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Cost of Ending Hunger – Consequences of Complacency, and Financial Needs for SDG2 Achievement

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Executive Summary

The number of hungry and malnourished people in the world remains unacceptably high. Achieving Sustainable Development Goal 2 (SDG2: Zero Hunger) by 2030 is moving increasingly out of reach, despite ongoing and widely publicized national, regional and global policy efforts to make progress (e.g. G7, G20 and the UN Food Systems Summit and its follow-up processes). In 2022, 9 percent of the global population (735 million people) were undernourished and 30 percent (2.4 billion people) faced moderate or severe food insecurity. Africa, in particular, stands out with persistently higher levels of food insecurity compared to the global average. This is especially the case for rural populations and women. The world is also not on track to achieve the 2030 targets for child stunting, child overweight, child wasting and low birthweight, important indicators of severe malnutrition.

The trends of promising decline in undernourishment ended around 2015. Starting in 2020, the world has experienced unprecedented food security disruptions, leading to what can be described as "lost years" in the pursuit of SDG2. Conflicts and climate change impacts remain key drivers of hunger. While the world was still recovering from the impacts of the COVID-19 pandemic, the war in Ukraine had adverse spillover effects on global food, fertilizer and energy markets. At the same time, the frequency of extreme weather has increased substantially since 2000. Countries most exposed to climate impacts exhibit the highest prevalence of undernourishment, especially in the Horn of Africa and South Asia. A more recent trend is the growing scepticism against development cooperation and multilateral partnerships.

To combat food insecurity, G7 nations attending the Elmau Summit in 2015 pledged to eradicate hunger and malnutrition for 500 million people by 2030 through an increase in bilateral and multilateral assistance. This pledge was reaffirmed in 2022 with a joint commitment of USD 14 billion towards global food security in that year. Both the Indian and Brazilian G20 presidencies put hunger eradication high on their agenda in 2023 and 2024 respectively. While overall aid from the 27 Development Assistance Community (DAC) member countries has increased in recent years, declines from key donor countries were observed in 2022. Among the G7, only Germany reached the 0.7 percent of Gross National Income (GNI) target in 2022. Encouragingly, G7 aid related to food security and rural development has been increasing (albeit with some fluctuations at country level), rising from US$ 9 billion in 2000 to US$ 24 billion in 2022.

Objectives of the study

This study follows from an earlier assessment carried out by ZEF and FAO in 2020, which identified policy actions and investments needed to achieve SDG2 by 2030. The 2020 study used a marginal abatement cost curve (MACC) to identify a mix of best least-cost investment options with the highest potential for reduction in hunger and malnutrition over the decade of 2020 to 2030. In light of recent developments in food insecurity and related drivers, such as inflation and changed contexts, this study now recalculates the investment needs and re-evaluates priority interventions to achieve the ambitious target of Zero Hunger. Two different analyses are provided:

- **"Urgency for 2030" – actions with short-term impactful investments:** The study presents a short-term focused Marginal Abatement Cost Curve (MACC) analysis, identifying interventions that can be feasibly invested in to achieve significant hunger reduction by 2030, i.e. mostly transfers.
- **"Realism with urgency" – investing for ending hunger by 2040 without further delay:** The need to prioritize interventions with sustained longer-term impacts jointly with the short-term actions are identified, i.e. a MACC analysis that also considers investments requiring more time to take effect beyond 2030.

Most of these interventions interact and complement each other. In order to gain an additional perspective, we use the MIRAGRODEP model to simulate the cost consequences of "lost years".

Key findings

"Urgency for 2030" – actions with short-term impactful investments

Meeting the G7 commitment of lifting 500 million people out of hunger by 2030 could be achieved by increasing existing investments by USD 27 billion annually or USD 146 billion over the six-year period between 2025 and 2030– more than double the estimated increase of USD 11-14 billion annually projected in 2020 given only six years are left for 2030. The ten impactful short-term measures identified in the study include digital agricultural information services, school feeding programmes, humanitarian assistance, female literacy improvement, scaling-up existing social protection programmes, and establishing new social protection programmes. This approach is called for on humanitarian grounds, but lacks long-term sustainability and economic efficiency.

Cost of complacency and changed circumstances

With only six years remaining until the 2030 deadline to end hunger (i.e. undernourishment), the range of technically feasible investment options becomes more and more limited. As a result, implementing the ten short-term measures to lift about **700 million people** out of hunger and malnutrition by 2030 would require an **increase of USD 93 billion annually or USD 512 billion over a six-year period between 2025 and 2030**. This marks a sharp increase in the projected costs compared to the 2020 estimate (USD 30 billion annually), highlighting the significant cost of delayed action.

The MIRAGRODEP modelling results done by FAO come close to the MACC estimate, projecting additional annual investment needs of UD 90 billion (or around USD 542 billion additionally in total between 2024 and 2030). Similar to the MACC, the modelling also emphasises the importance of increased spending in particular for humanitarian assistance and social security.

"Realism with urgency" – investing for ending hunger by 2040 without further delay

To reach SDG2, short-term actions would need to be combined with investments that have long-term impacts on a realistic time path. Thus, in the second scenario, the study extends the completion date to 2040 and takes interventions into account that require more time to take effect and achieve significant hunger reductions. To lift **500 million individuals** out of hunger by 2040, **additional investments of approximately USD 10 billion annually or USD 116 billion over the period between 2025 and 2040** are projected, including investments in agricultural research and development (R&D), agricultural extension services, small-scale irrigation expansion in Africa, female literacy improvement, ICT-based agricultural information services, nutrition-specific interventions, and scaling-up existing social protection programmes.

However, to end hunger, i.e. lift **about 700 million people** out of hunger by 2040, the additional cost almost doubles to about **USD 21 billion annually or USD 223 billion over a sixteen-year period between 2025 and 2040**, incorporating additional interventions such as school feeding programmes, and humanitarian assistance.

Implications for policies and global food system governance

In the fight against global hunger, the human and financial costs of complacency are significant. With limited time until 2030, feasible investment options become restricted and the cost of achieving Zero Hunger escalates. Extending the SDG 2 end line to 2040 would be a sad consequence of lack of sufficient action in the first decade of the SDGs. Such an extension of the end line is not proposed here, and should only be considered if the - indeed sizable - investment actions that could deliver the end of hunger by 2030 cannot be mobilized quickly now.

Recalculating the costs of hunger reduction and shifting policy agendas forward requires also addressing the causes of the failure to achieve needed progress. Thus, the following issues related to food systems governance and related broader policy implications should be considered:

1. **Immediate and concerted efforts are required** to mobilize substantial investments in short-term hunger reduction interventions, focusing on transfers to the needy, humanitarian assistance and social protection programs.
2. **Combining short-term actions with long-term strategies is essential for sustainable hunger reduction beyond 2030**, requiring a comprehensive innovation agenda that balances short-term impactful interventions with additional public and private investments in productivity-enhancing and sustainable solutions.

3. The important global policy actions that require attention to end hunger are:
    - facilitating integration of global level actions in the key areas of hunger reduction together with actions on climate resilience, health, biodiversity and international trade,
    - developing a strong finance agenda for the investments needed to end hunger and achieve other key nutrition targets,
    - encouraging institutional innovations and enhanced coordination for a sound science – policy interface from national to global levels, and
    - strengthening the capacities for national level implementation, especially in emerging economies, with increased domestic and international support,
    - leveraging initiatives such as the Global Alliance Against Hunger and Poverty proposed by the Brazilian G20 presidency to accelerate progress in this process.

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1. Introduction

Ensuring global food and nutrition security is indispensable for sustainable and equitable development. In 2022, 735 million people (9.2 percent of the global population) were undernourished[1] and 2.4 billion people (29.6 percent of the global population) faced food insecurity globally[2] (FAO et al., 2023). In 2022, these indicators remained elevated above pre-pandemic levels, reflecting ongoing challenges in recovery from the pandemic and associated economic downturn. Global, regional and country-level efforts towards ending hunger faced serious challenges as attention, as well as public funds, were diverted towards combating the consequences of the COVID-19 pandemic. The most vulnerable countries, especially the least developed countries (LDCs) are in a very precarious situation: in 2022, they host 249 million people chronically undernourished, 32 percent more than in 2015, and one-third of the global number. Policymakers continue to face greater demands on their budgets as economies struggle to recover fully from the effects of the pandemic; the additional fiscal demands are particularly taxing for previously fiscally constrained governments. The recovery to pre-pandemic levels was made more difficult by war in Ukraine, which sent shock waves through global food systems.

With nearly two-thirds of the time elapsed since the adoption of the Agenda for Sustainable Development by 2030, achieving the goal of a world free from hunger appears increasingly unlikely. Global trends in the prevalence of undernourishment and various indicators of food insecurity suggest that current efforts may not suffice to achieve Sustainable Development Goal 2 (SDG 2: Zero Hunger). Projections by the Food and Agriculture Organization (FAO) estimate that by 2030, approximately 600 million people will still face hunger (FAO et al., 2023), underscoring the urgent need for a significant shift in commitments, solidarity, financing, and actions, as the window of opportunity rapidly narrows.

To this end, various global initiatives and coalitions have been established to comprehensively tackle food insecurity. These initiatives include commitments made by the G7 and G20, as well as efforts stemming from the 2021 UN Food Systems Summit (UNFSS). At the G7 summit in Elmau, Germany in 2022, the bloc reaffirmed its commitment to "lift 500 million people out of hunger and malnutrition by 2030, as resolved in the 2015 G7 Elmau commitment" (G7, 2022b).[3] The German Federal Ministry for Economic Cooperation and Development (BMZ), in cooperation with the World Bank, established a Global Alliance on Food Security (GAFS) with

[1] Prevalence of Undernourishment (PoU) is the FAO's indicator for the extent of hunger. PoU measures the number of people who do not have regular access to enough calories, or dietary energy, for an active and healthy life (https://www.fao.org/interactive/state-of-food-security-nutrition/en). It is the official indicator for SDG 2.1.

[2] The FAO defines food insecurity as, "A person is food insecure when they lack regular access to enough safe and nutritious food for normal growth and development and an active and healthy life. This may be due to unavailability of food and/or lack of resources to obtain food."

[3] G7 Statement on Global Food Security

an aim to prevent famines and support the UN Global Crisis Support Group, translating political commitments into tangible actions. As part of this initiative, the G7 pledged an additional USD 4.5 billion to safeguard vulnerable populations from hunger and malnutrition, increasing their joint commitments for global food security to over USD 14 billion. Moreover, the G7 reiterated their commitment to enhancing the resilience and sustainability of agriculture and food systems, increasing agricultural productivity, promoting balanced diets, and supporting smallholder farmers (G7, 2022a). In line with this, the G7 Agricultural Ministers' Meeting in Miyazaki, Japan underscored the importance of strengthening the Agricultural Market Information System (AMIS) and launched a Global Food and Nutrition Security Dashboard to expedite responses to food crises (G7, 2023). Additionally, the French Presidency of the Council of the European Union introduced the Food and Agriculture Resilience Mission (FARM) to address the challenges posed by the war in Ukraine on global food markets. The UNFSS stimulated various initiatives and coalitions, such as the UN Food Systems Coordination Hub, the Zero Hunger Coalition, and the School Meals Coalition, aimed at fostering healthier and more sustainable food systems globally (UN, 2023). The Brazil G20 presidency has proposed a Task Force for a Global Alliance Against Hunger and Poverty to create a Global Alliance focused on mobilizing resources and knowledge to implement effective public policies and social technologies for reducing hunger and poverty worldwide. The Global Alliance against Hunger and Poverty is set to be launched at the G20 Summit in November 2024, with the participation of heads of state from both G20 and other interested countries.[4] These initiatives reflect a collective commitment to fostering healthier, more equitable, and sustainable food systems globally, aligning with the goals of achieving zero hunger and promoting healthy diets for all, as outlined in national pathways and regional initiatives. While this study focuses on global level actions and challenges related to achieving SDG2, it is noteworthy that a number of important regional and national initiatives have also been taken in recent years, partly as follow up to the UNFSS and partly independently. For instance, these actions include African Union coordinated initiatives, and others initiated by China, the EU, India, the US, Brazil and other Latin American countries.

Against this background, this study offers an examination of the global costs associated with eradicating hunger by 2030, emphasizing the critical importance of estimating these costs as a catalyst for immediate action. The Marginal Abatement Cost Curve (MACC) method applied here offers a distinct approach by identifying cost-effective interventions. While valuable, the MACC approach has limitations in capturing intertemporal dynamics and ancillary benefits of interventions. The MACC approach is complemented by model-based studies that provide valuable insights into the investments required, considering a wide range of interventions such as social protection, agricultural development, and infrastructure improvements. These modelling approaches recognize the complex interplay between different initiatives and offer

[4] https://www.g20.org/en/tracks/sherpa-track/hunger-and-poverty?page=3

insights into environmental trade-offs. While valuable, the model-based analyses have limitations in capturing the full spectrum of programmes and interventions. Integrating insights from both methodologies, this report seeks to highlight the urgency of investing in hunger eradication efforts. These efforts will outline the potential consequences of past complacency and emphasize the need for concerted and coordinated action towards realizing the vision of a world without hunger. Moreover, this study appraises the policy response to the disruptions in the progress towards the achievement of SDG2.

Following this introduction, the report is structured into five further chapters.

Chapter two presents the **progress towards achievement of SDG2 targets** on reduction in hunger, food insecurity, undernutrition, and improvements in the quality of women's diets. It examines global trends in undernourishment and food insecurity, assessing the effectiveness of efforts to achieve zero hunger by 2030. The chapter analyses the impact of climate change, conflict, COVID-19, and economic consequences on hunger, drawing comparisons with earlier projections made since 2015.

Chapter three takes stock of the **G7's and other national and international funding engagement towards achieving SDG2** and assesses the contributions of G7 countries and other stakeholders in funding initiatives related to food and nutrition security. It examines the global flow of development assistance, particularly focusing on funding allocated to food security, nutrition, and rural development. The chapter evaluates the relevance of official development assistance (ODA) in reducing hunger and malnutrition, with a specific emphasis on objectives 2.1 and 2.2 of SDG2.

Chapter four presents the estimates of the **global cost of reaching a world without hunger by 2030 and the costs of complacency** based on the MACC approach for assessing the costs of action and inaction. The findings on the additional investments needed to end hunger based on these analyses are presented. In view of lost time, this report presents alternative approaches to achieve SDG2 by 2030 through fast, impact-oriented investments and an efficient and sustainable set of investment policy scenarios for 2040.

Chapter five provides **implications for policy** drawn from the estimated costs of action. It synthesizes recommendations based on assessments of progress towards SDG2 targets, funding engagement, and the costs associated with achieving zero hunger by 2030. The chapter offers suggestions for policymakers on addressing the challenges identified and prioritizing actions to accelerate progress towards global food security and nutrition goals.

2. Food and nutrition security around the world in 2022[5]

As the world approaches the deadline for achieving SDGs, the necessity of tracking the evolution of hunger, malnutrition, and undernutrition worldwide is urgent. There is also the critical concern of identifying the regions and countries where progress towards zero hunger is sluggish, stalled, or in reverse. Populations in regions experiencing wars, conflict, and the effects of climate change—such as rising temperatures and erratic weather patterns—are particularly at risk. Regions previously known to have experienced these challenges demand special scrutiny. This section provides an overview of the status of food and nutrition security, with a primary emphasis on tracing changes in key indicators. It draws from various editions of the annual Status of Food and Nutrition Security reports of the United Nations Food and Agriculture Organization (FAO).

2.1 Insights into the drivers of hunger: COVID-19 and fiscal consequences, conflict, climate change and economic slowdown

The growing challenges facing global food security are multifaceted and complex, driven by a convergence of persistent and emerging factors. Among these, the intensification and interplay of conflict, climate variability and extremes, and economic slowdowns. When these factors are combined with highly unaffordable nutritious foods and widening inequalities, they significantly impede progress towards achieving SDG 2 targets. The interlinked nature of these challenges poses a "new normal" for agrifood systems, necessitating intensified efforts to transform these systems to ensure the delivery of nutritious, safe, and affordable diets for all (FAO et al., 2023).

The lingering effects of the **COVID-19 pandemic** continue to reverberate, with estimations indicating that between 690 and 783 million people faced hunger in 2022—an increase of 122 million individuals, compared to pre-pandemic levels. Looking ahead to achieving Zero Hunger by 2030, projections suggest that around 590 million people will still face hunger—an increase of 119 million people, compared to the scenarios unaffected by the pandemic the war in Ukraine and various weather shocks (FAO et al., 2023) that occurred in the 2020, 2021 and 2022 (FAO et al., 2023).

Conflict remains a primary driver of acute food insecurity and is particularly evident in global hunger hotspots, including Chad, Burkina Faso, Mali, the Democratic Republic of the Congo (DRC), Ethiopia, Afghanistan, Yemen, and Haiti among others (WFP & FAO, 2023). The war in Ukraine, with its impact on the global supply of food, fertilizer, and energy, exacerbated hunger and food insecurity worldwide, contributing to the FAO raising its 2030 projections of undernourished people by 23 million people. The war and conflict's economic ramifications—

[5] Sundus Saleemi and Lukas Kornher, both at ZEF, contributed to this chapter.

including significant inflation and disruptions in global trade, particularly affecting food and energy prices—further compounded these challenges (FAO et al., 2023). This war and the armed conflicts ongoing in Palestine, Ethiopia, Sudan, South Sudan, DRC, and the Sahel, has hindered progress towards SDG 2, worsening food and nutrition crises affecting millions of people (WFP & FAO, 2023).

Conflict triggers or worsens food crises in several ways. It disrupts food systems, causes displacement, and limits access to food, exacerbating protracted food crises affecting millions of people. Conflict also drives economic recessions, inflation, disrupts employment, and undermines resources for social protection and healthcare, all of which compromise food access and health. Moreover, conflict erodes resilience and forces destructive coping strategies that threaten livelihoods, food security, and nutrition (FAO et al., 2017). The Food Security Information Network (FSIN) and Global Network Against Food Crises (2024) attributed about half (48 percent) of the 281.6 million people experiencing food insecurity in 2023 to conflict situations. [6] Many countries facing high levels of undernourishment and food crises have experienced prolonged conflicts or are currently in conflict. For instance, the Prevalence of Undernourishment (PoU) in the Northern African region was 6.8 percent over 2020-2022, but excluding Sudan, it was 5.7 percent. In South Sudan, the PoU was 21.4 percent, in Sudan 11.9 percent, in Ethiopia 21.9 percent, and in DRC 35.3 percent, all countries currently experiencing conflicts (FAO et al., 2023). Urgent humanitarian action is needed, particularly in Gaza, where the entire population of 2.2 million people has been classified as being in Phase 3 (“Crisis”) to Phase 5 (“Catastrophe”) of the Integrated Food Security Phase Classification (IPC), with a serious risk of famine (IPC, 2023). In Mach 2024, the IPC projected that during the projection period (mid-March to mid-July 2024), the entire population of 2.2 million people is expected to be experiencing acute food insecurity, with 265,000 people in Phase 3 (“crisis”), 854,000 in Phase 4 (“emergency”) and 1,107,000 in Phase 5 (“catastrophe”) (IPC, 2024). More than half a million people in Gaza were starving, and nine out of ten ate less than one meal a day according to the World Food Programme (WFP, 2023b). In order to reflect the situation of complex emergencies the paper includes in the updated MACC analysis a humanitarian assistance component among the short-term investments, based on costs of actual humanitarian interventions at scale.

Climate variability and extreme weather events further exacerbate food insecurity by impacting agricultural productivity. The El Niño event, peaking in 2023, has caused drought conditions in regions like Central America and Southeast Asia, leading to decreased crop yields and worsening food insecurity. Additionally, floods and cyclones in areas such as East Africa and Southern Africa have disrupted agricultural activities, contributing to displacement and

[6] The estimation of the number of people experiencing acute food insecurity is conducted only for countries with food crisis (59 countries), the total number of people experiencing acute food insecurity at the world level is therefore higher. This estimation represents the number of people in IPC/CH Phase 3 or above, or equivalent.

heightened food insecurity (WFP & FAO, 2023). The frequency of climate extremes (heat spell, drought, flood, or storm) has substantially increased since 2000. From 2015 to 2020, nearly 52 percent of countries experienced three or four weather extremes, compared to only 11 percent of countries between 2000 and 2004 (FAO et al., 2021). Countries exposed to high climate change impacts exhibit the highest prevalence of undernourishment, particularly evident in regions like the Horn of Africa and South Asia. For instance, the PoU in Ethiopia was 21.9 percent over 2020-2022 and in Somalia, it is 48.7 percent, both significantly higher than the average for all of Africa (19.3 percent) (FAO et al., 2023).

Economic slowdowns further compound the struggle against hunger. The global economy, slowed by the COVID-19 pandemic, faces continued challenges with subdued growth, high commodity prices, and persistent inflation (WFP & FAO, 2023). Inflation and rising costs of living have worsened food insecurity, particularly in least developed countries, landlocked developing countries, and small island developing states, where food inflation rates have surpassed 5 percent. Additionally, the global economic slowdown has restricted access to credit and foreign exchange, limiting countries' ability to import essential goods, including food and fuel. High debt levels and limited access to credit have restricted governments' ability to invest in social protection programmes and resilience-building, exacerbating the plight of those most affected by economic shocks (WFP & FAO, 2023).

Statistical evidence underscores the impact of economic downturns on food security, showing a clear correlation between economic contractions and increases in the PoU. For instance, a ten percent decrease in economic growth between 2011 and 2017 corresponded to a 1.5 percentage point increase in PoU during the same period. Countries experiencing economic contractions saw a 5.1 percentage point higher increase in PoU compared to those with stable or growing economies over the same period, highlighting the detrimental effect of economic slowdowns on food security and nutrition (FAO et al., 2017). Particularly, most countries experiencing rising undernourishment amid economic slowdowns are middle-income nations that are highly dependent on food and fuel commodity imports or primary commodity exports for foreign exchange and tax revenue (FAO et al., 2023). This dependence exacerbates vulnerability to global price fluctuations, significantly affecting economy-wide factors like foreign exchange and tax revenue, thereby amplifying challenges to food security and nutrition. For some countries, **food import dependency** increases vulnerability to international market shocks, such as the COVID-19 pandemic and the war in Ukraine, which reduces market availability and increase import costs.

The **combined effects of these drivers** have led to a significant deterioration of already high levels of acute food insecurity, and prompted the World Food Programme (WFP) and the FAO to issue a forward-looking early warning for urgent humanitarian action. This action identifies global hunger hotspots that require urgent and scaled-up food assistance. Currently 18 hunger hotspots in 22 countries or territories are identified (Figure 1). The latest report from

October 2023 has listed Burkina Faso, Mali, South Sudan, Sudan, and Palestine (Gaza) as countries and/or territories of highest concern, with *populations facing, or projected to face, starvation* (Integrated Food Security Phase Classification [IPC] Phase 5) *or populations at risk of deterioration towards catastrophic conditions* (IPC Phase 4).[7] These countries require urgent attention (WFP & FAO 2023). Afghanistan, the Democratic Republic of the Congo, Ethiopia, Haiti, Pakistan, Somalia, the Syrian Arab Republic, and Yemen are hotspots of very high concern. Chad, Djibouti, El Salvador, Guatemala, Honduras, Malawi, Nicaragua, Niger, and Zimbabwe are further hunger hotspots. Until October 2023, about 100 million people in these hunger hotspots were faced with IPC Phase 3 or higher classification and in need of food assistance. WFP and FAO (2023) projected in October 2023 that this number could increase to about 158 million between November 2023 and April 2024.

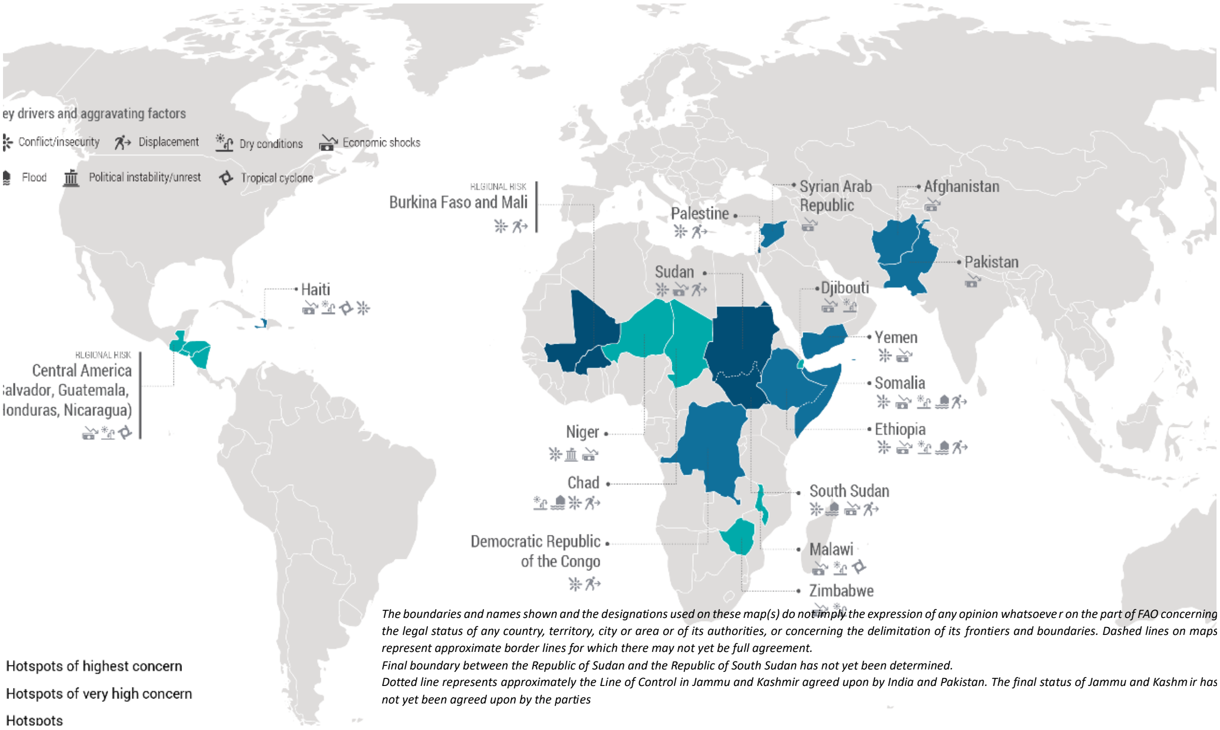

Figure 1: Hunger Hotspots between November 2023 and April 2024

Source: WFP and FAO (2023). Hunger Hotspots analysis (November 2023 to April 2024). Rome. https://doi.org/10.4060/cc8419en.

[7] The Global Report on Food Crises (GRFC) monitors the food security situation in countries/territories and classifies them based on the Integrated Food Security Phase Classification (IPC). The IPC is a 5-point scale from Phase 1, "Minimal" to Phase 5, "Famine/Catastrophe" and countries/territories in phases 3 to 5 are considered to require immediate humanitarian assistance to avert large-scale starvation, disease and mortality. In 2022, seven countries/territories had populations at "catastrophic" levels of food insecurity and half of the total population in the phase 4 "Emergency" were in four countries.

To assess the significance of the discussed drivers of food insecurity in the current context, the report compares changes in the Number of Undernourished (NoU), PoU, and population suffering from severe or moderate to severe food insecurity across various country groups. These groups are defined as follows: (1) fragile and conflict-affected countries based on the World Bank's classification; (2) countries at climate risk according to the top 20 long-term Climate Risk Index by Germanwatch (Eckstein et al., 2021) using data from Munich Re; (3) net food-importing countries as per the FAO's definition, and (4) countries that are experiencing an economic downturn during the COVID-19 pandemic, identified as those with negative economic growth between 2020 and 2022, based on the IMF's World Economic Outlook (IMF, 2023). The list of countries within each group is provided in Table A1 in Annex A.

Examining the trend in the number of undernourished individuals from 2015 to 2022, the data reveals an upward trajectory across all four country groups (Figure 2). Notably, conflict-affected and food-importing countries exhibit the most pronounced increases, with rises of approximately 65 and 80 million people, respectively. Remarkably, this increase accounts for half of the global rise in undernourishment, despite these countries hosting only about 27 percent of the global population (World Bank, 2024), in contrast to non-conflict zones. Similarly, the number of undernourished people in the 20 countries facing the highest climate risks increased by 65 million between 2015 and 2021. Conversely, the increase in undernourishment among countries experiencing economic downturns from 2020 to 2022 appears comparatively moderate. Additionally, our analysis includes trends in the population experiencing IPC Phase 3, 4, or 5, indicating a sharp rise since 2018, signifying a concentration of food insecurity in food crisis countries.

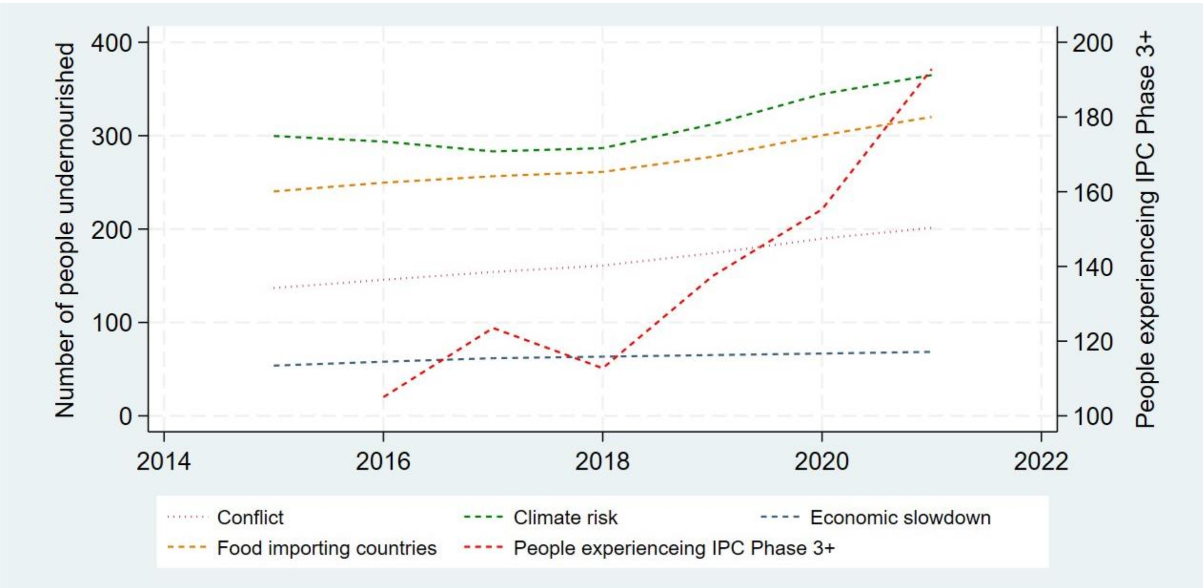

Figure 2: Total number of undernourished people in conflict-affected, food-importing, and climate risk-prone countries and countries facing economic downturns

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS and FSIN and Global Network Against Food Crises (2023).

