacerbate these challenges, with the population expected to grow from 19.1 million people in 2020 to 25.8 million people in 2030 (United Nations [UN], 2019).

As the population and incomes grow in Malawi, so too will demand for food and more dietary diversity, which will exacerbate environmental challenges. At the same time, Malawi 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 good will require significant efforts and resources—and therefore global solidarity; in other words, more domestic support and more external aid.

To support the transition to sustainable food systems in Malawi, this report aims to equip country-level decision-makers and the donor community with knowledge regarding the cost of sustainable food system transformation; evidence on which to base decisions regarding where and how to make investments to contribute to access to simultaneously 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).

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, facilitating access to services, improving food safety, and other endeavours.

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



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

Section 2 describes the key food system challenges facing Malawi today and to 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 outlines the implications of this transition, as well as the public investment required by the Government of the Republic of Malawi 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 the 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, Murphy et al., 2020 and Laborde, Parent et al., 2020 for more information.



2.0 Malawi's Agriculture and Food System Challenges

This section provides an overview of the trends for key aspects of the food system in Malawi 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 Malawi, the UN (2019) predicts that the country's population will grow from 19.1 million in 2020 to 25.8 million by 2030. This population growth is significant for Malawi, where over 82% of the population resides in rural areas (World Bank, n.d.), and 80% of the population is under 35 years old (OECD Development Centre, 2018; Mungai et al., 2016). Malawi is therefore predicted to remain one of the countries with the strongest demographic pressure, with an annual population growth rate of 2.7% in the next decade (compared to 1.1% worldwide) and a GDP per capita that will remain among the lowest in the world, despite the relatively strong economic growth, projected at 4.6% per year (World Bank, n.d.). This demographic pressure and economic need in Malawi will necessitate an increase in food consumption and production to address the nutritional needs of its population. Yet, the projections are not optimistic.

Agriculture is the leading employer in Malawi, accounting for over 75% of total employment. However, the sector's contribution to GDP is only 21% (World Bank, n.d.). Smallholder farmers operating on less than 5 ha constitute the bulk of agricultural producers in Malawi (Anseeuw et al., 2016). Most of them are poor and food insecure, operating at low productivity (Anseeuw et al., 2016). The average productivity of major crops in Malawi is less than 1,000 kg/ha over 60% of farmland (Mungai et al., 2016). In comparison, the Organisation for Economic Co-operation and Development (OECD) database 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. Critically, there is significant potential and opportunity for agricultural development in Malawi (see Figure A2 in Appendix A).

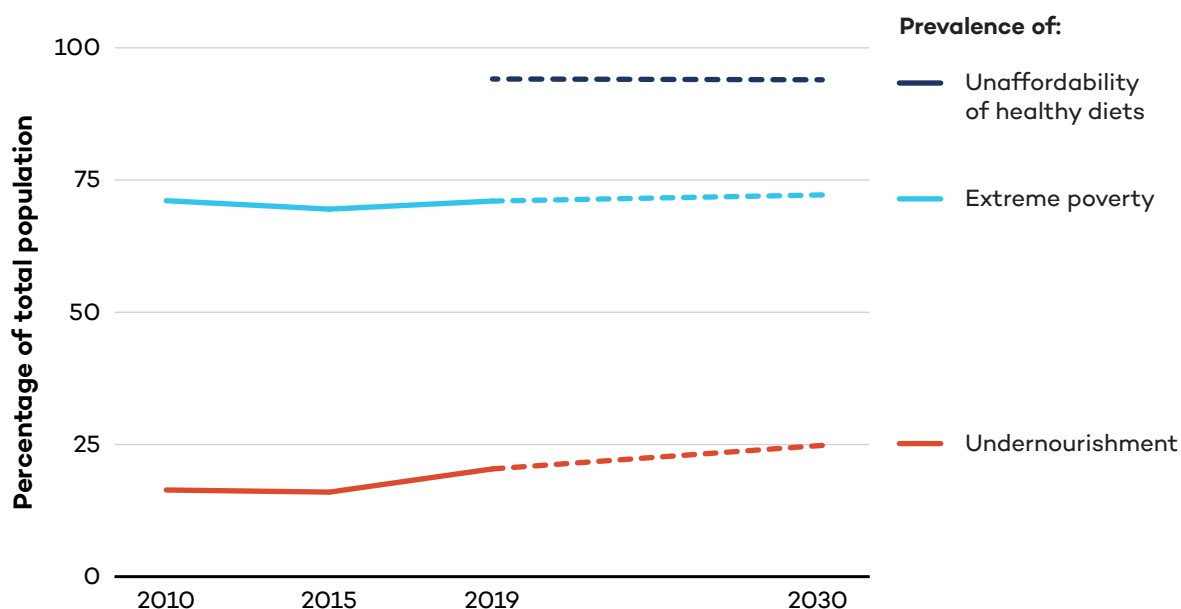
Food system transformation toward healthier diets and better environmental outcomes will not be possible without improving agricultural productivity. Such a transformation will require assistance to small-scale producers to achieve significant improvements in productivity, incomes, and access to markets, and to enhance resilience to meet related nutrition and food security needs in a way that does not increase vulnerability to climate change and worsen environmental degradation.



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

Hunger and poverty continue to pose critical challenges in Malawi. Currently, extreme poverty (at the USD 1.90 international poverty line) remains high in Malawi compared to the rest of sub-Saharan Africa: 69% versus 42% in 2016 (World Bank Development Research Group, 2021) (see Figure A3, Appendix A, for the geographical distribution of poverty across Malawi). The prevalence of undernourishment is comparable to the level in the region. In Malawi, the average prevalence of undernourishment in the 2018–2020 period was 17%, versus an average of 22% in sub-Saharan Africa (Food and Agriculture Organization of the United Nations [FAO] et al., 2021). At the same time, food insecurity remains high, especially in rural areas, with 51% of the population experiencing severe food insecurity in 2018–2020, versus an average of 26% in sub-Saharan Africa for the same period (FAO et al., 2021). These numbers reflect the fact that many of the poor in Malawi are small-scale producers, operating farms smaller than 5 ha. While producing sufficient calories at the annual level (as reflected by the prevalence of undernourishment), these small-scale producers face challenges posed by seasonal hunger from crop failures and by the hungry season, which covers the time between planting and harvesting (as reflected in the prevalence of severe food insecurity). The low productivity and income levels of these small-scale producers undermine their ability to improve production, escape hunger and poverty, and afford healthier diets.

Figure 1. Prevalence of hunger, poverty, and the unaffordability of healthy diets in 2030



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.³

³ As participants noted during the consultation, using a measure of healthy diets based on affordability is an issue in Malawi where the majority of the population are smallholder farmers who eat what they produce.



Whilst the predicted economic growth and improvements in agricultural production in Malawi will provide some mitigation against the growing demand for food, it is expected that the prevalence of extreme poverty and hunger will increase, to 72% and 25%, respectively, by 2030. Furthermore, healthy diets will continue to be unaffordable for most, with more than 90% of Malawi's population unable to afford a healthy diet by 2030 if the current trajectory is maintained (Figure 1).

2.2 Diet Composition and Quality

The composition of diets in Malawi, particularly for low-income households, is poor. In Malawi, diets for both low- and high-income households remain disproportionately dominated by starches and are lacking in vegetables, fruits, and animal-sourced foods. Malawi faces the dual challenge of addressing caloric sufficiency and increasing the consumption of more diverse food groups.

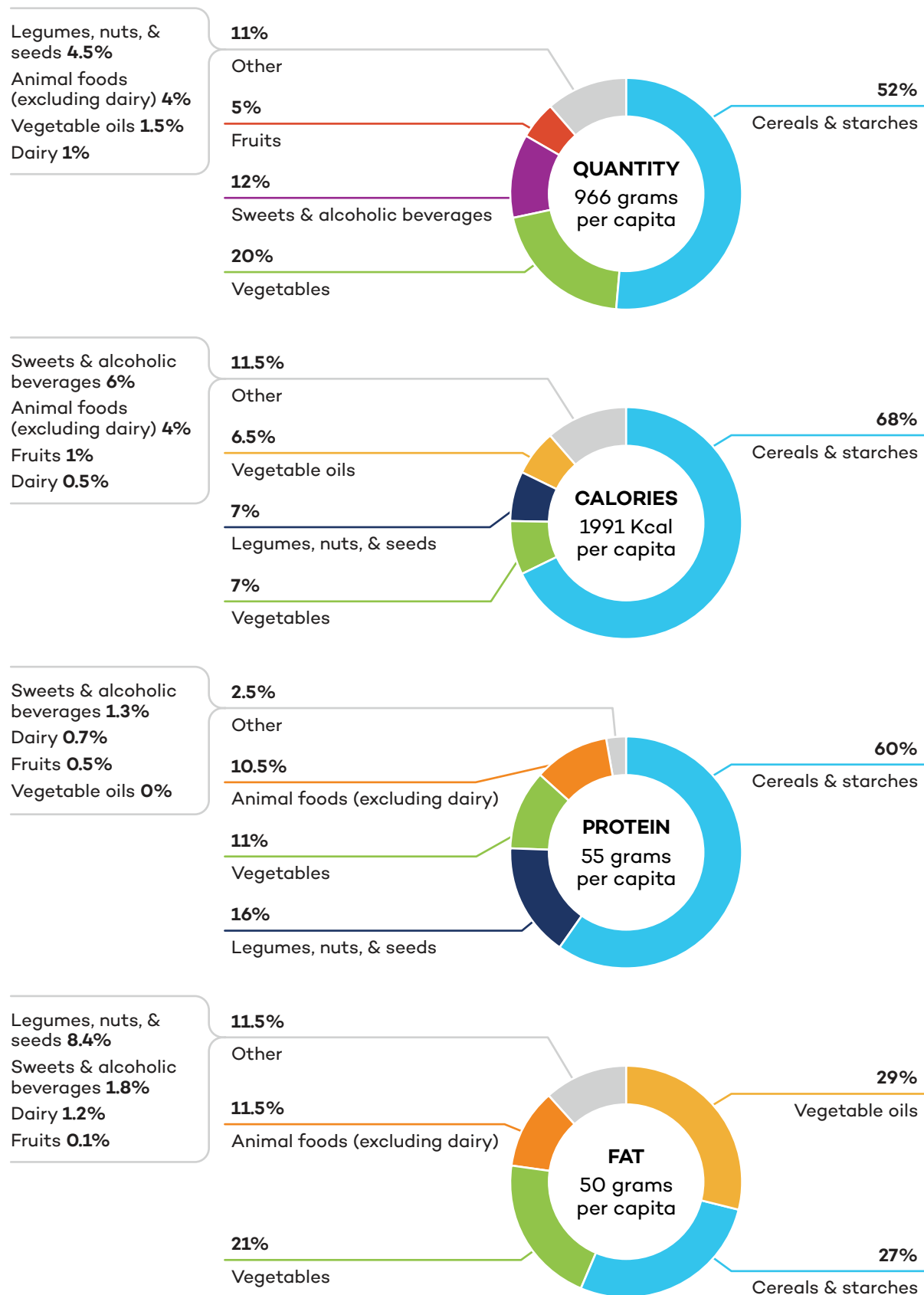
2.2.1 A Snapshot of Diets Today

The Malawian diet is mainly composed of cereals—primarily maize, starchy roots (cassava and potatoes), and starchy fruit (plantain)—contributing to high rates of micronutrient deficiencies and representing a leading cause of undernutrition (Bezner, Kerr et al., 2019). Malawi's decades-long focus on improving smallholder productivity has only moderately improved food security and nutrition outcomes. Current studies, as well as feedback from the stakeholder consultations (Box 2), indicate that some Malawian diets are lacking in terms of quantity (total calories consumed), and most are lacking in terms of quality (sufficient calories derived from nutrient-dense foods, such as meat, fish, eggs, dairy, legumes, fruits, and vegetables) as the country is currently grappling with widespread micronutrient deficiencies (Aberman, 2019; Kansanga et al., in press).

Using data from the FAO and the Living Standards Measurement Survey (LSMS), Figure 2 illustrates what foods households consume, including overall caloric intake and composition by food group.