Next, the report presents the changes in the prevalence of undernourishment and severe/moderate food insecurity from 2015 to 2021 across various country groups, compared to non-group countries. Table 1 provides a comparison of fragile/conflict-affected countries with non-fragile/non-conflict-affected countries; countries with high climate risks against those with lower climate risks; countries that experienced economic slowdown against those that did not; and net food-importing countries against non-net food-importing countries. Across all country groups, the prevalence of undernourishment, severe food insecurity, and moderate food insecurity increased during this period. Fragile and conflict-affected states, as well as countries with high climate risks and net food importing countries, experienced stronger increases in the prevalence of undernourishment compared to their counterparts. Similarly, the changes in the prevalence of severe food insecurity and moderate food insecurity vary among country groups, with notable increases observed in fragile and conflict-affected states and net food importing countries. Interestingly, countries that experienced an economic downturn saw a comparatively lower increase in the prevalence of undernourishment but a stronger increase in severe food insecurity and moderate food insecurity compared to those that did not experience such a downturn.

The disparities between country groups are most pronounced in fragile and conflict-affected states and net food importing countries, indicating the significant impact of conflicts on global food insecurity. Moreover, net food-importing countries are inherently more vulnerable to food insecurity, exacerbated by international market turmoil like the COVID-19 pandemic and the war in Ukraine, which disrupts trade and escalates transaction costs. This observation is concerning, especially given the incomplete inclusion of the effects of the Russia-Ukraine war in current statistics. Furthermore, studies by FAO et al. (2021) and Algieri, Kornher and von Braun (2024) highlight that countries facing multiple shocks—such as conflict in combination with economic downturns or high climate risk—experience the highest levels of food insecurity. FAO et al. (2021) notes that from 2000 to 2018, more than half of low- and middle-income countries (LMICs) experienced rising undernourishment, coinciding with multiple drivers such as conflict, climate extremes, and economic slowdowns. Alongside these drivers, poverty and inequality persist as major underlying causes of food insecurity.

Table 1: Impact of conflict, climate and economic slowdowns on hunger and food insecurity, 2014-2022

	Part of country group (=Yes)						Part of country group (=No)					
	PoU		Prevalence of severe food insecurity in the total population (%)		Prevalence of moderate food insecurity in the total population (%)		PoU		Prevalence of moderate food insecurity in the total population (%)		Prevalence of severe food insecurity in the total population (%)	
	2014-2016	2020-2022	2014-2016	2020-2022	2014-2016	2020-2022	2014-2016	2020-2022	2014-2016	2020-2022	2014-2016	2020-2022
Conflict	17.2	21.6	8.0	21.7	25.2	55.8	11.7	12.6	4.4	6.5	16.6	22.4
Climate	13.7	15.6	1.9	4.6	6.1	15.4	11.6	13.1	8.2	13.7	30.6	40.8
Food importing	16.1	18.9	8.9	18.4	27.5	48.1	10.9	11.8	3.0	4.6	13.3	18.6
Economic slowdown	10.6	11.7	6.7	11.1	27.9	39.1	12.9	14.6	4.8	9.1	16.9	27.3

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

2.2 Developments in global hunger reduction and global nutrition targets

The primary indicator to track progress towards SDG 2 is the Prevalence of Undernourishment (PoU) in the population. PoU is expressed as the percentage of the total population experiencing insufficient caloric intake to meet their dietary energy requirements. It is calculated from aggregated country-level data on food available for human consumption (compiled annually for most countries in the world in FAO's Food Balance Sheets) and on less frequently obtained data on food consumption from surveys, available for a growing (but still partial) number of countries. For each country, the distribution of average, daily dietary energy consumption in the population is compared with the distribution of dietary energy needs (derived from the composition of the population by age, gender, and physical activity levels) to produce an estimate of the proportion of the population that is chronically undernourished (i.e., lacking enough dietary energy for a healthy, active life). The NoU provides the absolute number of individuals experiencing undernourishment within a given region or country in millions.

Figure 3 shows global trends in PoU and NoU from 2000-2022. Until 2014 the global PoU and NoU numbers were on a declining trend. Since 2015/16, however, and sharply from 2019, the indicators have been trending upwards. The number of undernourished people across the world has risen from 589 million in 2015 to 735 million in 2022.

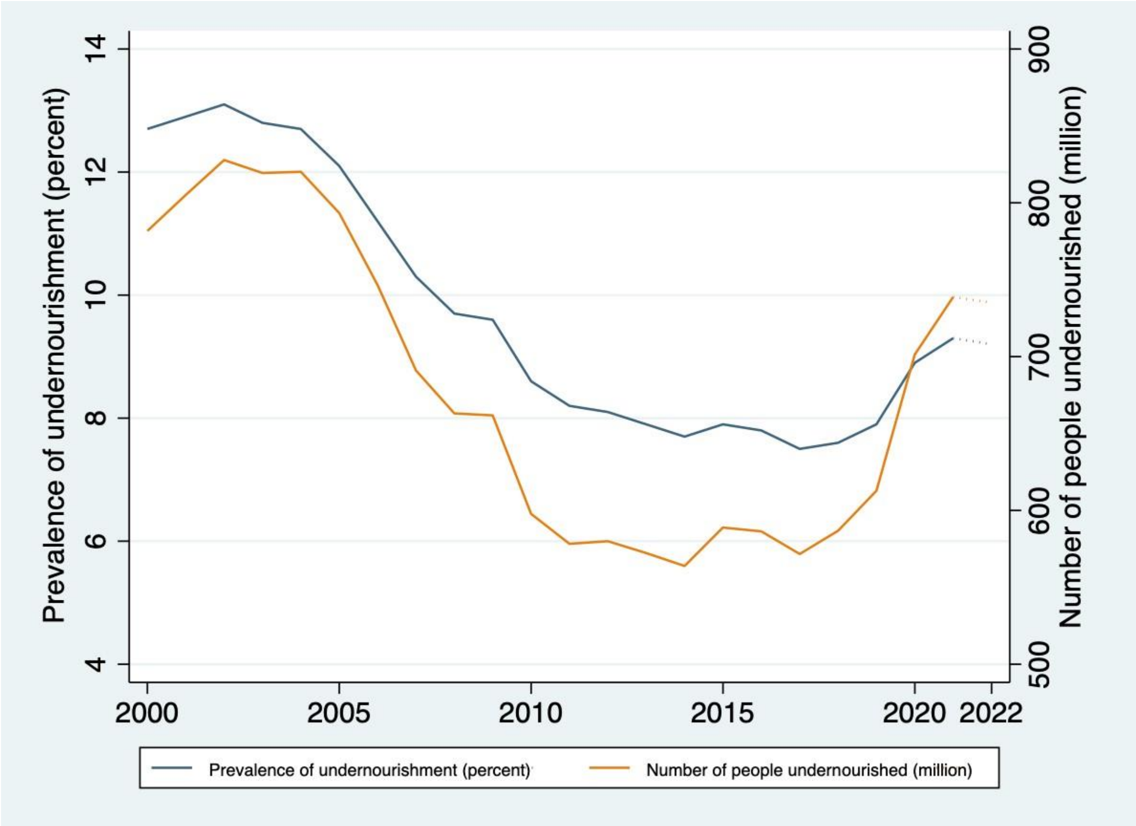

Figure 3: Prevalence and Number of Undernourished people in the world, 2005-2022

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

Table 2 shows FAOSTAT data on PoU and NoU numbers (in millions) globally and in select regions in 2005, 2010, 2015, and 2019-2022. Analysing the data reveals distinct trends over the two periods: from 2005 to 2015 and from 2019 to 2022. Globally, the PoU declined from 12.1 percent to 7.9 percent between 2005 and 2015. However, there was a sharp uptick in the PoU from 2019 to 2021 from 7.9 percent to 9.3 percent. This translated to an increase in the Number of Undernourished (NoU) from 612.8 million in 2019 to 738.8 million in 2021. This marked increase was driven by the economic downturn resulting from the COVID-19 pandemic, which disrupted food systems worldwide. The NoU are estimated to be 735.1 million in 2022.

There are regional differences in the overall trends: while the PoU decreased at the global level between 2021 and 2022, it *increased* in **Africa** during this time. The continent stands out with persistently higher levels of undernourishment compared to the global average. In **Oceania**, PoU also worsened to reach 7 percent, a level not experienced since 2005. In **Asia,** hunger was moderately reduced during 2021-2022 but still exceeded its pre-pandemic rate of 7.4 percent in 2019. In **Latin America and the Caribbean**, PoU has yet to fall back to its pre-pandemic rates. PoU in the region rose from 5.6 percent in 2019 to 7 percent in 2021, then fell to 6.5 percent in 2022. **Northern America and Europe** maintain consistently low levels of undernourishment, remaining below 2.5 percent throughout the observed period, suggesting a more stable food security situation in the regions.

Importantly, the evolution of undernourishment could not be attributed to a lack of supply at the global level. Poverty and inequality are key elements to explain why, even if global food supply is increasing continuously both in terms of total supply and per capita (Figure 4), the prevalence of undernourishment and moderate and severe food insecurity are still at high levels.

Inequalities were still high before COVID-19 and many years of progress towards eradicating extreme poverty were reversed. The number of people living on less than USD 2.15 (PPP 2017) per day is estimated to have increased by 61 million people to 762 million people in 2020. Even though the figures were projected to return to pre-COVID levels in 2023, three years have been lost in the fight against poverty. Worst of all, poverty in low-income countries is still worse than before the pandemic[8] and inequalities across and within countries have increased. Thus, achieving all food security dimensions is essential: even if there could be food available for all since the lack of economic access might prevent the reduction of hunger and food insecurity.

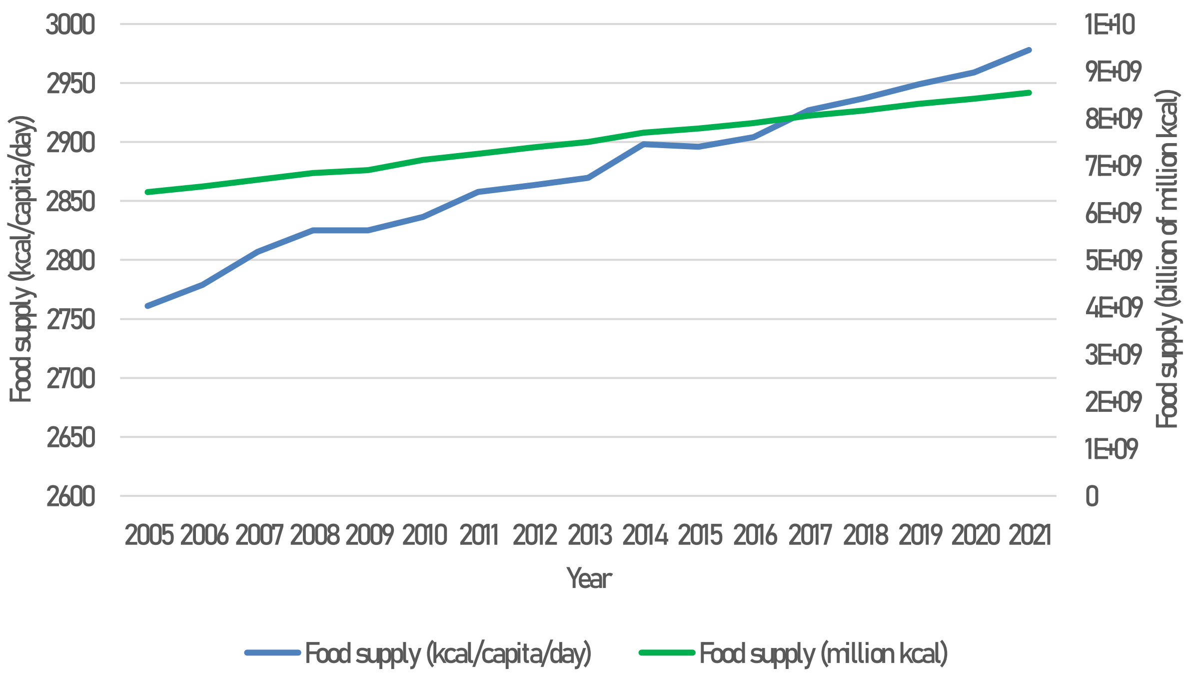

Figure 4: Evolution of the global food supply: total and per capita.

Source: FAO (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

[8] https://blogs.worldbank.org/opendata/poverty-back-pre-covid-levels-globally-not-low-income-countries

Table 2: Prevalence of undernourishment and Number of undernourished people in the world, 2005-2022

	Prevalence of undernourishment (percent)							Number of Undernourished (millions)						
	2005	**2010**	**2015**	**2019**	**2020***	**2021***	**2022***	**2005**	**2010**	**2015**	**2019**	**2020***	**2021***	**2022***
WORLD	12.1	8.6	7.9	7.9	8.9	9.3	9.2	793.4	597.8	588.9	612.8	701.4	738.8	735.1
AFRICA	19.2	15.1	15.8	17	18.7	19.4	19.7	178.2	159.2	189.6	225.1	254.7	270.6	281.6
Northern Africa	6.2	4.7	5.4	5.8	6	6.9	7.5	11.7	9.8	12.3	14.4	15.1	17.6	19.5
Sub-Saharan Africa	22.5	17.6	18.2	19.5	21.6	22.2	22.5	166.5	149.5	177.3	210.6	239.6	253	262
Eastern Africa	31.7	23.8	24.6	26.7	28.1	28.4	28.5	94.2	81.5	96.8	116.9	126.4	131.2	134.6
Middle Africa	31.9	22.5	23.3	24.8	27.6	28.5	29.1	36.3	30.1	36.7	44.4	51	54.2	57
Southern Africa	5.1	7.2	9.3	8.3	9.5	10	11.1	2.8	4.2	5.9	5.5	6.4	6.8	7.6
Western Africa	12.2	10.8	10.6	11	13.7	14.5	14.6	33.2	33.6	37.9	43.8	55.8	60.8	62.8
ASIA	13.9	9.3	8	7.4	8.5	8.8	8.5	551.9	392.8	357.8	343.9	396.2	414.1	401.6
Central Asia	13.8	6.6	4	2.8	3.3	3.2	3	8.2	4.2	2.8	2	2.5	2.4	2.3
Eastern Asia	6.8	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	104.2	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.
South-eastern Asia	17.3	11.1	7.5	5.3	5.3	5.3	5	97.6	66.7	47.9	35	35.2	36	34.1
Southern Asia	20.2	15.4	14	13.3	15.6	16.4	15.6	325.4	267.9	260.3	258.6	307.7	326	313.6
Western Asia	7.9	6.5	9.1	10.3	10.5	10.2	10.8	16.6	15.4	24.1	29.1	30	29.6	31.6
Western Asia and Northern Africa	7.1	5.7	7.4	8.2	8.4	8.7	9.2	28.3	25.2	36.3	43.6	45.1	47.2	51.2
LATIN AMERICA AND THE CARIBBEAN	9.3	6.2	5.3	5.6	6.5	7	6.5	51.9	36.7	32.9	36	42.3	45.6	43.2
Caribbean	18.4	14.7	13.2	14.2	15.2	14.7	16.3	7.4	6.1	5.6	6.2	6.7	6.5	7.2
Central America	8.1	6.8	6.7	5.1	4.8	5	5.1	11.7	10.6	11.2	9	8.5	8.9	9.1
South America	8.8	5.1	3.9	4.9	6.3	7	6.1	32.8	20	16.1	20.8	27.1	30.3	26.8
OCEANIA	7	6.5	6.2	6.4	6	6.6	7	2.4	2.4	2.5	2.8	2.6	2.9	3.1
NORTHERN AMERICA AND EUROPE	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	n.r.	n.r.	n.r.	n.r.	n.r.	n.r.	n.r .

Notes: * Projected values are based on the projected midranges.

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

Improvement of indicators of **child stunting** are also far from being achieved although there has been progress in terms of reducing the number and prevalence of stunting since 2012. In 2012, 26.3 percent of children under five were stunted, versus 22.3 percent in 2022 (see Table A2, Annex A). The prevalence of **wasting** among children under five years of age is low in most regions of the world, at 6.8 percent in 2022. The gender gap in measures of food insecurity that widened during the pandemic years (2020-2021) narrowed slightly in 2022. Africa remains an exception to this global trend, where the gender gap in moderate food insecurity increased and severe food insecurity remained unchanged in 2022 compared to 2020-2021. These trends highlight that special attention needs to be paid to the African continent, particularly to its rural population and women.

2.3 Developments in access to nutritious and sufficient food for all and the quality of women's diet

The second indicator for target 2.1 of SDG 2 tracks access to enough, safe and nutritious food for all, throughout the year. This progress is tracked with the indicator of **prevalence of moderate or severe food insecurity**, which is measured using the Food Insecurity Experience Scale (FIES). Target 2.1 of Sustainable Development Goal 2 looks beyond hunger towards the goal of ensuring access to nutritious and sufficient food for all. The indicator to monitor its progress, prevalence of moderate or severe food insecurity, is assessed using the Food Insecurity Experience Scale (FIES). People experiencing moderate food insecurity face uncertainties about their ability to obtain food and have been forced to reduce the quality and/or quantity of food they consume at times during the year, due to lack of money or other resources. It thus refers to a lack of consistent access to food, which diminishes dietary quality, disrupts normal eating patterns, and can have negative consequences for nutrition, health, and well-being.

Table A3 in Annex A provides data on the prevalence of severe food insecurity and moderate or severe food insecurity in the total population, expressed as percentages, for the years 2014 to 2022. Table A4 in Annex A presents the number of people experiencing severe food insecurity and moderate and severe food insecurity for the years 2014 to 2022. **Global** food security has deteriorated since 2014 as visible in the prevalence and number of people experiencing severe and moderate or severe insecurity. In 2015, 7.6 percent of the global population faced severe food insecurity and 21.7 percent of people faced moderate or severe food insecurity. In 2022, 11.3 percent suffered from severe food insecurity and 29.6 percent experienced severe or moderate food insecurity in 2022. In 2022, 900.1 million people experienced severe food insecurity and 2.4 billion experienced severe or moderate food insecurity. Since the launch of the SDGs in 2015, 745 million people have been added to those facing severe or moderate food insecurity. **Global** food insecurity particularly deteriorated during the COVID-19 years. Both severe and moderate or severe food insecurity increased between 2019 and 2021, with severe food insecurity rising from 9.3 percent in 2019 to 11.7 percent in 2021. Moderate or severe food insecurity trends show a similar pattern, increasing from 25.3 percent in 2019 to 29.6 percent 2022. There was a slight decrease in severe food insecurity from 11.7 percent in 2021 to 11.3 percent in 2022. However, moderate or severe food insecurity remained constant at 29.6 percent between the two years.

Severe and moderate food insecurity show regional patterns similar to PoU and NoU, with severe and moderate food insecurity rising in **Africa** in 2022, albeit at a lower magnitude compared to 2020-2021. From 2019 to 2021, both severe and moderate or severe food insecurity increased in Africa and across all its sub-regions. The prevalence of severe and moderate or severe food insecurity in Eastern and Middle Africa is alarmingly high; in 2022, 130.9 million people in Eastern Africa and 76.7 million in Middle Africa experienced severe food insecurity. Food insecurity has risen throughout the continent since 2015–an extremely troubling trend.

From 2019 to 2021, both severe and moderate or severe food insecurity also increased in most sub-regions of **Asia**. From 2019 to 2021, both severe and moderate or severe food insecurity increased in the **Caribbean and Central America**, with severe food insecurity increasing from 9.7 percent to 13.9 percent.

At a **global level**, food insecurity remains higher in rural area than in urban centers. In 2022, 33.3 percent of adults living in rural areas experienced moderate or severe food insecurity compared to 28.8 percent in peri-urban areas and 26 percent in urban areas (Figure 5). Similarly, severe food insecurity affected 12.8 percent of urban residents compared to 11.6 percent of peri-urban residents and 9.4 percent of urban residents. These differences in food insecurity across rural, peri-urban and urban areas are even more apparent in regions most affected by food insecurity. For instance, in Africa the prevalence of moderate or severe food insecurity amounts to 64.5 percent in rural areas –10 percent point higher than the one in urban areas. Similarly, the percentage of the population affected by moderate food insecurity is 8.3 percent points higher in rural areas than in urban areas in Latin America and the Caribbean. Finally, this rural gap in food security is particularly significant in low-income countries with 71 percent in rural areas against 63.7 percent in urban ones experiencing moderate food insecurity, and 30 percent in rural areas against 24.5 percent in urban ones experiencing severe food insecurity.

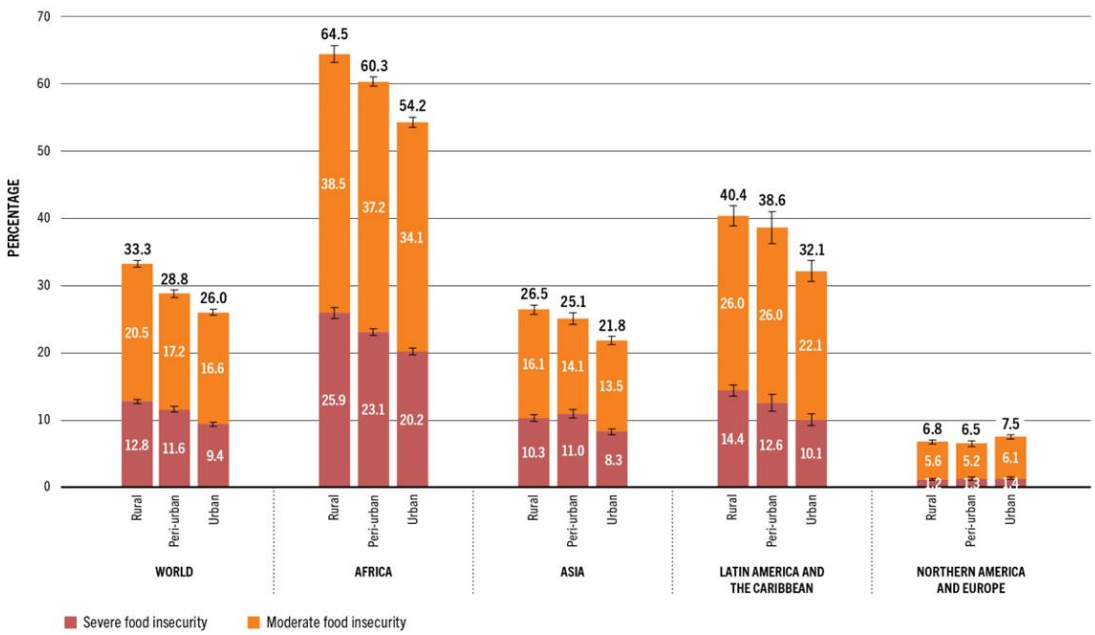

Figure 5: The prevalence of severe and moderate food insecurity among rural, peri-urban and urban population

Source: FAO et al. (2023)

There are **gender gaps** in the prevalence of severe and severe or moderate food insecurity. That is, in most parts of the world more women experience severe and severe or moderate food insecurity than men. Myriad factors make women more vulnerable to food insecurity compared to men. Socioeconomic disparities characterized by lower education levels, limited employment opportunities, and unequal pay often impede women's access to adequate food resources. Gender inequality, manifested through cultural norms and discriminatory practices in resource allocation exacerbates women's vulnerability to food insecurity. Women's disproportionate responsibility for unpaid care work constrains their time and resources for income generation. Environmental factors, such as climate change and environmental degradation, also disproportionately impact women, particularly in rural areas.

Globally, in 2022 the prevalence of severe food insecurity was 10.6 percent among women compared to 9.5 percent among men – a gap of 1.1 percentage points. This resulted in 35.3 million more women who experienced severe food insecurity in 2022. Table A6 in Annex A presents the gaps in the prevalence of severe and severe and moderate food insecurity between men and women. Table A2 in Annex A reports these gaps in absolute numbers (i.e., number of additional women compared to men who experienced severe and severe or moderate food insecurity).

COVID-19 shocks widened the gap between women and men from 0.7 percentage points in 2019 to 2.4 percentage points in 2021. The gap has narrowed between 2021 and 2022, but the prevalence rates were higher in 2022 compared to 2015, when the gap between the prevalence of severe food insecurity among women and men was 0.8 percentage points compared to 1.1 percentage points in 2022.

Gender gaps in the prevalence of severe and severe or moderate food insecurity also differ across different world regions. The effects of COVID-19 on these gaps were similarly varied. In Africa, the difference in the prevalence rate of severe and severe or moderate food insecurity is relatively small. In 2022, the gender gap in the prevalence of severe food insecurity was 0.5 percentage points. This means that 4.3 million more women than men experienced severe food insecurity in the region in 2022. The impact of the pandemic on gender gaps was most notable in **Asia**, where it increased from 0.9 percentage points to 3.5 percentage points. **Latin America and the Caribbean** also saw a widening of gender gaps in the prevalence of food insecurity between 2019 and 2021.

SDG 2 uses the following language to define target 2.2: "By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons." Among the indicators used to track the nutritional status of women for target 2.2 is the prevalence of anaemia among women aged 15-49 by pregnancy status. Progress on the prevalence of anaemia among women aged 15-49 years is abysmal. In the year 2019, the prevalence of anaemia among women aged 15 to 49 was 29.9 percent; over half a billion women aged 15 to 49 suffered from anaemia in 2019. Although several regions and the world as a whole made some progress between 2000 and 2015, the situation has reversed in recent years. Since 2015, the prevalence of anaemia in women from 15 to 49 years of age has not decreased in any region, nor globally. The prevalence rates are even worse among pregnant women; in 2019 36.5 percent of pregnant women aged 15-49 were anaemic. While the prevalence of anaemia among women does not capture access to healthy and nutritious diets, this can be tracked using indicators of dietary diversity. Minimum Dietary Diversity for Women (MDD-W) is the indicator used to track women's access to healthy and nutritious diets. MDD-W measures minimally adequate dietary diversity (consumption of at least 5 out of 10 food groups), which is one of several core components of healthy diets. Since the launch of the MDD-W in 2015, ten countries have collected nationally representative MDD-W data and many others have used it for research or impact evaluation at the subnational level.

Figure 6 shows MDD-W prevalence: the proportion of women of reproductive age (15 to 49 years of age) who reached MDD-W (consuming at least 5 out of 10 predefined food groups) at the national, urban, and rural levels, in select countries. Across the presented countries, urban areas exhibit higher MDD-W prevalence rates compared to rural areas, with variations observed depending on the country and year surveyed. Notably, there are instances of substantial disparities between urban and rural areas, as evidenced by Brazil and Tajikistan. There is, however, a need for the tracking of indicators of food and nutrition security disaggregated by gender. The rates of PoU and stunting and wasting among children are not disaggregated.

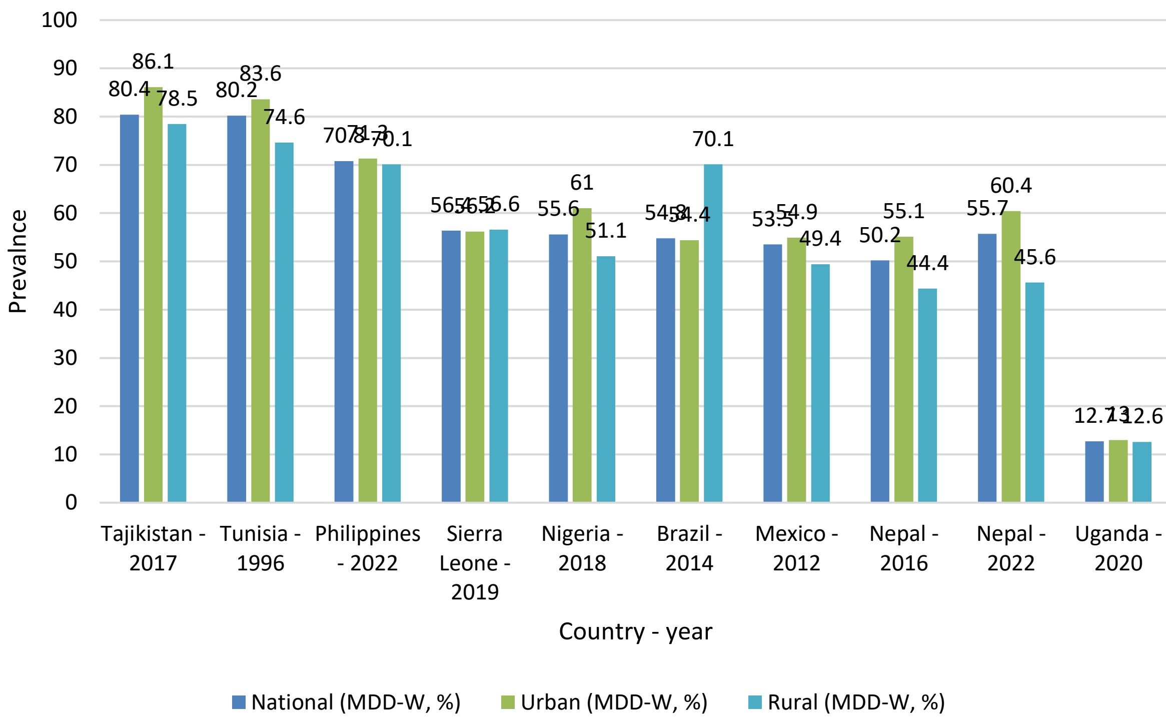

Figure 6: The proportion of women of reproductive age (15 to 49 years of age) who reached MDD-W (consuming at least 5 out 10 predefined food groups).