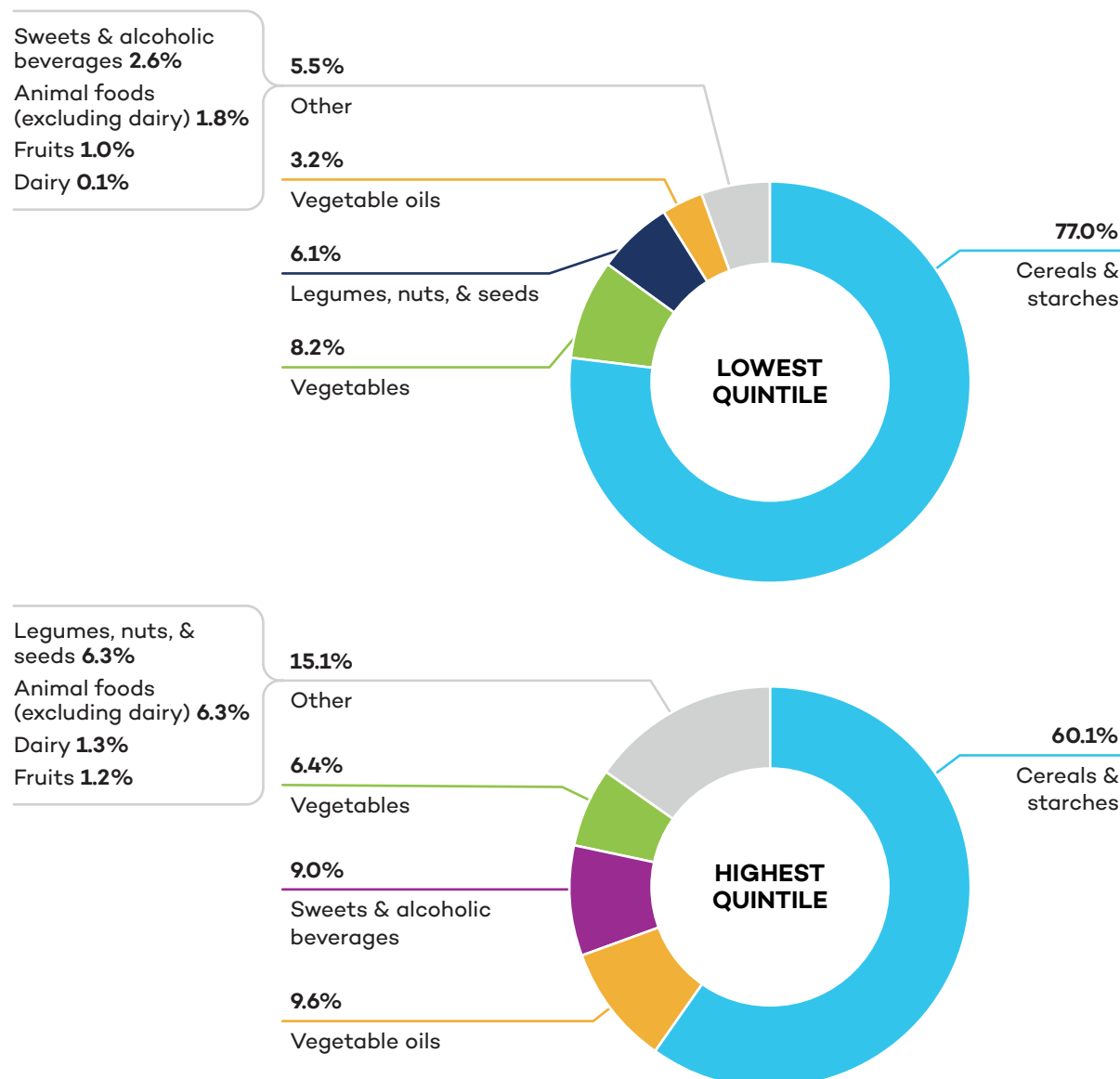
Figure 2. Overview of dietary composition, aggregated by food group, per capita, per day



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



Figure 3. Share of calories consumed, by food group and wealth quintile



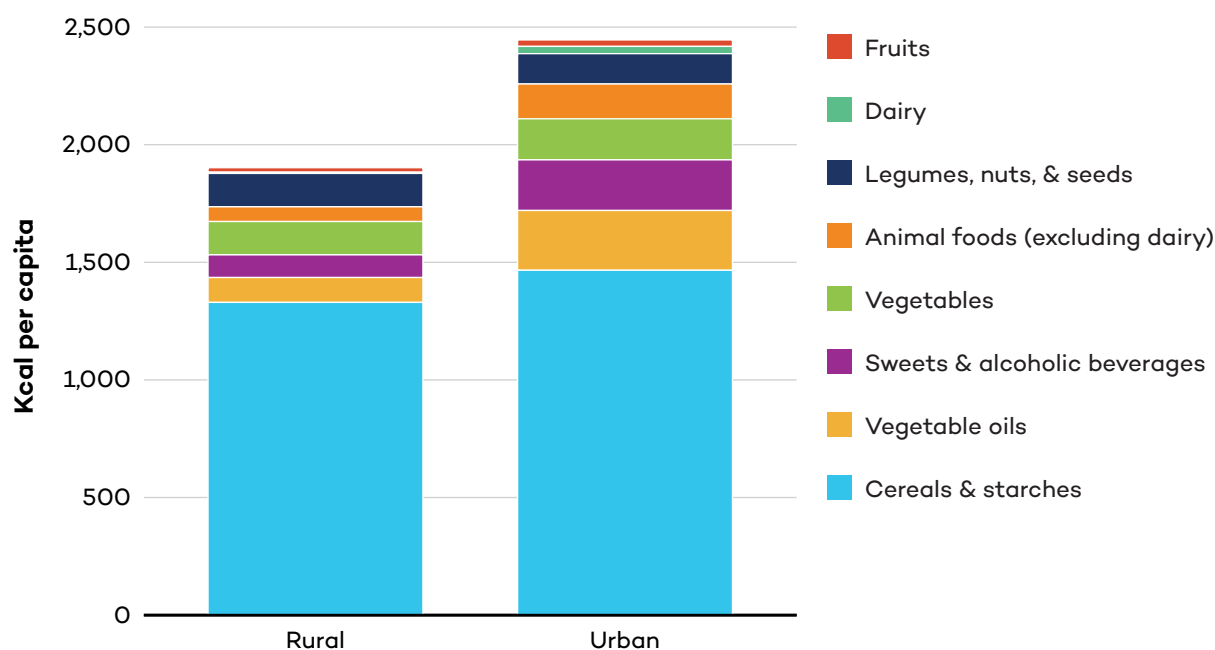
Source: Authors' analysis based on LSMS–IHS Malawi Wave 5 2019–2020 (World Bank, 2020) and nutrient coefficients based on FAOSTAT–SUA (FAO, 2021).

Reported consumption of grains and other starches—particularly maize flour, which is used in the preparation of nsima, a thick porridge which is a national staple in Malawi (see also Box 2)— is high relative to other food groups, accounting for over half of all consumption in terms of both overall mass consumed and caloric intake. Vegetables are widely consumed but only account for 6% to 8% of total caloric intake. Fruits account for a very small share of dietary intake and are highly seasonal in their consumption patterns. Dairy products and other animal-source foods account for a very small share of overall consumption: only 19% of households reported consuming dairy products in the previous 7 days, while 14% of households did not consume any animal-source foods within the reporting period. The poor level of diet quality is consistent with the low level of income, high prevalence of poverty, and



unaffordability of healthy diets. A small fragment of the Malawian population appears to be able to afford nutritive or healthy diets (30% and 6%, respectively) (FAO et al., 2020).

Figure 4. Calories consumed, by food group and location (Kcal per capita per day)



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

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

2.2.2 Nutrition Indicators

In terms of specific population groups, 2.7% of children under five are affected by wasting, and 37% are affected by stunting (National Statistical Office & ICF, 2017). While wasting rates have slowly declined over the past 2 decades from 6% to 2.7%, stunting has decreased substantially, from 54% in 2000 to 37% in 2015/2016 (National Statistical Office & ICF, 2017). Anemia affects one in three women of reproductive age, or 34.4%, which is slightly lower than the average for sub-Saharan Africa (Global Nutrition Report, 2020). However, anemia still represents a considerable challenge, and little progress has been made in recent years (Global Nutrition Report, 2020). The prevalence of obesity is very low in the country (4% in 2008 and 6% in 2016) (FAO, 2021), though over-nutrition may become more salient as the country continues to develop and urbanize.



Box 2. Food security and nutrition challenges and solutions from stakeholder consultations

- Malnutrition and poverty in rural areas and the farming community are prevalent and need to be improved to address food security and nutrition challenges.
- Most people in Malawi eat what they produce and rely on agriculture and home gardens. Improving the nutrition contributions of local production may contribute to improved nutrition if relevant information is made available.
- Many farmers cannot afford to purchase additional food items from the market to complement their diet from home gardens or agriculture. Support is needed to enable access to better diets, and information about healthier diets needs to be provided.
- In the move toward more affordable diets, the dietary share of animal-source and dairy products needs to increase. However, this sector is the main source of agricultural GHG emissions.
- Improving the affordability and accessibility of nutritious foods in Malawi is critical.
- Promoting food fortification to address specific nutritional challenges should be part of efforts to improve diets.
- There is a need to develop and adopt food-based dietary guidelines, which currently do not exist in Malawi. These should be consistently implemented across government.

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 A.

2.2.3 Current Dietary Policies

Like many countries in sub-Saharan Africa, Malawi does not have a set of national food-based dietary guidelines, as was emphasized during the stakeholder consultations (Box 2). Currently, there are working definitions of healthy diets. For example, one respondent in the consultations indicated that a healthy diet “should have a minimum of four of the six Malawi Food Groups (vegetable, fruits, animal-source fats (ASFs), fats and oils, pulses and legumes, and energy giving goods).” Other efforts toward dietary policies in Malawi include efforts to address single types of micronutrient deficiency, such as iodine, through mandatory salt iodization.

The national government has made broad commitments to improving nutrition, particularly from the perspective of undernutrition. In all of Malawi’s districts, acute malnutrition is addressed through community health services, which have substantially reduced severe acute malnutrition. These efforts are borne out in statistics related to vitamin A deficiency. According to the Demographic and Health Surveys, vitamin A deficiency among children under five dropped from 59% in 2001 to 4% in 2016 (Williams et al., 2021; Republic of Malawi, 2017). Although Malawi’s strategies reference overweight and obesity issues, in reality, the incidence is low (6% in 2016), which explains the lack of programs (FAO, 2021).



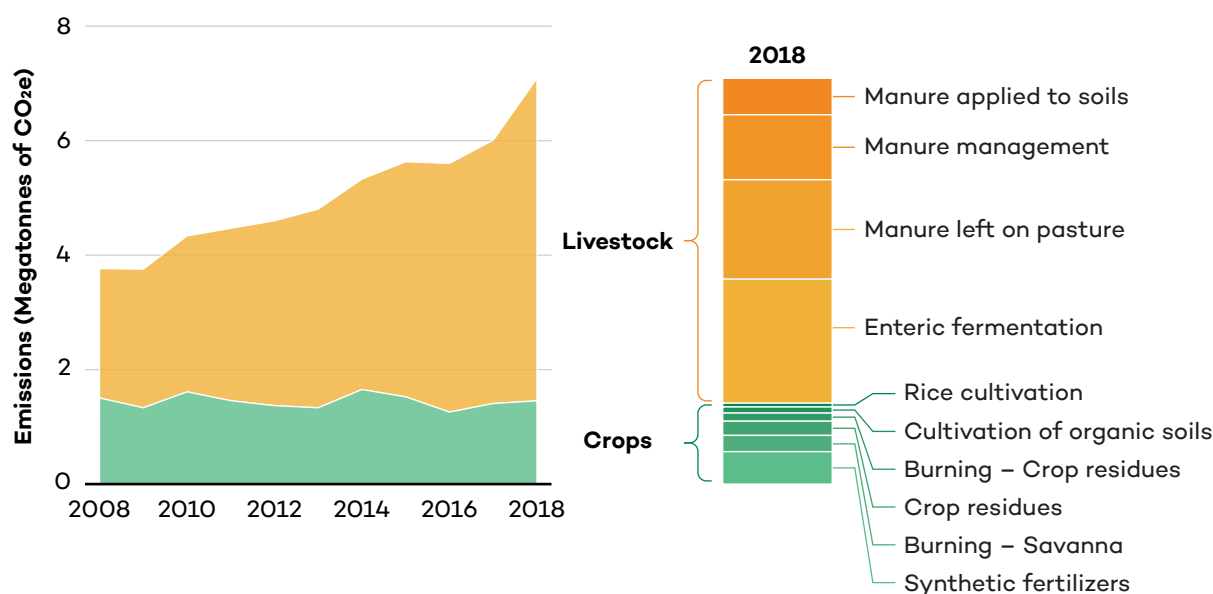
2.3 Climate Change Impacts, Mitigation, and Adaptation Responses

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. Policy pathways geared to food system transformation need to consider responses to climate change, including measures to assist smallholders in improving their capacities to adjust production practices to climate change impacts and variability. It is also critical to focus overall on more sustainable and resilient approaches to production intensification, with a specific focus on integrating environmental and climate perspectives into policies and strategies (see Box 3).

2.3.1 Climate Change Mitigation and GHG Emissions

Per capita GHG emissions from Malawi's economy are low overall, as would be expected in a low-income and largely agricultural economy: 1.1 tonnes of CO₂ equivalent (tCO₂e) per person on average in 2013–2017, compared to 3.5 tCO₂e for all least-developed countries and 7.5 tCO₂e globally in the same period (FAO, 2021).

Figure 5. Agricultural GHG emissions in Malawi



Source: Authors' calculations using data from FAOSTAT (FAO, 2021). Design of right panel adapted from *Climate-Smart Agriculture in Malawi* (International Center for Tropical Agriculture & World Bank, 2018).

During the 2008–2018 period, GHG emissions from agriculture nearly doubled. This has been driven in large part by increased livestock production, with the number of livestock units more than doubling in the last decade, increasing by 162% from 2008 to 2018 (Salmon et al., 2020). This increase in livestock production is expected to continue even without any additional policy interventions. Importantly, increased consumption of animal-sourced proteins is needed to assist with the transition toward healthier diets and to meet Malawi's

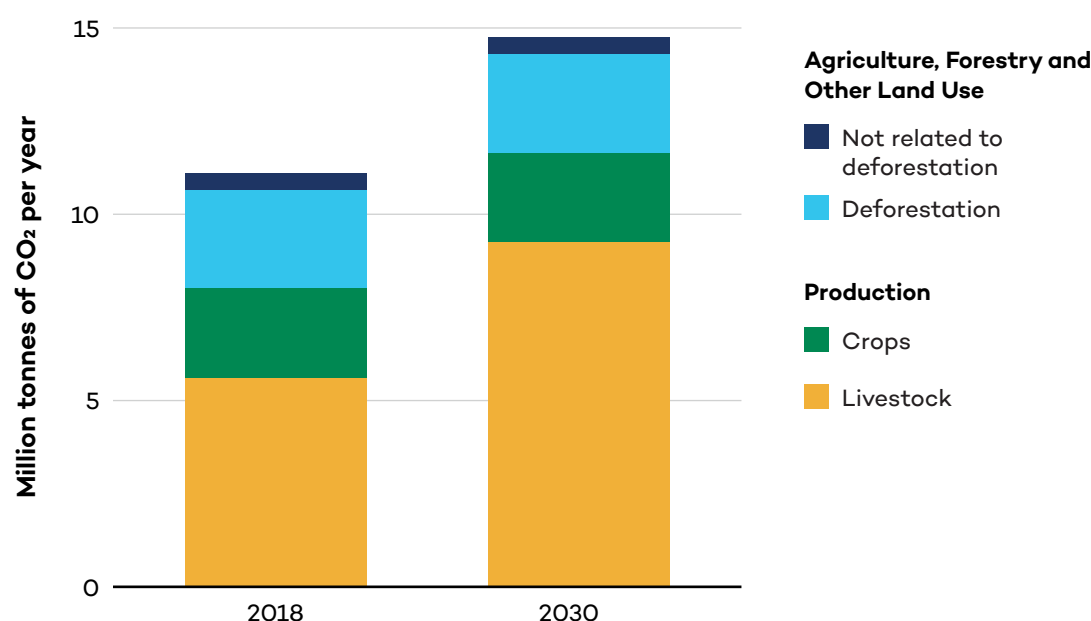


nutrition goals. Therefore, improving the emission efficiency of livestock production as the livestock sector grows could play an important role in Malawi keeping its emissions within its targets, as presented in the country's updated nationally determined contribution (NDC) under the Paris Agreement on Climate Change.

Other sources of GHG emissions include the application of fertilizers, the burning of crop residues in the fields, and the burning of savannas. However, these sources of emissions play a smaller role in total agricultural emissions than they did a decade ago (FAO, 2021).

As the agriculture sector continues to develop in response to the increased demand for food, particularly for animal products, agricultural emissions will continue to rise. In the business-as-usual (BAU) scenario, an increase of 4.4% per year till 2030 is projected for GHG emissions from agricultural production. The BAU scenario also shows a worsening trend for environmental indicators, including not only GHG emissions from agricultural production but also from land conversion to agriculture, as well as increased deforestation and water use. Nevertheless, the most significant growth and share in the total GHG emissions in the country will be increasing livestock production. All these trends reveal the need to take measures toward sustainable livestock intensification to allow the country to achieve its environmental and climate change objectives.

Figure 6. Agricultural and land-use emissions (domestic emissions only): Scenario without the NDC, 2018 and 2030, total



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

In terms of policy priorities for actions on GHG emissions, Malawi submitted its updated climate action plan under the Paris Agreement in July 2021 to the United Nations Framework Convention on Climate Change (UNFCCC) (Republic of Malawi, 2021a). Malawi's first NDC was submitted in 2015. In its updated NDC, the country presents its mitigation



commitments in the form of GHG emissions reduction targets, which contribute 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 country’s updated NDC does not include new data on the challenges of climate change and nutrition but refers instead to the findings from the country’s National Adaptation Programme of Action, developed in 2006. In its updated NDC, Malawi commits to an unconditional emissions reduction of 6% relative to BAU by 2040,⁴ based on domestically supported and implemented policies and measures. The NDC also puts forward a more ambitious target of a 45% additional reduction by 2040 relative to BAU—but this contribution is contingent on the provision of international support and funding. For both targets, the highest reduction contribution is assumed to come from the energy sector. For the agricultural sector, the updated NDC projects a 6% reduction in emissions by 2040 compared to BAU (Republic of Malawi, 2021a).

Box 3. Priorities to support smallholders’ production and adaptation to climate change from stakeholder consultations

- To address some of the nutrition challenges, it was seen as critical to improve nutritious food supply by promoting supply-side interventions, especially those with a focus on improving the production, processing, and storage of foods. These would deliver nutritional benefits by covering seasonal and micro-nutrient gaps.
- GHG emissions in Malawi are quite low compared to other countries; thus emissions in some sectors of the economy, including agriculture, need to grow to ensure overall development in the different sectors.
- Other environmental challenges such as soil degradation and lack of water (especially at the end of the dry season) must be considered when implementing measures to improve agricultural production.
- From the climate change perspective, maize is not the most climate-resilient crop, but a critical staple crop. We need to look into recommendations for more nutritious and more climate-resilient staple crops to improve contributions to healthier diets.

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 A.

2.3.2 Climate Change Impacts and Adaptation

Climate variability and climate change are already affecting the country’s economy, agriculture, and smallholders’ livelihoods. Records show that the mean annual temperature has increased by 0.9°C between 1960 and 2006; during the same period, Malawi experienced considerable interannual variations in precipitation across the country with a decreasing trend in mean seasonal rainfall (Republic of Malawi, 2021c). It is projected for the next decades (up

⁴ 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.



to 2050) that the mean annual temperature will increase; rainfall will decline in some parts and increase in other parts of the country. Overall, the number of extreme rainfall events is projected to increase (Adhikari & Nejadhashemi, 2016). Table 1 summarizes the predicted climate impacts to 2050.

Table 1. Impacts of climate change in Malawi

Impact	By 2050
Annual precipitation	5.4% decline to 24.6% increase
Change in surface runoff	Increase by 51.1%
Change in water yield	Increase by 54%
Change in annual soil moisture	Increase by 11.5%
Annual temperatures	Increase by 1.4–3.2oC

Data source: Adhikari & Nejadhashemi, 2016.

Significant differences in weather and climate change variability are expected across Malawi, specifically between the northern and southern parts of the country. The northern region is projected to be affected by increased precipitation and surface runoff, while the southern region will likely be more impacted by droughts. Increased surface runoff may lead to increased soil and nutrient loss in the north, while the southern part may face increased water stress and erosion. In addition, differences in terms of climate change impacts are anticipated for the areas around Lake Malawi, where more rainfall occurs due to the lake's contribution (Libanda et al., 2017).

In the last 50 years, Malawi has experienced several extreme weather-related events. Approximately 40 weather-related disasters occurred from 1970 to 2008, with 16 of these occurring between 1990 and 2008 (Republic of Malawi, 2016a). Between 2015 and 2017, Malawi faced four successive climate-related shocks, including the worst flood in 50 years in 2015 and the strongest El Niño event in 35 years in 2016, which resulted in erratic rains, prolonged dry periods, and one of the worst droughts in three decades. The drought led to a delayed start of the agricultural season and crop failure, resulting in a drop of 12.4% in agricultural production compared to the previous season, which was already down by 30% due to flooding in 2015 (Republic of Malawi, 2016a). Similarly, in 2019, Cyclone Idai led to the flooding of nearly 85,000 hectares of crops, affecting over 57,800 farmers (Office for the Coordination of Humanitarian Affairs, 2019). According to Malawi's National Agriculture Policy, the crop production sector is underperforming as a result of factors such as low adoption rates of agricultural technologies, pests, and climate change impacts (Republic of Malawi, 2016a).

The effects of climate change are undermining the country's ability to become food and nutrition secure. In particular, increased temperatures elevate the risk of heat stress, resulting in lower crop yields and crop failure. For example, maize has been and continues to be the main food crop grown in Malawi, accounting for about half of Malawians' caloric intake.



Studies show that in a climate change environment, maize yields could decrease by 14%–25% by 2050 (Warnatzsch & Reay, 2020). Heat stress can also negatively impact livestock production; however, this impact is not seen as a priority concern in the country’s policy document (Republic of Malawi, 2018c).

Climate change will mostly affect the poorest and most socially excluded groups in society, whose capacity to deal with climatic shocks is severely hampered. According to the Malawi National Resilience Strategy (Republic of Malawi, 2018c), the levels of risk and vulnerability of children under 5 and people living with HIV have increased during the most recent drought of 2016. Extreme climatic shocks, coupled with fluctuating market prices and existing chronic food and nutrition insecurity among the population, have led to increasing annual humanitarian needs. For example, following the 2015–2016 climate events, which had significant impacts on agriculture, 6.5 million people across 24 of Malawi’s 28 districts received humanitarian aid (Republic of Malawi, 2018c).

Malawi has taken steps to address climate change in the country, identifying key priority areas for climate change adaptation in policy documents as well as during consultations (see Box 3). Due to the vulnerability of Malawi’s population to famine and general risks related to food insecurity, ensuring food and water security in the context of climate change is a top priority. The 2006 National Adaptation Programme of Action and the 2016 National Climate Change Management Policy have articulated climate change impacts and possible interventions to ensure a coordinated and harmonized approach to climate change (Republic of Malawi, 2006, 2016b).