Source: FAO (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

3. Stock taking of the G7 and other national and international funding engagements towards achieving SDG2[9]

At the Elmau Summit in 2015, the G7 nations pledged to eradicate hunger and malnutrition for 500 million people by 2030 through increasing bilateral and multilateral assistance.[10] This pledge was reaffirmed in 2022, with a joint commitment of USD 14 billion towards global food security in that year.[11] This chapter uses the Official Development Assistance (ODA) database from the Organization for Economic Cooperation and Development (OECD) to examine these efforts.[12] This analysis is restricted to the period of 2000 to 2022 and ODA is disaggregated by recipient countries and by sectorial distribution over time, with a focus on food and agriculture related ODA.

3.1 Global flows of development assistance and the contribution of G7 countries

ODA is defined as the provision of resources, predominantly financial, by governments to other governments, to promote the economic development and welfare of developing countries. The United Nations has set a goal for countries to allocate 0.7 percent of their Gross National Income (GNI) to ODA.[13] In 2023, from the total 31 member countries of the Development Assistance Committee (DAC),[14] only five countries[15] (Germany, Denmark, Luxembourg, Norway, and Sweden) met or exceeded this target (OECD, 2024). Global public funding from DAC countries in the form of ODA (net disbursements) has been increasing since 2000, with the highest record seen in 2022: USD 213.4 billion (in constant 2022 USD) for that year alone—an increase of 37.4 percent from 2019 (see Figure 7). Based on preliminary data from the OECD (2024), this decreased slightly in 2023 by 0.2% in real terms. Between 2019 and 2023, ODA increased 18.7 percent, accounting 0.37 percent of the combined member countries GNI. This rise is associated with aid for Ukraine, humanitarian aid and contributions to international organisations.. Non-DAC countries are also significant contributors to ODA. These countries, which voluntarily share

[9] Miriam Romero and Christine Predo contributed to this chapter.

[10] Leader's Declaration G7 Summit, 7-8 June 2015. The G7 countries are: Canada, France, Germany, Italy, Japan, the United Kingdom and the United States

[11] G7 Development Ministers' Meeting Communiqué 19.05.2022; G7 Statement on Global Food Security 28.06.2022

[12] The ODA figures reported for 2022 are based on the data released on 22 January 2024.

[13] The 0.7% ODA/GNI target - a history

[14] https://www.oecd.org/dac/development-assistance-committee/

[15] Denmark is slightly below the threshold in 2022 due to strong domestic growth in its GNI. However, it reaches this target on a three-year average and have mechanisms to adjust future spendings accordingly to domestic growth evolution.

their data with the OECD, provided USD 11.2 billion in ODA in 2023 (with Türkiye being the largest contributor with 0.6 percent of GNI, USD 5.9 billion (in constant 2022USD).[16]

In 2022, ODA increased in 27 DAC member countries and fell in four other countries. Most noteworthy is the decrease by the United Kingdom, which reached the target of 0.7 percent of GNI in 2013 (OECD, 2024). However, since 2021 , the UK Government has reduced its contribution to 0.5 percent of GNI on ODA as a temporary measure to address the economic impact of the COVID-19 pandemic (Loft & Brien, 2023). This reduction translated into a 51 percent drop in aid levels in the same year (Laborde & Smaller, 2022). A declining trend is also recently noted for Germany, where the federal budget for the BMZ, for instance, declined from EUR 12.4 billion in 2020 to EUR 11.2 billion in 2024 (Bundeshaushalt, 2024).

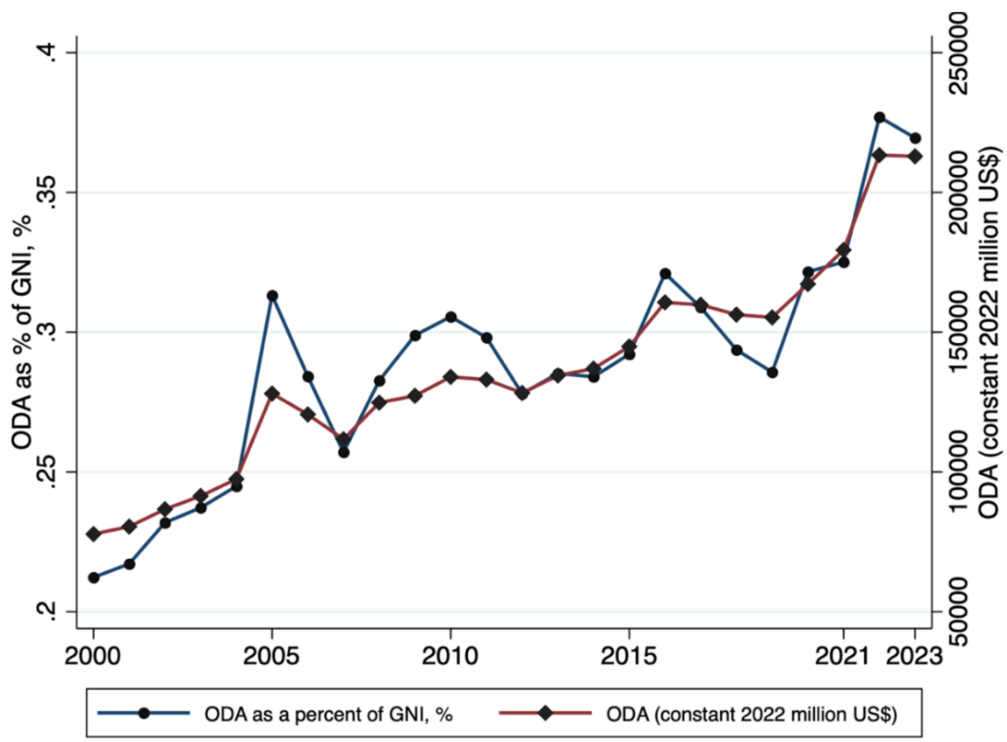

Figure 7: Net ODA and ODA as percent of GNI of DAC countries, 2000-2022 (ODA net disbursements, constant 2022 million USD)

Note: DAC country coverage was kept constant over the years except for some missing data for Hungary (2000-2002), Lithuania (2000), and Slovenia (2000-2004).

Source: Authors' own elaboration based on OECD (2024).

[16] https://public.flourish.studio/story/2150513/

The G7 countries contribute 76.6 percent of the 2023 global net ODA disbursements (in current prices), and their contribution in real terms has risen from USD 52.7 billion in 2000 to USD 162.6 billion in 2022 (in constant 2022 USD). However, in 2022 only Germany reached the 0.7 percent of GNI target. Nevertheless, the COVID pandemic and the war in Ukraine have drastically changed the overall picture. G7 ODA spending increased by 47 percent between 2015 and 2022, with 85 percent of this occurring in three years: 2020, 2021, and 2022. Except for the UK (minus 12 percent in 7 years), all other G7 countries have increased their ODA by 60 (Italy) to 93 percent (Japan).

Figure 8 shows the sectoral allocation of ODA commitments from the G7 countries in 2022. Emergency response received the highest allocation of USD 22.2 billion, followed by government and civil society with USD 17.7 billion. Yet, restricting aid allocations to specific sectors is not very meaningful as there are cross-cutting effects (ZEF & FAO, 2020) and could reflect different realities. Indeed, the increase of direct support to government and emergency response have been driven by the additional support to Ukraine (from 0.92 billion in 2021 by all DAC countries to 17.5 billion in 2022) and the sharp increase in 'in-donor' refugee cost registered by countries between 2021 and 2022, this type of recorded expenditures has increased by 104 percent, or 12 billion, and represented 10.3 percent of total ODA for the G7 countries, and up to 29 percent for the UK.

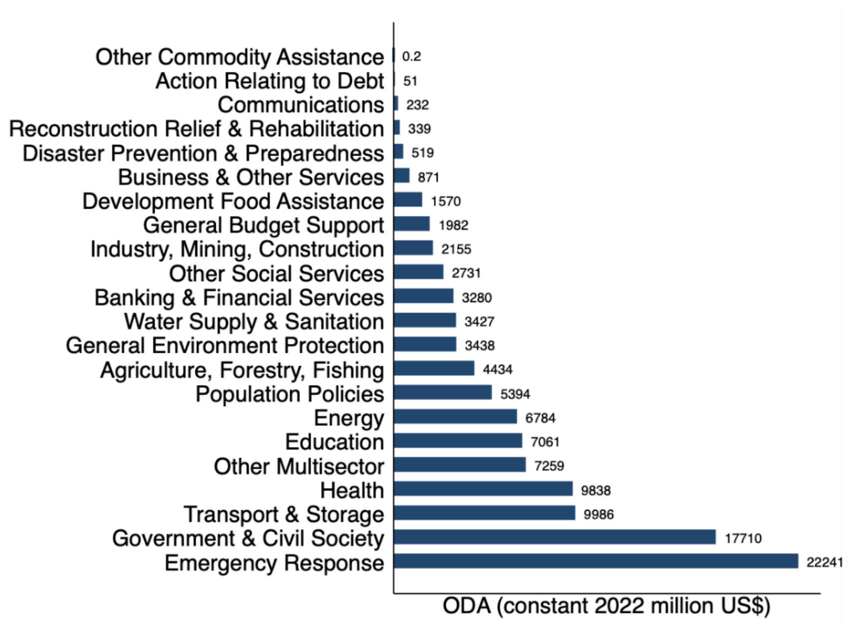

Figure 8: Sectoral allocation of total ODA by G7 countries, 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024).

3.2 Global allocation and relevance of ODA to food security, nutrition and rural development and the contribution of G7 countries and DAC countries

Targeted ODA for food security, nutrition, and rural development (as defined in this chapter) has the potential to effectively reduce hunger and malnutrition (Kornher et al., 2023) and is critical to achieving sustainable development targets, such as SDG 2 (Eber-Rose et al., 2020). Two associated factors explaining this relationship are: i) investment in agriculture and rural development is more efficient in reducing poverty and enhancing food and nutrition security for the majority of the world's impoverished and undernourished population, who predominantly live in rural areas and rely heavily on the sector; (Klasen & Reimers, 2017; Kornher et al., 2023) and ii) improving land productivity would increase food supply and rural incomes and, in turn, increase per capital caloric intake and reduce poverty (Kornher et al., 2023; Mary et al., 2018; Majid, 2004; Kaya et al., 2013). Thus, agricultural growth is more likely to be pro-poor and two to three times more effective than overall growth in reducing poverty and hunger in low-income countries (Christiaensen, Demery, & Kuhl, 2010; Webb & Block, 2012; Mary et al., 2019; Adjaye-Gbewonyo et al., 2019). In fact, aid allocated exclusively to the agricultural sector could have a stronger and more immediate impact than overall ODA (Kaya et al., 2013). Furthermore, recent evidence suggests that ODA targeting agriculture, is associated positively and significantly with increased foreign direct investments (FDI) in the agricultural, fisheries, and forestry sectors (Tian, 2023). When ODA allocated to agriculture is focused on adaptation, it contributes to increasing agricultural productivity growth, particularly among those countries with a higher climate readiness (Trentinaglia et al., 2023).

Agricultural investments yield multiple societal benefits, including economic growth, increased productivity, and environmental sustainability. Infrastructural improvements lead to lower transaction costs and link smallholders to both local and global markets (FAO, 2012). Moreover, public spending and social protection measures indirectly improves food security by increasing rural and urban incomes, thereby enhancing access to nutritious diets. These improvements lead to poverty alleviation and fosters economic expansion, potentially generating multiplier effects that sustain income growth and food security (ZEF & FAO, 2020).

Since 2000, ODA allocated to food security, nutrition and rural development made a significant contribution to alleviating hunger and malnutrition (Kornher et al., 2023). Furthermore, there is evidence that agricultural aid is associated with improving food and nutrition security (Mary et al., 2018, 2020). Mary et al., (2018) found that a 10 percent rise in overall nutrition-sensitive aid led to a 1.1 percent decrease in the prevalence of undernourishment (PoU) within two years, spanning from 2002 to 2015. A similar increase of 10 percent in per capita agricultural aid correlated with a 0.5 percent reduction in child stunting (Mary et al., 2020).

The body of literature on the effectiveness of official development assistance (ODA) is extensive and subject to significant debate (ZEF & FAO, 2020). Primarily stemming from significant methodological challenges addressed through various methodologies (Kornher et al., 2023). A large share of quantitative studies find that aid has a positive effect on economic growth through its positive effects on investments in physical capital (Dalgaard et al., 2004; Hansen & Tarp, 2000). Arndt et al. (2015) finds that aid impacts growth only in the long-term (i.e., 40 years) through positive effects of aid on investment, public spending (consumption and investment), as well as education. However, these effects are not visible in the short run (Arndt et al., 2010).

Establishing a direct link between ODA allocations and initiatives for food security, nutrition, and agriculture proves challenging (ZEF & FAO, 2020). There is currently no common measure of ODA for agriculture and food security, leading to significantly different estimates for how much is spent, where it is spent, on what it is spent. As a result, analysis of trends and outcomes towards achieving SDG 2 is problematic (Kornher et al., 2023). Furthermore, existing methodologies do not allow policy analysts and donors to get a comprehensive overview of the status of ODA in relation to financing the SDGs (Pincet et al., 2019). The various methods of defining ODA allocation on agriculture, food security, and nutrition involve distinct sets of Creditor Reporting System (CRS) codes, consequently resulting in differing values (Eber-Rose et al., 2020). Adding to this challenge, the process of classifying development cooperation projects that have multiple purposes and which yield broader impacts beyond their primary and singular objectives is complex. For instance, electrification or road construction may indirectly positively impact food security but might not be accounted for under ODA for agriculture and food security, due their primary objectives. Hence, such initiatives may be recorded under codes according to which donors perceived are the primary and relevant sector (Eber-Rose et al. *forthcoming,* ZEF & FAO, 2020).[17]

This study employs a comprehensive definition for food security, nutrition, and rural development ODA built upon the definition developed by Schwegmann and Wedemark (2014), and to remain consistent with a previous study (ZEF, FAO 2020).[18] This definition covers the ODA allocated to the agriculture sector, water supply and sanitation, various types of food aid and assistance (including emergency spending), and environmental protection (including the removal of landmines and explosive remnants of war). This definition is novel[19] in the way that includes

[17] Donors might often be influenced by policy priorities and a desire to maximise alignment between ODA records and their commitments 2 (Rose et al. 2023, forthcoming)

[18] Defining food security and nutrition ODA is a delicate task. FAO, in the State of Food Security and Nutrition 2024 (forthcoming) will propose a new operational definition, relying on but not limited to CRS code classification.

[19] In July 2024, the SOFI report will introduce a new approach of food security and nutrition ODA with a core definition, and an extended definition. It will also expand on the traditional analysis using CRS code to rely on machine learning and project description to identify more precisely which project has a partial or strong relevance

water supply and sanitation, as there is rigorous scientific evidence linking impact of access to safe drinking water, sanitation, and hygiene (WASH) to nutrition (Kornher et al., 2023; ZEF & FAO, 2020, WHO, 2015). To estimate ODA contributions to food security and rural development, based on this definition, the following OECD purpose codes are proposed:

- Agricultural – OECD sector code 311
- (Industrial Crops / Export Crops – OECD sector code 31162) – included in Agriculture
- Fishing – OECD sector code 313
- Forestry – OECD sector code 312
- Food Aid (Food Assistance and Emergency Food Assistance) – OECD purpose codes 52010 and 72040
- Environmental Protection (including Removal of Land Mines and Explosive Remnants of War) – OECD sector code 410 and purpose code 15250
- Rural Development – OECD purpose code 43040
- Water Supply and Sanitation – OECD purpose code 140

Using this inclusive definition, G7 countries spent an average of USD 14.6 billion (in constant 2022 USD)[20] per year from 2000 to 2022. However, the recent increase in ODA has been directed more towards addressing crises and emergency needs (von Braun et al., 2022). Between 2010 and 2014 (before the Elmau commitment), official donors spent an average of USD 3.5 billion (in constant 2022 USD) per year on emergency food assistance, with G7 donors averaging USD 2.9 billion (in constant 2022 USD) annually. From 2018 to 2022 (after the Elmau commitment), average spending on emergency food assistance increased to USD 7.9 (in constant 2022 USD) billion per year for official donors, with USD 5.8 billion (in constant 2022 USD) per year coming from G7 countries. This represented a substantial 125 percent increase for official donors and a corresponding 101 percent increase for G7 donors. Overall, G7 countries have increased their spending on emergency food assistance, yet they have not augmented long-term investments in agriculture and food security (von Braun et al., 2022). With the announcement of the Global Alliance for Food Security in 2022, however, it is expected that the G7 will allocate further ODA towards food security and hunger eradication. This allocation is hoped to yield long-term impacts (Laborde & Smaller, 2022).

The allocation of ODA by G7 countries to food security and rural development has shown significant growth over the period from 2000 to 2022. In 2022, G7 committed a total of USD 23.7 billion (in Constant 2022 USD) to food security and rural development, representing a 186

for food security and nutrition outcomes. It leads to partial inclusion of some spendings considered in this report, for instance on environmental protection.

[20] Based on bilateral ODA commitments.

percent increase compared to the USD 8.3 billion allocated in 2000. Over this 22-year period, the total ODA allocated to food security and rural development amounted to USD 336.9 billion, comprising 17 percent of the entire ODA from G7 countries. Most of this ODA was targeted at countries with a relatively higher prevalence of undernourishment, notably in Sub-Saharan Africa (von Braun et al., 2020).

Figure 9 shows the 2014, 2018 and 2022 ODA distribution by G7 member country in real terms. Food aid is primarily funded by the United States, which saw its ODA allocation almost double between 2018 and 2022. There is limited ODA dedicated to forestry, rural development, and, particularly, fisheries over the same period, which is mostly funded by France (see Figure B4 and Figure B5 in Annex B). Allocation for Agriculture ODA saw an increase by Germany and Italy, but a decrease by France, Japan, and considerably by the United Kingdom. No change was observed in this period of time among Canada and the United States (see Figure B3 in Annex B). Water and sanitation ODA allocation experienced a decrease across G7 countries (except for France) between 2018 and 2022 (see Figure B7 in Annex B). For a country like France, the role of environmental protection has become preponderant in the overall aggregate, with a sharp increase in the recent years, in particular focusing on biodiversity project in middle income countries.

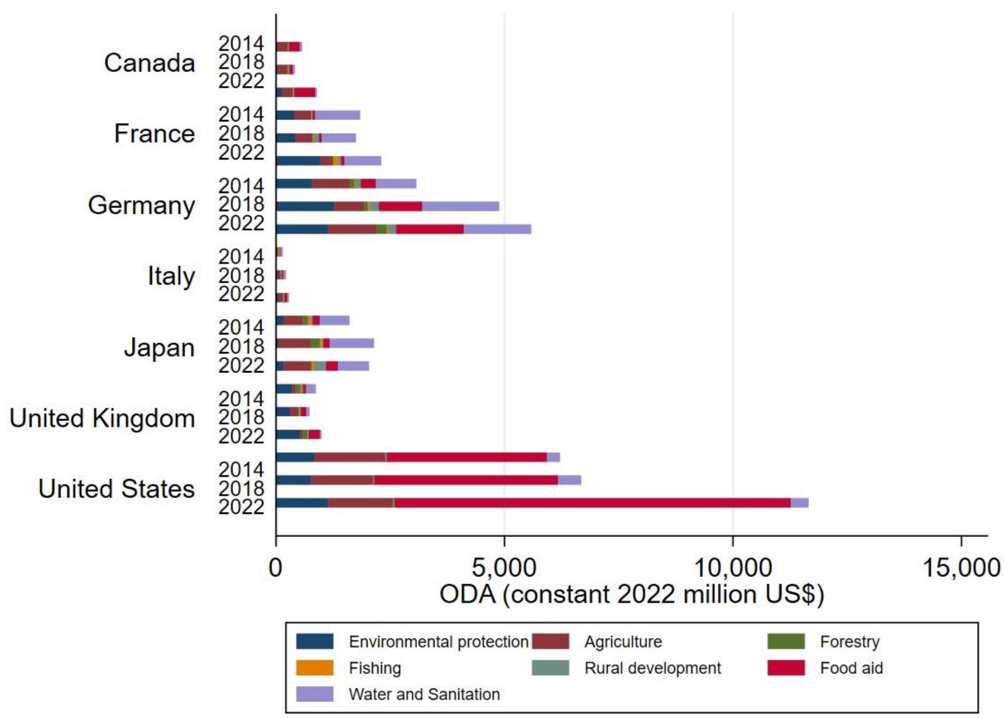

Figure 9: Sub-sector allocation of G7 food security and rural development ODA, 2014, 2018 and 2022 (ODA commitments, constant 2022 million USD)

Note: as shown in the figure, a large share of US ODA is food aid. While this is aid is helpful, some aspects of valuation of the US food aid, such as cargo preference laws and monetization practices, have raised concerns (Lentz, Mercier, & Barrett, 2017). Lentz et.al (2017) estimated that for every tax dollar spent on US food aid, only 35–40 cents reach those in need, with more funds allocated to shipping and handling than to actual food. Source: Authors' own elaboration based on OECD (2024).

4. The cost of reaching a world without hunger by 2030 and the costs of past complacency[21]

4.1 Investment needs to end hunger: The redesigned and updated Marginal Abatement Cost Curve (MACC)

Lost Years, Changed Contexts, and a Re-Booted MACC

Since 2015, when countries committed to SDG 2 and aimed to achieve zero hunger by 2030, the global community has faced numerous challenges and setbacks in achieving its target. Reflecting on the years that have passed since the adoption of SDG 2, it has become evident that progress towards ending hunger has been hindered by various factors, leading to what can be described as "lost years" in the pursuit of this goal. Particularly since 2020, the world has experienced unprecedented disruptions, exacerbating existing vulnerabilities and making the investment needs for hunger reduction interventions more expensive and possibly infeasible within the remaining timeframe until 2030.

The past two years have been marked by a record surge in global humanitarian needs, driven primarily by the enduring impact of the COVID-19 pandemic. Despite the scale-up in humanitarian assistance during 2021 and 2022, global economic challenges and long-term fiscal tightening have led to reduced funding levels in 2023. This reduction in funding comes at a critical moment when humanitarian needs, including acute food insecurity, remain alarmingly high (WFP & FAO, 2023). The lingering effects of the pandemic, coupled with new and protracted conflicts, increasingly severe climate shocks, high debt burdens, and trade restrictions, have collectively contributed to elevated prices and exacerbated food insecurity globally (WFP & FAO, 2023).

As the world moves towards the final stretch towards the 2030 SDG deadline, there are only six years remaining to achieve the ambitious target of zero hunger. Given this limited timeframe, it becomes imperative to identify and prioritize interventions that can still feasibly be invested in to make significant strides towards ending hunger by 2030. This necessitates a short-term focused approach that targets interventions with immediate impact and high potential for hunger reduction within the remaining timeframe. While short-term interventions are crucial for addressing immediate food security challenges of people in need, it is also important to consider interventions with longer-term impacts that may extend beyond the 2030 target. Many high-impact investments that could offer a sustainable reduction of hunger—such as investments in agricultural R&D, infrastructure development, and irrigation—require time to take effect and would not fully materialize within the next six years. However, their potential for significant

[21] Amy Faye contributed to this chapter.

hunger reduction in the long-term cannot be overlooked. Therefore, it is essential to incorporate these longer-term interventions into the planning and investment strategies to ensure sustained progress towards zero hunger beyond 2030. Initially, ZEF and FAO (2020) applied the MACC analysis five years ago to evaluate the cost-effectiveness of various measures aimed at reducing hunger and malnutrition. In this chapter, two new and different MACC analyses are presented to address the changed circumstances comprehensively. This is accomplished by updating the MACC and enriching it with new programmatic materials such as school feeding programmes and humanitarian assistance interventions in emergencies including conflict zones.

First, a short-term focused MACC figure is presented to help identify interventions that can be feasibly invested in to achieve significant hunger reduction by 2030. Second, the paper highlights the need to prioritize interventions with longer-term impacts by providing an additional MACC figure that considers interventions requiring more time to take effect and achieve significant hunger reductions by 2040. Through these MACC analyses, the report aims to provide policymakers and practitioners with valuable insights into the investment priorities and strategies needed to accelerate progress towards ending hunger on a global scale.

Marginal Abatement Cost Curve Approach

The Marginal Abatement Cost Curve (MACC) method, as employed by ZEF and FAO (2020), takes a distinct approach in identifying the most cost-effective interventions for ending hunger by 2030.[22] By prioritizing the most cost-effective strategies, the MACC approach facilitates the optimal allocation of limited financial resources for maximum impact. MACC-based studies provide a comprehensive overview of the investments needed to achieve zero hunger, incorporating a broader range of interventions than those typically included in modelling studies. Drawing parallels with its common applications in economic assessments of climate change mitigation and water policies, MACC provides an effective means of visualizing hunger reduction actions and initiating discussions on their economic viability.

The methodology for developing the global hunger reduction MACC involves a systematic process of identifying a range of intervention options, evaluating their cost, and hunger reduction potential through a comprehensive literature review and integration of model-based or large-scale intervention studies of global relevance. Key parameters, such as food security enhancement potential and intervention costs, are drawn from the findings of various model- and cost-benefit and impact evaluation studies on hunger reduction measures or, where necessary, calculated based on expert assessments. The interventions are then ranked based on their marginal costs (i.e., representing the annual per-unit cost of alleviating hunger or

[22] In this study, hunger is defined by the undernourishment concept of the Food and Agriculture Organization.

malnutrition) to depict the cost-effectiveness of achieving incremental levels of hunger reduction. The global hunger reduction MACC highlights the relationship between the cost of the interventions and their hunger reduction potential, capturing the additional costs incurred in lifting individuals out of hunger and malnutrition through each intervention.

Reference Scenarios

In this updated MACC-based assessment of investment options, reference scenarios are constructed by drawing upon historical trends to predict future developments. The assessment adheres to a "business as usual" approach or alternative scenarios that are formulated considering the potential impacts of climate change and socio-economic developments anticipated in the future. For instance, Hasegawa et al. (2018), through model-based foresight exercises, project that by 2030, the world could face a range of 251 to 842 million undernourished people, depending on climatic and socio-economic scenarios. If population growth is controlled and economic growth rates remain high, the number could drop to a range of 251 to 437 million. However, when factoring in climate change, this number rises to between 288 and 443 million. Under the worst scenario—with high population growth, economic stagnation, income inequality, and climate change impacts—the number of people facing undernourishment could reach between 617 and 842 million. According to a more recent estimate in the State of Food Security and Nutrition report, it is projected that almost 600 million people will experience chronic undernourishment by 2030, which would present a significant challenge to achieving SDG 2. This figure represents approximately 119 million more undernourished individuals compared to the scenario unaffected by COVID-19 or the war in Ukraine. Additionally, it reflects around 23 million more undernourished individuals compared to the scenario unaffected by the events of 2022 (conflicts and weather shocks), highlighting the potential exacerbation of global hunger due to the ongoing conflict (FAO et al., 2023) and acceleration of weather shocks. It also illustrates the long-lasting impacts of shocks and the difficulty to recover ‘lost’ years. In the updated MACC analyses, the reference scenarios of hunger trends presented above reveals both the scale of the challenge facing policymakers in achieving SDG 2, Target 2.1 and the investments required for success.

The cost and hunger reduction potential of the various investment options considered in this study are also analysed relative to a “business as usual” or reference scenario of investments, wherein the costs of investments are assumed to remain constant or grow only following historical trends. The costs in the reference scenario include all investments required to achieve the projected level of implementation of the intervention options by 2030, including the capital, operational, and programme costs, where applicable. For instance, the IMPACT model-based projection, from the study by Rosegrant et al. (2021), is used as a reference scenario for some interventions such as agricultural R&D and water resource management. Rosegrant et al. (2021)

used IFPRI's IMPACT model together with a global computable general equilibrium model (GLOBE) and several linked post-solution models to evaluate investment requirements, land-use changes, greenhouse gas (GHG) emissions, biodiversity, water quality, and micronutrient availability and dietary diversity under the business as usual scenario. In addition to the climate change assumptions, Rosegrant et al. (2021) consider investment in agricultural R&D and water resource management under the business as usual scenario. The projections of these investments under the business as usual scenarios are based on historical trends and expert opinions of long-term developments in the agricultural sector. Investments in water resource management are modelled endogenously, combining the IMPACT model with a suite of water models. Similarly, all investment options considered in this study are compared to a reference scenario to identify the incremental cost of implementing the investments.

Opportunities of 19 investments for hunger and malnutrition reduction

Table 3 presents 19 interventions considered in the updated MACC analysis, along with an overview of the data and approaches used in calculating their hunger reduction potential and implementation costs, as summarized, to ensure transparency in our assumptions. Among these 19 interventions, eight focus on enhancing crop yields at farm levels through improved technologies, extension services, crop protection measures, soil fertility management, and irrigation development. Five interventions aim to improve food systems efficiencies through improved ICT, infrastructure, and trade. Additionally, three interventions aim to support marginal groups in accessing food, while another three focus on reducing child malnutrition through enhanced child and maternal care. Further details of the calculations used to estimate the hunger reduction potential and costs of the interventions are provided in Annex C.

In the current MACC analysis, six types of adjustments were made to update the previous estimates of the annualized costs required to achieve zero hunger (ZEF & FAO, 2020):

1. The update of the previous MACC is adjusted for **inflation**. This is accomplished by leveraging the annual average global food consumer price index (FCPI) inflation rate of 3.96 percent and the annual average global producer price index (PPI) inflation rate of 4.33 percent from 2015 to 2022 to update the annual average costs of each intervention. The average inflation rates were calculated using data from World Bank's global database of inflation (Ha, Kose, & Ohnsorge, 2021).[23] The inflation effect shifts the MACC on average by more than 30 percent over the years 2015 – 2022.