Malawi has placed a strong focus on improving the capacity of farmers to produce and respond to climate change and other shocks. With respect to agricultural production, including crops, livestock, and fisheries, the focus is on promoting sustainable intensification in the sector. Policy documents aim to equip farmers with capacities to improve their production potential through access to machinery, inputs including fertilizer and seeds, and access to markets to sell their products and purchase healthier diet options (Republic of Malawi, 2006, 2018a). This priority is visible in donor-funded initiatives such as the KULIMA Programme, which seeks to increase agricultural productivity and diversification, especially through climate-smart agricultural practices, while simultaneously developing agricultural value chains and businesses (Malawi National Authorizing Officer Support Unit, 2017c; KULIMA Programme, 2019). Extension and skills development services and access are also identified as necessary to enable farmers to utilize improved inputs and information about market prices and to adapt production activities based on short-term forecasts and their development. The focus of extension services should also include specific soil and land management and cropping practices, such as crop diversification, agroecology, and agroforestry (Republic of Malawi, 2018a).

An important element of adaptation efforts directed at promoting sustainable intensification of agricultural production is improving the use of water resources and irrigation systems (Republic of Malawi, 2018c). Addressing the challenges of water access and water resource allocations for production contributes to building a resilient agricultural system by not only providing access to irrigation but also limiting the vulnerability of production. Heavy reliance on rain-fed agriculture makes the sector particularly vulnerable to the impacts of climate



change, especially in the southern part of the country. As a result, Malawi has supported a broad effort to promote sustainable intensification by encouraging new agronomic practices such as conservation, adoption of drought-resistant crops, and agroforestry as adaptive strategies to improve productivity and reduce food insecurity and malnutrition. Mirroring this, several donor-funded projects, including the Agriculture Sector Wide Approach and Green Belt Initiative (funded by the European Union), highlight the importance of sustainable water management and conservation practices (Malawi National Authorizing Officer Support Unit, 2017a). The EU has also funded efforts in the Salima district to develop medium-scale rice irrigation and improve farmers' access to markets (Delegation of the EU to the Republic of Malawi, 2018a).

Climate-adaptive agricultural practices have existed in Malawi for many years, and the government continues to support their adoption by smallholder farmers. Specific initiatives identified in national policy documents include legume intercropping,⁵ soil and water conservation,⁶ and organic fertilizers⁷ (Republic of Malawi, 2006; 2018a). In addition to national climate change adaptation initiatives, there are local adaptation initiatives and practices, including crop diversification, consumption of wild plants such as nyika, mixed crop and livestock farming, small-scale irrigation, and non-farm income-generating activities (Magombo et al., 2012). In addition, as was found in the Chikhwawa district, during climate extremes, smallholder farmers use early-maturing and drought-tolerant maize and sorghum (Magombo et al., 2012).

Another critical part of improving farmers' capacities to address challenges autonomously is enabling access to financial resources, savings, and access to financial services when needed. Access to financial resources creates a buffer for households to plan and better cope with challenges, including climate change impacts. Focusing on poor households, the Republic of Malawi is undertaking efforts to shape a new-generation National Social Support Programme with respect to nutrition and shock sensitivity as a reaction to malnutrition and recurrent (food) crises (Malawi National Social Support Programme II, 2018).

Finally, national adaptation efforts focus on disaster risk management to address the impacts of extreme events, such as droughts and floods, as well as recurring extremes.

⁵ A practice that improves climate resilience through the improvement of soil nutrient availability, enabling farmers with land shortages to diversify production and spread the risks associated with climate extremes.

⁶ Including putting up structures to prevent and reverse soil degradation. This is critical for improving productivity and reducing sensitivity to weather-related risks.

⁷ The use of composted crop residue and animal manure is key to enhancing productivity and crops' resilience due to the increase in soil carbon and soil nutrients, as well as improved water retention, particularly during periods of drought.



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

This section identifies pathways and the associated costs and interventions for addressing the interlinked challenges of the food system in Malawi. 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 improving the 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—to 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 Malawi, as well as the share of external resources needed. The methods and approaches are described in more detail 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 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 fewer people affected by hunger (SDG 2.1), a healthier diets target for improved nutrition (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) in 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).



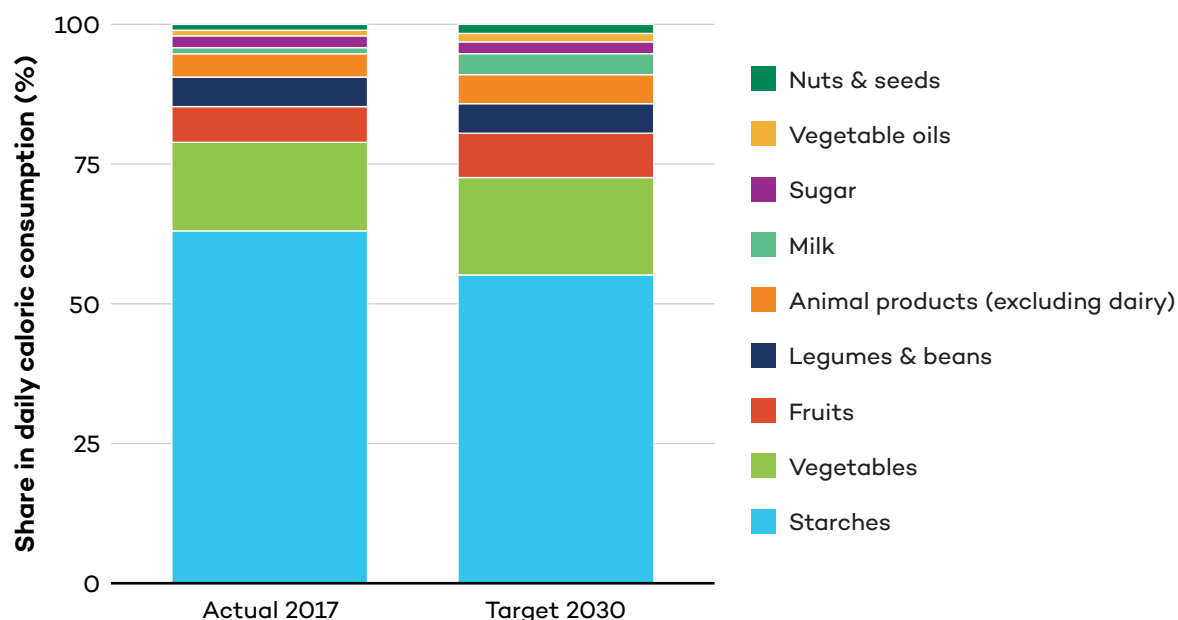
based on national and international guidelines and policy documents, a review of nutrition literature, and expert consultations, we focus on three targets for achieving healthier diets as appropriate for guiding national-level food system investment:

1. Overall **caloric intake** measured using the prevalence of undernutrition (PoU), with a target of less than 3% PoU in each country.
2. Adequate consumption of **non-starchy vegetables and fruits**, based on the World Health Organization (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 calcium and B12 consumption.

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 7 compares the existing dietary consumption patterns in Malawi with the dietary composition targets included in the modelling framework. When comparing the current diet and a healthier future 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.

Figure 7. Comparison of the current (2017) and targeted dietary composition in Malawi: consumption per capita



Further details about the model targets see Section 4.2.2.

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



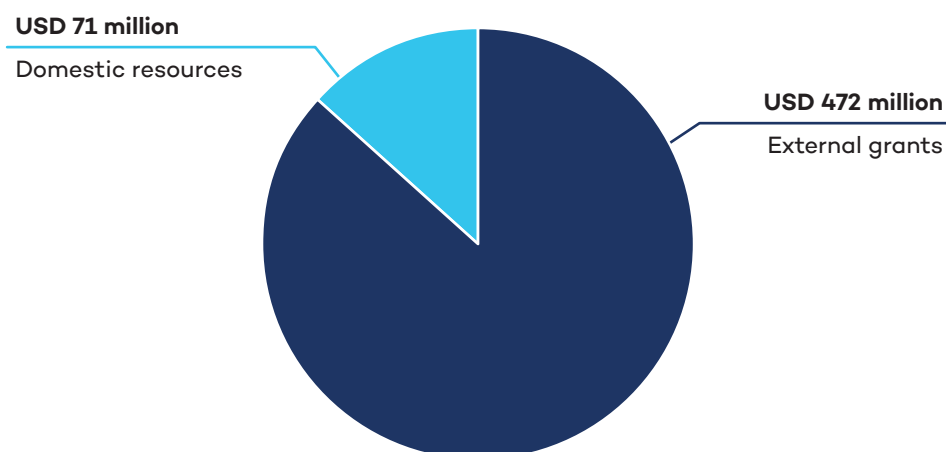
Policy interventions are grouped in three broad areas, following the modelling framework from *Ceres2030: Sustainable Solutions to End Hunger* (Laborde, Murphy et al., 2020):

- **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

Results from the modelling show that, in Malawi, it would cost an additional USD 543 million in annual public investment from now until 2030 to end hunger, double the incomes of 2.9 million small-scale producers households on average, transition to healthier diets for 14 million people, and protect the climate.

Figure 8. Additional public spending and donor contribution 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 215 million per year to projects directly affecting agriculture, food security, and nutrition in Malawi (see Figure 9).

The United States is by far the top donor to projects in agriculture, food security, and nutrition in Malawi (Figure 9). A desk review of the projects implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the EU and the United States

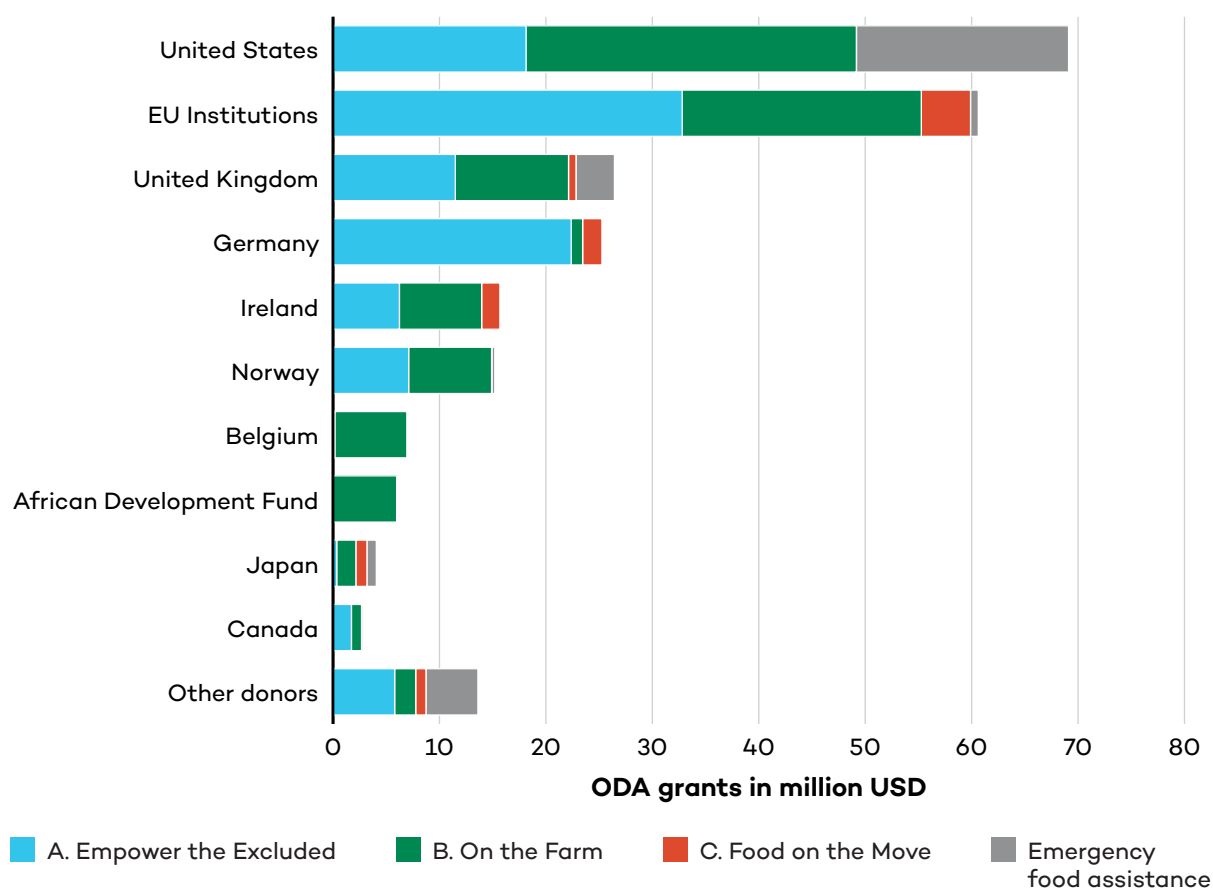


Agency for International Development (USAID) found 17 projects that are closely related to the nexus of food security, nutrition, and climate change. The focus of these projects ranged from nutrition education and school feeding programs to production support, agri-development, extension services, and capacity development (see Bizikova et al., 2022). Most of the identified projects focused on two elements of the nexus, for example, implementing measures to increase the production of diversified, nutritious crops and providing nutrition education on the crop's usage (USAID, 2018b) or increasing agricultural productivity through the use of climate-smart agriculture (KULIMA Programme, 2019; Delegation of the EU to the Republic of Malawi, 2018b). None of the reviewed projects drew strong links between or directly addressed all three aspects of the nexus.

In the context of Malawi's heavy reliance on external aid, its strategies and policy documents recognize the important role of ODA in promoting resilience, sustainability, and nutrition. For example, the country's resilience strategy stresses the importance of foreign assistance in agreements such as the Grand Bargain reached at the World Humanitarian Summit, the New Alliance for Food and Nutrition Security, the Scaling Up Nutrition Movement, the Sendai Framework for Disaster Risk Reduction, the Paris Agreement on Climate Change, and the United Convention to Combat Desertification (Republic of Malawi, 2018c).



Figure 9. Top 10 donors by average annual disbursement, 2017–2019



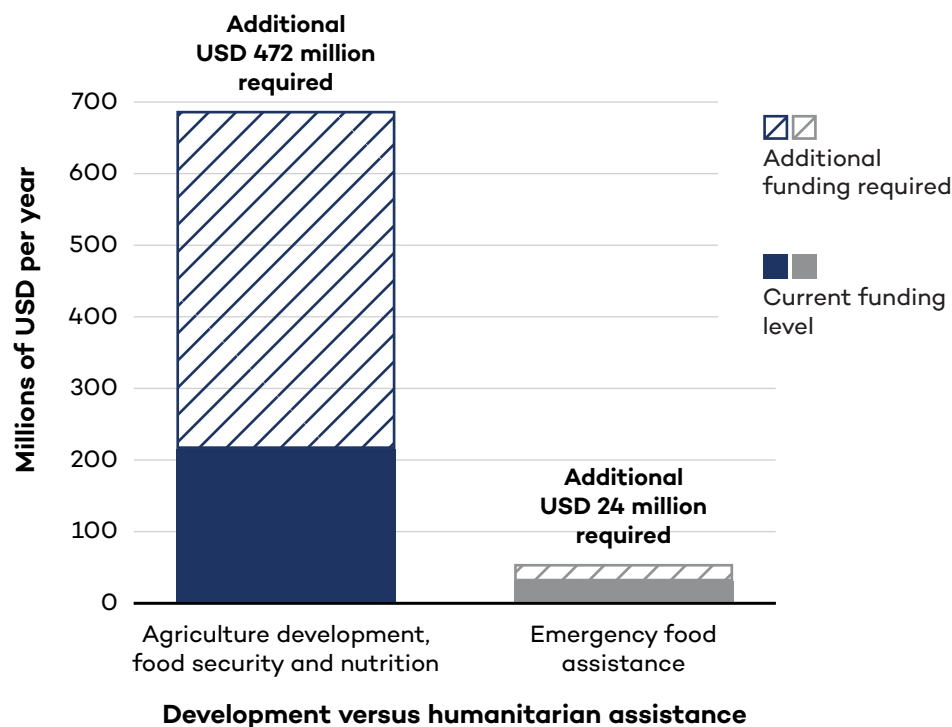
Source: Authors' analysis of OECD's Creditor Reporting System (OECD, 2021)

Results from the modelling show that of the additional USD 543 million required, USD 472 million 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 to achieve the SDG targets. Donors currently disburse an average of USD 215 million per year to projects directly affecting the food system in Malawi.

Importantly, 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 that there is significant underfunding of the longer-term investment needs (see Figure 10). Unless corrected, shocks and crises will continue to lead to massive rises in hunger and poverty. This is incredibly pertinent given the devastating impacts of current crises, including the considerable rise in the 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 10. 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?

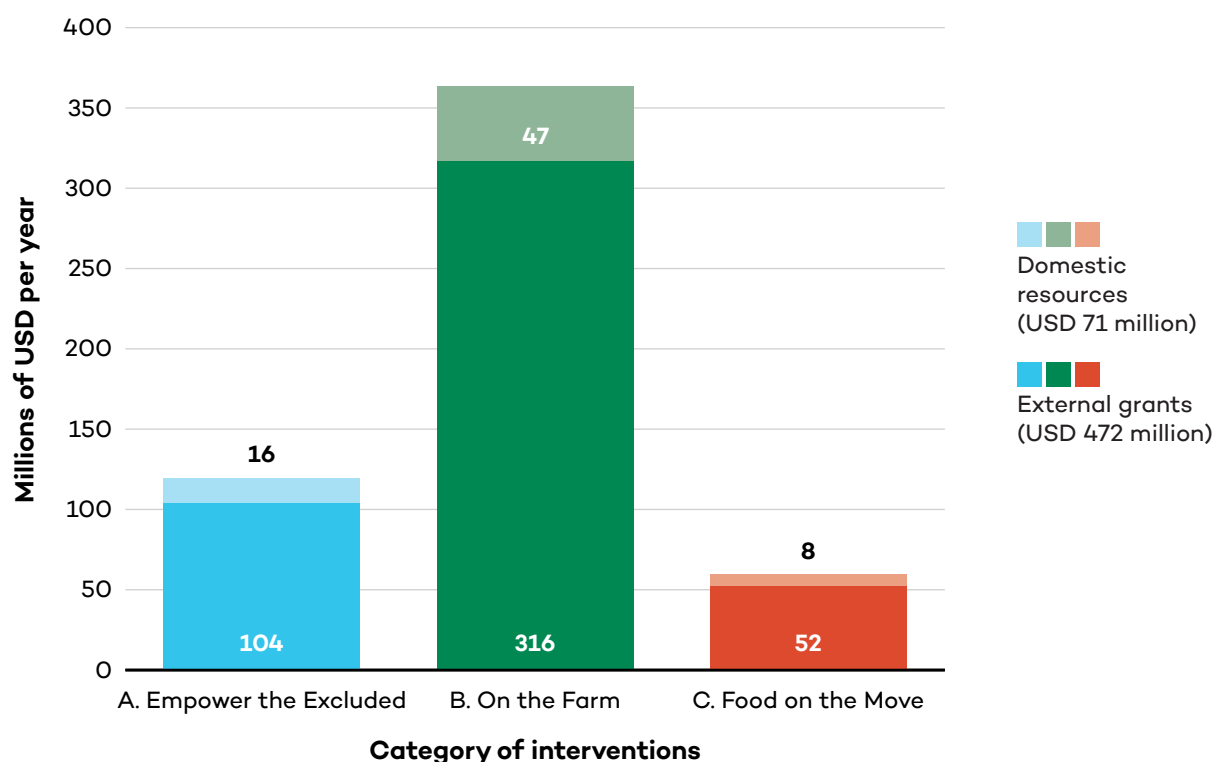
To achieve sustainable food systems transformation, what matters is not only the total public costs but also the allocations to specific interventions (see Figure 11) and policy and strategic support to promote the implementation of these interventions. In this context, it is critical to prioritize the actions and programs outlined in existing policies and strategies (as stressed during the consultations, see Box 4) and, if necessary, complement these policies with additional actions to account for the outcomes of the cost modelling.

3.3.1 Interventions Supporting Sustainable Food System Transformation

Figure 11 shows the allocation of the total public costs across the three areas: an additional USD 119 million per year is needed to “empower the excluded,” USD 364 million is needed annually “On the Farm,” and USD 60 million is needed every year for “Food on the Move.”



Figure 11. 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 364 million) is 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 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 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 4).

The next biggest share goes to empowering the excluded, which amounts to USD 119 million and includes social protection programs, vocational training, nutrition education, and school feeding programs. Nutrition education and school feeding programs were two priorities that were stressed multiple times by multiple participants during the consultations (see Box 4).

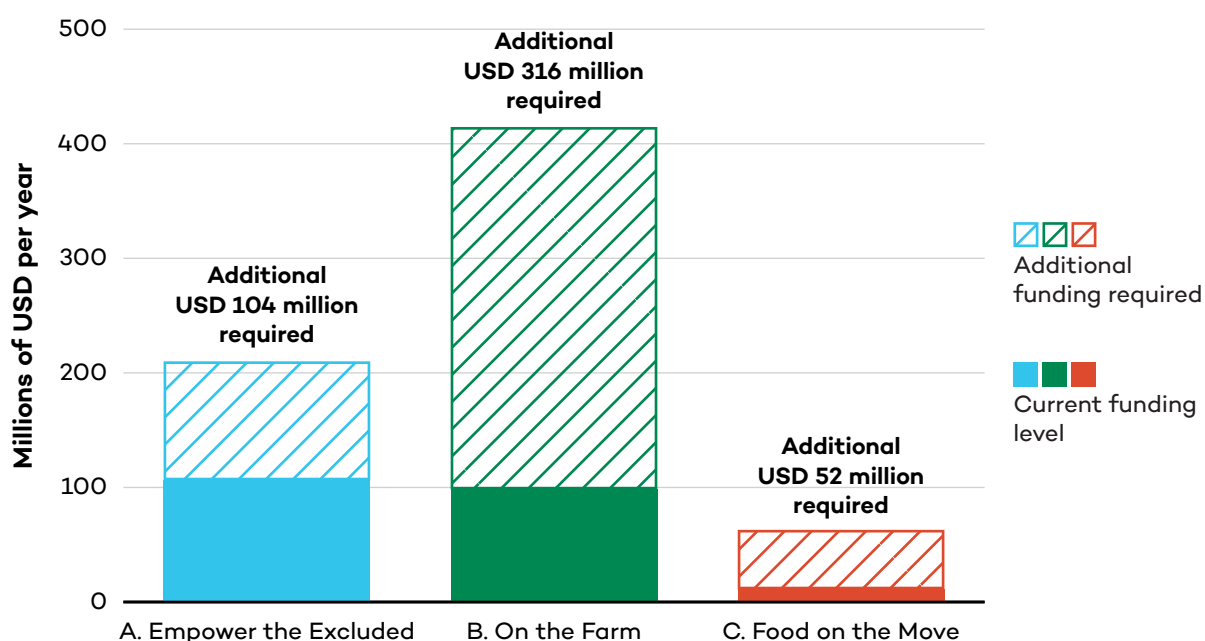
The smallest share of financial allocations (USD 60 million) is to be spent on market and value chain interventions, which are closely linked to farm-level measures and link producers to consumers. These interventions directly contribute to dietary diversity, as households with better access to local markets tend to have higher dietary diversity (Kansanga et al.,



in press). In addition, promoting access to storage, especially for nutritious foods (such as vegetables, fruit, and animal-source products), helps improve the nutrition of households accessing these foods.

The priority areas for the required increase in donor spending mirror this distribution across the three categories of interventions: an additional USD 316 million is needed on the farm, USD 104 million to empower the excluded, and USD 52 million for food on the move (Figure 12).

Figure 12. Total annual external funding required grouped by intervention category



Source: Authors' diagram, using data from the OECD's Creditor Reporting System (OECD, 2021) and MIRAGRODEP model simulations.