[23] The inflation adjustment did not apply to the cost estimates for school feeding programmes and humanitarian assistance investments, as these cost estimates were based on current figures from 2022 and did not require adjustment for inflation.

2. To account for the **lost years** since 2020, the total inflation-adjusted cost of each short-term intervention over a 10-year period is recalculated and then the annual costs over a six-year timeframe for the short-term focused MACC analysis is averaged, with 2025 as the reference year.[24]
3. The global landscape has been profoundly affected by **conflicts and food crises**, especially the war on Ukraine, which disrupted the global food, fertilizer, and energy supply and exacerbated hunger and food insecurity globally. The increased number of food emergencies in many countries—often in the context of military conflicts—underscores the broader ramifications for undernourishment worldwide. Targeted interventions with their costs at scale are included, based on costs of actual large-scale programmes by WFP (2023a) and the NGO Welthungerhilfe.
4. Furthermore, the **UN Food Systems Summit** in 2021 catalysed efforts to transform global food systems, leading to initiatives like the **School Meals Coalition**. This coalition aims to ensure that every child receives a healthy daily meal by 2030, emphasizing the role of school meal programmes in addressing food insecurity and supporting education and health systems (WFP, 2022). To align with these policy priorities, the MACC analysis incorporated the hunger reduction potential of school feeding programmes, drawing on cost estimates from the State of School Feeding Worldwide 2022 report (WFP, 2022).
5. The costs and / or impacts of **agricultural R&D, large-scale irrigation, soil-water management, and nutrition interventions** are updated based on a comprehensive literature search across online databases.[25]
6. Considering the fiscal constraints and high borrowing costs faced by developing countries, the report factors in increased **cost of capital** in our estimations. Initially, the cost of each intervention into contributions from donors (40 percent) and the respective countries (60 percent) are allocated, adhering to estimates provided by Laborde, Parent & Smaller (2020). Subsequently, the average interest rate on new external debt commitments (3.17 percent to 60 percent of the inflation-adjusted annual average intervention costs) is applied for low and middle-income countries (LMICs), which were sourced from the World Bank's International Debt Statistics (World Bank, 2023b).

[24] An exception to this adjustment are investments in "ICT – Agricultural information services", scaling up existing social protection programmes and establishing new social protection programmes where the assumed time frame is 5 years, i.e. 2025-2029, and hence do not require adjustment for lost years.

[25] Approximately 2,000 identified papers were screened based on specific inclusion criteria, particularly focusing on model-based studies that estimated the number of individuals to be lifted out of hunger and the corresponding investment requirements.

Table 3: Investment options for hunger and child malnutrition reduction and investment scenarios assumptions

	Interventions	Sources	Modelling Framework	Intervention Time Frame	Calculations and assumptions
1	Agricultural R&D	Rosegrant et al., 2021	IMPACT 3 modelling suite	Long-term	This option considers the hunger-reduction potential of increased investments in the CGIAR plus increased complementary investments in National Agricultural Research Systems (NARS), and increased research efficiency, where USD 2.1 billion, 1 billion, and 0.42 billion per year is invested for the CGIAR, NARS, and research efficiency, respectively.
2	Agricultural extension services	FAO et al. 2019; Ragasa & Mazunda, 2018; Ecker & Qaim, 2011; Blum & Szonyi, 2014; World Bank, 2020a	Econometric model	Long-term	The hunger-reduction potential of increased investment in extension service is estimated for 38 low and lower-middle income countries using the methodological note for calculating PoU (FAO et al., 2019) and the impact of extension services on Dietary Energy Supply (DES). The DES is estimated based on Ragasa and Mazunda's study (2018), which shows a 36 percent increase in value of farm production due to the extension services, and Ecker and Qaim (2011), which indicates the elasticity of DES to income to be 0.66. Based on Blum and Szonyi, (2014), the implementation cost is assumed to be 1 percent of the 38 low and lower-middle income countries' GDP in 2019 (based on WDI in 2019 [World Bank, 2020a]).
3	ICT: Agricultural information services	Hoddinott, Rosegrant, & Torero, 2013; FAO et al., 2019	Econometric model and cost-benefit analysis	Short-term	The hunger reduction potential of improved access to market information through ICT is estimated by extending Hoddinott, Rosegrant & Torero's (2013) poverty reduction estimates in six countries to cover 69 low and lower-middle income countries and then converting the poverty reduction estimates to hunger-reduction using an estimated correlation coefficient of 0.68 (FAO et al., 2019).
4	Irrigation expansion: Small scale irrigation expansion in Africa	FAO et al., 2019; FAO, 2020a; You et al., 2011; Passarelli et al., 2018; Ecker & Qaim, 2011	Econometric model	Long-term	The hunger-reduction potential of increased investment in small-scale irrigation expansion in Africa is estimated using the methodological note for calculating PoU (FAO et al., 2019), data from FAO's suite of food security indicators namely the DES, MDER, and the CV (FAO, 2020a) and the impact of the expansion on DES. The DES is estimated based on Passarelli et al. (2018), which finds a 2.5 times increase in agricultural income, and Ecker and Qaim (2011), which indicate an elasticity of DES to income of 0.66. The total annual cost of the expansion is assumed to be USD 3.8 billion per year, based on the estimate by You et al. (2011).
5	Female literacy improvement	Smith & Haddad, 2015; Shekar et al., 2017; World Bank, 2020a	Econometric model and cost-effectiveness analysis	Short-term	The stunting reduction potential of investment in women's education is estimated using Smith and Haddad's (2015) elasticity of stunting to female secondary school enrolment (-0.166) for 37 countries that account for 90 percent of the stunted children globally. It is also assumed that the female secondary enrolment rate between 2011 and 2015 is maintained over the next ten years, which is about 6.66 million additional female students enrolled at a per capita cost of USD 130. The estimated stunting reduction levels are then converted into the corresponding hunger reduction using an estimated equivalence coefficient of 0.997.

6	Social protection: Scaling up existing programmes	Hidrobo et al., 2018; reviewed papers in Table C2 in Annex C	Cost-effectiveness analysis	Short-term	Based on systematic reviews of cost-effectiveness studies of social protection programmes across different countries, the minimum per dollar cash transfer cost per capita is identified at USD 35.7 and used to calculate the annual per capita cost of scaling existing programmes. Based on the review of the current coverage of social protection programmes, it is estimated that about 103.1 million people could be targeted.
7	School feeding programmes	WFP, 2022; FAO et al., 2023	Cost-effectiveness analysis	Short-term	The hunger reduction potential of school feeding programmes is determined based on the number of children in primary schools across different income groups and the prevalence of stunting in those regions (FAO, 2023). Using a correlation coefficient of 0.997, this data is converted into hunger reduction estimates. The average annual cost per child is USD 41.83 in low income countries, USD 42.06 in lower-middle income countries, and USD 112.04 in upper-middle income countries, as per the State of School Feeding Worldwide 2022 report (WFP, 2022).
8	Humanitarian assistance	WFP & FAO, 2023; WFP, 2023a	Cost-effectiveness analysis	Short-term	The hunger reduction potential of humanitarian assistance is estimated based on the number of people in acute food insecurity in hunger hotspots, which is approximately 158.4 million, according to the Hunger Hotspot report (WFP & FAO, 2023). The annual cost per person for humanitarian assistance is assumed to be USD 55, based on WFP's annual expenditures per beneficiary in 2022 for transfers (food assistance, cash transfers, and vouchers) (WFP, 2023a).
9	Nutrition-specific interventions (Stunting)	Scott et al., 2020	Optima Nutrition model	Short-term	This option considers increased investment in scaling up 15 nutrition-specific interventions to 95 percent coverage over a 5-year period (2019–2024) and maintaining it until 2030 in 129 individual low and middle-income countries. Stunting reduction is converted into hunger reduction using an estimated correlation coefficient of 0.997.
10	Social protection: Establishing new programmes	Hidrobo et al., 2018; reviewed papers in Table C2	Cost-effectiveness analysis	Short-term	Based on systematic reviews of cost-effectiveness studies of social protection programmes across different countries, the maximum per dollar cash transfer cost per capita is identified at USD 88.9 and used to calculate the annual per capita cost of scaling existing programmes. Based on the review of the current coverage of social protection programmes, it is estimated that about 103.1 million people could be targeted.
11	Crop protection: insects, diseases, and weeds	Rosegrant et al., 2014	DSSAT model and IMPACT 2 modelling suite	Short-term	This measure simulates the hunger-reduction potential of investments that promote the adoption of crop protection technologies for insects, diseases, and weeds, with the goal of achieving a 50 percent adoption rate. To calculate the cost, it is assumed that the technologies are implemented on 175 Mha with USD 50 per ha cost (insects), USD 40 per ha cost (diseases), and USD 60 per ha cost (weeds).
12	Integrated soil fertility management	Rosegrant et al., 2014	DSSAT model and IMPACT 2 modelling suite	Long-term	This measure simulates the hunger-reduction potential of investments that promote the adoption of integrated soil fertility management, with the goal of achieving a 40 percent adoption rate. To calculate the cost, it is assumed that the technology is implemented on 175 Mha with USD 100 per ha cost.
13	Intra-African trade: African Continental Free Trade	World Bank, 2020b; FAO et al., 2019; Anderson, 2018	Global dynamic CGE model and cost-	Short-term	The hunger reduction potential of the AfCFTA is estimated converting World Bank's (2020b) poverty reduction estimate of 30 million by 2035. The poverty reduction by 2030 is first calculated using linear interpolation and converted into hunger reduction using a correlation coefficient of 0.68 (FAO et al., 2019). To estimate the implementation cost of the AfCFTA, Anderson (2018) is used when assuming that 5 percent of the economic

	Area (AfCFTA) agreement		benefit analysis		gains from the continental free trade agreement estimated to be USD 450 billion by 2035 in the study by World Bank (2020b).
14	Nitrogen-use efficiency	Rosegrant et al., 2014	DSSAT model and IMPACT 2 modelling suite	Long-term	This measure simulates the hunger-reduction potential of investments that promote the adoption of agricultural management practices and improved crop varieties to 75 percent to enhance crop nitrogen-use efficiency. To calculate the cost, it is assumed that the technology is implemented on 175 Mha with USD 500 per ha cost.
15	Food loss reduction along the value chain	Rosegrant et al., 2015	IMPACT 2 modelling suite	Long-term	The hunger-reduction potential of increased investments in post-harvest reduction is estimated assuming a scenario where a 10 percent reduction in the post-harvest loss is maintained globally by 2030 through increased investments in infrastructure.
16	International trade integration[26]	Anderson, 2018; FAO et al., 2019	Cost-benefit analysis	Short-term	The hunger-reduction potential of enhancing international trade is estimated by converting Anderson's (2018) poverty reduction estimate of about 160 million using a correlation coefficient of 0.68 (FAO et al., 2019). Following Anderson (2018), 5 percent of the estimated annual comparative static benefit of 2025 is assumed to be the adjustment cost of the trade reform.
17	Infrastructure (Road, Rail, and Electricity)	Rosegrant et al., 2017	IMPACT 3 modelling suite	Long-term	This option simulates the hunger-reduction potential of a mix of infrastructure improvements in developing countries, focusing primarily on improvements to transportation infrastructure (road building, road maintenance, and railroads) and increased rural electrification.
18	Irrigation expansion: Large-scale irrigation expansion	Rosegrant et al., 2017, 2021	IMPACT 3 modelling suite	Long-term	This option reflects the hunger-reduction potential of large-scale irrigation expansion in developing countries by 2030, with projected irrigated area expansion of 20 million hectares by transforming rainfed areas (Rosegrant et al., 2017) plus a 15-percentage point increase in basin efficiency by 2030, based on water infrastructure investment and water management improvement in food production units (Rosegrant et al., 2021).
19	Soil-water management	Rosegrant et al., 2021	IMPACT 3 modelling suite	Long-term	This measure considers the hunger-reduction potential of water availability by enhancing technologies such as water conservation in rainfed areas through rainwater harvesting, broad-beds and furrows, percolation dams, tanks, and other technologies and management practices that improve water uptake capacity of plant and soil water holding capacity.

Source: Authors' own elaboration.

[26] This study uses projected impacts of the Doha Development Agenda (DDA) which seems the best available projection of impacts of international trade integration. The implementation of the DDA is currently unclear but regional trade integration for instance in Africa is ongoing.

4.2 Costs of ending hunger by 2030 and by 2040

In this section, the results from the two different MACC analyses—each highlighting a different aspect of the investment needs for hunger reduction interventions—are presented. The results are summarized in Table 5.

Scenario 1: "Urgency for 2030" – actions with short-term impactful investments

Interventions that can feasibly be invested in to achieve a significant reduction in hunger by 2030 include actions that can quickly reduce undernourishment. These actions mainly include transfers to the needy, rather than productivity-enhancing and economic inclusion investments for the undernourished. The results of this short-term investment-focused MACC analysis are presented in Figure 10. Overall, the ten short-term measures included in this MACC analysis have the potential to lift about 730 million people out of hunger and malnutrition over the six years between 2025 and 2030. To meet the G7 commitment of **lifting 500 million people** out of hunger and malnutrition by 2030, an incremental average annual investment of approximately **USD 27 billion** will be required. The average cost per person lifted out of undernourishment would be USD 53 for 500 million people. This investment is allocated towards a mix of short-term, least-cost intervention options, such as ICT-based agricultural information services, scaling-up existing social protection programmes, school feeding programmes, humanitarian assistance, female literacy improvement, nutrition-specific interventions, and establishing new social protection programmes (Table 4). This approach has important humanitarian benefits, but lacks sustainability and economic efficiency.

As illustrated in Figure 10, investing in "ICT: Agricultural information systems," school feeding programmes, and humanitarian assistance are options that have a relatively large hunger-reduction potential. Scaling-up existing social protection programmes and establishing new social protection programmes to serve food-insecure households can reduce the number of people at risk of hunger by about 206.2 million, at an annual per capita cost of about USD 48 and USD 119 per undernourished, respectively. Investments in "Crop protection: Insects, Diseases, Weeds," "African Continental Free Trade Area (AfCFTA) agreement," and improvements in international trade (completion of the DDA) can considerably decrease undernourishment by about 152.4 million. These hunger-reduction measures are relatively expensive investment options that have broader development impacts beyond reduction of hunger. Finally, with regards to investments to reduce child malnutrition (stunting among children below the age of 5 years), while investment in women's education provides the lowest cost option, school feeding programmes and nutrition-specific investments can significantly reduce the number of stunted children by about 145.5 and 38.6 million at an annual cost of about USD 51 and USD 110 per undernourished, respectively.

Table 4: Hunger reduction potential of short-term interventions and cost of implementation from 2025 to 2030

Least-cost Rank	Interventions	Number of people lifted out of hunger (million)	Number of people lifted out of hunger (Cumulative, million)	Annual cost (USD million)	Annual cost (Cumulative, USD million)	Annual cost per individual lifted out of hunger (USD)	Total Investment costs (2025-2030, million)	Total cost per individual lifted out of hunger (USD) over 2025-2030
1	ICT - Agricultural information services	26.6	26.6	774	774	29.1	5936	210
2	Social protection - Scaling up existing programmes	103.1	129.7	4917	5692	47.7	24587	225
3	School feeding programmes	145.5	275.2	7472	13164	51.3	44834	288
4	Humanitarian assistance	158.4	433.6	8878	22041	56.0	53265	314
5	Female literacy improvement	2.6	436.2	194	22235	74.6	1163	420
6	Nutrition-specific interventions	38.6	474.9	4234	26470	109.6	25406	614
7	Social protection - Establishing new programmes	103.1	578.0	12247	38717	118.8	61236	560
8	Crop protection - Insects, Diseases, Weed	28.3	606.3	5998	44715	212.0	35990	1187
9	Trade - African Continental Free Trade Area (AfCFTA)	15.3	621.6	4159	48875	271.9	24956	1523
10	Trade - International trade integration (DDA)	108.8	730.4	68553	117428	630.1	411319	3529

Note: Number of people lifted out of hunger and annual cost of each intervention are compiled and computed based on the studies and assumptions presented in Table 3. The costs of the interventions are adjusted for inflation until 2022, account for the years of intervention lost since 2020, and factor in the cost of capital. For each intervention, the number of people lifted out of hunger by the proposed investments is calculated as the difference between the projected number of hungry people in the business as usual 2030 scenario and the projected number of hungry people in the 2030 investment scenario. The annual cost per individual lifted out of hunger is then calculated as the annual cost divided by the number of people lifted out of hunger. The cumulative figures for the number of people lifted out of hunger and annual costs across the interventions reflect the total hunger reduction possible from all interventions and the total annual investments required. Total cost per person lifted out of hunger is calculated as total net discounted cost over the 6 years period (with the exception of ICT and establishing new and scaling up existing social protection programmes where the time frame is 5 years, i.e. 2025-2029). The discount rate is assumed to be 2 percent. The total cost per individual lifted out of hunger is then calculated as the total net discounted cost divided by the number of people lifted out of hunger.

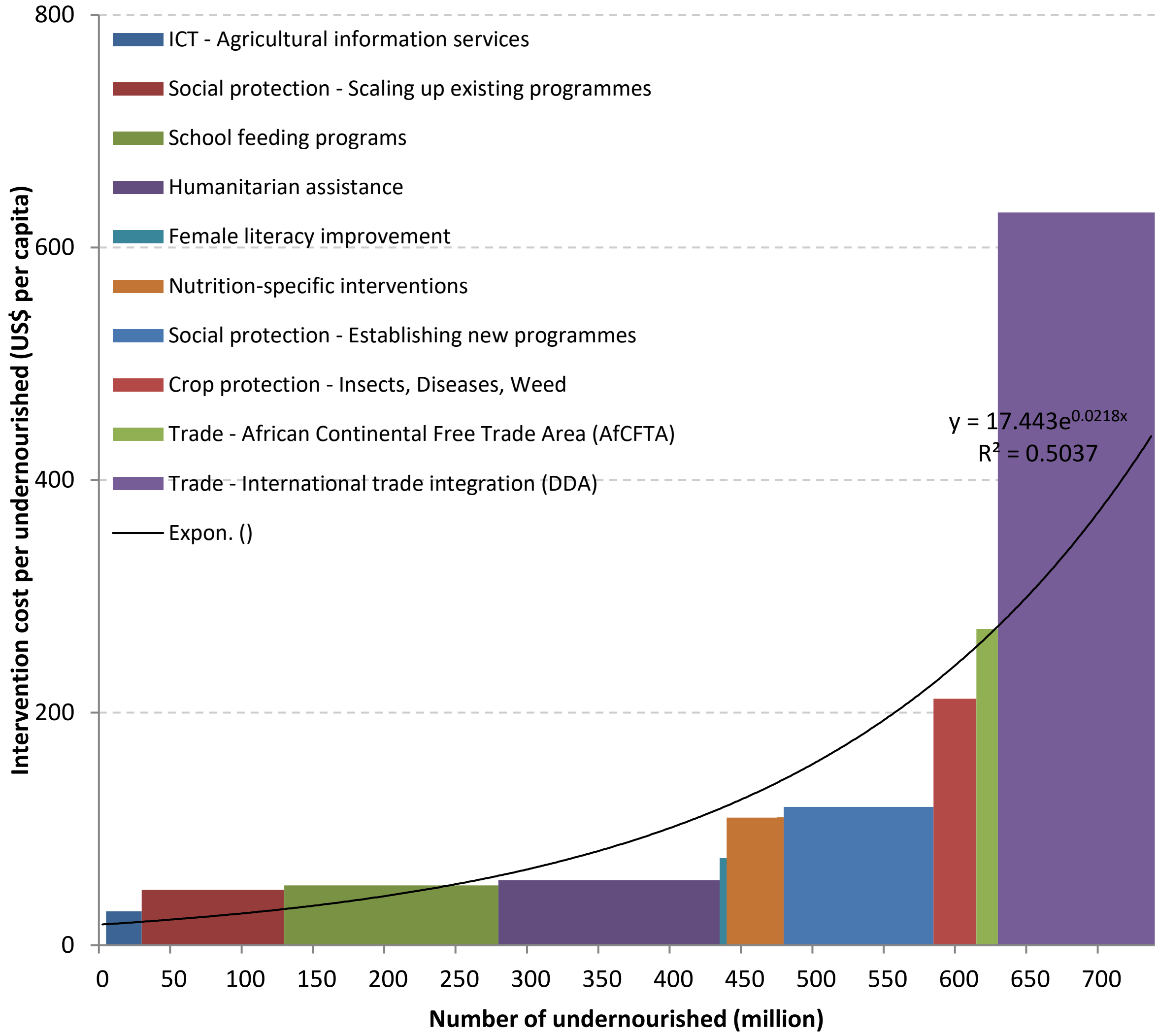

Figure 10: MACC of short-term interventions to eradicate hunger and malnutrition from 2025 to 2030

Note: The MACC for hunger shows the cost of each hunger reduction measure such that each bar represents a single intervention where the width shows the number of individuals lifted out of hunger, the height its associated annual per-capita cost, and the area its associated total annual cost. The total width of the MACC reflects the total hunger reduction possible from all interventions, while the sum of the areas of all of the bars represents the total annual cost of reducing hunger through the implementation of all interventions considered. The positions of the bars along the MACC reflect the order of each intervention by their cost-effectiveness based on the annual per-capita costs. When moving along the MACC from left to right, the cost-effectiveness of the interventions worsens as each next intervention becomes more expensive than the preceding. It is important to note that this figure is subject to considerable uncertainty given various assumptions made in the calculation, missed synergies and potential overlap between interventions and impact of extreme events not considered when estimating the costs.

Cost of complacency – if action had been taken in 2020

The findings of the short-term investment-focused MACC analysis, which considers the "lost years"[27], highlight the significant **cost implications of complacency**, when compared with the costs that would have been spent addressing hunger since 2020. Despite the potential of the ten measures included in this MACC analysis to lift millions of people rather quickly out of hunger and malnutrition by 2030, the required annual investments have escalated compared to earlier estimates (ZEF and FAO, 2020). Specifically, to meet the G7 commitment of **lifting 500 million people** out of hunger and malnutrition by 2030, an incremental average annual investment of approximately **USD 27 billion** would be needed, which significantly higher than the earlier estimate of **USD 12 billion (USD 11 to 14 billion)** (ZEF & FAO, 2020). These comparisons with earlier MACC estimates reveal a stark contrast in investment requirements, where due to the changed circumstances and late and too low actions. Additionally, while theoretically the investments under consideration might be further scaled up to facilitate an end of hunger by 2030, this would probably be at the high end of the costs per person. With only six years remaining until the 2030 deadline, the range of technically feasible investment options becomes limited, and the cost of achieving zero hunger increases substantially. This disparity emphasizes the escalating costs of inaction and underscores the urgent need for immediate and concerted efforts to accelerate progress towards achieving zero hunger by 2030.

Scenario 2: "Realism with urgency" – investing for ending hunger by 2040 without further delay

Sustainable and economically-efficient policies to overcome undernourishment, short-term actions would need to be combined with long-term actions on a realistic time path. The report presents such a MACC estimation that extends the SDG 2-endline to 2040, considering that investments in interventions requiring more time to take effect to achieve significant hunger reductions. To fulfil the G7 commitment of **lifting 500 million people** out of hunger and malnutrition by 2040, an incremental average annual investment of approximately **USD 10 billion** is projected for a mix of least-cost intervention options, including agricultural R&D, agricultural extension services, small-scale irrigation expansion in Africa, female literacy improvement, ICT-based agricultural information services, nutrition-specific interventions, and scaling existing social protection programmes (Table 6). However, to lift **about 700 million**

[27] The short-term investment-focused MACC analysis considers the "lost years" for ten hunger and malnutrition reduction measures over the period of six years spanning from 2025-2030 and adjusts for inflation where needed. The cost of the interventions also incorporates the impact of fiscal constraints and high borrowing costs faced by developing nations, factoring in the cost of capital by applying the average interest rate on new external debt commitments for Low & Middle-Income Countries (LMIC) to the inflation-adjusted annual average intervention costs.

people out of hunger and malnutrition by 2040, this figure substantially rises to about **USD 21 billion** annually, incorporating additional interventions of school feeding programmes and humanitarian assistance (Table 6). Investments in these areas demonstrate a considerable hunger reduction potential, with relatively low annual costs per undernourished individual. The average cost per person lifted out of undernourishment for this scenario would be about USD 20 for 500 Million people and about USD 29 for about 700 million people respectively.

As illustrated in (Figure 11), investing in low-cost options like agricultural R&D, agricultural extension services, small-scale irrigation expansion in Africa, and ICT-based agricultural information services can yield significant hunger reduction benefits. Conversely, scaling up existing social protection programmes, humanitarian assistance, and establishing new social protection programmes have higher associated costs but can substantially reduce the number of people at risk of hunger by about 365 million. Furthermore, investments in crop protection, integrated soil fertility management, trade agreements, nitrogen-use efficiency, infrastructure development, global large-scale irrigation expansion, and soil-water management offer considerable hunger reduction potential, albeit at higher costs and with longer timeframes—extending beyond the 2030 deadline—for their effects to materialize.

Lastly, in addressing child malnutrition, investments in women's education, nutrition-specific investments, and school feeding programmes demonstrate significant potential in reducing the number of stunted children by about 186.8 million at an annual cost of about USD 28, USD 41 and USD 51 per undernourished, respectively. This comprehensive analysis underscores the importance of balancing short-term and long-term investment strategies to effectively address hunger and malnutrition on a global scale.

Table 5: Annual and total cost to lift 500 million and 700 million people out of hunger: Comparison across three MACC analyses

MACC analysis	**Annual and total cost to lift about 500 million people out of hunger (USD, billion)** (total cost in brackets)	**Annual and total cost to lift about 700 million people out of hunger (USD, billion)** (total cost in brackets)
MACC analysis – "Earlier estimate" 2020 – 2030	*12 (94)*	*30 (185)*
MACC analysis – "Short-term investments" 2025-2030	27 (146)	93 (512)
MACC analysis – 2025-2040	10 (116)	21 (223)

Note: Annual and total cost of lifting 500 million and 700 million people out of hunger across the three MACC analyses are calculated using the trapezoidal rule for integrals, i.e. the sum of $(x_i - x_{i-1})(y_i + y_{i-1})/2$. This method involves summing up the areas of trapezoids formed by consecutive data points, where $'x'$ represents the number of people lifted out of hunger by each intervention, and $'y'$ represents the annual or total cost per individual lifted out of hunger, corresponding to data points presented in Table 4 and Table 6.

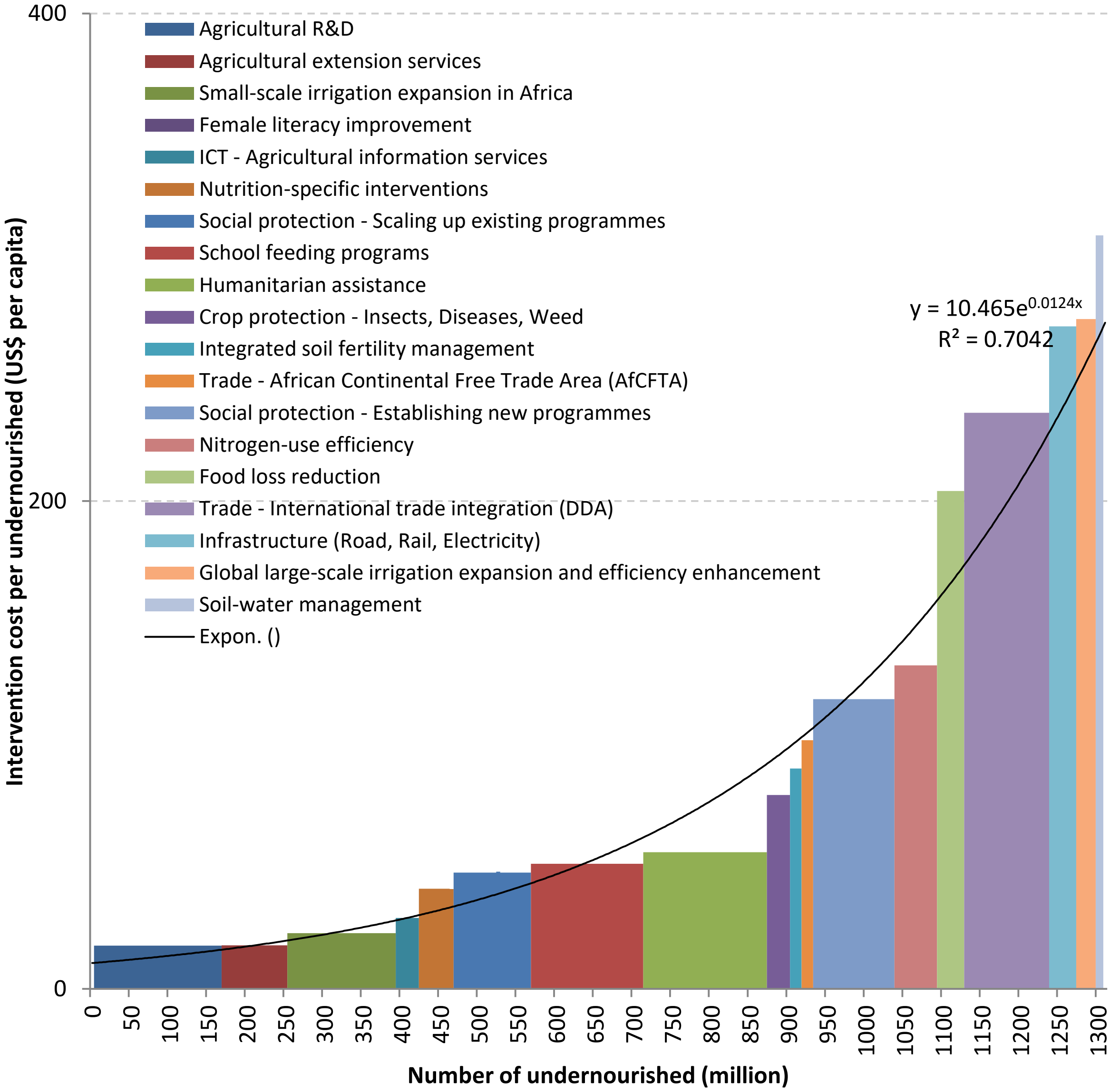

Figure 11: MACC of interventions to eradicate hunger and malnutrition from 2025 to 2040

Note: The MACC for hunger shows the cost of each hunger reduction measure such that each bar represents a single intervention where the width shows the number of individuals lifted out of hunger, the height its associated annual per-capita cost, and the area is associated with total annual cost. The total width of the MACC reflects the total hunger reduction possible from all interventions, while the sum of the areas of all of the bars represents the total annual cost of reducing hunger through the implementation of all interventions considered. The positions of the bars along the MACC reflect the order of each intervention by their cost-effectiveness, based on the annual per-capita costs. When moving along the MACC from left to right, the cost-effectiveness of the interventions worsens as each following intervention becomes more expensive than the preceding. It is important to note that this figure is subject to considerable uncertainty, given various assumptions made in the calculation, missed synergies and potential overlap between interventions and impact of extreme events not considered when estimating the costs.