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

From a policy perspective, there are a number of specific strategies and policy actions that could support the interventions included in the macroeconomic model. Farm-level interventions identified as top priorities for public financing are listed in Malawi's policy documents and strategies, including the Agricultural Investment Strategy, Agricultural Strategy, Natural Resilience Strategy, National Agricultural Policy, and the country's updated NDC (Republic of Malawi, 2006, 2016a, 2018a, 2018c, 2021a). Measures listed in the policy documents that are particularly relevant to our findings include, for example, improving farmers' access to high-quality inputs, including seeds, fertilizers, and technologies, as well as access to mechanization services and markets (Chirwa & Doward, 2013; Dorward & Chirwa, 2014; Republic of Malawi, 2018a). An example of concrete action by donors to advance these policies is the Malawi Improved Seed Systems and Technologies project, which aims to increase the supply, accessibility, and use of improved, drought-resistant seeds (CIMMYT



International Maize and Wheat Improvement Center, n.d.). However, as emphasized during the consultations, supply-side interventions and efforts to diversify production need to be accompanied by nutrition education on the utilization, storage, and end products that can be created with nutritious crops. USAID's Improving Nutrition with Improved Crops and Awareness initiative exemplifies this dual approach complementing supply-side interventions to increase the production of nutritious crops with nutrition education (USAID, 2018b).

The National Agricultural Investment Plan and Natural Resilience Strategy also emphasize extension services such as introducing local crops, agroecology, and soil management practices (Republic of Malawi 2018a, 2018c). These documents suggest specific kinds of participatory, demand-driven extension services that also use farmer organizations to assist with improving farmers' knowledge and skills in planting, processing, and facilitating collective action connecting farmers to markets. For all these services, the policy documents prioritize moving the efforts close to farmers by, for example, establishing extension databases and agricultural resource centres at the district level. These priorities could be incorporated into existing initiatives, such as USAID's Strengthening Agricultural and Nutrition Extension in Malawi project, which already works with service providers to deliver more effective agriculture, food, and nutrition extension and advisory services (Rivera & Moore, 2019; USAID, 2018a).

In order to achieve the estimated contributions to poverty reduction, food security, and healthy diets, the findings stress the need to focus on specific policies on livestock as part of farm-level measures. Such measures could also address GHG emissions increases and other environmental impacts created due to the growing livestock numbers and management practices that are currently in use. The policies and strategies for changing the livestock sector are prominently featured in the country's agricultural investment, livestock policy, and resilience strategies (Republic of Malawi, 2006, 2016a, 2018a, 2018c). In these strategies, the main focus is on reducing livestock mortality as a result of underdeveloped water supply infrastructure and on addressing animal health challenges. The policy documents seek to advance breeding and veterinary services and to invest in community watering holes. The analysis shows that these measures are critical to creating a prosperous livestock sector and that the selection of breeds and manure management—and a focus on small ruminants, in particular—should be prioritized in the policy documents. However, despite the prominence in policy documents, the desk review found no projects implemented by GIZ, USAID, or the EU that had a strong focus on sustainable livestock intensification. Programs and interventions that support the sustainable development of the livestock sector should therefore be a critical priority for increased public investment, both for the Government of the Republic of Malawi and the donor community.

Measures to promote storage and market access, especially through participation in farmer organizations, are presented in the National Agricultural Investment Plan (2018). It is important to integrate market and value chain interventions with strategies and policies on climate change, as improved access to storage and markets along the value chain builds farmers' resilience by ensuring more diverse opportunities to generate income and sell more diversified products. The National Agricultural Investment Plan (2018) briefly touches on the implications that storage has on reducing post-harvest loss; however, efforts to reduce food waste and loss have limited focus, and there is room to improve them in the future. Currently, there is minimal evidence of food loss and waste being a priority for the government or



donors. Only one of the 17 donor-funded projects reviewed—the EU’s Farm Income Diversification Programme (FIDP II), SUN Component—mentioned the need to reduce post-harvest losses as part of its objectives (Bizikova et al., 2022; Malawi National Authorizing Officer Support Unit, 2017b).

In addition, Malawi’s Greenbelt Initiative combines efforts focused on two of the three broad areas (on the farm and food on the move), prioritizing increased productivity, irrigation, and other market infrastructure development, as well as farmers’ access to financial resources. This initiative aims to enhance irrigation for smallholder farmers to increase productivity, incomes, and food and nutrition security at the household and national levels (Republic of Malawi, 2010). The initiative builds upon the successes of similar programs, such as the Farm Input Subsidy Programme, by intensifying irrigation farming, livestock, fisheries, infrastructure development, agro-processing, and market development.

Measures to empower the excluded have the most direct impact on national nutritional outcomes but are also important for food security, alleviating poverty, protecting the climate, and adapting to climate change. Most of the interventions—social protection, nutrition education, vocational training, and school feeding programs—are considered Malawi’s top priorities. Currently, there are a significant number of donor-funded projects focusing on nutrition education and dietary diversification. Examples include Nutrition and Access to Primary Education and USAID’s McGovern Dole Food for Education Program, which provide school meals for primary school pupils (GIZ, n.d.b; USAID, 2018b); the Food and Nutrition Security Programme, which provides nutrition education for women and children (GIZ, n.d.a); and the Food for Peace Program, which aims to improve food and nutrition security for women, children, and other vulnerable groups (USAID, 2021). Despite the number of existing initiatives, efforts to support nutrition education and dietary diversification should, and do, remain an area of priority for Malawi. This emerged strongly from both the stakeholder consultations (see Box 4) and national policy documents. For example, the Government of the Republic of Malawi is undertaking further efforts to shape a new generation of social protection through the Malawi National Social Support Programme II, with a focus on nutrition and resilience building by providing targeted income support, skills development, and capacity building on healthy diets and food choices (Republic of Malawi, 2012; MNSSPII, 2018). In this context, both the transition pathway and the National Resilience Strategy (Republic of Malawi, 2018c) suggest considering the out-migration of surplus labour from agricultural and rural areas, especially from degraded, very small farms that cannot produce enough income. The strategy also suggests support for sectors such as mining, construction, and services to encourage farmers and farm workers to diversify and explore new labour markets.

Finally, addressing gaps in the transition toward healthier diets can be bridged through increased biofortification, especially for those most impacted by challenges in their nutrition. According to the country’s National Multi-Sector Nutrition Policy (Republic of Malawi, 2018b), biofortified foods contribute to diverse nutrition diets in the country. The findings indicate that biofortified food can improve the nutritional aspects of diets and facilitate the pathway toward healthier diets. Currently, there are no initiatives implemented by the EU, GIZ, or USAID in Malawi that focus on the biofortification of foods or the accessibility of biofortified foods. However, stakeholders in the consultations noted that the fortification



program in Malawi is fairly good, with particular nutritional benefits observed from pro-vitamin A maize and iron-fortified beans; the issue is the affordability of biofortified and fortified foods for those most in need of them (Food Systems Summit Dialogues, 2021). The Malawi National Multi-Sector Nutrition Policy (Republic of Malawi, 2018b) identifies this issue, noting the importance of developing biofortified foods that meet food safety standards and that are accessible to the groups most significantly impacted by low nutrition in their diets. The strategy emphasizes that this should be a priority for policy-making and implementation. The strategy also stresses the importance of engaging the private sector in delivering biofortified and fortified foods, in general, to consumers. National stakeholders suggested subsidies or community-level fortification as potential strategies that could increase the accessibility of biofortified foods for the communities that most require them (Food Systems Summit Dialogues, 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 the implementation of the transformation scenario also improves the capacities of farmers to adapt, promotes the overall resilience of the agricultural sector, and reduces the environmental footprint. Farmers' income gains and diet improvements can be jeopardized if climate resilience is strengthened.

Climate change impacts, responses, and resilience building need to be an integral part of any future agriculture and food systems strategy. As emphasized during the consultations, it is important to ensure that climate change responses, including building the capacities of farmers to adapt, are mainstreamed into interventions and policy documents (Box 4). Many of the donor-funded initiatives emphasized the need to build resilience to climate change and climatic shocks, in particular through the adoption of climate-smart agriculture and the development of national- and district-level capacities to mainstream, plan, and implement climate-resilient development and agriculture plans. This focus on climate resilience is reflected in national policy priorities. Several country documents, such as the National Resilience Strategy, Malawi's updated NDC, and the adaptation strategy, stress the importance of building farmers' capacities to make production choices that build resilience and will not contribute to increasing vulnerability (Republic of Malawi, 2006, 2018c, 2021a, 2021b). The National Resilience Strategy (2018–2030), for example, outlines a vision for the country's future with an emphasis on rural areas. It provides a framework that is aligned with the focus of this project, emphasizing an integrated, cross-sectoral approach to addressing chronic food insecurity and pathways to reduce poverty (Republic of Malawi, 2018c). The National Resilience Strategy identifies broader rural development priorities and supports sustainable intensification rather than focusing only on farm-level priorities and capacities (Republic of Malawi, 2018c). The policy aims to address a significant gap in agricultural production, especially the very low yields, and to ensure that both plant and livestock production are resilient and able to meet the country's climate change mitigation priorities.



This is significant as improvements to diets achieved as a result of focusing on existing technologies and agricultural production choices alone will increase GHG emissions and make it challenging to implement climate change policy measures. In this context, sustainable intensification will require improving agricultural productivity with production techniques that are GHG efficient. The policies will also need to make these techniques more economically attractive to small-scale food producers than alternatives.

In terms of climate change mitigation, the transition pathway assumes that Malawi will be able to achieve its GHG emissions reduction commitments listed in its updated NDC. The findings show that the most relevant interventions are those related to livestock production, as growing livestock production—due in part to its contribution to healthier diets—is seen as a significant and increasing contributor to the country’s GHG emissions. Interventions focused on livestock production assume a move toward small ruminants and improved feed choices and manure management—practices that will help reduce agricultural emissions.

The interventions also enable a number of specific adaptation efforts, such as planting and seed choices, irrigation and soil management, and access to storage and markets. Climate-proof water management plays a critical role in farm-level and market interventions through policy support actions, such as ensuring livestock access to water, climate-/drought-/disease-resistant varieties, and extension support so that farmers can adjust production to account for climate change impacts. In this context, on-farm interventions provide direct support to farmers to produce more food, improve production quality, and increase production diversity, which contributes to adaptation and resilience building. Thus, there is a role for extension services and targeted subsidies to promote crop diversification from maize to fruits and vegetables, legumes, and oilseed production.

In addition, a critical part of national adaptation efforts focuses on disaster risk management to address the impacts of extreme weather events, such as droughts and floods. This report does not consider the impacts of and responses to extreme events, yet from the policy perspective, integration of these issues is necessary to achieve improvements in productivity, food security, and diets. While mitigating the effects of climatic shocks was only specifically addressed in one identified donor project, several referenced the need to develop regional and district-level capacities to plan and respond to the impacts of climate change (Delegation of the European Union to the Republic of Malawi, 2018b; KULIMA Programme, 2019; The Global Climate Change Alliance Plus Initiative, 2018; USAID, 2020).

Finally, the emphasis on improved practices at the farm level and in other interventions means that specific policies, programs, and interventions need to be designed to foster climate change adaptation and build resilience. In all cases, the achievement of these multiple objectives should be monitored using appropriate indicators for farm-level, individual, household, system, and aggregate outcomes. Of the 17 donor-funded projects reviewed in this research project, only one—Alikepo Programme (2019)—mentioned monitoring and evaluation as part of its objectives or strategy. This needs to be mainstreamed into the design and implementation of development projects in order to check the impact and maximize effectiveness.



Box 4. Policy priorities and implementation challenges from stakeholder consultations

- Need to establish food-based dietary guidelines for Malawi that can be implemented consistently across the government and mainstreamed into all relevant strategies.
- Introduce the adopted dietary guidelines in school feeding programs or in improvements to the provision of food in boarding schools. Such curriculum changes would work toward addressing the nutritional challenges and stereotypes that emerge at an early age.
- Develop nutritional frontline workers' programs to assist with dietary improvements.
- Subsidies and other community-level fortification programs are needed to make fortified foods more accessible to the communities and to those within communities who most need them.
- Need specific policy frameworks to promote nutrition education and awareness about healthier diets.
- The production of diversified crops needs to be accompanied by education on their utilization, storage, and the end products that can be created.
- Efforts need to be made to increase consistency across ministries and their programs. There are often good policies within specific ministries, but they are isolated and operating in silos.
- Donors often focus their support on the production of policy documents and frameworks and less on their implementation. From this perspective, Malawi already has a fairly good body of policies and strategies; what is lacking is the will and support to bring policies together to the extent that they are funded and operationalized.
- Implementation issues also emerge due to competing priorities, so adopting a multisector approach and emphasizing interventions with benefits across different sectors (as our research outputs do) may help address implementation issues.
- Create an enabling environment to encourage farmers to take risks, diversify their production, and potentially explore commercial productions.

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 A.



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 not happen without 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. People affected by hunger often have no choice but to depend on staple foods rather than consume more nutrient-rich foods like meat, dairy, fruits, and vegetables. These tensions are real for the people of Malawi. Policy efforts promoting nutrition education, access to healthier affordable foods, and school feeding programs can help reduce these tensions to some extent.

Improvements in 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.

Tensions will not only be created at the level of actual measures but also during policy development and coordination. As mentioned during the consultations, competing priorities and limited resources to prioritize actions lead to the implementation of some policies but not others (Box 4). Thus, as emphasized by national stakeholders, adopting a multisector approach, combined with coordination across sectors and agencies, will help prioritize interventions with benefits across different sectors and may help address implementation issues.

Malawi will need to decide what trade-offs they are willing to make based on the best available evidence while maximizing synergies. To some extent, new policies and interventions can help manage and mitigate some of the tensions. For example, public investment in agriculture can support environmentally sustainable intensification to reduce GHG emissions from the sector and accelerate efforts to reduce food loss and waste so that more food is available. Currently, coverage of food loss and waste in policy documents and donor initiatives is limited. There is a clear need to explore how and to what extent efforts on sustainable intensification can be linked to efforts to reduce food loss, and additional efforts to work along the value chains to reduce food waste might be needed.

Malawi's policy documents and the findings both show that there is a need to make livestock production 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. These efforts should go hand in hand with addressing the immense productivity gap in agriculture, particularly in the livestock sector. Animals in highly efficient production systems can use more energy for growth, milk production, or egg production rather than just survival. This is typically achieved through more and better feed and better animal health and genetics.



Another key factor is how manure is dealt with, as it accounts for a large portion of emissions from animal agriculture. The model includes interventions that collectively offer some proxy for interventions to improve the GHG efficiency of animal agriculture—for example, R&D, extension services, and livestock subsidies for agroforestry and improved forage. The GHG limits also “bias” the model against ruminant meat since these 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 emissions-efficient animal-source foods, especially since the consumption of these foods will tend to increase as incomes increase, even without public intervention.

Finally, as mentioned earlier, indicators for farm-level, individual, household, system, 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 in this report, 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 the FAO, the World Bank, major development agencies (GIZ, USAID, UK aid, and others), and the country's policy documents. To access peer-reviewed literature, we searched the ScienceDirect database (www.sciencedirect.com) for papers focused on Malawi and papers outlining regional trends with specific details on Malawi 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 1,236 papers were collected. The research team briefly screened the abstracts of the papers, and those papers that were deemed relevant were included in the report. 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 33 documents were collected. Finally, we reviewed strategies and policy documents published by ministries and government agencies in Malawi and selected 11 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 the environmental and climate change impacts of agricultural production; fed 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 appraise 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, 17 projects were reviewed. See Bizikova et al. (2022) 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 the 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 A.

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 Malawi based on the analytical framework developed in the Ceres2030 project⁹ (www.ceres2030.org).

As part of the project's modelling approach and as another important contribution to the project, a microeconomic analysis of changing diets, food habits, and nutrition was undertaken. To do so, micro-level consumption data from the LSMS¹⁰ 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 a 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. More details of the microeconomic approach are described in Appendix A.

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 model¹¹ 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 nationwide 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 prevalence of undernourishment is reduced (to less than 3%), nutritious food targets are set out to achieve healthier diets (e.g., increasing fruits and vegetables and animal-source proteins), the average net income of small-scale producers doubles 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.

⁹ See Laborde, Murphy et al., 2020 and Laborde, Parent et al., 2020 for more information.

¹⁰ LSMS-IHS Malawi Wave 5 2019-2020 (World Bank, 2020).

¹¹ The model is adapted from the MIRAGRODEP model. See Laborde et al., 2013.



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.), double the incomes and productivity of small-scale producers (SDG 2.3), and constrain GHG emissions in agriculture (SDG 2.4).

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 the FAO’s PoU. Specifically, the level of undernourishment in the country is reduced to less than 3%.

4.2.2.2 Healthier Diets

Currently, there is no universally accepted definition of a healthy diet. Neither has Malawi established food-based dietary guidelines or concrete nutrition targets. Yet, in order to estimate costs for achieving healthier diets, there is a need to establish a quantitative target in the model. Three 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 “universally healthy” diets. Under current policy scenarios, we do not believe “universally healthy” diets will be feasible by 2030 for all Malawians. 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 the appropriateness of diets can vary. 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 national and international guidelines and policy documents, a review of nutrition literature, and expert consultations, we have focused on three targets for achieving healthier diets in Malawi:

1. Overall **caloric intake**, measured using the PoU, with a target of less than 3% PoU.
2. Adequate consumption of **non-starchy vegetables and fruits**, based on 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 adequate calcium and vitamin B12 intake.

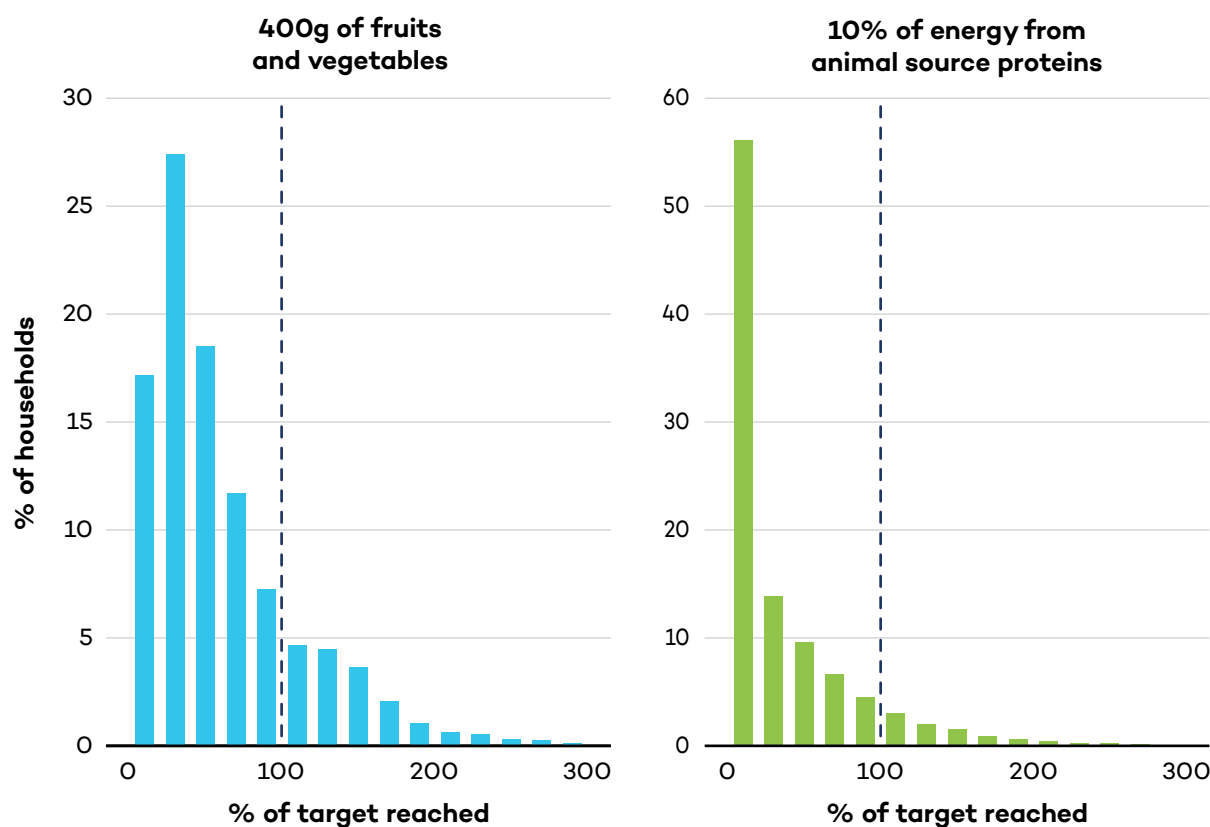
A set of targets for sufficient caloric intake at the household level is based on the modelling of household consumption in comparison to calorie requirements (FAO, 2001), adjusted for the age and sex of household members. For fruits and vegetables, a minimum target of 400 g per person per day is set 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, which are commonly insufficient in diets. An overall



minimum 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. 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 Malawi. Figure 13 shows the distribution of households in Malawi for each of these two indicators by the share of the overall target achieved.¹² Overall, 17% of households are achieving the fruit and vegetable target, and fewer than 11% of households reported at least 10% of their energy intake from animal-source food.

Figure 13. Current distribution of households by share of healthy diets target



Source: Authors' analysis based on LSMS–IHS Malawi Wave 5 2019–2020 (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.

¹² For visualization, a small number of households whose share exceeds 300% 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 which highlights the critical importance of including climate change impacts and responses.¹³ 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' intended NDCs or NDCs. Malawi's intended NDC was first submitted in 2015 and updated in July 2021. The updated NDC contains Malawi's current climate commitments with targets till 2040 (see Section 2.3.1). Thus, for Malawi, these targets were used to calculate targets for 2030, for inclusion in the model. For Nigeria and Ethiopia, the countries' NDC targets focus on 2030. Each country has a carbon budget (permitted GHG emissions) for agriculture; 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 diets 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:¹⁴ nutrition education¹⁵ and school feeding programs. In consultations,

¹³ Recent water–energy–food nexus studies often call for a climate change, water, energy and food nexus (Hoff, 2011).

¹⁴ 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.

¹⁵ Participants in the consultations in Malawi noted that nutrition education should also qualitatively include social and behavioural changes.




national stakeholders in Malawi and Ethiopia emphasized the importance of opportunities to increase nutritional outcomes through changes to school curricula, the introduction of dietary guidelines in school feeding programs, and improvements to the provision of food in boarding schools. It was noted that these interventions would work toward 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.” Table 2 lists the interventions and breaks them down into categories.

Table 2. 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 to climate change. Nonetheless, how each intervention affects each of the four modelled targets can be complex—in particular, 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 that 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 (as is the case in Malawi), fertilizer subsidies can lead to land savings outcomes and deliver 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 2). 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 from 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 of most concerned include modelling within-year variations 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 into the model.

4.4.1 Data Limitations

The microdata used in the analysis were intended to give the best possible representation of diets in Malawi. The primary data source is the World Bank LSMS, which provides interview data drawn nationally and subnationally 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 now 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 to 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 Malawi experience variation 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 number of macro- and micronutrients individuals receive at different points in the year. There is variation in the timing of surveys that allows a partial observation of seasonal variation across households (see Bizikova et al., in press). However, since each household was not interviewed at all points in the year, there is no observation of seasonal variations within households. The estimates therefore reflect average consumption in a given year. Within-year variation in diets is an important concern that 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 that 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, according to the Malawi National Resilience Strategy (Republic of Malawi, 2018c), the severe drought of 2016, coupled with fluctuating market prices and existing chronic food and nutritional insecurity among the population, led to higher annual humanitarian needs. During the period from 2016 to 2017, over 6.7 million severely affected people in 24 out of Malawi's 28 districts received humanitarian aid (an estimated 40% of Malawi's total population) (Republic of Malawi, 2018c). Similarly, in Ethiopia and Nigeria, natural disasters, including droughts, floods, diseases, and pests (specific to some regions), have affected the livelihoods of significant numbers of people (Federal Democratic Republic of Ethiopia, 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 the subsequent impacts that might affect these outcomes were beyond the scope of this project.



4.4.3 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, family status, and model factors such as access to assets and caloric intake (Bizikova et al., 2022). 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, and 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. Yet, 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. This is especially critical in the context of Malawi, as implementation challenges due to a lack of resources and political support emerged strongly from the consultations as a key bottleneck for Malawian food system transformation, as opposed to an absence of policy frameworks (Food Systems Summit Dialogues, 2021).