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Table 6: Hunger reduction potential of interventions and cost of implementation from 2025 to 2040

Least-cost Rank	Interventions	Number of people lifted out of hunger (millions)	Number of people lifted out of hunger (Cumulative, millions)	Annual cost (USD millions)	Annual cost (Cumulative, USD millions)	Annual cost per individual lifted out of hunger (USD)	Total Investment costs (USD, million) over 2025-2040	Total cost per individual lifted out of hunger (USD) over 2025-2030
1	Agricultural R&D	168.5	168.5	2987	2987	17.7	47787	241
2	Agricultural extension services	81.5	250.0	1453	4440	17.8	23248	242
3	Small-scale irrigation expansion in Africa	142.3	392.3	3248	7687	22.8	51963	310
4	Female literacy improvement	2.6	394.9	73	7760	28.0	1163	384
5	ICT - Agricultural information services	26.6	421.5	774	8534	29.1	3871	137
6	Nutrition-specific interventions	38.6	460.1	1588	10122	41.1	25406	558
7	Social protection - Scaling up existing programmes	103.1	563.2	4917	15040	47.7	24587	225
8	School feeding programs	145.5	708.8	7472	22512	51.3	119558	697
9	Humanitarian assistance	158.4	867.2	8878	31389	56.0	142041	761
10	Crop protection - Insects, Diseases, Weed	28.3	895.5	2249	33639	79.5	35990	1080
11	Integrated soil fertility management	16.6	912.1	1500	35138	90.3	23994	1227
12	Trade - African Continental Free Trade Area (AfCFTA)	15.3	927.4	1560	36698	101.9	24956	1385
13	Social protection - Establishing new programmes	103.1	1030.5	12247	48945	118.8	61236	560
14	Nitrogen-use efficiency	56.5	1087.0	7498	56443	132.7	119968	1802
15	Food loss reduction	36.0	1123.0	7352	63796	204.2	117637	2773

16	Trade - International trade integration (DDA)	108.8	1231.8	25707	89503	236.3	411319	3208
17	Infrastructure (Road, Rail, Electricity)	34.1	1265.9	9263	98766	271.6	148212	3689
18	Global large-scale irrigation expansion and efficiency enhancement	25.3	1291.2	6950	105716	274.7	111193	3730
19	Soil-water management	12.7	1303.9	3925	109641	309.0	62795	4197

Note: Number of people lifted out of hunger and annual cost of each intervention are compiled and calculated based on the studies and assumptions presented in Table 3. The costs of the interventions are adjusted for inflation until 2022 and factor in the cost of capital. For each intervention, the number of people lifted out of hunger by the proposed investments is calculated as the difference between the projected number of hungry people in the business as usual 2040 scenario and the projected number of hungry people in the 2040 investment scenario. The annual cost per individual lifted out of hunger is then calculated as the annual cost divided by the number of people lifted out of hunger. The cumulative figures for the number of people lifted out of hunger and annual costs across the interventions reflect the total hunger reduction possible from all interventions and the total annual investments required. Total cost per person lifted out of hunger is calculated as total net discounted cost over the 16 year period (with the exception of ICT and establishing new and scaling up existing social protection programmes, where the time frame is 5 years, i.e. 2025-2029). The discount rate is assumed to be 2 percent. The total cost per individual lifted out of hunger is then calculated as the total net discounted cost divided by the number of people lifted out of hunger.

5. Review of selected model-based cost estimates for ending hunger and assessing the cost of inaction in a dynamic general equilibrium model

5.1 Review of selected model-based cost estimates for ending hunger

The preceding MACC analysis offers a transparent approach to identifying cost-effective interventions for ending hunger by 2030 and beyond, thus, optimizing the allocation of financial resources for maximum impact. However, it has limitations in capturing intertemporal dynamics, synergies, or trade offs, and interactions among interventions. This section complements the MACC approach by examining model-based studies that estimate the cost of achieving zero hunger. Despite their strengths, model-based studies also have some limitations as they might not fully capture all interventions needed to address hunger globally, due to data limitations and modelling scope.

Several model-based studies have estimated the cost of achieving zero hunger, each using different targets and methods. This review focuses on recent studies using the International Food Policy Research Institute's (IFPRI) IMPACT model (Robinson et al., 2015) and MIRAGRODEP model (Laborde et al., 2013).

Sulser et al. (2021) conducted an analysis of adaptation costs to climate change under various future scenarios, focusing on mitigating climate change impacts on hunger through investments in agricultural R&D, water management, and rural infrastructure in developing countries. Using the IMPACT model, they simulate shifts in the global food system to evaluate investment strategies aimed at mitigating climate change impacts up to 2050, while also analysing trade-offs across SDGs related to poverty, hunger, and water. Their findings indicate that climate change impedes progress toward ending hunger, potentially causing an additional 78 million people to face chronic hunger by 2050, with over half of them in Sub-Saharan Africa. Increased investments in agricultural R&D could offset these impacts, necessitating an annual increase in international agricultural R&D funding from USD 1.62 billion to USD 2.77 billion between 2015 and 2050.

In a subsequent study, Rosegrant et al. (2021) analyzed the investment gap required to achieve significant progress towards ending hunger (SDG 2), reducing greenhouse gas (GHG) emissions from agriculture (SDG 13), and improving water use efficiency and reducing agricultural water pollution (SDG 6) by 2030. Using the IMPACT model, the study estimated the public and private investments in agricultural R&D that would be required to reduce hunger prevalence to below 5 percent by 2030, considering the impact of climate change. The investment scenario requires an additional USD 4 billion annually, with a substantial portion coming from the private sector. These investments are important for adapting agriculture to climate change and preventing climate-induced hunger risks. Collectively, the estimated investment gap to reduce hunger to 5 percent globally and align GHG emissions with the Paris Agreement pathways is USD 10.5 billion, annually. It is important to note that, while these investments are anticipated to reduce global hunger to 5 percent, hunger levels in Sub-Saharan Africa are projected to remain around 12 percent until 2030.

Laborde et al. (2016) used the MIRAGRODEP dynamic global model to estimate that ending hunger by 2030 would require an additional annual investment of USD 11 billion from 2015 to 2030. This model combines a dynamic multi-country multi-sector CGE model with household surveys, allowing for precise targeting of interventions, based on identified households experiencing hunger. The household-level targeting improves spending efficiency compared to models based on national averages. The MIRAGRODEP model focuses on reducing hunger prevalence to 5 percent or less, rather than absolute eradication, and also considers sub-goals of SDG 2 like raising agricultural productivity and ensuring sustainable agricultural systems. The interventions in the model include social safety nets through food subsidies, farm support to boost productivity and incomes, and rural development mainly via infrastructure investments. While nutrition interventions are recognized as important, they are not included in the model due to limitations in household data.

Laborde and Torero (2023) analyzed the impact of six intervention scenarios targeting the agrifood systems using the MIRAGRODEP model. The study focused on four interconnected objectives, including ending hunger and malnutrition, achieving high-quality diets for all, ensuring the sustainable use of biodiversity and ecosystems, and eliminating poverty to support the preceding goals. These objectives collectively contribute to achieving high-quality diets for all, while ensuring environmental sustainability and inclusiveness. The study proposed instruments and interventions as the means to achieve these objectives, with interventions representing policy actions aimed at altering the existing state of the world, and instruments translating these interventions within the model space. The study proposed six scenarios that combine the four objectives and instruments to address trade-offs and tailor pathways towards achieving the overarching goal. The interventions considered by the study, for instance, include producer subsidies on staple products to end hunger, differentiated consumption subsidies to promote sustainable diets, carbon taxes to address environmental sustainability, and progressive tax systems to support household redistribution. They found that reducing hunger by 2030 to a 5 percent prevalence is achievable through the structural improvements in agrifood systems, leading to a reduction of 314 million hungry individuals (**Fehler! Verweisquelle konnte nicht gefunden werden.**). The study findings show that by increasing farm productivity and reducing food loss and waste, the number of undernourished people could be significantly decreased. Additionally, 568 million individuals could afford healthy diets by 2030. The cost of these hunger reduction measures represents 8 percent of global food market value, which could be mobilized for investment in food value chains, national economies, and social safety nets. They also show that well-targeted social safety nets could grant another 2.4 billion people access to healthy diets.

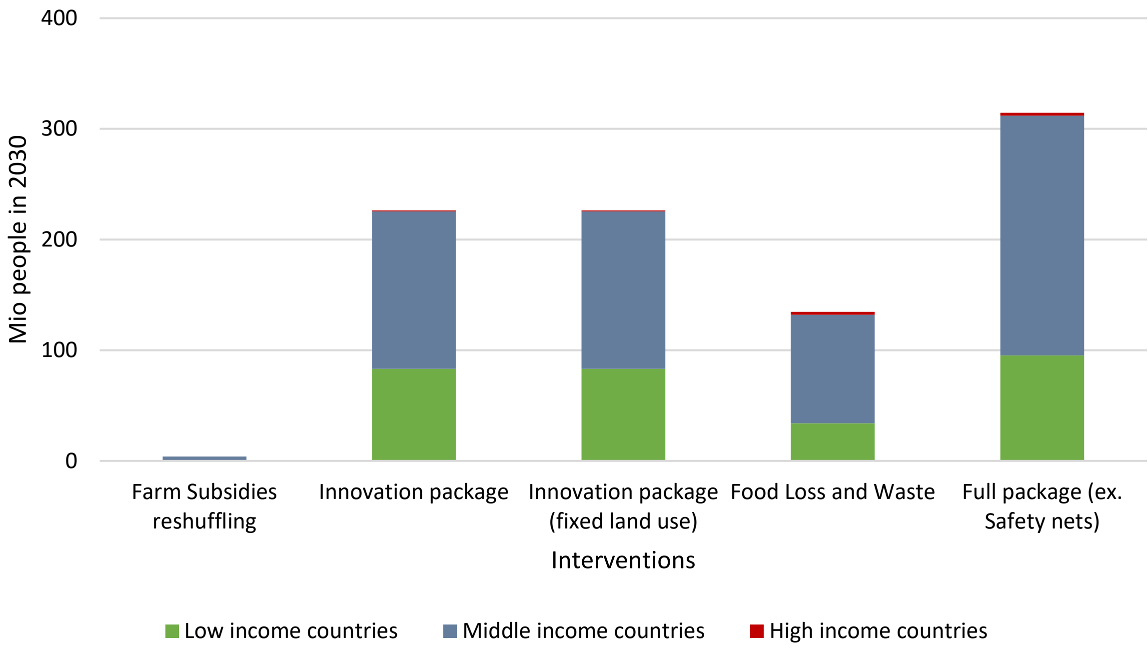

Figure 12: Reduction in chronic undernourishment

Note: Interventions considered in the figure exclude safety nets and school feeing programs.

Source: Laborde and Torero (2023).

Furthermore, Laborde and Torero (2023) identified potential synergies among interventions that could address various causes of hunger, while minimizing the overall cost of the interventions. Although trade-offs exist across interventions, the study finds that they are relatively minimal, with the most significant trade-off observed for innovation and full technological packages, which exhibit positive effects, particularly in reducing food loss and waste. The study also indicates that addressing the income gap for the 3 billion individuals unable to afford healthy diets would require a substantial annual redistribution of USD 1.4 trillion globally. However, through strategic investment in a variety of interventions, countries could significantly reduce the global cost of safety nets by approximately two-thirds, or USD 428 billion, by 2030. Additionally, combined interventions have the potential to mitigate environmental trade-offs that are associated with the interventions. The study emphasizes that “no single intervention could achieve the end of malnourishment, and synergies are needed to tackle the various source causes of the problem, but also to minimize the total cost of the package. However, their complementarity goes beyond their impacts on household food security and their cost-effectiveness, and therefore we also need to combine them to address heterogeneous environmental trade-offs.”

Overall, the review of model-based studies highlights diverse strategies and investment needs to achieve SDG 2, emphasizing hunger eradication and improved nutrition. The studies employ different methodologies and focus on specific aspects of SDG 2, such as reducing hunger prevalence, doubling agricultural productivity, and addressing climate change impacts. The comprehensive approach proposed by these studies involves substantial financial commitments, with cost estimates ranging from USD 11 billion to USD 52 billion annually. Targeted interventions are also diverse and include sectors such as agricultural R&D, water management, rural infrastructure, and social protection. Despite challenges in modeling all dimensions of food security and sustainability, integrating findings from these studies is crucial for informing effective investment strategies and policy decisions aimed at ending hunger and achieving broader development goals.

5.2 Modelling the cost of inaction in a dynamic general equilibrium framework

Introduced in the Ceres2030 project (see Laborde et al., 2020; von Braun et al., 2020), the use of a multi-country, multi-sectoral, dynamic computable general equilibrium model has proven to be a useful way to provide an integrated approach to calculate the required amount of additional investments to reach a given target (e.g., reduction or elimination of the PoU) or set of targets (e.g., PoU, emissions, small scale food producers' productivity). Rather than providing an update of the Ceres2030 analysis, this report focuses on estimating the cost of inaction in the fight against hunger in this framework.[28]

Assessing the cost of inaction in this framework is not a trivial exercise, especially without properly defining key elements of what should be included or not. Indeed, several options could be considered. In a first sub-section, the report provides a discussion of different technical solutions and their implications for policymakers in order to promote an accurate interpretation of the numbers. In a second sub-section, the methodology used in this report is summarized to indicate key differences with the Ceres2030 assumptions as well as similarities and differences with the MACC approaches. Finally, the estimates of the cost of inaction are presented and the different drivers are briefly explained.

A first attempt to answer the question about the cost of inaction could be to compare an updated food 2018 to 2030 security and rural development investment cost estimate with the one provided in 2020 (i.e., an additional 396 billion, in 2017 USD constant USD)—of which 168 billion will be provided by external donors. However, this update will include a number of elements that should not be included in the cost of inaction. When considering why an

[28] An update of the Ceres 2030 project is, however, is being conducted in the context of the Hesat2030 project https://www.hesat2030.org/. Similarly to Ceres2030, the project is support by the Bill and Melinda Gates Foundation, and the German Federal Ministry for Economic Cooperation and Development (BMZ). It aims identify high-impacts interventions and provide an updated and extended costing towards ending hunger sustainably, nutritiously and equitably.

updated assessment made today will differ from the Ceres2030 exercise, the following five effects influence why there is a different and overall higher cost. The first two effects could be associated with the size of the problem to be dealt with (i.e., number of undernourished people), the third effect is about concentrating spending in a shorter window, and the last two are about the cost of individual actions or the overall efficiency of the portfolio.

1. **The future did not unfold as expected** (i.e., differences between assumptions and realities for 2018-2023 led to a grimmer situation in 2024). The Ceres2030 estimates were built from the observed 2018 economic reality and adjustments are needed to account the shock associated with the COVID-19 pandemic, based on assumptions made in early 2020. However, as discussed in section 2.1, the actual evolution of events deviated from projections in Ceres2030, leading to a more severe situation in 2024. It can be argued that, in some cases, the observed changes are directly related to a lack of investment leading to increased hunger and associated costs (e.g., early warning systems, improved varieties, better irrigation systems or contingent social safety nets to mitigate the direct effects of weather shocks). However, in other cases, additional costs could not be associated with the cost of inaction (e.g., civil wars in Ethiopia, Sudan, South Sudan, Yemen, or international conflicts like the war in Ukraine).
2. **The collective vision of the future has changed** (i.e., there are different assumptions for the 2024-2030 period and they are less optimistic). A number of structural assumptions for the near future have changed over the last few years—ranging from demographics projections to economic growth, sustainable levels of debt or agricultural productivity and yields—leading to a more pessimistic outlook. Revised projections indicate slower economic growth, more limited capacity to finance expected investments through debt instruments, and stronger impacts of climate change on yields. As before, some of these changes are independent from the lack of investment in ending hunger in the previous years, while others could be included.
3. **There is less time to do more.** Starting from a more complex reality (i.e., relatively higher levels of hunger) and with more pessimistic projections, more investments are expected. Mechanically, concentrating 12 years of investments (2018 to 2030) into 6 (2024-2030) will lead, *ceteris paribus*, to double the annual efforts.
4. **Doing more in less time is more expensive.** From a macroeconomic perspective—and based on actual limited absorption capacity of most countries with high levels of undernourishment—the concentration of investments in a shorter period of time will lead to a non-marginal shock. This shock will trigger high prices for capital goods (linked to investments), higher wages for skilled workers (e.g., extension agents), and overall higher prices for food (increasing the cost of social safety nets and school meals). At the macroeconomic level, this shock will lead to real appreciation of the exchange

rates, resulting in an increase in foreign capital flows (driven by policies and not profitability). These different effects create a number of challenges, including a loss of economic competitiveness economy-wide and an increase in the cost of individual interventions, translating in the needs of more money for the same volume of interventions and a reduction in the pro-growth outcomes of a longer period of investments.

5. **In less time, a different set of actions could be performed.** As discussed in chapter 4, different interventions have different time frames and rates of return (e.g., cash transfers, with immediate effects but very limited efficiency and leading to major demand shock, or agricultural R&D investments, which deliver peak benefits after 15 or 30 years but are associated with core productivity gains and major societal gain)s. A lower amount of time (i.e., five years) will exclude most longer investment options, R&D, human, or physical capital investments, from the most cost-benefit solutions. In particular, these supply side interventions are critical to generating "snowball" effects and the future generation of investments. In the Ceres2030 framework, these dynamic investments were critical to delivering the final outcomes. While the first generation of investment (e.g., the first goat given to a household) will be paid for with public money (domestic or international), the following generations will be paid for by the household, based on the earnings from the initial investment. Thus, the public investment initiates a virtuous dynamic circle. This household effect is mimicked by sectoral dynamics: structural investments increase productivity, which leads to a more profitable agricultural sector, which is more attractive to private investors (domestic or foreign). Finally, higher levels of growth increase the country's GDP, influence the overall poverty reduction dynamics, and forms the basis for taxation, allowing the government to support future investments. All these effects, captured in the general equilibrium models, could not occur with short term spending.

These five drivers explain why comparing old and new costs, even with the same modeling approach, will not properly answer the question of the cost of inaction. This is especially the case when some increases in cost are attributed to the missed investment opportunities, rather than to the deterioration of the global food security situation for elements independent from the lack of proper spending in the last few years. Because of this complexity—particularly due to the multiplicity of shocks occurring in recent years, the heterogeneity of country situations, and the overall levels of uncertainty on some causal pathways—all of these factors go beyond the scope of this report. A simplified approach is proposed to determine the cost of inaction, while still taking advantage of our modelling framework to build a proper counter-factual. Two values are estimated, considering two slightly different questions, especially to control for the two first effects discussed above.

Scenario 1 – "2018 world": The report considers the world how it was envisioned in 2020 (by Ceres2030). In this world (that did not happen) the cost of ending hunger—namely bringing the PoU in each country to 3 percent or less by 2030—is compared by considering investments and spending over 12 years (2018-2030) versus 6 years (2024-2030). In this case, the paper does not consider the deterioration of the world but, rather, focuses purely on the composition effects of investments and the lack of cumulative benefits of early investments. For the sake of simplicity, this approach is called the "2018 world."

Scenario 2 – "2023 world": In the world as it is known today (and under current projections for 2030) and aligned with the SOFI 2023 assumptions, the reports estimates what will have been the cost needed to achieve the same exercise in 12 years, and then in 6 years. Importantly, this does not mean that in 2018, economic agents and governments were anticipating what has happened between 2018 and 2023. Instead, they continue to discover information year after year, but in this second case the world follows the path it actually took. This is the "2023 world."

Eradicating hunger efficiently requires action on both the supply and the demand sides simultaneously and requires consideration of the direct and indirect effects. One way to assess the complexity of the world is to rely on large scale computational modelling—in this case, the general equilibrium model MIRAGRODEP (Bouet et al. 2022). In the model, government and households are represented separately, allowing for a better understanding of the impacts of specific interventions on the private and public sectors, distinctly (Laborde et al., 2013). To estimate the number of people lifted out of hunger and the associated costs, the model minimizes total public costs of reducing caloric hunger by optimally allocating financial resources among the portfolio of interventions considered. This logic is illustrated in Figure 13.

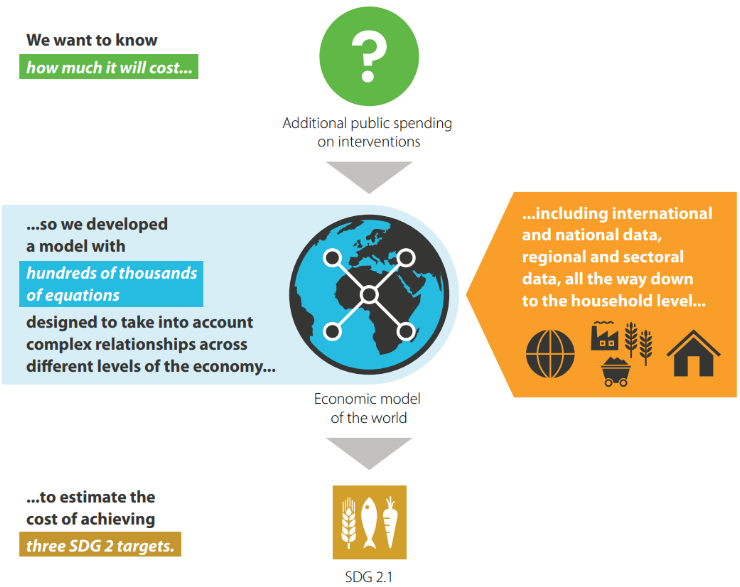

Figure 13: An integrated framework to assess the cost of ending hunger efficiently.

Source: adapted from Laborde et al. (2020)

Such a framework has some limitations, however. For example, it requires significant computational power, large amounts of data and transparency about numerous assumptions, and will associate any action with a large number of direct and indirect effects. All of this has the potential to dilute the primary impacts of a given investment. However, it also presents unique opportunities for analysis because it is a consistent framework with microeconomic foundations and macroeconomic closure rigor. Also, it uses a large number of household level data to capture distributional impacts of policies, but also allows for enhanced targeting across households based on their "hunger status" or more easily observable proxy variables such as "income status," to avoid wasting resources. The cost of each intervention is borne by either the public or private sector. Additionally, each intervention impacts specific variables (e.g., agricultural productivity, input costs paid by farmers, etc.), which reduce caloric hunger.

The improved targeting is also enhanced on two additional fronts. As a global model, based on country level data, the framework allows researchers to capture country level specifics in terms of needs and solutions, as well as specifying country level funding rules. The model can also be used to optimize spending across interventions (i.e., to minimize the public costs of bringing all countries to a level of PoU of 3% or below by 2030). This triple targeting (i.e., the right households, in the right countries, with the right mix of interventions—and optimized at the country level) allows for the identification of the most cost-efficient solutions.

To be effective, the additional public investment needs to be allocated to a balanced portfolio of interventions. Ceres2030 modelled a portfolio of interventions using 14 policy instruments grouped into three broad categories: (1) Empowering the Excluded, (2) On the Farm, and (3) Food on the Move (Table 7). Table D1 in Annex D provides further details of the different policy instruments used to represent interventions in the MIRAGRODEP model. In particular, the table outlines the number of years needed to get the full pay-off of the investments, along with additional information on the data sources and how the modelling approach differs from that applied in the Ceres2030 report. Importantly, this additional information provides insights into why some interventions will be neglected by the optimization process when moving to the shorter time frame.

Even if not exhaustive, this more holistic modelling approach uses diverse policy instruments so that investment in interventions will benefit from synergies, avoid bottlenecks, and balance trade-offs. For example, a fertilizer subsidy could be provided to help farmers increase yields, but its effectiveness would be hampered if a poor road network makes it too costly for produce to reach markets. A production subsidy may boost food production and producer incomes, but could result in clearing of land and unsustainable agricultural practices. The mix of policy instruments used in the model thus includes interventions that account for these interactions and complement each other, illustrating with broad strokes an appropriate investment strategy to accomplish multiple objectives.

Table 7: Interventions and Policy instruments considered in the Ceres2030 framework

Intervention	Policy instrument
Empowering the excluded	
Social protection	Food subsidy
Education	Vocational training
On the farm	
Input subsidy	Fertilizer subsidy
Production subsidy	Investment subsidy Capital endowment Production subsidy
R&D	National Agricultural Systems (NARS) CGIAR
Extension Services	Extension Services
Rural Infrastructure	Infrastructure
Livestock subsidy	Agroforestry Improved forage
Food on the move	
Post-harvest losses	Storage
Rural Infrastructure	Roads

Source: Laborde et al. (2020)

Using a large-scale modular model also implies that, when comparing two economies, even the same intervention, with the same marginal impact (i.e., the same MACC defined at the microeconomic level) will have differentiated cost-benefits. For instance, depending on the initial level of openness, the same increase in productivity generated by local extension services will have the same microeconomic impact on production at the farm level, but a differentiated impact on agricultural prices and, therefore, food consumption and farmer incomes.

5.3 Summarized findings on additional investments needed to end hunger, based on the MIRAGRODEP model results

Using the MIRAGRODEP model and the methodology described above, the costs of eliminating hunger in the two different situations are estimated for the world as it was expected in 2020 (2018 world), and with the latest changes (2023 world). The share of the cost for donors, considering the Ceres2030 co-funding rules, are then outlined. All values are indicated in billions of 2017 constant USD for the whole period considered. The summary results are provided in Table 8.

Table 8: Cost to end hunger for donors, Billions constant USD 2017

	2018-2030	2024-2030	Additional costs	Variation
In the 2018 world	142.53	329.55	187.02	131.2%
In the 2023 world	222.44	541.35	318.91	143.4%

It is apparent that 12 years of donor contributions should have represented 142.5 billion in the 2018 world and 222.4 billion in the 2023 world. Thus, the deterioration of the global situation since 2020 has increased the cost by about USD 80 billion, or an additional USD 50 billion. As discussed, part of the deterioration of the global situation could be linked to a lack of action. However, it must also be acknowledged that, to a large extent, investments to end hunger since 2018 have not impacted the trajectory of climate change and extreme events, or conflicts (both civil and international). Still, previous investments should have helped create more capacity for resilience.

Interestingly, it is apparent that the cost for the 2018 world (142.5 billion or 11.88 annually) is lower than the Ceres2030 investment numbers (14 billion annually), since only a part of the agenda (no constraint on smallholder income or GHG) is considered.

While the increase in cost due to the changes in the world are significant, they are dwarfed by the real lack of action. In the 2018 world, delaying investments by 6 years adds a cost of 187 billion constant USD, or an increase of 131% compared to the 142 billion (total 329.5 billion, or 54.8 billion per year). This is more than a simple compression of investments and, as illustrated in Figure 14: , the composition of investments has changed. In the 2023 world, the increase of cost is even more important with an additional 318 billion constant 2017 USD and an increase of 143% for a total of 541.35 billion (or 90 billion, annually). These two numbers provide a reasonable range of the cost of delayed actions: between +130 and 140% of cost, or 187 to 318 billion (i.e., an additional 15 to 26 billion, compared to the initial costing). Delaying action has led to more human suffering and much higher costs when attempting to solve the problem in the present day.

Mobilizing such resources in a short period of time seems unlikely and rethinking a strategy over more years may be needed to deploy the right set of sustainable investments. Figure 14 illustrates the change in the nature of the spending. In both "worlds," it can be observed that the largest increase occurs in the "*empower the excluded"* type of investments, mainly through safety nets (see Figure 15 for details in terms of structure of composition). In a short period of time, a number of productive, long-term investments and part of the "*on the farm"* category, become less attractive, and food aid (through different mechanisms) becomes the main solution to achieving the targets by 2030. The observed scaling up of food aid in 2022 as a response to the food crisis is an illustration of this mechanism in the real world, but also shows the difficulties associated with maintaining such high level of spending over many years. Improving the system, especially through storage and reduction of post-harvest losses included in *"food on the move"* appears to be also more attractive in the short term, since it helps deliver locally produced food that already exists at a better cost. This approach also helps increase smallholder incomes and their capacity to support their own food security.

Between the two stages of the world, the distribution of global hunger is also slightly different. New hotspots (e.g., Ethiopia, Sudan, Afghanistan, and Horn of Africa) are changing both the nature of needed investments (i.e., country-specific needs) and the overall burden for the donor communities, because the co-funding rule depends upon the level of development of the partner countries. A shift of hunger from Asia and Latin American Countries to Africa—as happened between the 2018 world projections and the 2023 world projections—has led to a stronger contribution of donors and a higher cost for the same total investments (donor plus domestic, since the domestic share is lower in Africa than in other regions).

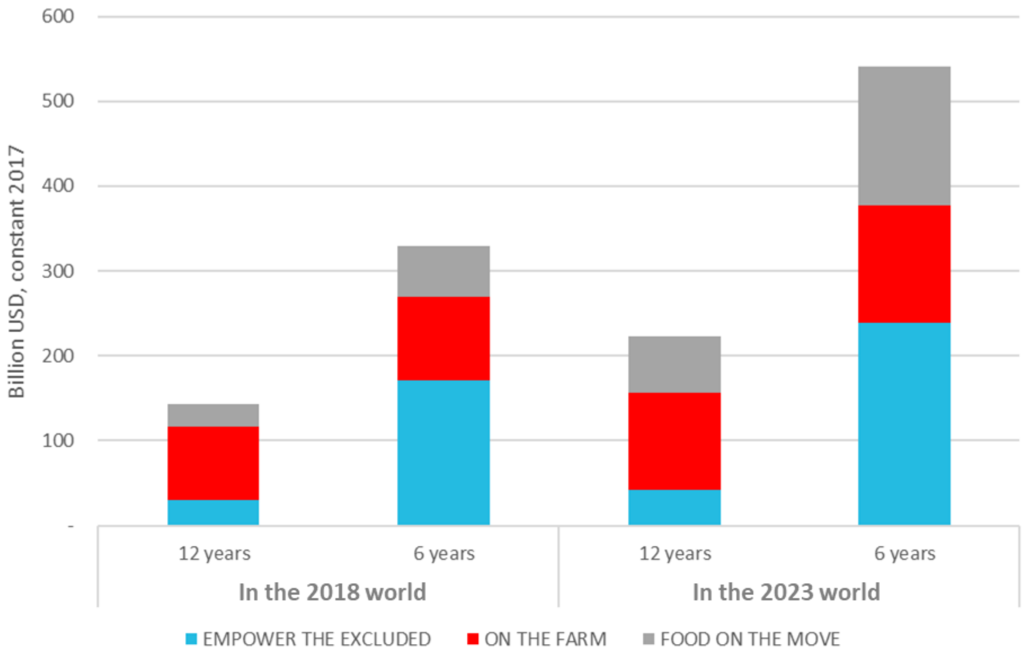

Figure 14: Evolution of the donor cost to eliminate hunger by 2030

Source: Authors own calculations.

Figure 15 provides more detailed information on the share of each intervention in the global portfolio. In the 2023 world, R&D spending is largely eliminated, due to the inability to deliver within six years. Meanwhile, social safety nets are scaled, value chain interventions and market access are boosted, and some more basic support to producers is scaled up (e.g., a significant increase in relative terms for output and input subsidies that could be seen as way to deliver a short term boost of production to cope with higher input prices in the 2023 world, in particular).

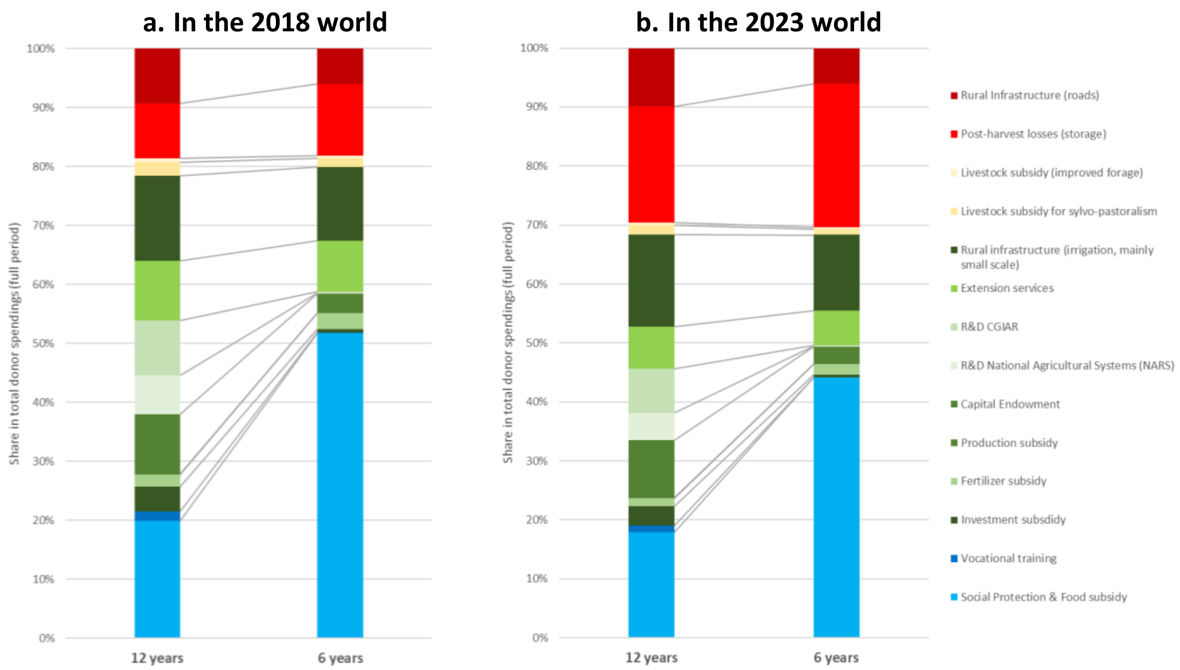

Figure 15: Evolution of structure of spending

Source: Authors own calculations.

6. Conclusion and policy implications

Recent global projections have shown that the world is not on track to achieve Zero Hunger and Malnutrition by 2030, in line with SDG 2. In the past few years, the number of undernourished people has been on the rise again, from 588 million people in 2015 to 735 million in 2022. The majority of the world's 402 million undernourished people are found in Asia, while Africa is the region with the fastest growth. Considering the total number of people affected by moderate or severe levels of food insecurity, an estimated 2.4 billion people in the world did not have regular access to safe, nutritious and sufficient food in 2022 and 3.1 billion people could not afford healthy diets.

Without improvement of the situation, the number of people suffering from hunger will be about 590 million by 2030 (FAO et al., 2023). This is about 119 million more undernourished people than in the scenario in which neither the COVID-19 pandemic nor the war in Ukraine had occurred. The world is also not on track to achieve the 2030 targets for child stunting, child overweight, child wasting, and low birthweight—important indicators of severe malnutrition. According to estimates, in 2022, 22 percent of children under 5 years of age were stunted, 7 percent were wasted, and 6 percent were overweight.

Overseas development assistance has an important role to play in achieving zero hunger and malnutrition. Analyses of ODA flows show that ODA from the G7 countries specifically allocated to food security and rural development has almost tripled from USD 8.3 billion in 2000 to USD 23.7 billion in 2022 (in Constant 2022 USD). Most of this ODA was targeted at countries with a relatively higher prevalence of undernourishment, notably in Sub-Saharan Africa. In 2022, a significant portion of G7 member countries' ODA was allocated to agricultural development, while water and sanitation, food aid, and environmental protection also received substantial investments. Germany has increased its contributions to these sectors most in recent years, followed by Japan, France, and the United States.

The MACC analyses presented in this study emphasize the urgency and escalating costs associated with addressing hunger and malnutrition:

1. The short-term investment-focused MACC analysis highlights **feasible actions that can significantly reduce undernourishment by 2030**. The estimated additional annual investment required to meet the G7 commitment of lifting **500 million people** out of hunger by 2030 is approximately **USD 27 billion**, annually—significantly higher than the earlier estimate of USD 12 billion (ZEF & FAO, 2020).
2. The additional cost of the feasible short-term measures aimed at **lifting about 700 million people out of hunger and malnutrition by 2030 rises to USD around 90 billion**, annually. This marks a sharp increase in the projected costs compared to the 2020 estimate (USD 30 billion annually).

3. Extending the SDG 2 end line to 2040, additional investments of approximately USD 10 billion annually are projected to lift 500 million people out of hunger and malnutrition by 2040, rising to USD 21 billion annually to target about 700 million people.

Implications for policies and global food systems governance

The analyses presented in this study emphasize the urgency and escalating costs associated with delayed action. Moreover, it is to be expected that moving the last 100 million people out of undernourishment in the coming years will require more and different investments than the first 100 million. With limited time until the 2030 deadline, feasible investment options become restricted, and the cost of achieving Zero Hunger soars. It is the high costs of inaction which calls for immediate action.

However, sustainable and economically efficient policies necessitate combining short-term humanitarian action with long-term interventions on a realistic timeline. Extending the SDG 2 end line to 2040 is not proposed here. It would be an unfortunate consequence of a lack of sufficient action in the first decade of the SDGs. Such an extension of the end line should only be considered if the—indeed sizable—investment actions that could deliver the end of hunger by 2030 cannot be mobilized quickly enough.

Recalculating the costs of hunger reduction and shifting policy agendas forward is not satisfactory unless the causes of the failure to achieve the needed progress are addressed. This leads us to issues of food systems governance and related broader policy implications of this study:

1. **Immediate and concerted efforts are required to mobilize substantial investments in short-term hunger reduction interventions**, focusing on transfers to the needy, humanitarian assistance, and social protection programs. Indeed, ending hunger soon is investment in sustainable human development and peace.
2. **Combining short-term actions with long-term strategies is essential for sustainable hunger reduction beyond 2030**, requiring a balance of short-term impactful interventions with additional investments in productivity-enhancing and sustainable solutions, including investments in agricultural R&D, agricultural extension services, small- and large-scale irrigation, integrated soil fertility management, soil water management, nitrogen use efficiency enhancement, food loss reduction, and infrastructure. In brief, this is a comprehensive innovation agenda (von Braun et al., 2023).
3. Looking at global actions or the lack thereof in the past half-decade suggests that **the global governance of food and nutrition needs revisiting and reform**. Initiating pathways that can lead to such reform processes seems overdue (von Braun and Birner, 2016). The commitments by the G7 and G20 were important and did mobilize additional

resources for ending hunger, but further support is needed to strengthen implementation capacities and establish follow up mechanisms. Furthermore, stronger and more structured engagement of the corporate sectors of the food system, finance institutions and the science communities around the world in food systems transformation processes would be welcome.

4. **The important global policy actions that require attention to end hunger are**:

- facilitating **integration of global level actions** in the key areas of hunger reduction, jointly with the actions on climate resilience, health, biodiversity, and international trade. This requires more than dialogues; it calls for institutional changes. In climate policy, due consideration of food and agriculture issues was finally achieved at COP28 in 2023,
- developing a strong **finance agenda** for the investments needed to end hunger and achieve other key nutrition targets,
- encouraging institutional innovations and enhanced coordination for a sound **science – policy interface** at the global level that is well networked with regional and national interfaces,
- strengthening the **capacities for national-level implementation** of actions, especially in emerging economies with increased domestic and international support, and
- **leveraging initiatives** such as the Global Alliance Against Hunger and Poverty proposed by the Brazilian G20 presidency **to accelerate progress**.

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Annex A – Section 2

Table A1: List of countries categorized by conflict, climate, economic slowdown, and as food importing nations

Conflict	Climate	Food importing	Economic slowdown
Afghanistan	Afghanistan	Afghanistan	Afghanistan
Armenia	Bangladesh	Angola	Angola
Azerbaijan	The Bahamas	Antigua and Barbuda	Antigua and Barbuda
Burundi	Germany	Burundi	The Bahamas
Burkina Faso	Dominica	Benin	Belarus
Central African Republic	Fiji	Burkina Faso	Barbados
Cameroon	Guatemala	Bangladesh	Bhutan
Democratic Republic of the Congo	Haiti	Barbados	Republic of the Congo
Republic of the Congo	India	Bhutan	Cape Verde
Comoros	Cambodia	Botswana	Czech Republic
Eritrea	Madagascar	Central African Republic	Dominica
Ethiopia	Myanmar	Ivory Coast	Ecuador
Federated States of Micronesia	Mozambique	Democratic Republic of the Congo	Spain
Guinea-Bissau	Nepal	Comoros	Fiji
Haiti	Pakistan	Cuba	Federated States of Micronesia
Iraq	Philippines	Djibouti	Equatorial Guinea
Kiribati	Puerto Rico	Dominica	Grenada
Lebanon	Thailand	Dominican Republic	Hong Kong
Libya	Vietnam	Egypt	Haiti
Marshall Islands	Zimbabwe	Eritrea	Jamaica
Mali		Ethiopia	Japan
Myanmar		Gabon	Kyrgyzstan
Mozambique		Guinea	Saint Kitts and Nevis
Niger		The Gambia	Lebanon
Nigeria		Guinea-Bissau	Libya
Papua New Guinea		Grenada	Saint Lucia
Palestine		Honduras	Sri Lanka
Sudan		Haiti	Lesotho
Solomon Islands		Jamaica	Macau
Somalia		Jordan	Mexico
South Sudan		Kenya	Republic of Macedonia
Syria		Cambodia	Myanmar
Chad		Kiribati	Mongolia
East Timor		Saint Kitts and Nevis	Mauritius
Tuvalu		Laos	Namibia
Venezuela		Liberia	Palau
Yemen		Saint Lucia	Russia
Zimbabwe		Sri Lanka	Sudan
		Lesotho	Solomon Islands
		Morocco	Suriname
		Madagascar	Thailand
		Maldives	East Timor
		Mali	Tonga
		Myanmar	Trinidad and Tobago
		Mongolia	Tunisia
		Mozambique	Ukraine
		Mauritania	Saint Vincent and the Grenadines
		Mauritius	Venezuela
		Malawi	Vanuatu
		Namibia	Samoa
		Niger	Yemen
		Nepal	
		Pakistan	
		Peru	

		Rwanda Sudan Senegal Solomon Islands Sierra Leone El Salvador Somalia South Sudan São Tomé and Príncipe ESwatini Chad Togo East Timor Trinidad and Tobago Tunisia Tuvalu Tanzania Uganda Saint Vincent and the Grenadines Venezuela Vanuatu Yemen Zambia	

Table A2: Prevalence of child stunting, child overweight, low birthweight, *and* exclusive breastfeeding (<6 months), 201*9*-20*22*

	Child stunting (percent)		Child overweight (percent)		Child wasting (percent)	Low birthweight (percent)		Exclusive breastfeeding [b] (percent)	
	2012	**2022**	**2012**	**2022**	**2022**	**2012**	**2020**	**2012**	**2021**
WORLD	26.3	22.3	5.5	5.6	6.8	15	14.7	37	47.7
AFRICA	34.4	30.0	5	4.9	5.8	14.5	13.9	35.4	44.3
Northern Africa	23.5	21.7	11.8	12.3	6.3	14	14.1	40.8	n.a
Sub-Saharan Africa	36.2	31.3	3.8	3.7	5.7	14.5	13.9	34.4	45.1
Eastern Africa	38.6	30.6	3.9	3.6	5	14.7	14.0	48.6	59.1
Middle Africa	37.9	37.4	4.5	4.6	5.6	12.8	12.2	28.4	44.4
Southern Africa	23.4	22.8	12.3	11.4	3.5	16.4	16.4	n.a.	32.8
Western Africa	34.5	30.0	2.3	2.4	6.7	14.9	14.3	22.1	35.1
ASIA [c]	28.2	22.3	4.8	5.1	9.3	17.2	17.2	39	51.5
Central Asia	39.3	7.7	2.9	5.0	13.7	25.4	6.0	46.5	44.9
Eastern Asia [c]	14.7	4.9	8.2	8.3	2.1	6.3	5.5	29.2	35.3
South-eastern Asia	40.3	26.4	2.7	7.4	14.3	26.1	12.5	47.2	48.3
Southern Asia	16	30.5	6.5	2.8	4.2	8.1	24.4	30.3	60.2
Western Asia	7.7	14.0	6.6	7.2	1.5	5.5	12.3	28.4	31.7
Western Asia and Northern Africa	30.4	17.9	6.4	9.8	7.8	12.8	13.1	33.4	n.a
LATIN AMERICA AND THE CARIBBEAN	19.1	11.5	9.1	8.6	3.5	12.2	9.6	31.9	42.6
Caribbean	21.2	11.3	10.4	6.6	4.9	13.1	11.7	37.2	31.4
Central America	12.7	16.9	7.4	6.7	1.4	9.5	10.9	34.3	37.7
South America	13	9.0	6.5	9.7	2.9	11.4	8.8	29.4	46.8
OCEANIA [d]	18.2	44.0	6.6	13.9	1	10.9	17.9	21.7	59.5
Australia and New Zealand [e]	10.1	3.4	7.9	19.3	1.4	8.6	6.4	42.2	n.a
NORTHERN AMERICA AND EUROPE	40.9	3.8	9.3	7.6	8.3	17.4	7.4	56.6	n.a
Northern America [f]	3.4	3.6	12.4	8.2	n.a.	6.4	8.1	n.a.	25.8
Europe	4.2	4.0	9.2	7.3	n.a.	7.4	7.0	n.a.	n.a

Note: n.a. is where population coverage is under 50 percent.
Sources: Data for stunting, wasting and overweight are based on UNICEF, WHO & World Bank. 2023. UNICEF-WHO-World Bank: Joint child malnutrition estimates - Levels and trends (2023 edition). https://data.unicef.org/resources/jme-report-2023, www.who.int/teams/nutrition-and-food-safety/monitoring-nutritional-status-and-food-safety-and-events/joint-child-malnutrition-estimates, https://datatopics.worldbank.org/child-malnutrition; data for exclusive breastfeeding are based on UNICEF. 2022. Infant and young child feeding. In: UNICEF. https://data.unicef.org/topic/nutrition/infant-and-young-child-feeding; data for low birthweight are from UNICEF & WHO. 2023. Low birthweight joint estimates 2023 edition. https://data.unicef.org/topic/nutrition/low-birthweight; www.who.int/teams/nutrition-and-food-safety/monitoring-nutritional-status-and-food-safety-and-events/joint-low-birthweight-estimates.

Table A3: Prevalence of food insecurity at severe level only, and moderate or severe level, measured with the FIES, 2014-2022

	Prevalence of severe food insecurity in the total population (percent)						Prevalence of moderate or severe food insecurity in the total population (percent)					
	2014	**2015**	**2019**	**2020**	**2021**	**2022**	**2014**	**2015**	**2019**	**2020**	**2021**	**2022**
WORLD	7.8	7.6	9.3	10.8	11.7	11.3	21.2	21.7	25.3	29.4	29.6	29.6
AFRICA	16.8	17.2	20.2	22.4	23.8	24	44.5	45.4	52.3	56	59.9	60.9
Northern Africa	10.2	9	8.7	9.5	11.2	12	29.6	26.2	28.8	30.2	34	32.4
Sub-Saharan Africa	18.4	19.1	22.8	25.4	26.6	26.6	48.1	49.8	57.7	61.8	65.7	67.2
Eastern Africa	21.8	22	25	28.1	28.7	27.7	56.7	56.8	63.5	66.5	66.8	69.2
Middle Africa	n.a.	n.a.	n.a.	36	37.8	39.1	n.a.	n.a.	n.a.	70.1	75.4	78.4
Southern Africa	8.9	9	9.3	11	11	12.5	21.4	21.7	22.1	24.7	24.7	25.9
Western Africa	10.2	11.4	16.6	19.9	21.7	22	36.1	39.8	51.7	59	66.7	66.4
ASIA	7.1	6.6	8.1	9.6	10.4	9.7	17.7	17.7	21.2	25.7	24.5	24.2
Central Asia	1.6	1.4	2.3	4.8	5	4.6	8.4	9.1	13.5	17.8	20.1	17.4
Eastern Asia	0.8	0.8	1.3	2	1	1	6	5.9	7.4	7.8	6.1	6.2
South-eastern Asia	2.1	1.9	1.8	2.1	2.6	2.6	14.6	14.5	14.5	15.5	16.9	16.8
Southern Asia	14.3	13.2	16.3	18.8	21	19.4	27.8	27.7	34.3	43.1	40.6	40.3
Western Asia	8.3	9	8.9	9.6	10.2	10.3	28.7	30.9	29.9	35.1	38.7	35.5
Western Asia and Northern Africa	9.2	9	8.8	9.5	10.7	11.1	29.1	28.7	29.4	32.8	36.5	34.1
LATIN AMERICA AND THE CARIBBEAN	7.5	7.3	9.7	12.5	13.9	12.6	24.5	27.3	31.5	39.3	40.3	37.5
Caribbean	n.a.	n.a.	n.a.	32.4	25.7	28.2	n.a.	n.a.	n.a.	65.4	59.5	60.6
Central America	6.5	6.7	7.3	7.3	8	8.6	30.2	30.3	28.2	34.2	34.1	34.5
South America	5.4	5	8.5	12.7	15.1	12.7	18.4	22.6	29.9	38.8	40.9	36.4
OCEANIA	2.5	2.6	3.8	2.6	4.5	3.4	11.5	10	13.6	12.1	13	13
NORTHERN AMERICA AND EUROPE	1.4	1.4	0.9	1.2	1.5	1.5	9.3	9.3	7.1	7.8	7.7	8

Notes: n.a. = not available, as data are available only for countries, representing less than 50 percent of the population in the region.

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

Table A4: Number of People experiencing food insecurity at severe level only, and moderate or severe level, measured with the FIES, 2014-2022

	Number of severely food-insecure people (million)						Number of moderately or severely food-insecure people (million)					
	2014	**2015**	**2019**	**2020**	**2021**	**2022**	**2014**	**2015**	**2019**	**2020**	**2021**	**2022**
WORLD	570.8	561.5	719.8	850.7	927.3	900.1	1559.5	1612.4	1966.4	2307.2	2342.5	2356.9
AFRICA	196.4	206.3	268.1	305	331.1	341.8	521.4	544.8	695	761.7	834.5	868.3
Northern Africa	22.7	20.5	21.5	23.8	28.7	31.1	66.2	59.9	71.2	75.9	86.9	84.3
Sub-Saharan Africa	173.7	185.8	246.6	281.2	302.4	310.6	455.2	484.9	623.7	685.8	747.6	783.9
Eastern Africa	83.6	86.6	109.3	126.2	132.1	130.9	217.2	223.5	277.9	298.8	308.2	327.4
Middle Africa				66.5	71.9	76.7				129.4	143.5	153.7
Southern Africa	5.6	5.7	6.2	7.4	7.5	8.6	13.4	13.8	14.7	16.6	16.8	17.8
Western Africa	35.7	41	66.1	81.1	90.8	94.4	125.9	142.7	205.7	240.8	279.1	285.1
ASIA	311.9	293.7	377.3	449.5	486.1	456.9	779.9	791	981.8	1196.8	1151.5	1144.9
Central Asia	1.1	1	1.7	3.6	3.8	3.5	5.7	6.3	9.9	13.3	15.3	13.4
Eastern Asia	13	12.4	21.4	33.4	17	16	96.9	95.7	123	129	102.3	103.4
South-eastern Asia	13.5	11.9	12.2	13.9	17.7	17.8	92	92.5	96	104	114.2	114.4
Southern Asia	262.8	244.7	316.9	371.3	417.9	389.2	510.7	514.7	668.1	849.8	807.6	809.2
Western Asia	21.5	23.8	25.1	27.4	29.7	30.3	74.6	81.8	84.8	100.7	112.1	104.4
Western Asia and Northern Africa	44.3	44.3	46.6	51.2	58.4	61.4	140.8	141.7	156	176.6	199	188.7
LATIN AMERICA AND THE CARIBBEAN	46.4	45.3	62.5	81.8	91.1	83.4	151.3	169.8	203.8	256.4	264.3	247.8
Caribbean				14.2	11.4	12.5				28.7	26.3	26.9
Central America	10.8	11.2	12.8	12.9	14.3	15.4	49.9	50.7	49.3	60.3	60.6	61.9
South America	21.9	20.8	36.5	54.7	65.5	55.4	75.1	93.3	128.3	167.4	177.4	159
OCEANIA	1	1.1	1.7	1.1	2	1.5	4.6	4	5.9	5.3	5.8	5.9
NORTHERN AMERICA AND EUROPE	15.2	15.1	10.3	13.3	17	16.5	102.3	102.8	79.8	87	86.4	90

Notes: n.a. = not available, as data are available only for countries, representing less than 50 percent of the population in the region.

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

Table A5: Absolute gender difference in prevalence of food insecurity at severe level only, and moderate or severe level, measured with the FIES, 2014-2022

	Prevalence of severe food insecurity in the total population (millions)						Prevalence of moderate or severe food insecurity in the total population (millions)					
	2014	**2015**	**2019**	**2020**	**2021**	**2022**	**2014**	**2015**	**2019**	**2020**	**2021**	**2022**
WORLD	25.4	22.5	22.7	35.7	75.1	35.3	60.1	56	48.5	80.8	119.1	79.7
AFRICA	6.8	3.7	5.4	5.6	4.5	4.3	14.4	8.9	12.8	10.7	7.6	10.4
Northern Africa	2	-0.2	0.9	0.6	0	0.9	4.3	1.4	3.3	0.1	0.5	1.5
Sub-Saharan Africa	4.8	3.9	4.5	4.9	4.4	3.4	10.2	7.5	9.6	10.5	7.1	8.9
Eastern Africa	4	4.4	3.5	4	3.7	2.5	6.7	6.2	4.1	4.7	5	6.7
Middle Africa				-0.1	0.1	0				1.4	1.6	1.3
Southern Africa	0.6	0.6	0.5	0.7	0.7	0.3	1.1	1.2	1.2	1.4	1.3	0.3
Western Africa	0.2	-1	0.5	0.4	0	0.7	1.1	-0.9	2.9	3.1	-0.9	0.4
ASIA	11.9	11.4	12	25	58.8	20.6	16.4	17	9.8	34.1	65.3	26.3
Central Asia	0.1	0.1	0.1	0.2	-0.2	0.2	0.6	0.4	0.6	1.1	-0.4	0.3
Eastern Asia	-2.5	-2.1	-6.5	-7.1	-1.7	-1	-5.6	-4.7	-17.1	-22.3	-8.4	-9.1
South-eastern Asia	-0.6	0.2	0.4	0	0.4	0.7	-0.7	2.2	0.2	2.7	1.1	1.6
Southern Asia	15.9	12.6	17.5	31.1	59.1	18.8	23.1	18.5	25.4	50.6	69.9	29.2
Western Asia	-1	0.6	0.6	0.7	1.3	2	-0.9	0.6	0.7	1.9	3.1	4.3
Western Asia and Northern Africa	0.9	0.4	1.3	1.3	1.3	2.9	3.4	2	4	2	3.6	5.8
LATIN AMERICA AND THE CARIBBEAN	4.5	4.2	5.6	6.4	11.7	8.4	11.8	13.2	18.9	28.3	34	27.9
Caribbean				0.5	0.5	0.8				1.2	0.9	1.1
Central America	0.8	0.8	0.9	1.6	1.8	1.7	2.6	3.4	5	8.8	9.4	7.7
South America	3.3	2.8	4.1	4.3	9.4	5.9	8.9	8.7	12.7	18.4	23.9	19.2
OCEANIA	0	0	0	-0.1	-0.4	0	0	0.4	0.5	-0.2	-0.2	0.2
NORTHERN AMERICA AND EUROPE	2.3	3.1	-0.2	-1.1	0.5	2	17.5	16.5	6.6	7.9	12.3	15

Notes: n.a. = not available, as data are available only for countries, representing less than 50 percent of the population in the region.

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

Table A6: Absolute gender difference in prevalence of food insecurity at severe level only, and moderate or severe level, measured with the FIES, 2014-2022

	Prevalence of severe food insecurity in the total population (percent)						Prevalence of moderate or severe food insecurity in the total population (percent)					
	2014	**2015**	**2019**	**2020**	**2021**	**2022**	**2014**	**2015**	**2019**	**2020**	**2021**	**2022**
WORLD	0.9	0.8	0.7	1.2	2.4	1.1	2.1	1.9	1.6	2.6	3.8	2.4
AFRICA	1.6	0.6	0.9	0.9	0.6	0.5	3.2	1.5	2.2	1.5	0.6	1.2
Northern Africa	2.6	-0.2	1	0.8	0	1	6	2	4.2	0.3	0.8	1.9
Sub-Saharan Africa	1.2	0.8	0.8	0.8	0.6	0.3	2.2	1.1	1.4	1.5	0.4	0.8
Eastern Africa	2.7	2.9	1.7	1.8	1.5	0.6	3.7	2.9	0.6	0.7	0.9	1.9
Middle Africa	n.a.	n.a.	n.a.	-1.3	-1	-1.2	n.a.	n.a.	n.a.	0.9	1.1	0.4
Southern Africa	1.8	1.8	1.7	2.1	2.1	0.2	3.3	3.2	3	3.4	3.5	-0.9
Western Africa	0.1	-1.1	0.5	0.4	-0.1	0.5	0.9	-1.1	2.4	2.6	-0.8	0.4
ASIA	0.9	0.8	0.9	1.6	3.5	1.4	1.4	1.4	1	2.4	4.1	1.9
Central Asia	0.4	0.2	0.2	0.8	-1.3	0.2	1.8	1.3	1.4	3.5	-2.6	0.1
Eastern Asia	-0.4	-0.3	-0.9	-1	-0.2	-0.1	-0.7	-0.7	-2.4	-3.2	-1.1	-1.2
South-eastern Asia	-0.3	0	0.1	0	0.1	0.3	-0.5	0.8	-0.2	0.9	0.1	0.4
Southern Asia	3	2.5	3.1	5.1	8.9	3.2	4.8	4	4.9	8.7	11.1	5.4
Western Asia	-0.3	1.6	1.5	1.7	2.2	2.9	2.1	4	4.2	5.6	6.9	7.6
Western Asia and Northern Africa	1.1	0.8	1.3	1.3	1.3	2.1	3.9	3	4.1	3.1	4	4.9
LATIN AMERICA AND THE CARIBBEAN	1.6	1.5	1.9	2	4	2.6	4.1	4.4	6.2	9.5	11.5	9.1
Caribbean	n.a.	n.a.	n.a.	2.1	1.8	3.1	n.a.	n.a.	n.a.	4.4	2.8	3.9
Central America	0.9	1	1	2	2.3	2	2.6	3.9	6.1	11.5	12	9.2
South America	1.9	1.5	2.1	2	4.9	2.9	4.9	4.6	6.4	9.3	12.3	9.6
OCEANIA	0	0.3	-0.1	-0.3	-2.4	0	-0.4	3	2.5	-0.9	-1	0.8
NORTHERN AMERICA AND EUROPE	0.4	0.5	-0.1	-0.3	0	0.3	2.7	2.5	0.8	1	1.8	2.3

Notes: n.a. = not available, as data are available only for countries, representing less than 50 percent of the population in the region.