5.0 Recommendations and Conclusions

Malawi is not on track to achieve the SDGs by 2030. Without more and better public investment, hunger and 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 UN 2030 Agenda was meant to unfold.

All of this could be reversed. This report shows that Malawi only needs an additional USD 543 million per year between now 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 the levels of Malawi's NDC commitment, and increase resilience to climate change.

The report recommends the Government of the Republic of Malawi and its development partners:

1. **Increase public investment by an additional USD 543 million per year from 2023 to 2030 to achieve the transition to sustainable food systems.** The effects would be transformative. It would end hunger, double the incomes of 2.9 million small-scale producers households on average, transition to healthier diets for 14 million people, protect the climate and increase resilience to climate change. Development partners should provide an additional USD 472 million, from a current baseline of USD 215 million on average per year for 8 years (2023–2030). The Government of the Republic of Malawi should provide an additional USD 71 million 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, particularly irrigation infrastructure, livestock productivity, and agroforestry.** An additional USD 364 million per year is needed to improve farm productivity and incomes, an additional USD 119 million per year for social protection and education, and an additional USD 60 million per year to move food to markets. Interventions to support irrigation infrastructure and livestock production through agroforestry can have particularly strong synergies for simultaneously improving access to food, healthier diets, and climate change mitigation and adaptation. Policies that encourage the adoption of climate-proofed water management, climate-resilient crops, and extension support for farmers to adjust production to account for climate change impacts must accompany other farm-level interventions, together with a focus on women and other vulnerable groups.
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 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 impacts of social protection programs, nutrition programs, and agricultural productivity programs.

4. **Ensure climate resilience is built into agriculture and food system policies and programs.** This goal includes targeted support to improve productivity in the context of climate change by providing extension services for those most vulnerable, particularly women, through seed choices that promote climate resilience; investment in climate-resilient machinery and equipment; interventions to protect soil health and biodiversity, conserve water, and limit land-cover change; and targeted improvements in disaster preparedness to address severe climate change impacts.
5. **Increase support for environmentally sustainable intensification** to increase crop and livestock productivity with production techniques that are compatible with Malawi's climate adaptation and mitigation commitments. Livestock policies should prioritize breeding, manure management, and a focus on small ruminants, as well as fiscal incentives to make sure improved techniques are economically attractive and commercially viable for small-scale producers.
6. **Continue targeted social protection programs,** targeting the most vulnerable to support national nutritional and development strategies and build resilience to climate change.
7. **Develop and adopt food-based dietary guidelines,** which currently do not exist in Malawi and which would help set country-led targets for the transition to healthier diets. These should be consistently implemented across all levels of government.
8. **Increase coverage of food loss and waste in policy priorities and donor-funded projects.** Reducing food loss and waste can contribute to the increased availability of food, especially nutritious foods such as fruits and vegetables that tend to spoil.
9. **Increase support for regional and national institutions to improve their 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.



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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 microeconomic 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 to 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, 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 into various agencies' strategies and national policy frameworks. 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 foods. This stage informed the scope of policy instruments to be considered but also the cost information and potential benefits from measurement and evaluation (M&E) 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 donor-funded projects relevant to the nexus of food systems, climate change, and healthier diets, see the Malawi Country Diagnostic Report (International Food Policy Research Institute & International Institute for Sustainable Development, 2022).

Second Consultation

The second consultation was organized as an Independent Dialogue of the United Nations Food Systems Summit and was held on May 24, 2021. This consultation was organized as a webinar in partnership with the Department of Nutrition, HIV, and AIDS. The consultation included a group of 26 stakeholders and national actors.¹⁶

¹⁶ See <https://summitdialogues.org/dialogue/20093/> for more details on the consultation.



The specific purpose of the dialogue was to receive inputs on reasonable steps toward a food system transition pathway to healthier diets in Malawi. Specifically, the focus of the dialogue was to receive inputs and feedback from stakeholders on proposed context-sensitive healthy diets, on what they view to be the criteria and consideration for healthier diets and food system transformation, and on the possible interventions and policies to achieve this based on their prior experience and opinions on potential opportunities.

One of the main findings of the dialogue was the need to explore the nexus of food security, nutrition, and climate change in greater depth so that food system transformation and the policies to bring it about are crosscutting and not considered in silos. Other findings included an identification of the need to establish food-based dietary guidelines for Malawi that can be implemented consistently across the government and an awareness of a lack of resources for the implementation of existing policies and interventions that could bring about sustainable food system transformation. Specifically, in Malawi, there are lots of policies and strategy plans, and a lot of support, especially from donors, focuses on the production of these documents, as opposed to their implementation. The focus needs to be given to the translation of these frameworks into policy.

Another key issue that emerged from the discussions was the affordability and accessibility of nutritious foods in Malawi. Some participants noted the continued need for supply-side interventions, especially those with a focus on improving the production and preservation of foods. These would have nutritional benefits by covering seasonal gaps and covering micro-nutrient gaps. On the other hand, participants noted that nutrition education and greater policy frameworks are needed to promote the awareness about, and utilization, of the existing body of knowledge on nutritious foods and food safety. Even with increased production, education in terms of end products that can be created from the diversified crops is required. One of the major areas that was highlighted in this regard was the opportunity to increase nutritional outcomes through the introduction of dietary guidelines in school feeding or in improvements to the provision of food in boarding schools. Such curriculum changes would work toward addressing the nutritional challenges and stereotypes that emerge at an early age. However, the point was raised that it is unclear how effective knowledge dissemination is in triggering behaviour changes, especially in ingrained actions and beliefs.¹⁷

Third Consultation

The third round of consultations occurred on September 14, 2021, in the form of a virtual webinar. With a smaller group of participants (16), 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:

- Participants wanted a more in-depth explanation of how we chose our healthier diets target and our definition of what constitutes a healthier diet: What decisions were

¹⁷ For a more detailed report on the second consultation, see <https://summitdialogues.org/dialogue/20093/official-feedback-20093-en.pdf?t=1627396411>.



made about which food groups to include and which not to? And why did we choose to adopt targets that moved toward healthier diets rather than achieving them?

- Within our modelling targets, we currently have a target for calcium consumption from dairy products, with a particular focus on emphasizing dairy consumption. Participants questioned why the focus is on dairy when calcium can be sourced from a wide range of other products.
- Looking at the three countries and their dietary targets, Malawi and Nigeria seem to have similar situations and similar targets. Participants requested a more detailed explanation of why Ethiopia is at such a lower level, especially for the dietary target by 2030.
- It was noted that the category of intervention currently called nutrition education should include social and behavioural change.

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 A1. A statistical summary of key nutritional indicators

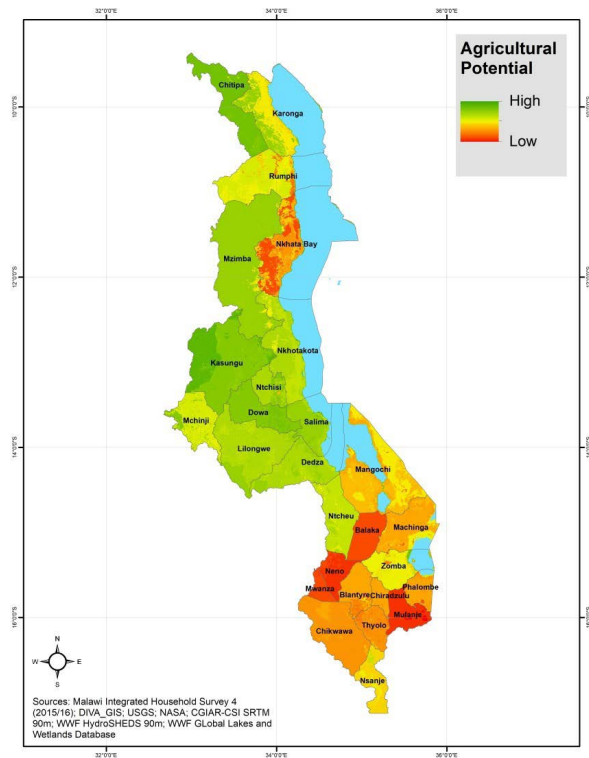
		SD	Min	Max.	N
Calories (Kcal)	2074.28	1172.01	0.00	14796.39	11434
Cereals & starches	1398.39	696.06	0.00	7860.13	11434
Legumes, nuts & seeds	143.70	229.74	0.00	3960.66	11434
Vegetables	145.39	166.56	0.00	2325.56	11434
Fruits	22.42	36.97	0.00	477.89	11434
Dairy	10.82	43.34	0.00	663.59	11434
Animal foods (excl. dairy)	86.70	162.86	0.00	3112.97	11434
Vegetable oils	140.92	219.56	0.00	4135.58	11434
Sweets & alcoholic beverages	125.94	175.68	0.00	2864.91	11434
Protein (grams)	57.15	34.18	0.00	616.93	11434
Cereals & starches	33.77	16.66	0.00	196.63	11434
Legumes, nuts & seeds	8.94	14.20	0.00	289.13	11434
Vegetables	6.08	6.57	0.00	93.24	11434
Fruits	0.31	0.52	0.00	6.09	11434
Dairy	0.47	1.84	0.00	39.44	11434
Animal foods (excl. dairy)	6.80	11.32	0.00	240.27	11434
Vegetable oils	0.02	0.10	0.00	2.79	11434
Sweets & alcoholic beverages	0.76	1.52	0.00	20.69	11434
Fat (grams)	52.65	48.23	0.00	667.37	11434
Cereals & starches	13.98	7.55	0.00	97.15	11434
Legumes, nuts & seeds	4.22	11.97	0.00	272.63	11434
Vegetables	10.48	14.47	0.00	203.91	11434
Fruits	0.07	0.12	0.00	1.98	11434
Dairy	0.65	3.29	0.00	63.03	11434
Animal foods (excl. dairy)	6.36	13.44	0.00	235.91	11434
Vegetable oils	15.84	24.69	0.00	464.87	11434
Sweets & alcoholic beverages	1.07	5.68	0.00	104.93	11434

Source: LSMS-IHS Malawi Wave 5 2019–2020 (World Bank, 2020).



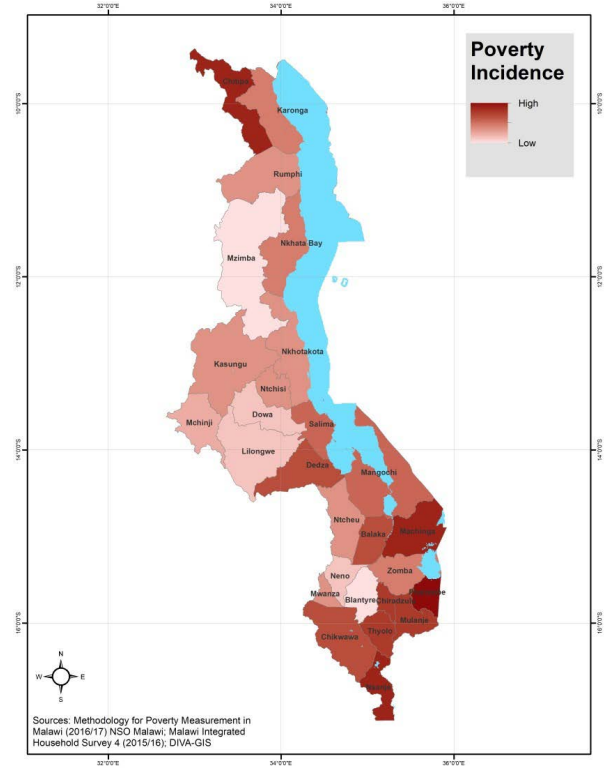
Appendix D. Maps

Figure D1. Agricultural potential in Malawi



Source: Maruyama et al., 2018.

Figure D2. Poverty in Malawi



Source: Maruyama et al., 2018.

The project is funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the European Commission, through the GIZ implemented projects Knowledge for Nutrition (K4N) and Agricultural Policy and Food and Nutrition Security as a contribution to the 2021 UN Food Systems Summit. The results will contribute to the Summit's goal of providing healthy diets for all, in a sustainable way, and will be published to coincide with the dates of the Summit.

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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