Source: FAO. (2024). FAOSTAT: Suite of Food Security Indicators. www.fao.org/faostat/en/#data/FS

Annex B – Section 3

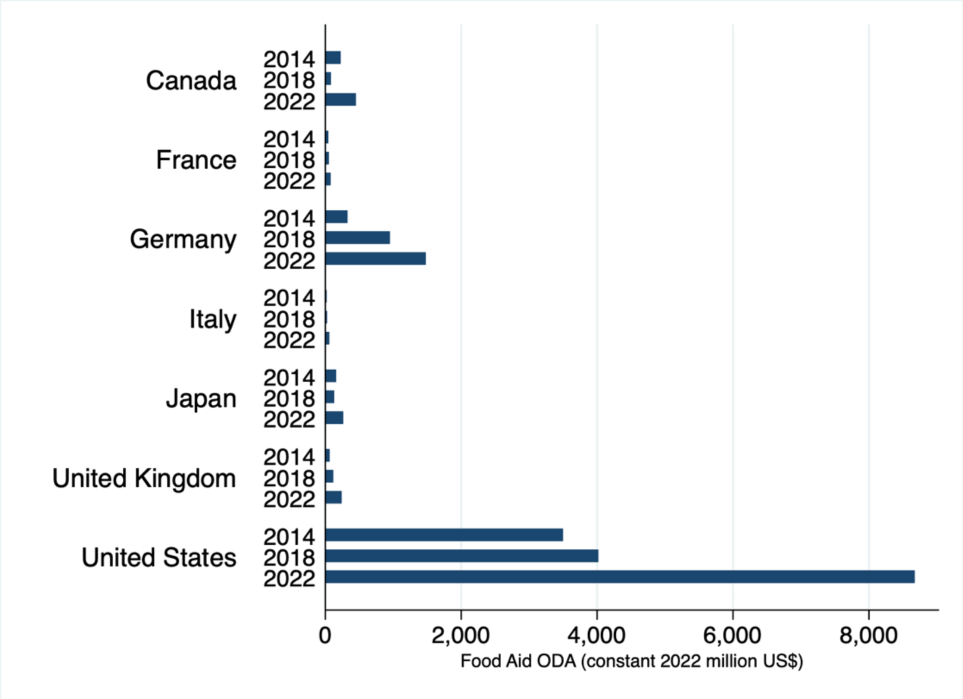

Figure B1: Allocation of Food Aid ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

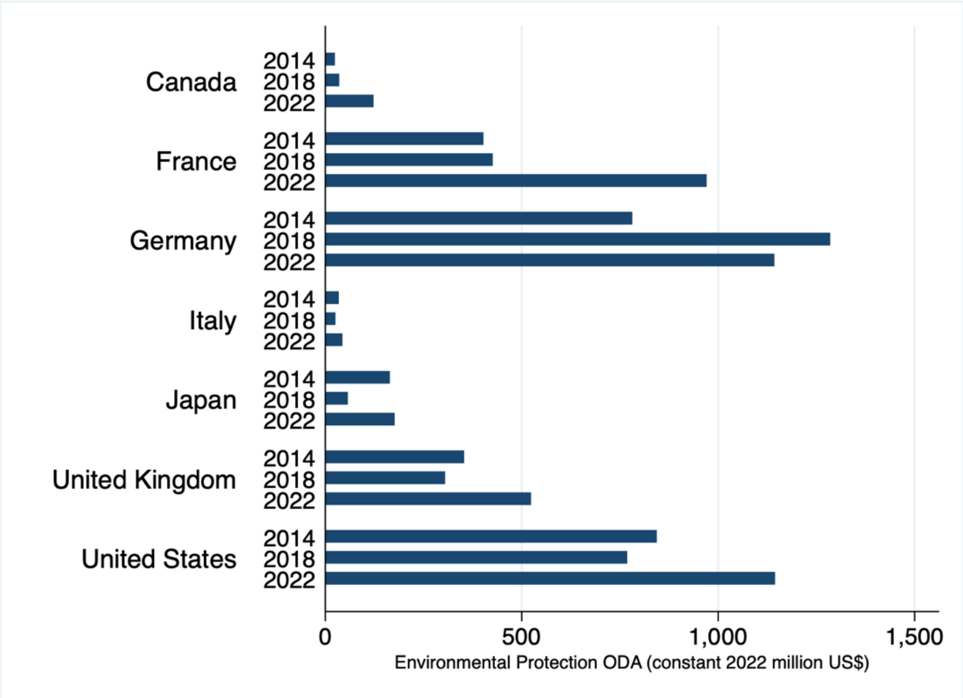

Figure B2: Allocation of Environmental Protection ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

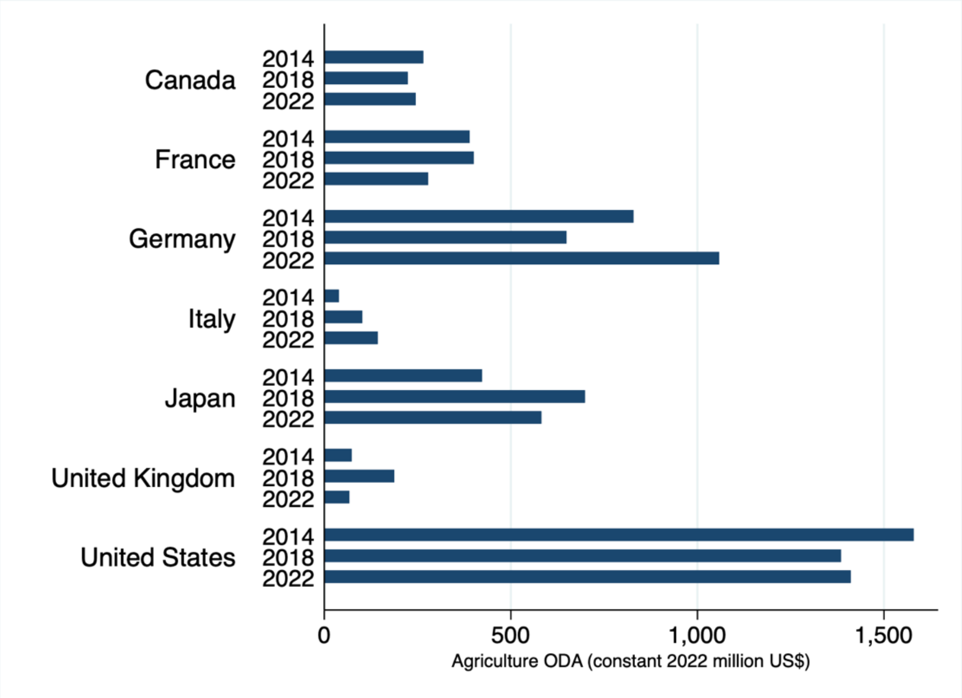

Figure B3: Allocation of Agriculture ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

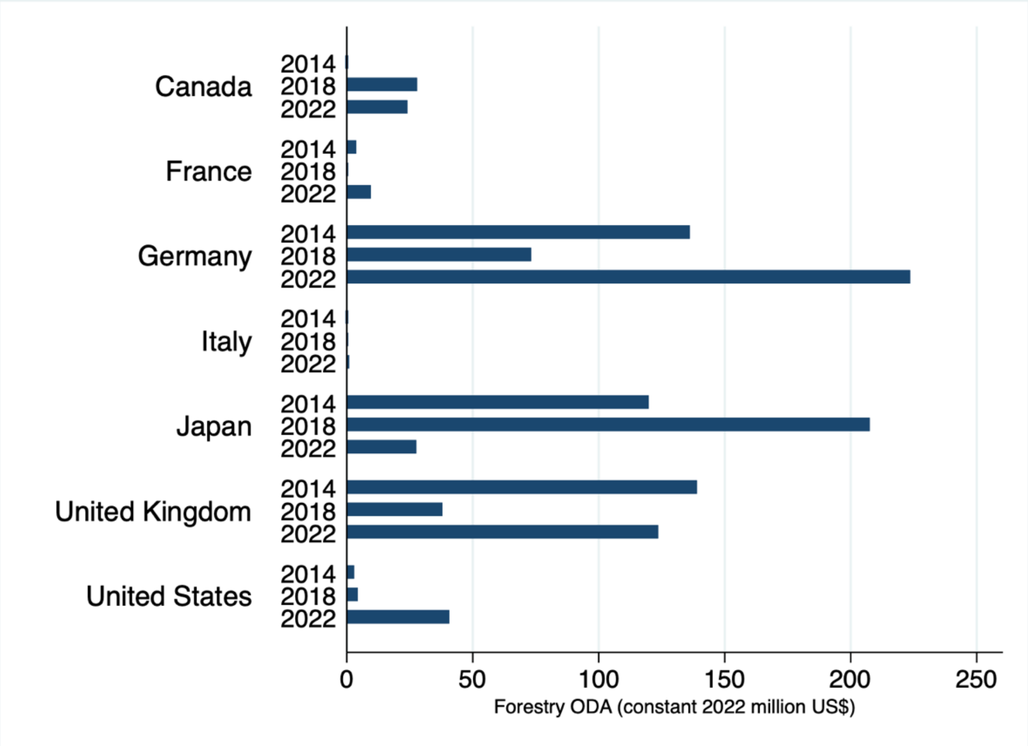

Figure B4: Allocation of Forestry ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

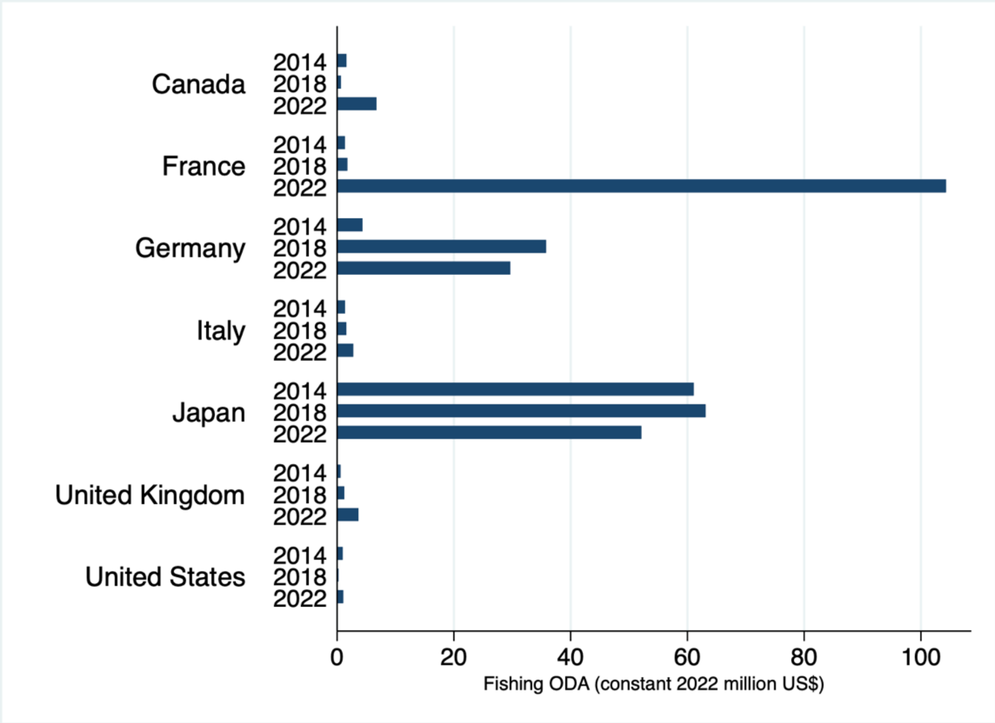

Figure B5: Allocation of Fishing ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

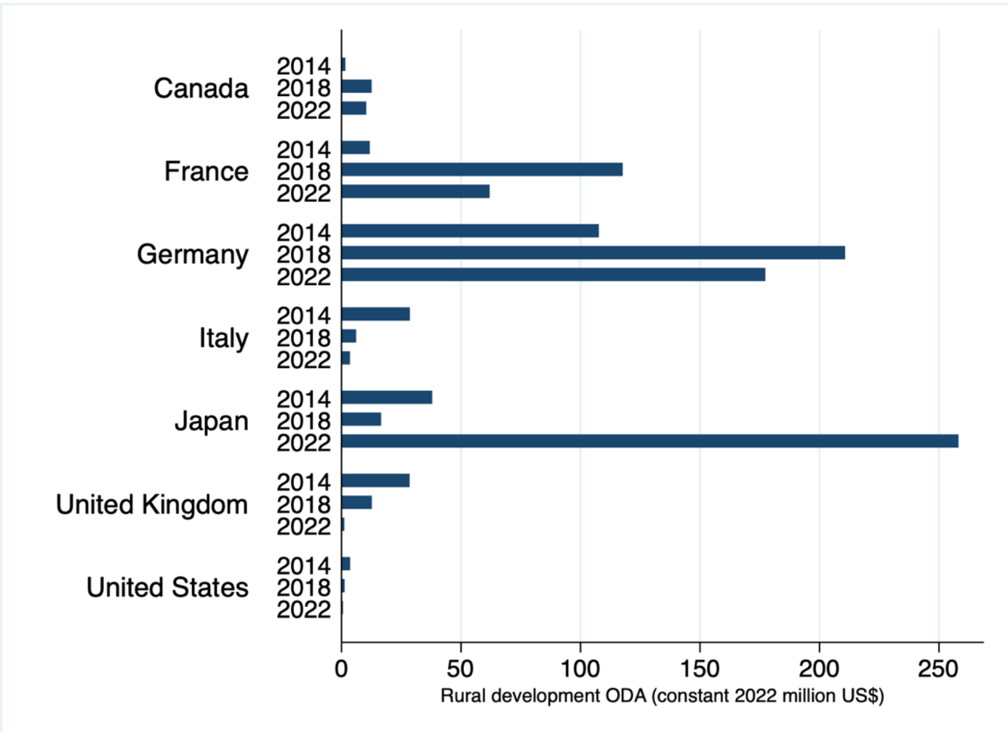

Figure B6: Allocation of Rural development ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

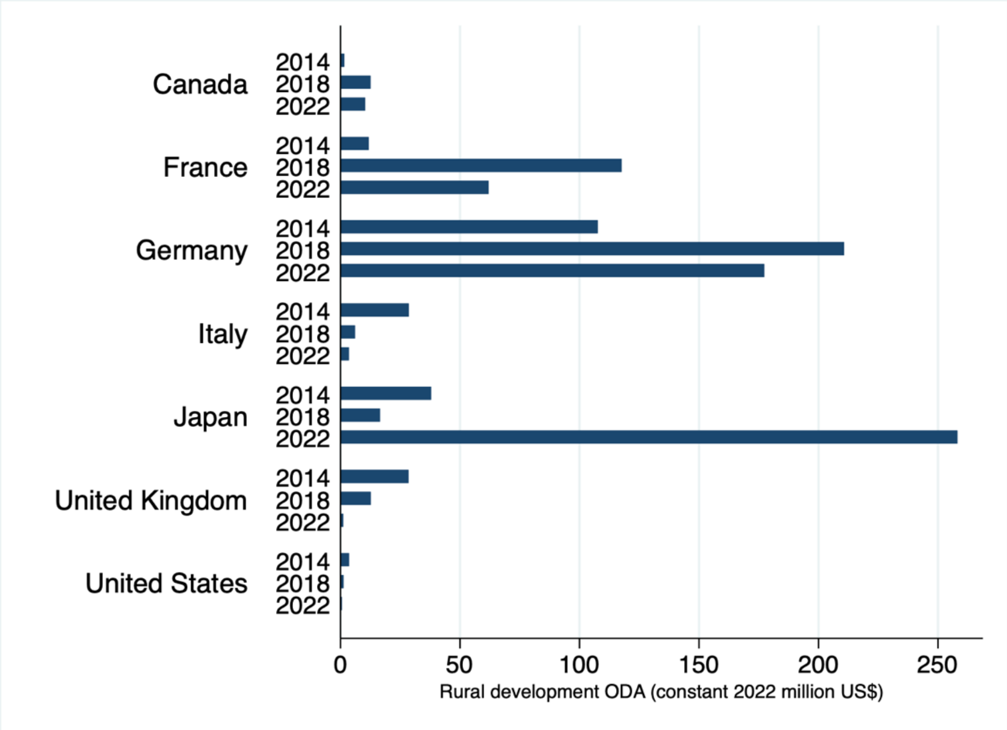

Figure B7: Allocation of Water and Sanitation ODA by G7 countries, 2018 vs 2022 (ODA commitments, constant 2022 million USD)

Source: Authors' own elaboration based on OECD (2024)

Annex C – Section 4

Investment in agricultural R&D and agricultural R&D efficiency enhancement

Rosegrant et al. (2021) simulated the impact of significant increases in agricultural R&D investments and improved research efficiency on global hunger by 2030 and 2050. Incremental to the investment projected under the reference scenario, this scenario simulates increased investments by the CGIAR plus increased complementary investments by National Agricultural Research Systems (NARS) and investments in higher research efficiency. Research efficiency is achieved by advancing breeding techniques and effective regulatory and intellectual property rights systems that speed up the time needed to identify and disseminate new varieties. According to Rosegrant et al. (2021), increased investment in agricultural R&D and research efficiency enhancement would lead to a reduction of 168.5 million undernourished persons by 2030 with an additional annual average investment cost of USD 3.52 billion per year starting from 2015. The estimated cost is adjusted to USD 47.8 billion per year on average and USD 17.7 per individual lifted out of hunger, considering inflation and the cost of capital (Table 6).

Investment in agricultural extension services

Ragasa and Mazunda (2018) evaluated the impact of agricultural extension services on food security, particularly within the context of a heavily subsidized agricultural input system. Their findings indicate that access to agricultural extension services can substantially increase the total household value of production by 36 percent, potentially boosting annual income per person by USD 6.30.

This study assessed the hunger reduction potential associated with investing in agricultural extension services using data from FAO's food security indicators, including the Dietary Energy Supply (DES), Mean Dietary Energy Requirement (MDER), and Coefficient of Variation (CV) (FAO, 2020a). Following FAO's methodology for calculating the Prevalence of Undernourishment (PoU) and Number of Undernourished (NoU) (FAO et. al., 2019), the impact of agricultural extension on these indicators was estimated. Using the correlation coefficient from Ragasa and Mazunda (2018) and the income elasticity of dietary energy supply from Ecker and Qaim (2011), it was found that agricultural extension could potentially rescue approximately 81.5 million people from hunger. To determine the investment requirements for agricultural extension services, Blum and Szonyi's (2014) suggestion of allocating 1 percent of GDP to agricultural extension was adopted. Initially, the earlier MACC analysis projected an annual investment of around USD 2.09 billion in agricultural extension to lift 81.5 million people out of hunger. In the current MACC analysis considering long-term investments, this estimate was updated to approximately USD 1.5 billion to achieve the same outcome. This updated figure includes adjustments for inflation and the cost of capital (Table 6).

Investment in irrigation expansion, water use efficiency and soil-water management

Sulser et al. (2021) have evaluated the impact of increased investment in irrigated area expansion coupled with increased water use efficiency irrigation expansion, water use efficiency, and improvements in soil-water management systems that affect agricultural production through changes in water availability. For **irrigation expansion**, it is assumed that about 20 million hectares of agricultural land will be converted to irrigated land in developing countries, offsetting about 22 million hectares of rainfed area. In certain regions, the expansion of irrigation will not entirely replace rainfed agriculture and will lead to an overall increase in land use, as observed in Sub-Saharan Africa (SSA), where the total harvested area is projected to increase by 2.7 million hectares compared to the reference scenario by 2030. To simulate the additional benefit of **water use efficiency**, basin efficiency is assumed to increase by about 15 percentage points by 2030, increasing agricultural output while conserving water.[29] Improved water use efficiency is achieved through the adoption of efficient water management systems that utilize high-efficiency technologies like sprinkler and drip irrigation. The **irrigation expansion plus water use efficiency scenario** would cost an additional USD 8.10 billion per year, with the largest share of about USD 1.42 billion per year going to Sub-Saharan Africa. This scenario costs 30 percent more than conventional irrigation expansion because the efficiency improvements apply to all irrigated areas, i.e. 412 million hectares across developing countries, not just the newly expanded areas of 20 million hectares. In the current MACC analysis that considers the long-term investments, the investment cost for this scenario was updated to approximately USD 6.9 billion, considering adjustments for inflation using the annual average global producer price index (PPI) inflation rate from 2015 to 2022 (4.33 percent) and the cost of capital using an average interest rate on new external debt commitments for Low & Middle-Income Countries (LMIC) (3.17 percent) to 60 percent of the inflation-adjusted annual average intervention costs (Table 6).

To estimate the additional investment cost for **soil-water management**, Sulser et al. (2021) simulate the benefits of adopting practices such as no-tillage agriculture and rainwater harvesting to improve the water holding capacity of soils and make precipitation available for plants. The IMPACT model incorporates this aspect by increasing the parameter for effective precipitation in the water module. The parameter is increased over time by 5 to 15 percent to reach the maximum level in 2045. The parameter also varies by region, reflecting the technology currently applied within different regions. The cost of implementing these

[29] In the IMPACT model, basin efficiency is represented by a ratio of beneficial water depletion (crop evapo-transpiration and salt leaching) to total irrigation water depletion at the base scale. Thereafter, a prescribed basin efficiency incremental rate is assumed depending on water infrastructure investment and water management improvement in a food production unit.

technologies is estimated in the earlier study by applying the USD 179 per hectare cost to both rainfed and irrigated cropland in developing countries; an additional cost of USD 4.6 billion annually. In the current MACC analysis that considers the long-term investments, the investment cost for this scenario was updated to approximately USD 3.9 billion, considering adjustments for inflation and the cost of capital (Table 6).

Investment in small-scale irrigation expansion in Africa

In estimating the hunger reduction potential of expanding small scale irrigation in Africa, data is first obtained from FAO's suite of food security indicators namely the DES, MDER and the CV (FAO, 2020a). Then following FAO's methodological notes for calculating PoU (FAO et al., 2019), the new PoU and NoU as a result of the impact of small-scale irrigation expansion in Africa is calculated based on 3SLS regression coefficient of 2.5 from Passarelli et al. (2018) who assessed pathways from scale irrigation to food security in Ethiopia and Tanzania. To estimate the impact of small-scale irrigation expansion on the DES, the report uses the correlation coefficient given by Passarelli et al. (2018) and multiply it by Ecker and Qaim's (2011) income elasticity of dietary energy supply (calories) of 0.66. The additional number of individuals rescued from hunger due to expansion of small-scale irrigation expansion is the difference between the new NoU and the business as usual scenario, i.e. about 142.3 million people rescued from hunger (**Fehler! Verweisquelle konnte nicht gefunden werden.**). To estimate the annual investment required for small-scale irrigation expansion in Africa, You et al.'s (2011) estimate of 7.3 million hectares of potential expansion in the earlier study with an investment cost of USD 38 billion is used. After adjusting the cost estimate for inflation and the cost of capital, about USD 3.2 billion per year would be required over a period of 16 years. The annual per capita cost of lifting an individual out of hunger would be USD 22.8 (Table 6).

Investment in crop protection – Chemical control of diseases, insects, and weeds

Using the IMPACT model, Rosegrant et al. (2014) estimated that chemical protection of crops through the application of herbicides, insecticides and fungicides can reduce the number of people at risk of hunger by 1.62, 1.85, and 1.73 percent respectively by 2050 (Table C1). Based on linear interpolation, it is estimated that investment in crop protection for insects, diseases and weeds would lead to hunger reduction of about 10.1, 8.8 and 9.4 million respectively by 2030. Rosegrant et al. (2014) also show the child malnutrition reduction potential of additional food supply enhanced by the adoption of chemical protection of the crops of about 18 million by 2030. Based on data on the total area and per hectare costs of the implementation of chemical protection application (Gianessi, 2013; Rosegrant et al., 2014), the total costs of each intervention was estimated to be USD 2.6 billion for crop protection from insects, diseases and weeds. In the current MACC analysis that considers the long-term investments, the investment cost for this scenario was updated to approximately USD 2.2 billion, considering adjustments for inflation and the cost of capital (Table 6). By dividing total intervention costs by the number of people lifted out of hunger, the cost of chemical protection of the crops per undernourished person, amounting to 79.5 per undernourished can be obtained.[30]

Table C1: Crop protection potential to reduce hunger and related costs

		Baseline (1)	Crop Protection Scenario – Insects, diseases, & weeds (2)	Source or formula (3)
A	Contribution of the technology to hunger reduction (2050, %)		-5.2	Rosegrant et al. (2014)
B	Number of people at risk of hunger (2050, million)	1087.5	-56.5	B2 = B1 x A2;
B*	Number of people at risk of hunger (2030, million)	1033.1	-28.3	Based on linear interpolation
C	Contribution of the technology to reduce child malnutrition (%)		-0.79	Rosegrant et al. (2014)
D	Number of malnourished children (2050, million)	116.8	-0.9	D2 = D1 x C2;
D*	Number of malnourished children (2030, million)	130.4	-18.16	Based on linear interpolation
E	Total area of implementation (Mha)		175	Gianessi (2013); Rosegrant et al. (2014)
F	Per ha cost of crop protection for Insects, diseases, & weeds (USD per ha)		50, 40, & 60	Assumption
G	Total annual incremental implementation cost (million)		2,625	G = E x F/10
I	Annual average global producer price index (PPI) inflation (Median, 2022) (2015-2022) (%)		4.33	HA, Kose, & Ohnsorge (2021)
J	Average interest on new external debt commitments for Low & Middle Income Countries (LMIC) (%)		3.17	World Bank (2023)
k	Total annual incremental implementation cost (million, Inflation adjusted (2015-2022))		3532	K = G*(1+(4.33/100)$^{(1,8)}$
L	Total annual incremental implementation cost (million, Inflation and cost of capital adjusted)		3569	L = ((K*(0.40)) + ((K*0.60)*(1+0.0317)) (Assumed 60% national investment cost based on Laborde, Parent, and Smaller (2020)).
M	Total annual average incremental implementation cost (million, Inflation and cost of capital adjusted) (2025-2040)		2249	M=L*10/16
N	Cost per capita (USD per capita, Inflation and cost of capital adjusted)		79.5	H = M / (B*)

Source: Authors' own elaboration based on Rosegrant et al. (2014) and Gianessi (2013).

Investment in nitrogen-use efficiency and integrated soil fertility management

Rosegrant et al. (2014) used the IMPACT model to assess the potential benefits of adopting alternative agricultural technologies, such as varieties with enhanced nitrogen-use efficiency and integrated soil fertility management (combining chemical and organic fertilizers). They

[30] It should be noted that Rosegrant et al. (2014) do not consider the effects of pesticides on ecosystem health, farm workers, downstream settlements, and consumer health. Hence, the cost of unintended consequences as a result of pesticide applications is not considered in this study. However, we do acknowledge their importance across agriculture and public health.

evaluated future scenarios to understand the impact on yield growth, production, food security, food demand, and agricultural trade. Their estimates suggest that investments promoting the adoption of these technologies could reduce the number of people at risk of hunger by 113 million and 33.3 million by 2050, respectively. Based on linear interpolation, the earlier study assumed that 56.5 and 16.6 million people would be lifted out of hunger by 2030. Using data on the total area (175 million hectares) and the per-hectare costs of implementing the two technologies (USD 500 and USD 100 per hectare), the earlier study estimated the incremental annual average costs of each intervention to be USD 8.8 billion and USD 1.8 billion over a ten-year period for nitrogen-use efficiency and integrated soil fertility management, respectively. In the updated MACC analysis focusing on long-term investments, the investment costs for these scenarios were adjusted to approximately USD 7.5 billion and USD 1.5 billion over a sixteen-year period for nitrogen-use efficiency and integrated soil fertility management, respectively (Table 6). These figures account for inflation adjustments and the cost of capital

Investment in ICT - Agricultural information services

Hoddinott, Rosegrant, and Torero (2013) evaluated the impact of improved access to ICT-enabled market information on smallholder welfare, focusing on the Renters Market Light (RML) programme in India. This programme offers farmers weather forecasts, local market prices, and commodity information via mobile phones for a monthly fee of USD 1.50. They extended this model to six countries, assuming information access for six months per year at an annual cost of PPP USD 21.92 per household with 5.5 members. By averaging impact estimates from studies in Africa and South Asia, the study projected a 3.75 percent increase in agricultural income in Africa and 2.4 percent in South Asia due to higher prices. The study explored alternative benefit scenarios and estimated poverty reduction using household expenditure data adjusted for inflation. Assuming the programme reaches 2 million households in India, 1 million in Bangladesh, and 5 percent of the rural population in Africa, they projected an income increase of 1 percent to 4.8 percent for Bangladesh and India and 2 percent to 7.5 percent for the four African countries. Poverty reduction ranged from 0.8 percent to 3.8 percent in Bangladesh and India and 1.2 percent to 4.5 percent in African countries.

Following this approach, the earlier MACC analysis first estimated the poverty reduction potential of scaling up the RML programme to farmers in 69 low- and lower-middle-income countries, using household expenditure data and assuming a 35 percent contribution from crop sales. Based on updated mobile phone access data, a projected 5-percentage point increase in ICT use among rural populations is projected. The 5-percentage point increase was then applied to the rural population to determine the additional number of people using ICT services. By aggregating the country-level population using ICT services and adjusting for poverty reduction, and then multiplying it by the hunger to poverty correlation coefficient (i.e., 0.68), it is possible to obtain the number of people lifted out of hunger by ICT interventions. Subsequently, the cost of USD 21.92 per person from Hoddinott, Rosegrant, and Torero (2013) was multiplied by the targeted number of farmers to calculate the total cost of scaling up the intervention over five years. The annual cost per hungry person was then estimated by dividing the total cost by the number of hungry people addressed. Following this methodology, it was determined in the earlier MACC analysis that the intervention could lift 26.6 million people out of hunger at an average cost of USD 26.2 per undernourished lifted out of hunger annually. In the updated MACC analysis focusing on long-term investments, the annual total investment costs of this scenario was adjusted to approximately USD 0.8 billion over a five-year period (Table 6). This figure accounts for inflation adjustments and the cost of capital.

Investment in infrastructure and market access

In the earlier MACC analysis, the investment scenario in infrastructure improvements were developed based on empirical studies highlighting the impact of infrastructure development on food availability and the associated unit cost (Rosegrant et al., 2017). These scenarios were integrated into the IMPACT global food supply and demand model by adjusting the price wedges between producer and consumer prices, reducing the margin between the prices by 1 percentage point per year until 2030, and then assessing the resulting impact on food security outcomes. The analysis identified a need for approximately USD 10.8 billion in annual incremental investment across developing countries to enhance productivity along the food value chain and reduce marketing margins by better aligning supply and demand.

In the updated MACC analysis focusing on long-term investments, the estimated annual total investment cost for this scenario was adjusted to approximately USD 9.3 billion over a sixteen-year period (Table 6). This adjustment factors in inflation and considers the cost of capital

Investment to reduce food loss along the food value chain

Rosegrant et al. (2015) applied the IMPACT model to assess the investment needs to reduce global food loss, by applying a weighted grouped logistic regression to estimate the potential reduction in post-harvest loss due to developments in various infrastructure variables. The results highlight the importance of infrastructure development in reducing post-harvest loss, particularly in Sub-Saharan Africa. Integrating the fitted results into the IMPACT global food supply and demand model, they simulated the impact of increased post-harvest reduction investment scenarios on food security. A scenario of a 10 percent reduction in post-harvest losses by 2030 would help to reduce food prices, increase food availability, and improve food security. Specifically, the assessment indicated that food loss reduction measures would help lift 70 million people out of hunger by 2050 with an annual average incremental investment of USD 34 billion in infrastructure. Instead of taking the full annual USD 34 billion incremental investment in infrastructure, 25 percent or an annual allocation of USD 8.58 billion to food loss reduction is assumed.[31] In the updated MACC analysis focusing on long-term investments, the estimated annual total investment cost for this scenario was adjusted to approximately USD 7.4 billion over a sixteen-year period (Table 6). This adjustment factors in inflation and considers the cost of capital.

Trade - International trade integration (DDA)

With a focus on estimating the impact of completing the Doha Development Agenda (DDA) on hunger, the earlier MACC analysis converted the poverty reduction estimates into hunger reduction estimates using a correlation coefficient estimate between hunger and poverty of 0.68 (FAO et al., 2019), amounting to 108.8 million. However small they might be, trade reforms carry associated costs, encompassing expenses related to negotiating the reform and private adjustments for firms and workers. Approximately, 5 percent of the estimated annual comparative static benefit of 2025 is assumed to be the adjustment cost of the trade reform for the period of six years, amounting to a total of USD 300 billion investment. This allocation emphasizes spending required for negotiation support and policy advocacy, private costs for industry and labor adjustments, and social costs like safety net provisions for affected workers. In the earlier MACC analysis, an assumed annual investment cost of USD 30 billion was based on these considerations. In the updated MACC analysis focusing on long-term investments, the estimated annual total investment cost for this scenario was adjusted to approximately USD 25.7 billion over a sixteen-year period (Table 6). This adjustment accounts for inflation and incorporates the cost of capital.

Trade - African Continental Free Trade Area (AfCFTA) agreement

The World Bank (2020b) study estimates that by 2035, the AfCFTA will remove about 30 million people out of poverty.[32] Using linear interpolation from the 2035 figures, the earlier MACC analysis projected that about 22.5 million people will be lifted out of poverty by 2030. Thus, converting the 2030 poverty reduction figures using the poverty-hunger correlation coefficient of 0.68 (FAO et al. 2019), it was found that 15.3 million people could be lifted out

[31] The investment in infrastructure required to achieve 10 percent reduction in post-harvest loss by 2030 has additional larger benefits in other sectors of the economy more broadly beyond the agriculture sector. Hence, 25 percent investment cost allocation is assumed for post-harvest loss reduction annually following Rosegrant et al. (2015).

[32] The World Bank (2020b) study quantified the long term economic and distributional impacts of AfCFTA using a dynamic CGE and microsimulation model. Using the GTAP database, and complemented by other data on trade restrictions, the World Bank assessed the gendered implications on economic growth, international trade, poverty reduction, and employment and estimated that the AfCFTA could see an increase in average real incomes by 7 percent. Accounting for country heterogeneity, structural transformation, shifts in demand as income circumstances change, and changes in dynamic comparative advantage, the lowest impacts on real incomes were 2 percent, and the largest up to 14 percent. Notably, a recent study by Simola et al (2022) estimated that only 1 million people will be lifted out of hunger by 2030 as a result of the AfCFTA, which is negligible compared to that of the World Bank estimates. However, the study did not estimate the costs of implementation or the income gains, making it challenging to assess their figures accurately.

of hunger. The World Bank (2020b) report also indicated that the total income gains of implementing the AfCFTA would reach about USD 450 billion by 2035. As discussed above, Anderson (2018) assumes that about 5 percent of such gains would be lost to adjustment costs as trade reforms entail certain costs both for the implementation of the reform and the private cost of adjustments for firms and workers. Thus, having adjusted for the 5 percent cost and spreading the cost over the 10-year period, the earlier MACC obtained an annual implementation cost of USD 2.25 billion. In the updated MACC analysis focusing on long-term investments, the estimated annual total investment cost for this scenario was adjusted to approximately USD 1.6 billion over a sixteen-year period, considering adjustment for inflation and cost of capital (Table 6).

Investment in social protection programmes

Several studies from different regions have evaluated the cost-effectiveness and impact of social protection programmes on food security outcomes. A meta-analysis by Hidrobo et al. (2018) examined 58 studies spanning 22 years and 25 countries, showing that social protection programmes increase caloric availability or acquisition by an average of 8 percent. As regards the cost-effectiveness of social protection programmes, a systematic review of journal articles, programme and policy documents was conducted to identify social protection programmes, objectives, number of beneficiaries, amount of transfer, their types, and programme costs. The review was broadly divided into conditional cash and in-kind transfers. Considering geographical representativeness, internal and external validity, and transferability in addressing issues surrounding the transfer, cost and impact on food security outcomes, studies from broader continental groupings was considered. Table C2 summarizes the studies considered.

Considering that most of the studies and programmes reviewed were targeted to reduce poverty and food security among other outcome variables, it is important to obtain a picture of the proportion of poor – and by extension the proportion of undernourished – individuals that they could address. Using data from the World Bank's World Development Indicators on poverty rates and household sizes (World Bank, 2020a), the earlier MACC analysis adjusted and harmonized the studies' beneficiary data to individual level transfers and costs. Eventually the proportion of the poor covered by the study was also calculated by taking the ratio of beneficiaries to the total number of the poor. **Fehler! Verweisquelle konnte nicht gefunden werden.** below summarizes these results.

Table C2: List of papers considered in estimating the cost of social protection

Authors	Year	Country	Method	Cost	Transfer	Beneficiaries
Mesquita et al.	2016	Brazil	Review	0.4% of GDP	USD 35	24,000 households
Miller et. al.	2011	Malawi	RCT	USD 1.3 million	USD 14 per household per month.	83,000 households
Barber et al.	2008	Mexico	Review		USD 15 per household per month	
Sumberg et al.	2011	Nigeria	Review		USD 45 per child per year.	
Ahmed et al.	2005	Bangladesh	PSM		8.19/month	
de Lima et al.	2020	Brazil	Ethnographic		USD 21.5	12 million
Booth et al.	2019	Indonesia	Review	1.6% of GDP (USD 1.112 trillion)	USD 119 per person	6.2 million
Raghunathan et al.	2017	India	Regression	USD 30.77 million	USD 75	3.89 million
Piperata et al.	2016	Brazil	Ethnographic	0.5% of GDP	USD 21.5	
Cabral et al.	2014	Brazil	A cohort study	0.5% of GDP	USD 21.5	10,000
Caldés & Maluccio	2005	Nicaragua				
Gaentzsch	2019	Peru	MDID	1% of GDP (USD 1.897 billion)	USD 152 (PPP)	750,000
Doocy & Tappis	2017	DRC	CTR		USD 54	32,010
Caldés et al.	2006	Latin America		USD 155.52 million	USD 13 per month	2.6 million rural households
Hidrobo et al.	2014	Ecuador	RCT		USD 40	3642

Source: Authors' own elaboration.

To calculate the number of the undernourished potentially addressed by social protection programmes, the earlier MACC analysis took the mode of the transfer and multiply it by the number of undernourished (NoU). Based on the systematic review, the assumption is that on average about 30 percent of the undernourished can be addressed by conditional cash transfers. The cost is also multiplied by the proportion of the poor potentially reached by the programme. Considering that certain developing and emerging countries already have well-established social protection programmes and that efforts to scale up existing programmes would come at a low cost compared with countries which would need to establish new programmes at a higher cost, social protection was categorized into two interventions to differentiate these costs. For the new social protection programmes that would be established, the total cash transfer cost was assumed to be USD 88.9 per person per year based on the most expensive per dollar cash transfer cost of USD 1.74 identified from DRC, while for scaling existing social protection programmes, the total cash transfer cost was assumed to be USD 35.7 per person per year based on the lowest per dollar cash transfer cost of USD 0.1 identified from Mexico (Table C3).[33]

Table C3: Per capita cost of social protection programmes per month based on studies reviewed

Country	Transfer (USD) per month (1)	Cost Transfer Ratio (USD) (2)	Programme cost (USD) (3)	Household size (count) (4)	Transfer (USD) per capita per month (5)	Cost per transfer per capita per month (USD) (6)	Proportion of the poor addressed (7)
Brazil	28.25	0.41	11.63	3	9.42	3.88	0.24
Malawi	14	0.6	8.4	5	2.8	1.68	0.35
Ethiopia	9.8	0.6	5.9	5	2	1.18	0.01
India	6.25	0.25	1.6	5	1.3	0.3	0.25
Indonesia	6	0.25	1.5	4	1.5	0.38	0.18
Nicaragua	18	0.63	11.3	4	4.5	2.83	
Peru	12.67	0.5	6.3	4	3.2	1.58	0.22
DRC	4.5	1.74	7.8	5	0.9	1.57	
Nigeria	3.75	0.6	2.3	5	0.75	0.45	
Bangladesh	1.36	0.25	0.3	4	0.34	0.09	0.22
Mexico	13	0.1	1.3	4	3.25	0.33	0.46
Iraq	22	0.25	5.5	5	4.4	1.10	
Honduras	3.58	0.50	1.8	4	0.9	0.45	
Ecuador	40	0.61	8.19	4	10	2.05	0.17

Source: Authors' own elaboration based on the reviewed papers (see Table C2) and WDI (World Bank, 2020a).

Table C4 summarizes the results of the reduction in the number of individuals affected by hunger and their associated incremental costs as estimated by the earlier MACC analysis. Generally, conditional cash transfers could lift 206.1 million people from hunger – costing about USD 3.7 and USD 9.2 billion annually over a five-year period.

Table C4: NoU addressed by conditional cash transfers and associated costs

Classification	Population at risk of hunger (million)	Investment incremental costs per population rescued from risk of hunger (Million USD)	Investment incremental costs per person rescued from hunger (global average)
Social Protection - Scaling up existing programmes	103.1	3677	35.7
Social Protection - Establishing new programmes	103.1	9158	88.9

Sources: Authors' own elaboration based on reviewed papers (see **Fehler! Verweisquelle konnte nicht gefunden werden.**).

In the updated MACC analysis focusing on long-term investments, the estimated annual total investment cost for these scenario was adjusted to approximately USD4.9 & USD 12.2 billion

[33] To calculate the average annual cash transfer cost per capita, we took the average of column 5 in Table C2 which was equal to USD 2.7 per month. And we took either the maximum or the minimum per dollar cash transfer cost in column 2 and multiplied it by the aforementioned average per capita cash transfer amount to get the USD 4.7 and USD 0.27 costs, respectively. We then added the costs to the average per capita cash transfer amount to get the monthly total transfers per capita USD 7.41 and USD 2.97 values, respectively and annualize the costs by multiplying the values by 12 months.

over a five-year period (Table 6). This adjustment accounts for inflation and incorporates the cost of capital.

Investment in nutrition-specific interventions

Recently, Scott et al. (2020) estimated the effect of scaling up of four stunting interventions to 95 percent coverage for 129 countries over 11 years between 2019 and 2030. The study used the Optima Nutrition model across 129 countries to assess the impact of four stunting interventions over the 11-year period. The study compared two scenarios, one maintaining current intervention coverage and another where each of the stunting interventions were scaled up to 95 percent coverage over a 5-year period (2019-2024) and maintained until 2030. The stunting interventions considered in this study include, intermittent preventative treatment of malaria during pregnancy (IPTp), infant and young child feeding education, vitamin A supplementation and lipid-based nutrition supplements for children. The average cost-effectiveness of these stunting interventions were estimated as they were integrated into an expanding package of interventions. The total financing needed to scale up the four interventions targeting stunting and achieve a reduction of approximately 38.8 million stunted children was estimated to be around USD 19.8 billion over an eleven-year period. In the updated MACC analysis focusing on long-term investments, the estimated stunting reduction was converted to hunger reduction using an estimated correlation coefficient between stunting and prevalence of undernourishment of 0.997, which amounted to 38.6 million people lifted out of hunger. The estimated annual total investment cost for these scenario was adjusted to approximately USD 1.6 billion over a sixteen-year period. This adjustment accounts for inflation and incorporates the cost of capital (Table C5).

Table C5: Cost of nutrition-specific interventions over 10 years and potential stunting reduction

	Indicator	Value
A	Reduced child malnutrition due to nutrition-specific interventions (million)	38.8
A*	Reduced child malnutrition due to nutrition-specific interventions (million)	38.6
B	Child malnutrition prevention costs (USD billion, total for the period 2019-2030)	19.8
C	Annualized cost (billion USD) (N = B / 11)	2
D	Annualized cost (billion USD, inflation adjusted)	2.5
E	Annualized cost (billion USD, inflation and cost of capital adjusted)	2.5
F	Annualized cost (billion USD, inflation and cost of capital adjusted) (2025-2040)	1.6
G	Annualized cost per capita (USD) (F = F/ A*)	41.1

Source: Authors' own elaboration based on Scott et al. (2020).

Investment in female literacy

To estimate the potential stunting reduction due to investments in women's education, the earlier MACC analysis followed Shekar et al. (2017) and based the estimates on WDI data on female secondary school enrolment for the 37 countries that account for 90 percent of stunting in the world. For each of the 37 countries, a trend was first calculated for female secondary enrolment on the basis of the changes over the period of five years between 2011 and 2015 (B), which is assumed to continue over the 10-year period between 2020 and 2030 (C) (Table C6). Then using the regression coefficient estimated by Smith and Haddad (2015) (E), reductions in stunting between 2020 and 2030 were calculated to be about 2.63 million (F), with the expectation that the five-year trend continues. This estimate was then converted into hunger reduction using an estimated correlation coefficient between stunting and prevalence of undernourishment of 0.997 (Q), which is equivalent to 2.61 million people lifted out of hunger by 2030 (R). [34] To estimate the annual incremental investment required for female literacy between 2020 to 2030, the earlier MACC analysis used the UNESCO (2015) estimates of the per capita annual expenditure required for lower secondary school in low and lower middle-income countries per student. UNESCO (2015) estimated that in 2012 lower secondary enrolment in low income countries was 29 million (J) which costed USD 130 per student (O). Thus, the cost was in total USD 3.7 billion in 2012. Given the five-year trend estimated, there would be about 6.66 million additional females' secondary enrolment (N), which in the earlier MACC analysis came at a cost of USD 87 million annually (P).

In the updated MACC analysis focusing on long-term investments, the estimated annual total investment cost for this scenario was adjusted to approximately USD 73 million (R). This adjustment accounts for inflation using the annual average global producer price index (PPI) inflation rate from 2020 to 2022 (4.33 percent) and incorporates the cost of capital (Table C6).

Table C6: Cost of female literacy improvement over 10 years and potential stunting reduction

	Indicator	Value	Unit	Source
A	Baseline Female secondary school enrolment rate (FSSE) (2019)	83.02	%	WDI 2019 (World bank, 2020a)
B	Growth rate of FSSE rate (2011-2015)	0.013	%	$\Delta \ln FSSE$
C	Growth in 10 years (2020 – 2030)	0.13	%	$B \times 10$
D	Actual growth in FSSE rate (2020-2030)	10.98	%	$A \times C$
E	Stunting elasticity to female secondary school enrolment	-0.166		Smith & Haddad (2015)
F	Stunting prevalence reduced from 2030	1.82	%	$D \times E$
G	Stunting in the base year (2019)	144	Million	WFP
H	No. stunting reduced from the base year (2019)	2.62	Million	$G \times \frac{F}{100}$
I	Female secondary school enrolment rate in 2012	39.68	%	WDI 2019 (World bank, 2020a)
J	No. of female students enrolled in secondary school (2012)	29	Million	UNESCO (2015)
L	Percentage change in female students' enrolment	1.09	%	$\frac{(A-I)}{I}$
M	No. female students enrolled in secondary school by 2030	60.67	Million	$J + J \times L$
N	No. additional female students enrolled in secondary school by 2030	6.66	Million	$\frac{M+D}{100} * L - L$
O	Per capita secondary school expenditure per year (low income countries)	130	USD	UNESCO (2015)
P	Annual total incremental cost of the additional female students enrolled in secondary school	86.62	USD in million	$N \times \frac{O}{10}$

[34] This estimate is however an underestimation of the impact of investments in women's education as it only considers the impact on child stunting and does not consider the additional benefits such as increased productivity and higher income which can further contribute to hunger reduction.

Q	Annual total incremental cost of the additional female students enrolled in secondary school (Inflation adjusted (2015-2022))	114	USD in million	Q = P*(1+(4.33/100)$^{(1,8)}$
R	Annual total incremental cost of the additional female students enrolled in secondary school (Inflation and cost of capital adjusted))	116	USD in million	R = ((Q*(0.40)) + ((Q*0.60)*(1+0.0317)) (Assumed 60% national investment cost based on Laborde, Parent, and Smaller (2020)).
S	Annual total incremental cost of the additional female students enrolled in secondary school (Inflation and cost of capital adjusted)) (2025-2040)	73		S=R*10/16
T	Correlation coefficient between NoU and no. of stunted children	0.997		Own estimates
U	Reduction in the no. of people under risk of undernourishment (2030)	2.61	Million	H ×T
V	Annual per capita cost of female literacy improvement per person lifted out of hunger	28	USD	S/U

Source: Authors' own elaboration based on World Bank (2020a); Smith and Haddad (2015); UNESCO (2015).

Investment in school feeding programmes

School feeding programmes serve as vital investments aimed at addressing stunting and promoting child development through a nexus of nutrition and education. Well-designed and equitable school feeding initiatives have been shown to contribute significantly to child development by extending years of schooling, enhancing learning outcomes, and improving overall nutrition. These programmes consistently enhance energy intake, micronutrient status, and school attendance, with particularly notable impacts for girls. Additionally, school feeding has demonstrated effectiveness in reducing anemia among primary school-aged children and adolescent girls. Integrated into national social protection systems, school feeding becomes a critical safety net, shielding vulnerable families and children from poverty and social exclusion while fortifying local economies through support for smallholder farmers and sustainable food markets (Alderman et al., 2024; WFP, 2022).

The UN Food Systems Summit in 2021 sparked transformative efforts, exemplified by initiatives like the School Meals Coalition, striving to ensure every child receives a daily healthy meal by 2030, highlighting the role of school meal programmes in addressing food insecurity and supporting education and health systems. The MACC analysis, aligning with these evolving policy priorities, integrates the hunger reduction potential of school feeding programmes, drawing on cost estimates from the State of School Feeding Worldwide 2022 report (WFP, 2022). According to the report, approximately 724 million children are enrolled in primary schools worldwide. Among them, 115 million attend schools in low-income countries, 320 million in lower middle-income countries (including BRICS nations), 211 million in upper middle-income countries (also including BRICS), and 78 million in high-income countries. For school feeding programme coverage, the report reveals significant disparities based on income levels. In low-income countries, an average of 18 percent of schoolchildren benefit from school meals, while in lower middle-income countries, the coverage increases to 39 percent. Further, in upper middle-income countries, 48 percent of enrolled children receive school meals, and in high-income countries, the coverage extends to 61 percent. Overall, approximately 41 percent of primary school children globally benefit from school meal programmes, with coverage increasing with income levels (WFP, 2022).

In the updated MACC analysis focusing on long-term investments, the reduction in the number of stunted children through investments in school feeding programmes is estimated by adjusting the number of children enrolled in primary schools in Low-income countries (LIC), Lower-middle income countries (LMIC) and Upper-middle-income countries (UMIC) by the prevalence of stunting in the regions, i.e. 33.5 percent, 28.1 percent, and 8.3 percent, respectively (FAO et Al., 2023). The estimated stunting reduction is then converted to hunger reduction using an estimated correlation coefficient between stunting and prevalence of undernourishment of 0.997, which amounted to 145.5 million people lifted out of hunger. To estimate the annual incremental investment required for school feeding programmes, the updated MACC analysis focusing on the long-term investments used the estimates by WFP (2022) of the annual average per child of school meal expenditure required for a child in primary school in low, lower- and upper-middle-income countries. WFP (2022) estimated that in 2022 a school meal per child costed annually USD 41.8, USD 42.6, and USD 112.04 per child. Thus, the cost is estimated to be in total USD 7.5 billion annually on average. This would mean that, a 145.5 million reduction in hunger would come at an incremental annual cost of only about USD 51.3 per person lifted out of hunger.

Investment in humanitarian assistance

Humanitarian assistance emerges as a crucial measure in combating hunger, especially amid conflict-driven acute food insecurity observed in global hunger hotspots. The war in Ukraine has significantly escalated global hunger and food insecurity due to disruptions in food, fertilizer, and energy supply chains, resulting in a projected increase of 23 million undernourished individuals by 2030 (FAO et al., 2023). This conflict, along with ongoing armed conflicts in various regions, has posed serious setbacks to achieving Sustainable Development Goal 2 (SDG 2), exacerbating food and nutrition crises impacting millions of vulnerable populations (WFP & FAO, 2023).

The WFP and FAO (2023) have issued alarming warnings about acute food insecurity affecting approximately 158.4 million people across 18 hunger hotspots spanning 22 countries and territories, including two regional clusters, from November 2023 to April 2024. Burkina Faso, Mali, South Sudan, and Sudan are among the highest concern areas, with Palestine newly added due to escalating conflict in October 2023. These hotspots face or are projected to face starvation or catastrophic conditions, necessitating urgent attention. Additionally, Afghanistan, the Democratic Republic of the Congo, Ethiopia, Haiti, Pakistan, Somalia, the Syrian Arab Republic, and Yemen are designated as hotspots of very high concern, with a high number of people facing critical levels of acute food insecurity. The report highlights increased armed violence, ongoing conflicts, and geopolitical tensions exacerbating global displacement, particularly in regions like the Sahel and the Gaza Strip. Furthermore, sluggish global economic growth, high international food prices, and adverse weather conditions, such as El Niño, are compounding food insecurity challenges. Urgent and scaled-up humanitarian assistance is needed across all hotspots to prevent further deterioration of acute food insecurity and malnutrition, despite challenges posed by limited humanitarian access due to various factors, including conflict and administrative barriers.

In the updated MACC analysis, the annual average cost of providing humanitarian assistance to 158.4 million people in the hunger hotspots annually was estimated based on the WFP's annual expenditures per beneficiary of USD 55 in 2022 for transfers[35] (food assistance, cash transfers, and vouchers) (WFP, 2023a). After adjusting for the cost of capital, the total annual investment required for humanitarian assistance is estimated to be USD 8.9 billion on average (Table 6). This would mean that, a 158.4 million reduction in hunger would come at an incremental annual cost of only about USD 56 per person lifted out of hunger.

[35] This annual average per capita cost estimate aligns closely with the annual per capita costs of food and cash transfer programmes implemented by the NGO Welthungerhilfe in conflict-affected countries such as Sudan, Syria, Afghanistan, and the Sahel.

Annex D – Section 5

Table D1: Description of the policy instruments included in MIRAGRODEP

Policy Instruments	TARGETING / COVERAGE	STRUCTURAL EFFECTS	NATURE OF EXPENDITURE	DURATION OF BENEFITS
EMPOWER THE EXCLUDED				
Food subsidy	Food items for households with income below the poverty line (USD 1.95 purchasing power parity [PPP])	Food cost reduction per capita through an endogenous, homogenous subsidy rate at the household level	Cost of the public subsidies	1 year
Vocational training		Allows people to move between rural and urban employment more easily	Cost of the public subsidies	20 years
ON THE FARM				
Investment subsdidy	All agricultural sectors, all producers	*Ad volumen* subsidy to *domestic investments*	Cost of the public subsides	20 years
Fertilizer subsidy	Crop sectors, all producers	*Ad valorem* subsidy on chemical inputs used by agricultural sectors and yield effects capturing changes in the production function	Cost of the public subsidies	1 year
Capital endowment	All agricultural sectors, only small-scale producers	Allocation of physical capital (e.g. machinery, livestock) given to targeted households	Investment goods bought by public expenditures	20 years
Production subsidy	All staple crop sectors, all producers	*Ad valorem* production subsidy applied to the farm gate price	Cost of the public subsidies	1 year
R&D National Agricultural Systems (NARS)	All agricultural sectors, all producers	Agricultural total factor productivity (TFP) is increased based on the stock evolution of NARS R&D	Additional NARS expenditures spent on public services	30 years
R&D CGIAR	All agricultural sectors, all producers	Agricultural TFP is increased based on the stock evolution of CGIAR R&D	Additional CGIAR expenditures spent on public services	30 years

Extension services	All agricultural sectors, small-scale producers	Efficiency of production factors, i.e. difference between physical and efficient units, for small-scale producers	Public services expenditures	15-20 years
Rural infrastructure (irrigation, mainly small scale)	Crop sectors, all producers	Agricultural TFP is increased based on the growth of irrigated area	Aggregated capital goods for expenditures based on unit costs by type of investments	15 years
Livestock subsidy for sylvo-pastoralism	Dairy sector, small-scale	*Ad volumen* subsidy. Ad volumen reduction in GHG emissions.	Cost of the public subsidies	1 year (+ 5 years for fixed cost compoment)
Livestock subsidy (improved forage)	Ruminant sector, small-scale producers	*Ad volumen* subsidy to year 1 fixed costs (extension, seed, and inputs)	Cost of the public subsidies	5 years
FOOD ON THE MOVE				
Post-harvest losses (storage)	Crop sectors, small-scale producers	Efficiency of production factors for small-scale producers and reduction of an initial shadow tax on factors of production (price effects over the year).	Aggregated capital goods for expenditures based on unit costs by type of investment	20 years (but with fast delivery)
Rural Infrastructure (roads)	All agricultural sectors, all producers	Agricultural TFP is increased based on the growth of road infrastructure	Aggregated capital goods for expenditures based on unit costs by type of investment	20 years

Social Accounting Matrix (SAM) and trade data in MIRAGRODEP are based on GTAP11, a publicly available global database containing bilateral trade information, transport, and protection linkages among 141 countries or regions for all 65 GTAP commodities or services for four reference years (Laborde et al., 2022). Household data comprises consumption and production data primarily from the World Bank's Living Standards Measurement Study (LSMS). Lastly, the parameters used for modelling interventions are based on Laborde, Parent, and Smaller (2020). Importantly, the same base year data (macroeconomic and household surveys) is used for all the simulation conducted in this report.

The use of an updated 2017 base year dataset is a first difference with the Ceres2030 estimates and approach but will ensure comparability between the different computations presented in the next section. This change is relatively minor but important to underline to explain while specific numbers could differ from Laborde, Parent, and Smaller (2020). The other, and most important difference is the number of target considered. In this current exercise, only the elimination of hunger (3 percent of less for the PoU) is considered, while Ceres2030 was considering the end of hunger (SDG2.1), the doubling of economic productivity for small scale food producers (SDG2.3) under a constant GHG budget for agriculture (SDG 2.2). The two additional targets were released to be more consistent with the MACC approach, but also because the reduced time frame, 6 years, had very drastic implications about the pathway for productivity increases (choice of interventions), and the magnitude of the productivity increase. Indeed, in a number of countries, the doubling of small-scale producers economic productivity is a very challenging target due to slow progresses, or even actual declines (e.g. Malawi, see FAO et al., 2023) in the last 6 years. The key differences in terms of data, or assumptions for the period 2018-2030, used in our two approaches are presented in **Fehler! Ungültiger Eigenverweis auf Textmarke.**.

Table D2: Key assumptions for the dynamic projections

Assessment	Population projects	Macroeconomic projections	Agricultural productivity	Adjustment of unevenness of food distribution	Major events included in the baseline assumptions
The 2018 world	UNDESA – 2019 version	Based on World Economic Outlook (IMF) October 2019. Modified to include the COVID-2019 impacts as described in Laborde, Martin and Vos (2021)	Consistent with the Future of Food and Agriculture report (FAO, 2018)	none	COVID-19 (based on estimates)
The 2023 world	UNDESA – 2022 version	Based on World Economic Outlook (IMF) April 2023.	Consistent with the yield trajectory provided in the OECD-FAO outlook 2022-2031	Household surveys adjusted in the 2018-2022 period through cross entropy to mimick the evolution of the coefficient f	COVID-19 (actual) Economic slowdown post COVID-19, including for China Reduced production from Ukraine Energy price shocks 3 years of La Nina